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TE-RE-RD 2015

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4-6 Iunie 2015

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CONFERENCE PROFRAMME

Thursday, June 04	Friday, June 05	Saturday, June 06
	Breakfast	Breakfast
14.00-15.00 Registration of participants	08.30-09.30 Registration of participants	09.00-13.00 Possible trip
15.00-15.30 Opening ceremony	09.30-11.00 Oral presentations "Sections 1 and 2"	13.00 – 14.00 Brokerage Section ”Green Partners”
15.30-18.00 Plenary session	11.00-11.30 Coffee break	14.00- Participants departure
18.00-20.00 Welcome cocktail	11.30-13.00 Oral presentations Section 1 and 2"	
	13.00-14.30 Lunch	
	14.30-16.00 Oral presentations "Sections 1 and 2	
	16.00-16.30 Coffee break	
	16.30-17.30 Workshop1:”Conceptual models of energy recovery from waste leather industry” Workshop 2: ”Education and training in Hydrogen based economy”	
	19.30-22.00 Conference dinner	

INVESTIGATION OF THE EFFICIENCY OF AIR SOLAR COLLECTOR

Dimitar Atanasov[1], Mincho Minchev, Atanas Tashev

University of Food Technologies - Plovdiv, Bulgaria

ABSTRACT

The air solar collectors transform renewable solar energy into heat, which can be used for passive heating of residential and administrative buildings, and to reduce energy consumption when drying various materials.

The information for characteristics of the air solar collectors must be presented in an accessible and comprehensible way to the end consumer. The efficiency of the collector is plotted as a function of the operating conditions - $\eta = f\ (\Delta T/G)$.

These values are determined experimentally as the test results are presented in graphical form.

1. INTRODUCTION

When electromagnetic radiation impinges on a material one fraction can be transmitted, a second fraction is reflected, and a third fraction is absorbed [2]. They are the important characteristics from the standpoint of the utilization of solar energy [3]. Energy conservation yields, at each wavelength, that

$$T(\lambda) + R(\lambda) + A(\lambda) = 1, \quad (1)$$

where T, R, and A denote transmittance, reflectance, and absorptance, respectively. Another fundamental relationship, also ensuing from energy conservation and referred to as Kirchhoff ’ s Law, is

$$A(\lambda) = E(\lambda), \quad (2)$$

with E being emittance, i.e., the fraction of the blackbody radiation that is given off at a particular wavelength. Eq. (2) is of practical relevance mainly for $\lambda > 3$ µm [2].

Among solar heating systems the solar air heater occupies an important place because of minimal use of materials [5,6]. According to [5] the convenient representation of efficiency for sheet and tube solar energy collectors is

$$\eta = Q_u/A_c.G, \quad (3)$$

where A_c surface area of the collector, LB (m^2), Q_u useful gain of energy carried away by fluid per unit time ($kJ\text{-}h^{-1}$),G incident solar radiation ($kJ\text{-}m^{-2}\text{-}h^{-1}$) [5].

Solar collectors are the key component of active solar-heating systems. They gather the sun energy, transform its radiation into heat, and then transfer that heat to a fluid (usually water or air). The solar thermal energy can be used in solar space-heating systems. In general, solar air heaters are flat-plate collectors (FPCs) [1,3], consisting of an absorber, a transparent cover, and backward insulation. Despite the similarity in designs, the different modes of operations and different properties of the heat transfer medium greatly affect the thermal performance and electric energy consumption for forcing the heat transfer medium through the collector. In most cases, solar air heaters are operated in the open-loop mode [1].

Flat-plate solar collectors are designed for applications requiring energy delivery at moderate temperatures. They utilize both beam and diffuse solar radiation, and do not require sun tracking [6].

One of the simplest practical applications of the sun is the air-heating collector which is simple to make, cheap to exploit, ecologically friendly and widely used, particularly in agricultural production drying [3].

Solar air heaters are inherently low in thermal efficiency due to low heat capacity and low thermal conductivity of the air in comparison to the liquid-type solar collectors. The performance of solar air heaters is mainly influenced by meteorological parameters (direct and diffuse radiation, ambient temperature, and wind speed), design parameters (type, materials, insulation) and flow parameters (air flow rate, mode of flow). The principal requirement for these designs is a large contact area between the absorbing surface and air [1].

The main problem is the low heat transfer coefficient between the absorber and air which reduces the thermal efficiency. Various absorber plates and glazing systems have been used in solar collectors. It is offered in a variety of design solutions, a variety of absorbent material solutions [1] etc.

It should be noted that the solar radiation received by the collector, throught the day, is not constant [1].

The efficiency of the solar collector depends on the collector covered material; absorber and it's place in the collector and air velocity in the collector. The main efficiency parameter of a solar collector is the air heating degree chosen as the criterion of efficiency [3].

When carrying out the practical studies for various structures and operating conditions are obtain data on efficiency in the range from 0,58% to 0,62% [1,4].

The best design practices and sensitivity to material properties for solar air heaters are investigated, and absorber solar absorptivity and glazing transmissivity are found to have the strongest effect on performance. Wind speed and maintaining a constant air outlet temperature is also found to have a significant impact on performance [4].

Purpose of the work

The purpose of this study was to determine and present the efficiency of an air solar collector with aluminum absorber and straight ribs.

2. METHODOLOGY

The investigated solar air collector is made of absorber with straight ribs. The distance between the ribs is 30 mm. The absorber is covered with a non-selective black lacquer, because of the fact that the collector is to be used mainly during the plenty of sunlight (summer and part of the spring and autumn). Extruded expanded polystyrene (Fibran XPS) is it used for thermal insulation of the body. In carrying out the experiments were used 4 types transparent covers - common white glass, polycarbonate plate, low emission (K) glass with hard coating and borosilicate glass. The efficiency is determined and by several values of the air velocity in the range 1,9 – 3,8 m/s.

A principle scheme of the solar air collector used for the research is presented on fig. 1.

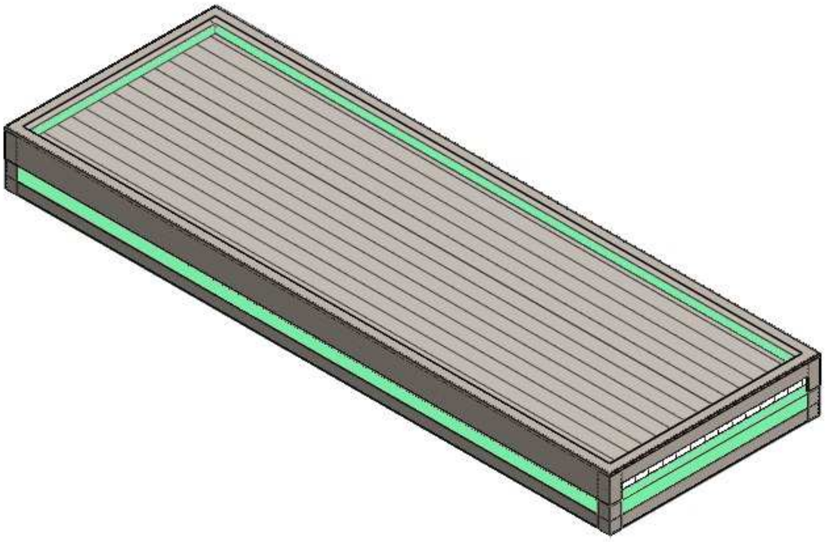

Fig. 1. Scheme of a solar air collector.

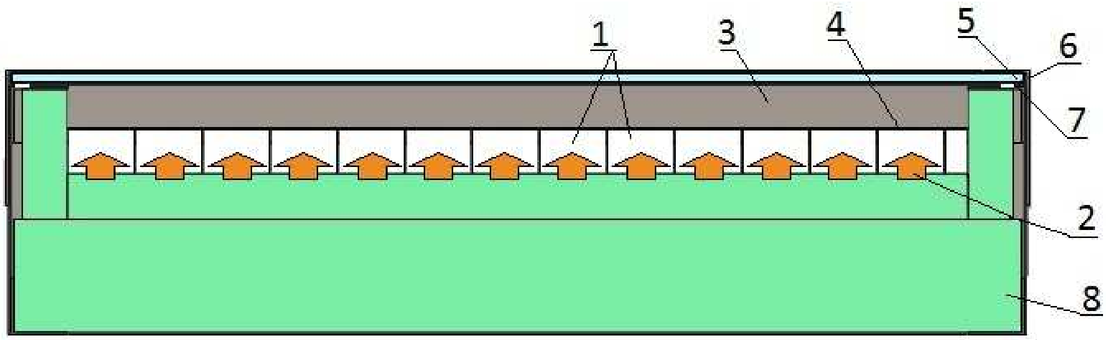

Fig. 2. Cross-section view of the solar air collector.
1 – air flow channels, 2 – direction of the air flow, 3 – air filled space between the absorber and the transparent cover, 4 – absorber with a black painted mat coating, 5 – transparent cover, 6 - gasket, 7 – aluminum case, 8 – insulation

The research is conducted in the period 12-18.08.2014 at a natural source of energy – solar irradiation. The experimental design is located on a south facade of a building. The air solar collector is at 30^{o} angle with respect to the horizon.

During the experiment for the determination of the collector's characteristics the following parameters are measured: temperature at the collector's inlet and outlet and the environment, solar radiation, airflow velocity at the outlet of the collector.

The temperature measurements are done every minute using a controller type TC800 and thermo resistant sensor.

The intensity of the solar radiation is measured continuously every minute during the entire research using a solar radiation sensor model PYR, Decagon Devices, USA.

The airflow velocity is measured in a straight cylindrical channel with length L >5 d using a turbine anemometer type Almemo 2290-2/3, Ahlborn.

Using the saved parameters the collector efficiency is calculated with equation 3 and its' characteristics are presented by the dimensionless parameter $\Delta T/G$ or

$$\Delta T = T_{avg} - T_0, \qquad (4)$$

and

$$T_{avg} = \frac{T_{in} + T_{out}}{2}, \qquad (5)$$

Where ΔT is the temperature difference, K; T_{avg} – average collector temperature, °C; T_0, T_{in} and T_{out} are respectively the temperatures of the environment, collector's inlet and outlet, °C.

Results

Experiments are conducted to determine the efficiency of solar air collector depending on the operating conditions. The influence of the air flow rate and the type of the transparent cover are investigated. The obtained results are presented graphically in Fig 3. and Fig. 4.

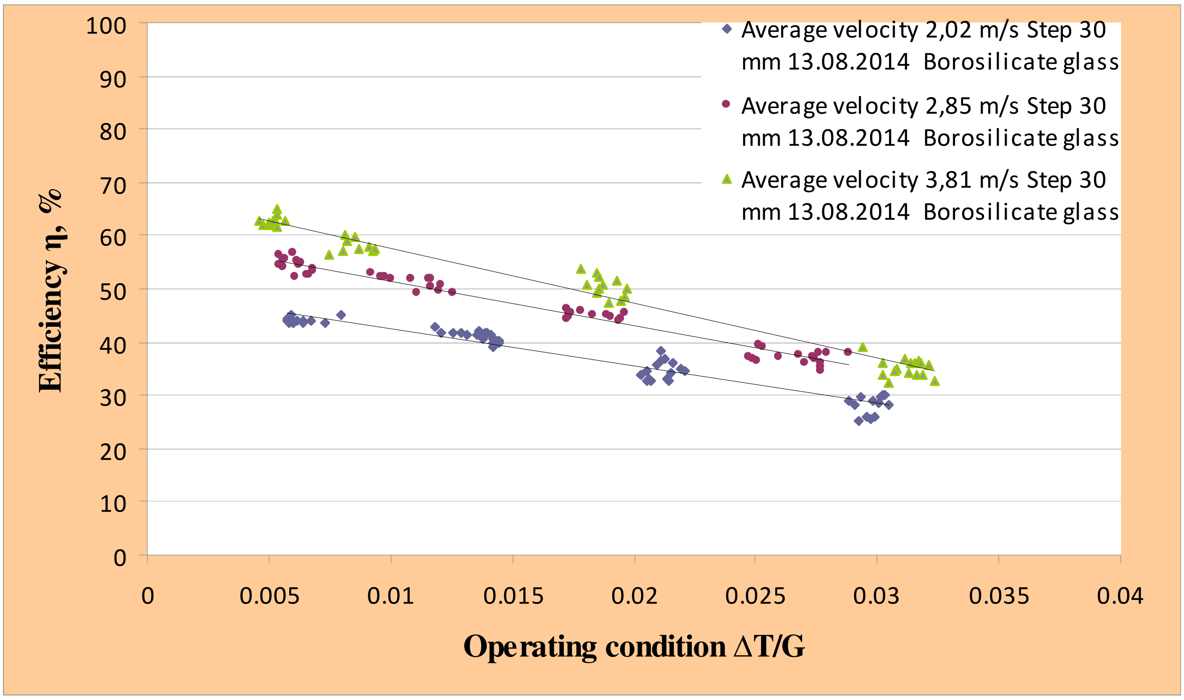

Fig. 3. Influence of the rate of air flow on the efficiency of the collector.

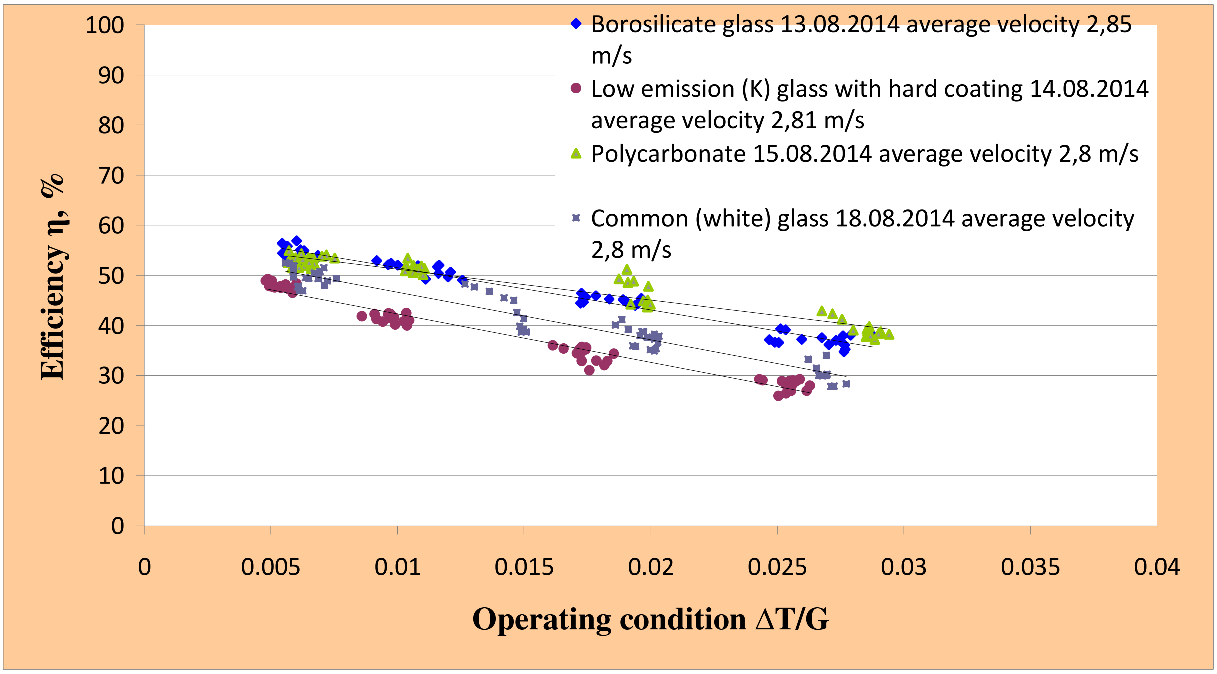

Fig. 4. Influence of the transparent cover on the efficiency of the solar collector.

3. CONCLUSION

The typical solar collector dependence of the efficiency of operating conditions is obtained according to $\eta = f\ (\Delta T/G)$. The type of transparent cover and the air flow velocity have a significant influence on the efficiency of the tested air collector.

From the experimental results it is seen that the highest efficiency is obtained by polycarbonate transparent cover. Lower values are obtained with the borosilicate and common (white) glass. The lowest efficiency is obtained for low emission K glass with hard coating.

The velocity influence has an expected trend. Increasing the velocity leads to an increase in the collector's efficiency at the respective operating conditions.

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ECONOMIC AND THERMAL ANALYSIS OF STEAM TURBINES FOR BIOMASS CHP PLANTS

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ABSTRACT

This paper analyzes the opportunity and the efficiency of the biomass power plant based on Rankine-Hirn thermodynamic cycle. The innovative aspect of this research is focused on the concept of integrated use of the biomass for energy purposes, from the crops formation and initiation up to the electricity and heat markets. The different constructive solutions analysis of the low power steam turbines permits estimation of technical performances and economic indicators, to obtain a successful project.

The main goals are a maximized internal efficiency of the turbine at lowest rated load and positive economic indicators (payback period, net present value, internal rate of return)

1. INTRODUCTION

In today's Romania, energy use of solid biomass is gaining speed, for all the main sources: wooden biomass, cereal straw briquettes energy willow and so on. For the blooming energy willow crops, the cultivated area is over 1000 ha. In 2013, Covasna County held its first energy harvesting willow, with a production of 50 t/ha at harvest moisture of 50%. The entrepreneurs are selling the chopped biomass with 50 €/t to the firms and individuals, mainly for heating purposes, to be burned in stoves and hot water boilers.

The local use in small heating installations is restricted by complicate transport and storage. The design of power plants with an output of 200-2000 kW, allows an efficient recovery, especially in locations near the crops. The high calorific energy willow chips (about 16,000 kJ/kg) will expect that power.

Only use of steam boilers with efficient and environmental friendly combustion coupled with turbines in current production is the main need for harnessing energy willow crops. The selected combustion technology (willow chips entrained by the primary air) imposes a tunnel-burner attached to the combustion chamber. Superheated steam conditions are required by the turbine input parameters, while the steam exhaust pressure is higher than usual.

2. TECHNICAL SOLUTIONS

Two constructive and functional schemes for steam power plants are compared in this study. The main goals of the research are to determine the technical feasibility, the maximized internal efficiency of the turbines in order to obtain positive economic indicators (payback period, net present value, internal rate of return), using the same source of live steam, that is a solid biomass burning boiler, using energy willow chops, briquetted cereal straw or wooden chops with similar fuel characteristics.

The first case to be analyzed that presented in figure 1, derived from the example from [2], and which was treated in extenso in [1].

The corresponding power plant is composed of:

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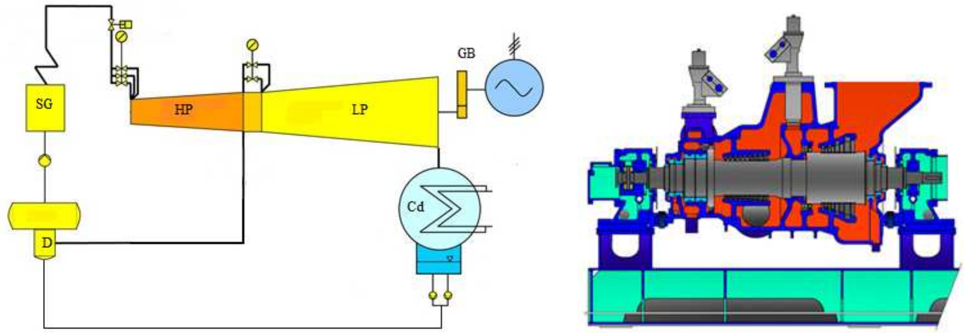

Figure 1. The 2000 kW_e power plant scheme and the condensation steam turbine

- A superheated steam boiler (p_0=35 bar, t_0= 350 °C, t_{al}=135 °C) fuelled by dry chopped energy willow B[kg/s]), generating 2,92 kg/s live steam;
- A steam turbine (P_e= 2000 kW_e, p_c=0.1 bar, n=10500 rpm) composed of two sections, each one with a Rateau control stage and several pressure compounded stages;
- An electric generator with 4 poles coupled to the turbine trough a gearbox;
- A deaerator;
- The condensate pumps and the feed-water pump.

The original steam turbine had a controlled extraction at 3 bar, but we assimilated it with two condensing turbines in cascade (high pressure –HP and low pressure –LP). The overall design performances of the plant are presented in Table 1

Table 1 Design and performance data of the 2000 kWe TPP

$P_{BG\ HP}$ [kW_e]	993	$\eta_{i\ HP}$	0.785
$P_{BG\ LP}$ [kW_e]	1007	$\eta_{i\ LP}$	0.793
$P_{TH\ SG}$ [kW_{th}]	8213	η_{SG}	0.90
B[kg/s]	0.5133	η_{EA}	0.2435

The second case steam turbine may be considered as deriving from the above scheme, from which only the HP part is kept as a back-pressure stand-alone turbine. The resulting schema is a more simplified, since it has no condenser and no cooling circuit. The steam delivered to the heat consumer is returned in form of condensate, which is in turn inserted in the circuit by a circulation pump, which is assumed to have the same contribution to the internal electrical services of the power plant as in the first case.

The back-pressure steam turbine has only 1 MWe and two constructive and functional solutions have been considered: one with disks and diaphragms of the impulse type, and the other, a reaction type turbine with drum type rotor. Each of the exemplified steam turbines have a Rateau type impulse control stage, but, due to very small volume flow rate, the impulse turbine has partial arc admission on the first pressure stages, that lead to increased loss of energy in the corresponding stages.

Table 2 Design and performance data of the 1000 kWe impulse turbine

$P_{BG\ HP}$ [kW_e]	1004	$\eta_{i\ HP}$	0.75
$P_{TH\ SG}$ [kW_{th}]	7252	η_{SG}	0.90
B[kg/s]	0,45	η_{EA}	0.173
Q_{TH}[kW_{th}]	5589	η_{TA}	0,89

Table 3 Design and performance data of the 1000 kWe reaction turbine

$P_{BG\ HP}$ [kW_e]	1025	$\eta_{i\ HP}$	0.755
$P_{TH\ SG}$ [kW_{th}]	7089	η_{SG}	0.90
B[kg/s]	0,445	η_{EA}	0.185
Q_{TH}[kW_{th}]	5476	η_{TA}	0,9

Tables 2 and 3 contain the main data from the thermal calculations of the two variants of backpressure steam turbines. The main values don't differ much in magnitude for the two variants, but a slight advantage of using the reaction type steam turbine is worth mentioning. In both cases, the rotational speed was 6000 rpm, so that a reducing gear is necessary, as in most of the commercially available steam turbines of the same power range.

An important observation should be made: the backpressure turbine operation is strictly tied with the heat demand from the consumer, so that whenever there is no demand for heat, the steam turbine is shutdown. That fact leads to the modification in the power plant schema, that is to have a leading high pressure steam turbine of a simple design, which delivers its steam to a low pressure condensing turbine, that is to be used when is no demand for heat. The constructive solution for each turbine can be chosen from the axial flow, radial flow or axial – radial flow, as shown below [11].

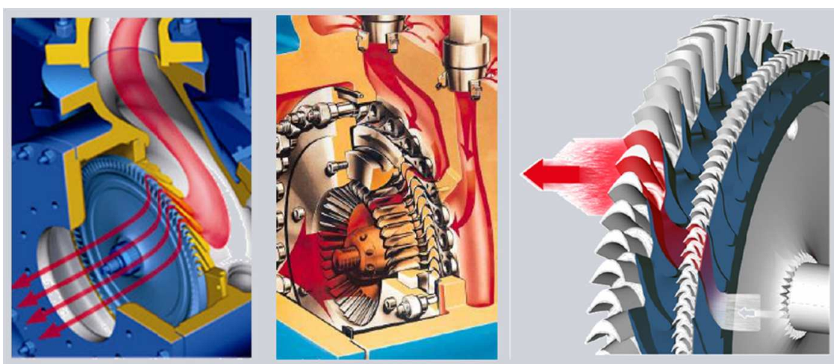

Figure 2. Different types of flow in a single stage steam turbine [11]

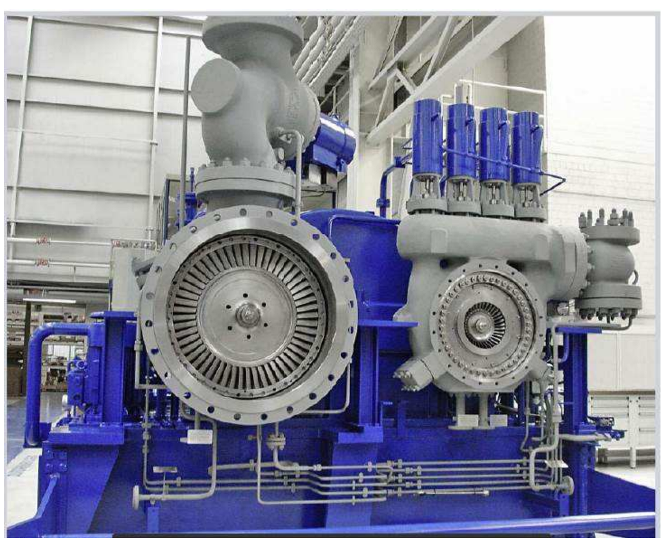

Figure 3. Tandem solution for biomass CHP plant steam turbine [11]

3. ECONOMIC ANALISYS

The economic analysis is carried on a period equal to the lifetime expectance of the equipments (usually 20 to 30 years). The revenue is represented by the available electricity generated and sold. There are two main components: the market price (p_{el}= 40 €/MWh) and the incentives for the electricity generated in renewable power plants (3 green certificates of p_{GC}=27-52 €/MWh).

In order to estimate the price of the biomass power plant some information is supplied in the literature [6], [7]. The specific cost of the biomass power plant in Euro/kW is given as function of electrical power in MW and while the absolute values differ, the relative ones have the same trend, to diminish with the increase in the unit power. The values in Figure 3, were calculated using the supplied formula and the values in Figure 4 were obtained from some of the examples presented in [7]

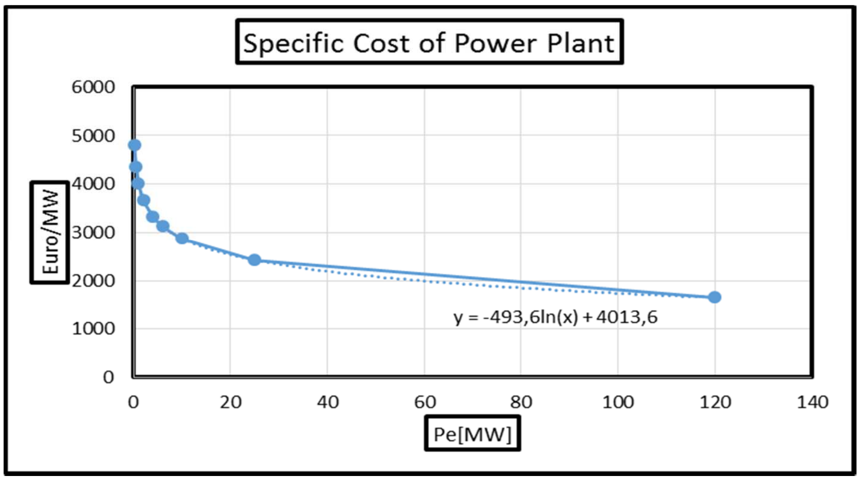

Figure 4. Specific cost of power plant C=-493,6*ln(Pe)+4013,6 [6]

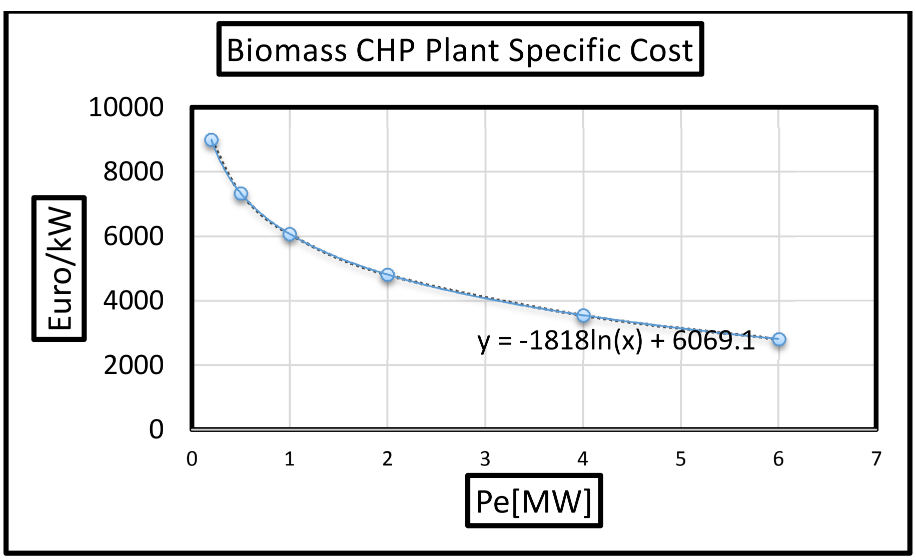

Figure 5. Specific cost of Biomass CHP Plant C=-1818*ln(Pe)+6069,1[7]

The expenses are represented by the annual return of the investment, the interest (if the investment cost is covered even partially by a loan), the fuel cost, O&M cost, insurance, etc.

Considering an annual discount rate a, it is possible to compute the economic indicators, such as: simple payback time (T_s), net present value (NPV), internal rate of return (IRR). The conditions for a good power generating system are: NPV > 0, IRR > a, T_s < lifetime and related to the investor satisfaction.

$$NPV = \sum_{t=0}^{n} \frac{V_t - C_t}{(1+a)^t} \;; \qquad \text{IRR} = a^* \text{ for } NPV = \sum_{t=0}^{n} \frac{V_t - C_t}{(1+a^*)^t} = 0 \;; \qquad \sum_{t=0}^{n_{\min}=T_s} (V_t - C_t) \geq 0$$

where: - V_t – revenues of year t; C_t – expenses of year t; - n – power plant lifetime.

The study case is based on a powerplant producing P_{BG} and delivering to the network $(1\text{-}\varepsilon)\cdot P_{BG}$, ε being the internal electricity consumption (assumed 10%). The annual operation time was estimated at 7000 hours, integrated with the forest activity (energy willow crop).

The common input figures for the economic analysis are:

- O&M costs $C_{O\&M}$ = 30,000 €/MW$_{ei}$+4 €/MWh$_e$[1];
- Energy willow price p_{ew} = 20 €/t; (the willow culture and the power plant are integrated in the same business, so the price is lower than 50 €/t)
- Electricity market price p_E = 40 €/MWh$_e$;
- Green certificate price p_{GC} = 40 €/MWh$_e$;
- Discount rate a = 10%;
- Planned payback period T_p = 7 years;
- The investor has the money for the project and does not borrow it from the bank.

In table 4 are represented the components of the capital costs:

Table 4 Components of the capital costs of the biomass power plant

No.	Component	200 kW$_e$	2000 kW$_e$	M.U.
1	Turbine+annexes+gearbox+electric generator	2100000	3000000	€
2	Steam generator+deaerator	300000	400000	€
3	Pumps	120000	240000	€
4	Fuel supply and storage plant	50000	100000	€
5	Chimney	50000	106154	€
6	Total equipment	2620000	3846154	€
7	Services & labor	487000	769231	€
8	Contingency	173000	384615	€
9	Capital cost	3280000	5000000	€
10	Specific capital cost	3280	2,500	€/kW$_{ei}$

The economic analysis results are shown in table 5.

Table 5 Results of the economic analyze of the biomass TPP

No.	Economic criteria	1000 kW$_e$	2000 kW$_e$	M.U.
1	T_s	7.3	5.3	years
2	NPV	1170892	24671709	€
3	IRR	14.09	21.50	%

Another aspect to be taken into account is the ratio of Heat to Power produced in the cogeneration power plants using solid biomass as fuel, some authors [7], inclining for H/+2*P for the condensation steam turbines and H+P for the backpressure type, from efficiency considerations.

Further work could be done from a different approach, which is the energy and exergy analysis of the types of installations of the biomass power plant: the condensation/extraction and the back pressure steam turbines. Such study would provide very useful information especially when dealing with part load operation of the steam turbines [10], [11].

5. CONCLUSIONS

Analyzing these results, we can draw the conclusion that both projects are feasible. However, a slight slippage of a single input data (such as the value of the green certificates, or even the interruption of the support mechanism) can easily bring loses to the project and put the investor in a difficult situation. It is also possible to increase the revenues of the plant if the electricity market price will rise in the future. The 2000 kW_e TPP has an overall efficiency twice then the 1000 kW_e TPP, but its capital cost is quite double. For the 1000 kWe TPP the necessary crop area for energy willow is about 380 hectares/2 year harvest, while for the 2000 kW_e TPP is about 776 hectares.

After the comparative analysis of the studied technical schemes, the following conclusions were drawn:

- The smaller TPP is suitable to work in remote areas, while the larger one is better to be connected to the grid.
- While the nominal power increases, the economic indicators are increasing too.
- The support mechanisms for renewable energy sources (green certificates) are vital for the project success.

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ECOLOGICAL EDUCATION, A NATIONAL PRIORITY

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ABSTRACT

Out of a natural need, ecology became a requirement in different sector of the social life. The ecological component of the general knowledge represents a milestone of reflection of the stakeholders, both in private and government positions, to prevent environmental catastrophes. Applying ecology in science and technology represents Earth's chance to health and only by having as a base an ecological conscience and conduct we can generate a new lifestyle guided by national and international collaboration regarding the green economy. Education's responsibility is to help present and future generations acknowledge the danger of limitless intervention of the human in nature. On this subject, programmes and project are implemented with the purpose to train the future citizens to be respectful and responsible with the environment.

1. INTRODUCTION

Ecology is the science that studies the interaction between organisms and their habitat.

Every year, June 5th is the date of The International Environment Day.

The progress of science and technology brought many advantages to the community under the aspect of material comfort, but also many problems like: irrational consumption of natural resources, water, soil and water pollution, massive deforestations.

Nuclear energy, information technology and genetics are just a few domains that offer solutions for a developing society, but they also bring great dangers: demographical explosion, population agglomeration, unemployment and so on; this creates the perfect context for human relations pollution.

In other words, the technological era gives us 2 perspectives: climax and/or doom?

An answer to this question is given trough the the imperative of the ecological education that has its foundation in the international environmental law and the personal right to a healthy environment, all correlated with the rights to life and development.

The international environmental law is based on the following documents:

- UN Conference Declaration regarding environment and human development (Stockholm, June 1972)
- Berna Convention on wildlife and natural environment conservation (September, 1979)
- Geneva Convention on pollution (November, 1979)
- UN World Charter for Nature (October, 1982)
- Ecological Forum of Rio de Janeiro (1992)

Some international organisations were created especially for managing environmental protection: United Nations Environment Programme (UNEP) proposed supervision plans for the environment and data acquisition on pollution and environmental degradation.

UN bodies are involved in environmental protection management.

2. METHODOLOGY

Another of the present paper is centred on the methodology and **the strategies to deliver ecological education in the higher technical education**.

These will respect the learning activity specifications, but also the particularities of the groups involved in the process.

The focus will be on **the interactive strategies**: individual exercises, in pair or in groups; debate; flyer presentation; art-creative techniques; researching information, supplementary resources, Internet access; strategies proposal; mass media monitoring; role playing, real life experience scenarios, critical thinking; event organising and participation in community service; law analysis; collages, poster design; updating the portfolio; viewing and commenting on movies and documentaries; community project simulation; creating and applying a project on ecological education.

These strategies will offer the learning framework for, on one hand, assimilating of the content elements and on the other hand, creating attitudes and exercising the abilities of the student by putting him in a real life situation simulation.

During these activities there will be used modern means that: have an active, participative, conscience, motivational and efficient character; modular and ergonomic furniture: Flipchart, audio-video means, computer; handouts; worksheet; original or translated written materials; legal documents.

The tasks will be individual, in 2 or 3 person teams or in larger groups (5-6 students), which require active participation of each individual.

The learning methods (*odos*=way, path; *metha*=to, towards) represent the ways used by the professor to help students discover life, nature, world, things and science.

Creating an engaging teaching-learning activity assumes using methods, techniques and procedures that will get the student involved in the process, with the purpose to develop thinking, to stimulate creativity and to develop the interest towards learning.

This way, the student is helped to understand the world he lives in and to apply his learnings in different life situations.

The methods are the essential element of the didactic strategy, representing the performing aspect, the actionable part of a the whole assemble that defines a given curriculum.

In this context, the method can be considered as the tool used to fulfil the instructional activities' objectives.

The methods and the techniques will respect the subject centred principle and will lead to a development of the abilities and integrative, transferable and useful competencies, both in the academic life and personal or work life.

The chosen methods are active, being more or less different from the conventional transmission of information to obtain an engaging and meaningful participation of the students.

Choosing these methods is an essential aspect and it was made regarding the individual needs of development of the participants, the objectives and conditions that programmes offers: adapting the work tasks to the competencies that are to be trained; active participation of the students; developing the capacity of the students to live the situations, to analyse and to take proper decisions accordingly.

As ways of realising the ecological education, the following can be used: educational activities at kindergarten and school, themed lessons, courses and workshops, laboratory work, research practice of the students, trips, debates, round tables, conferences.

Next, a few of the most important activities are described in short:

- **group discussion** is a loud voice thinking process, a space for sharing ideas, for exploring ideas, for debating problems and for working together on a keynote;
- **group debate** is a learning or formation method with very different objectives; the debate group focuses on experience exchange between participants; the main aspect of any group debate is discussing a problem on which people have different feelings and opinions about;
- the **focus group** is useful for: evaluating a situation; determining the needs and attitudes of a specific population; planning interventions and fit answers;
- the **brainstorming** is the method through which the group obtain a vast pool of ideas, shared spontaneously and without any evaluation; it has great results for group working;
- the **projects' method** consists of asking the participants to solve a problem on a given template of a similar problem;
- the **experience exchange method** is about sharing experiences from different backgrounds and situations;
- the **portfolio** comprises the most relevant products of one's activity in regard of a certain purpose.

It is recommended to: use less verbal methods, less oral communication; improve verbal methods, they don't need to be eliminated; use more and more action-based methods through which involvement is encouraged; use methods that stimulate group creativity, adapted to the age and individual particularities; use high tech methods for generating motivation and abilities to use new technologies.

It is essential that the methods to be chosen in such way that they stimulate abilities, attitudes, competences and acquisition of knowledge necessary for progress.

Choosing the right methods is based on: the main objectives, the proposed subject, the needs of the participants, the specific needs.

3. CONCLUSIONS

Personally, I consider that to solve the environmental problems of our times we have to start with a few clear guidelines: a solid knowledge system regarding the troposphere and the biosphere of the planet; understanding the human-nature relationship from the ecosystem balance point of view; acknowledging the importance of environmental protection; finding ways to improve and restore the human-nature ratio; the collaboration spirit for political, economical and cultural participation.

As of this moment, with all the technological advancement, Earth is our only home and is a must to protect it and think long term regarding all our actions as a species.

Education is the main part of the process of giving the knowledge and tools that help humans to be self directed and act according to a certain direction. In this sense, *ecological education* is that kind of education that equips people with all the elements needed to better understand the environment, to integrate themselves with the ecosystems they live, to act fast and properly when natural or man-made disasters happen, to use the Earth's resourses in a sustainable way and to have a general environment oriented conduct.

Nowadays, with all the digital revolution that is happening is very easy to improve the teaching methods by adding modern devices and appropachies to the very solid framework of education that we already have, therefore the whole educational process will be much more attractive and engaging.

The ecological education will become very easyily a topic of interst among students because will all the new technology we can show the history of Earth, simulate natural processes and create a more interactive context in which the participants can truly understand the cause and effect of their actions and humanity's, in general, so they will change their behaviour and become sustainable citizens of the global village.

As a closing, I want to share a few questions that are good for reflecting upon:

- *Is ecology a priority?*
- *Are we interested in this aspect?*
- *What will we lose if we ignore this aspect?*
- *In which way should we change our mindset?*
- *What is the information of which we should be aware of?*
- *Are these changes worthy?*
- *Can we save the planet?*
- *How will the next 10 years be, but the next 50?*

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THE NEW EDUCATIONS - ENVIRONMENTAL EDUCATION

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ABSTRACT

Recently, the competition for utilising natural resources and the fast growth of the industrial production created serious phenomenons, at first ignored, among which the ecological crises. Being unable to ignore production, it is mandatory to respect the environmental characteristics as a life support and its productive potential. These problems make it a necessity to have a corresponding approach of the ecological problems of the environment. This paper is focused exactly on that: education for the environment.

1. INTRODUCTION

Current society's conditions are extending towards an education that comprises the society as whole, even though we are living in a more united and connected world, new problems appear and affect all the humanity.

The major global desire is to have a world based on cooperation, respect and peace.

For such objectives great political, diplomatic, religious, scientific and educational efforts are being made, giving birth to "new educations" like: education for the environment/ecological education; social education; leisure education; mass media education; communication education; nutritional and sanitary education; economical education; demographic education; etc.

Out of all of these we will focus on **environmental education**.

The purpose of it is forming the ecological conscience and conduct, which starts in the family, continues in the kindergarten, school, university and later through life long learning.

Only based on this timeline and having a continuity we can nurture: love for nature, abilities to protect it, ecological attitudes and convictions etc.

As **objectives** of the environmental education we identify: **ecological training**, **ecological beliefs forming** and **ecological behaviours forming**.

Ecological training

One of the main causes of the negative attitude towards environment is not knowing the effects and dangers on the human kind of the destructive interventions of the human in nature.

Ignoring the problems the environment faces with and having a hostile behaviour towards environmental conservation generates even more bad influence on the Earth.

That is why it is an absolute must to gain knowledge regarding the man-nature relationship.

These will form the ecological culture that will be referring at: using the environment, its resources and landscapes, keeping a balance and preventing or fighting pollution.

Ecological beliefs forming

At the basis of forming them there is the ecological knowledge and the stronger it is the greater the change to transform in to beliefs.

They represent the sum of interdisciplinary elements from intellectual, moral and aesthetic education.

Thus, ecological beliefs are constructed upon: knowing the status of the human in relation to “nature’s rights”; understanding the necessity of productivity, conservation and improvement of the environment; rational use of Earth’s resources.

Ecological behaviours forming

The ecological behaviours refer to caring about about the environment, to the interventions on it against pollution and degradation, but also to the involvement in actions for its conservation, enrichment and beautification.

The ecological attitude is very important and is a result of beliefs and sentiments, doubled by the individual’s and collectivity’s responsibility towards nature.

2. METHODOLOGY

The rich content give an array of many possibilities of achieving the objectives of environmental education.

Environmental education has a complex, interdisciplinary character, reuniting elements that involves every aspect of the humanity’s life.

Every category of disciplines/objects of study has the possibility and duty to include the ecological dimension.

So, **the humanist and social disciplines** can comprise knowledge regarding the material and aesthetic value of nature, human behaviours and their influence on social life, **the scientific education/training**, like mathematics, physics, chemistry, geography, biology are in the category of sciences about nature, emphasising the objective laws that govern the nature and **the technological disciplines** show the pollution situations or the ways to fight against it.

All the disciplines provided in the learning programmes have the role to emphasise man’s responsibility regarding his interventions in nature and to instil to everybody the wish to actively participate at the protection and improvement of the environment.

Both the curriculum and the extracurricular activities - trips to discover nature, artistic and documentary movies, camps, actions for environment protection - complete the range of tools for environmental education.

In this way, I refer to a series of interactive methods of individual and team work used in the higher education system.

The modern education is centred on an action based methodology, on promoting interactive methods that put to work the thinking, intelligence, imagination and creativity mechanisms.

“Activism” means an effort of personal, interior and abstract, reflection, a mental action of searching and researching the truths, of generating new knowledge, also the “exterior activism” comes to serve as a material support of the interior activism.

After **the main didactic function**, we can classify the interactive methods and techniques as follows:

a. **Interactive group teaching-learning methods:** Reciprocal teaching; Jigsaw method; Cascade; Student Teams Achievement Division/ STAD; Teams/Games/Tournament/TGT; Share-Pair Circles; Pyramid method; Dramatic learning.
b. **Knowledge fastening and systematisation and evaluation methods:** Cognitive map/Conceptual map; Matrices; Cognitive chains; Fishbone maps; Spider map – Webs; Lotus Blossom Technique;
c. **Problem solving through creativity methods:** Brainstorming; Starbursting; Thinking hats; Carousel; Multi-voting; Round Table; Group Interview; Case study; Critical incident; Phillips 6/6; 6/3/5 technique; Creative controversy; Fishbowl; Focus group; Four corners; Frisco method; Buzz-groups; Delphi method.
d. **Group research methods:** Topic or project group research; Team experiment; group portfolio.

Let us analyse a few.

Through the **reciprocal teaching/learning** the students are in the situation to teachers themselves and to explain to their colleagues the solution of a problem.

The method is very appropriate for scientific text studies. The students of the same group will collaborate for understanding the text and solving the tasks, after that the solutions are to be presented in front of the group.

The main advantages of this methods are: stimulates and motivates, helps students to learn to learn text working techniques, gives them techniques that can be used independently afterwards, stimulates the concentration capacity.

The Jigsaw or “the interdependent group method” is strategy based on team-learning. Each student has a study task in which he has to become an expert on; he has at the same time the responsibility of transmitting the accumulated knowledge to the other students involved. The method assumes a thorough preparation of the material given for study.

The brainstorming is an interactive method used to generate new ideas as a result of group discussions. The result of these discussions is the best solution to be used. The way to obtain these solutions is that of stimulating creativity inside the group, in a friendly and without critique atmosphere.

The pyramid or the snowball method has its basis on interweaving individual activity with group activity. It consists of incorporating the activity of each member of the collective in a bigger process, meant to help the group solve a given task or a problem at hand. Similar to the other methods based on pair and team work, the pyramid method has its advantages to stimulate learning trough cooperation, to boost self trust, first in small pairs and then in big groups. The only disadvantage is the evaluation part being a hard task to determine the exact contribution of each participant.

The bunch method represents the model or organised ensemble of procedures that form the actions undertaken simultaneously by the professors and students and which lead to a planned and efficient way to realise the desired objectives. It is a way to create associations of ideas and to offer new meanings to ideas already assimilated. It is a technique to search the path to your own knowledge emphasising your own understanding of the content.

Lotus Blossom Technique assumes the deduction of connections among ideas or concepts, starting from a central topic. The main problem or topic determines the other 8 secondary ideas that are built around the main one, similar to the petals of a blossom flower.

The lotus technique can be used in a group setup, being flexible for large categories of ages and backgrounds and it also can be used as an *individual lotus* as an exercise to stimulate creativity and self evaluation.

These are just a few of the group work interactive methods. Each one of them records pros and cons, yet, the most important aspect is the timing for their use.

The educator is the one to decide and has the capacity to choose the proper method for the people involved in the learning process.

In theory and in practice of the contemporary didactic, the issue of interactive teaching knows new scientific approaches, that are complex, interdisciplinary, supported by arguments that regard active and reflexive participation of students in the process of teaching-learning-evaluation.

3. CONCLUSIONS

The environmental education is about the relationship between man and nature.

As a being gifted with education, the human permanently adapted to the environment, intervening on nature and modifying it in its interest.

Nowadays, we see a revolution of automatisation and digitalisation of activities in different sectors, proof that man exceeded its relationship with nature being able to travel in interplanetary spaces.

But the extreme industrialisation came with negative effects with a high impact on natures' balance.

Environmental pollution with different toxic and radioactive substances, massive deforestation, vegetation destruction on large surfaces and so on produced disastrous results that affected the human life itself.

The chance to fix this problem resides in adopting a new lifestyle, with better production -consumption models, cooperation and global acknowledgement of all citizens about the gravity of the problems we are facing.

Thus, environmental education is a must from a vital necessity of human's own existence point of view.

These problems for the content and justifies the role and importance of environmental education.

Personally, I consider that the following framework statements motivate this chosen topic: the subject is current and it has a major social impact; the information pool about environment and its problems is rich and diverse; it is a subject of current scientific interest on medium and long term; the impact on human life is significant; it allows developing programmes and project for a better future etc.

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DEVELOPMENT OF THE DEMANDED INFORMATION FOR INTRODUCTION OF POROUS SYSTEMS IN THERMAL POWER STATIONS OF POWER PLANTS

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ABSTRACT

Research on limit thermal streams in the mesh porous structures working at joint action of gravitational and capillary forces and cooling the high-forced devices of power stations is conducted. Settlement dependences of critical thermal streams are received and analysed. On the basis of the solution of a hydrodynamic problem, dealing with the definition of critical loading and skilled data, the devices with porous structures with a high resource of work, which allows for solutions to economic and ecological problems, are designed. The demanded information on the heat transfer modes, management of integrated and internal characteristics of heat exchange is received, generalised are diverse processes of warmth and a mass exchange.

1. INTRODUCTION

The introduction of porous systems in production preceded the research work on transfer of energy and substance in the heat exchangers, containing capillary and porous coverings of various heat conductivity and porosity. Poorly heat-conducting natural mineral environments with small porosity and metal structures possessing high porosity [1-4] were tested. Comparisons were made with highly effective heat-exchange devices [5,6].

Intensity of heat transfer and forcing mode prompted controlled by a porous elliptical wave energy devices division and gases [7], as well as by the combined action of capillary forces and mass [8-15].

2. METHODOLOGY

Heat exchange characteristics were measured using integral [1-3,14,15] and optical (high-speed filming, holography and photoelasticity) methods [2,4,6,7,9-11,13].

Generalisations of experimental data , in order to obtain the calculated dependences, have been carried out for boiling processes, transpiration, mass transfer, and bubbling foam generation [1,2,4,6,8,12,15].

The investigation of porous systems [1-4,6-15] revealed that the integral characteristics and plumbing process of steam superheating, which defined the liquid, have been influenced by the following independent variables:

- The pressure in the system, corresponding to the saturation temperature of the liquid, which determines the thermal properties of the liquid and vapour;
- The heat flux density;
- Excess fluid in the cross section of capillary-porous structure, creating the subcooling and forced fluid flow;
- Heating method;

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- Heating method;
- Type of material, from which the steam generating wall is constructed from;
- A liquid supply method;
- Type of intensifier (surfactants; perforation; profiled surface collections - redistributors, vibration; porous walls; gas-liquid dispersoids; gas extraction and washing structures);
- Type of material and capillary-porous structure, the way it is applied;
- Geometry of the heating surface;
- Operating hours of the porous system.

The ways of studying the porous systems for obtaining the demanded information are given in figure 1. The main direction is the conduction of basic researches, theory of similarity, modeling, experiment in laboratory and the industry. On this basis calculation ratios turn out and the system design, which takes into account ecological-economic optimisation, is made. Hereinafter the heat transfer modes, the studied sizes and processes, ways and methods of achievement of information are also listed. This information is published in [1-4]. In our development the general term "capillary and porous" is used in relation to a system.

In the theory of thermal pipes the term "capillary and porous body" is applied to all matches. However, being guided by that all time, big m, aren't capillary, and the behaviour of liquid in such time needs to be considered, taking into account the gravitational force as its influence. It will be shown with an accuracy which doesn't exceed 6%. Therefore, capillary and porous bodies have capillary potential much more than weight field potential, and in porous bodies both potentials are comparable among themselves. At capillary radius, it is less than a m, and the regularities of transfer of vaporous moisture are caused by the molecular mode.

Technical solutions of different devices were protected by copyright certificates on inventions and patents [1-3,6,7,13,14].

The average length of free run of a molecule of air and steam at room temperature m and m respectively is equal. Therefore the laminar current of Poiseuille and Fick's law of diffusion aren't carried out. In the presence of pressure drop of a molecule of gas move not separate layers, but independently from each other, gradually facing walls of capillaries. Molecules of gas will pass through a capillary independently from one another (a Knudsen's current or an effusion), without forming an aerodynamic stream no laminar, nor turbulent character.

Ways of data acquisition

Basic researches	Similarity and modeling of processes and installations	Semi-empirical and empirical settlement ratios	Measurement on plants

Integrated and thermohydraulic characteristics

Heat transfer modes: beginning of boiling, active process of boiling, boiling crisis. Management of power processes: division, concentration, drain and accumulation One-dimensional two-phase streams taking into account the compelled current not - heated liquid in vertical and the horizontal closed and opened channels. Nature of the phenomena and mechanism of processes.	Synthesis of processes of boiling, explosion, destruction foam. Heat transfer intensifiers	Integrated and internal characteristics of process of steam formation Integrated and optical methods of measurement.	Integral characteristics $(q, \alpha, t_w, t_n, C, \sigma)$

Required information

Design: choice of regime and design data; ecological and economic optimization	Operation: ways, start-up, stop, suction of gases and washing of structures	Safety (ecological, fire, explosive), cooling, sealing, small amount of liquid

Fig. 1. The scheme of research of capillary and porous systems used to obtain the required information.

In fig. 1. designations are accepted:

q- thermal loading; α-thermolysis coefficient; σ- thermal tension; *ΔP*- hydrogasdynamic resistance; *C*– concentration; *R* – radius, τ – time; $\bar{\text{n}}$- density of the centres of generation; $\bar{\text{f}}$- generation frequency; $\bar{\varphi}$- moisture content.

Indexes: *cr* – critical; about – detachable; *p* – growth; *w* – wick; *st* – steam.

When boiling liquid in open capillaries the partial vapour pressure turns partly into barometric pressure of air in the environment, thus the diffusive mechanism of transfer of steam in a porous body is superseded by molar process of transfer of steam, which can be described using Poiseuille's law.

On the whole in the system studied porous bodies (environments) or structures and, only in certain cases, capillary – porous, as a rule, are considered.

3. DISCUSSION AND ANALYSIS

It is necessary for the analysis of limit opportunities of porous system for transfer of energy and substance from the equation for [2] to determine the greatest height of a heatexchange surface of *h* with which hydrodynamic crisis of heat exchange would occur. Sizes δ_w, as *k*, b_w, *H, P* will act as variables.

Demands the solution of the equation for q_{cr} the high accuracy of calculation whereas, having rejected the first member of the equation, it is possible to solve this equation with almost the same degree of accuracy. The equation will take the form hereinunder:

$$\text{q}_{\text{cr}} = \frac{C}{B} = 2\varphi'_{cr} \cdot r \cdot \delta_{\phi} \cdot \rho_f \cdot k \cdot (gH\cos\beta + \frac{2\sigma}{\rho_f R_n})/3h^2 \cdot \nu_f \qquad (1)$$

where r - warmth of steam formation; ν_f - kinematic viscosity.

From the equation (1) the relation in an explicit form does not contain $\frac{m_f}{m_{st}}$, however it is taken into consideration through sizes φ'_{cr} and *k*. At $\varphi'_{cr} \to 0$, size $\text{q}_{\text{cr}} \to 0$, i.e. in an interface of porous structure evaporate almost all moisture would be evaporated, resulting in a boiling crisis. Here $\frac{m_f}{m_{st}} \approx \tilde{m}$- excess of liquid m_f in relation to steam consumption m_{st}.

We will consider two extreme cases taking place in the experiments: thickness of the wick $\delta_{w1} = 1{,}5 \cdot 10^{-3} m$ and $\delta_{w2} = 0{,}15 \cdot 10^{-3}$ m. For the size $\delta_{\phi 1}$, we will have:

$$\varphi'_{cr} / h^2 = 140{,}4/(9{,}81H + 0{,}447) \qquad (2)$$

where permeability $k = 5{,}8 \cdot 10^{-10} m^2$, hydraulic diameter $d_h = 0{,}55 \cdot 10^{-3} m$, *P=0,1 MPa* pressure.

As pressure sizes H are also related by a ratio δ_w

$$H \cdot \delta_w = 15 \cdot 10^{-3} m \text{ then } 10\, m \le H \le 100\, m \qquad (3)$$

$$\text{At, } H = 10\ m\ \varphi'_{cr} = 0{,}1,\ h = h_{\max} = 0{,}26\ m \qquad (4)$$

For the size δ_{w2} the equation takes the following form:

$$\varphi_{cr}^{'} / h^2 = 1386/(9{,}81H + 1{,}76) \quad (5)$$

At $H = 100\ m$, $\varphi_{cr}^{'} = 0{,}1$ we receive a close value of height of the heat exchange surface $(h_{\max} = 0{,}266\ m)$.

The reviewed examples pertain to a case, in which all cooling liquid moves in the free section of the porous structure $K = K_{h.p.}$ (an operating condition of a heat pipe (*h.p.*)). Both the equations (2) and (3) form a relationship between the hydrostatic pressure H with the height of a heatexchange surface h.

We will solve the equation for q_{cr} (1) concerning size $\varphi_{cr}^{'} / h^2$ for a case when a part of liquid, due to its surplus, could flow down on a surface of a porous body (*wick*), i.e. coefficient $K = K_c = (2{,}5...3{,}1)\cdot 10^{-7}\ m^2$, K_c - conditional coefficient of permeability.

In this case the insignificant external pressure created by the height of the liquid column H would be required and capillary potential $\rho_f gH << 2\sigma / R_h$ would significantly exceed the gravitational potential. Thus sizes H and δ_w will also not be related to each other. In this particular case the solution of the equation (1) would be as follows:

For $\delta_{w1} = 1{,}5\cdot 10^{-3}\ m$:

$$\varphi_{cr}^{'} / h^2 = 0{,}126(9{,}81H + 0{,}47); \quad (6)$$

for $\delta_{w2} = 0{,}15\cdot 10^{-3}\ m$:

$$\varphi_{cr}^{'} / h^2 = 17{,}4(9{,}81H + 1{,}76) \quad (7)$$

where ρ - liquid density; g – acceleration of gravity;

σ - coefficient of a superficial tension; R_h - meniscus radius. At the sizes of H *=10 m* and $\varphi_{cr}^{'}$ - 0,1, we will get the values of height of the heating surface $h_{\max 1}$*=2,86 m* and $h_{\max 2}$ *=0,758 m*, i.e. for thin structures crisis of boiling will occur at smaller sizes of h.

The solution to the equation (1) concerning height of a column of liquid H is of interest to both cases of hydrodynamics of liquid: $K = K_{h.p.}$ and $K = K_c$. When all liquid moves in the live section of porous structure ($K = K_{h.p}$) it is bound to create a rather higher pressure. For the studied cooling system when h = (0,1 … 0,7), δ_w = (0,15 … 1,5) m, b_w = (0,08 … 1) the m, at $\varphi_{cr}^{'}$ =0,1 sizes H measures tens of metres of water column. In the second case when the excess of liquid at its free running off to an external surface of porous structure is created ($K = K_c$), the corresponding excess of the column of liquid is equal to only a couple of millimeters.

The condition $\rho_f gH << 2\sigma / R_h$ can take place not only at a horizontal arrangement of the cooling system, but also in the case when the part of liquid flows down on an external surface of porous structure $(K = K_c)$.

From the equation (1) it isn't necessary to draw a conclusion that infinitely increasing a hydrostatic pressure $\rho_f gH$, it is also possible to increase the size q_{cr} since size K can lose physical meaning of permeability as the main consumption of liquid will be out of the live section of structure, freely flowing down on porous material. Besides at $q \le 6\cdot 10^4\ W/m^2$ [6] there will be a redistribution of the warmth, which is selected by steam formation and convection up to boiling process degeneration.

At size $q \to q_{cr}$, despite a large amount of liquid with an expense $G_f = f(H)$, there will occur crisis phenomena which will lead to a burnout and destruction of the heatexchange surface. In this case, in equation (1) the inequality will be executed $\rho_f gH >> 2\sigma / R_h$ and we would be bound to enter a multiplier K/K_c. In a case when $\rho_f gH \approx 2\sigma/R_h$, the size of the valid pressure $\Delta P_{h+cr} = (1{,}5...2)\cdot(2\sigma/R_h)$, and size H makes some tens of millimetres depending on the structure's thickness.

We will establish the equality $h = f(H)$, let the size be $K = K_{h.p.} = 5{,}8\cdot 10^{-10} m^2$.

For $\delta_{w1} = 0{,}15\cdot 10^{-3} m$ from equation (2) we would get:

$$h = f(0{,}32...1)(0{,}0699\,H + 3{,}18\cdot 10^{-3})^{0,5} \quad (8)$$

For $\delta_{w2} = 0{,}15\cdot 10^{-3} m$ from equation (3) we will have:

$$h = (0{,}32...1)(7{,}1\cdot 10^{-3} H + 1{,}27\cdot 10^{-3})^{0,5} \quad (9)$$

Here it is supposed that mass moisture content can change from the moment of the beginning of boiling $(\varphi' \to 1)$ before crisis of boiling $(\varphi' = \varphi'_{cr} \to 0{,}1)$ [12].

The carried-out analysis allows to determine the height of a heatexchange surface, as well as the thickness of a porous structure, which correspond to critical thermal loading. The accounting of boiling in a porous body is made by means of account moisture φ' content and parameter $\tilde{m}$ which creates the directed current of unheated liquid with insignificant speed and allows to provide stability of a two-phase stream in the boundary pulsing liquid layer.

We will give settlement sizes q_{cr} on equation (1) and the overheat size ΔT_{cr} corresponding to it at various pressure values.

The assessment of the temperature difference in porous structure is necessary in order to allow for a steady operation of the cooling system. Such an assessment however is rather arduous and that is connected with the difficulty of determination of effective coefficient of heat conductivity at the time of crisis of the boiling, depending on many factors, the main one of which is the availability of steam-and-water mix in an interface, the contact resistance between a skeleton of structure and a wall and between elements of the skeleton subjected to change from the extent of pressing of structure to a wall and from change of temperature level of work that leads to thermal expansion of a wire of a grid [8]. Besides, in the crisis mode, the thickness of a liquid layer is of uncertain size. Therefore calculation of size q_{cr} cannot be made in the analytical way and sought to be a subject of pilot studies [14,15].

Table 1. Critical thermal loadings q_{cr} and temperature pressures ΔT_{cr}.

		P, MPa			
		0,01	0,1	8	20
1. q_{cr}, W/m^2	a) $K = K_{T.T.}$	$2{,}95\cdot 10^4$	$6\cdot 10^5$	$6{,}9\cdot 10^5$	$1{,}66\cdot 10^5$
	b) $K = K_c$	$3\cdot 10^5$	$6\cdot 10^5$	$2{,}5\cdot 10^5$	$5{,}8\cdot 10^3$
2. ΔT_{cr}, K		14,2	60	55,2	7,75

Basic data of calculation are:

$H = 10$ *m;* $\cos\beta = 1$*;* $R_h = 0{,}275.10^{-3}$ *m,* $h = 0{,}27$ *m;* $\varphi'_{cr} = 0{,}1$*;* $\delta_w = 1{,}5.10^{-3}$ *m,* $K = 5{,}8.10^{-10}$ m^2. Here β - a surface tilt angle to a vertical.

In the calculation, it is supposed that the cooling liquid fills all live section of structure and doesn't flow down on the porous body. Structurally the latter is realised by creation of a channel and its installation in the porous structure.

If, however, an excess of liquid is created and a part of it can freely flow down on an external surface of the porous body, it is necessary to enter a conditional coefficient of permeability K_c [1].

Comparing the provided data, we observe that in a case where $K = K_c$ for high pressures the stronger influence of size P on size q_{cr} as fast decrease of coefficient σ starts affecting.

CONCLUSIONS

1. Thus, by means of imposing of gravitational potential it is possible to expand size q_{cr} and to stabilise the dependence $q_{cr} = f(P)$ for the wide range of change of pressure (0,01…20 *MPa*). This is particularly important when the system operates under high pressure.
2. Moisture content $\varphi^{'}$ has impact on size q_{cr} through the relation $\tilde{m}$, and the size $\varphi^{'}_{cr} = (0,1...0,15)$ thus received from researches information for sizes $\mathrm{q}, \alpha, \sigma, \Delta\mathrm{P}, \mathrm{C}, \mathrm{R}_{\mathrm{cr}}, R, dR/d\tau,\ \overline{R}_0, \overline{n},\ \bar{f}, \overline{\tau}_p, \overline{\varphi}_{cr}, q_{cr}$ is sufficient for introduction of porous devices.

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OPTIMIZATION OF THE EXCESS COOLER IN THE CAPILLARY-POROUS COOLING SYSTEM IN THERMAL POWER PLANTS

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ABSTRACT

Research on the influence of liquid consumption on heat exchange in porous materials have been conducted, whence settlement formulae of an optimum consumption of liquid depending on thermal loading and the type of porous structure have been obtained. The principles of design of porous structures of evaporators are constructed. A description is given of the mechanism of process of steam formation in the offered porous cooling system with use of internal characteristics of boiling.

1. INTRODUCTION

The use of porous materials in heat-stressed elements in the design of aircraft [1], heat exchangers [2-10], melting units [4], in mountain equipment for cooling of torches of rocket type [2] demands that a reliable functioning of a surface of heating is ensured and the detrimental temperature of a wall causing devastating cyclic temperature tension is circumvented

For this purpose researche of the new porous cooling system [5,9] in which cooling liquid is brought to a steam-generating surface by means of common operating capillary and gravitational forces , which demand optimization of a cooler, has been carried out.

In the developed capillary-porous systems the study of the dynamics of non-homogeneous (heterogeneous) multi-phase media deserves attention. They contain macro inhomogeneity (inclusion). Amongst heterogeneous systems the disperse mixes , consisting of two phases, one of which – bubbles, drops, firm particles [5,9] are of notable interest.

When modelling heterogeneous mixes two main assumptions arise: the extent of non-uniformity (inclusions) in mixes, for instance, the size of a bubble or wavelength, is many times more molecular – kinetic sizes, and at the same time the extent of non-uniformity there are many times less than distances at which average (macroscopic) parameters of mix or phases change significantly. These assumptions allow the equations of mechanics of continuous single-phase environments to be used, specifically for the description of processes in or about separate inclusions (microprocesses) and to describe macroprocesses in the environment, such as the environmental current in porous structures, their distribution of waves, characterizing processes integrated (average or macroscopic) by parameters. However, there is no analytical decision for the boiling streams. Therefore the carried-out study of the processes by optical methods about wick space and in capillary and porous structures, as well as in the field of steam bubbles, is necessary for short circuit of the average equations of the movement of disperse environments. Thus we defined values of thermal streams, coefficients of heat-exchange and permeability of porous structures, emission of liquid from structure [3,7]. A number of effects proceeding with

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small concentration of a disperse phase can be quantitatively described by formulas for two-phase streams. Processes of a steam generation, dust arrest, destruction of materials, twirled streams of gas-suspensions belong to such effects [2].

The theoretical solution to problems of wave dynamics of blow and detonation in the condensed environments with phase transitions allows to count porous elliptic systems when passing strong waves with pressure (1-100) *hPa* in the metals, minerals and polymers concentrated in the second focus of an elliptic toroid (in a target). As a result, new substances, their modifications and phases are formed, metals are strengthened, and synthesis processes are realised. In one device at the same time it is possible to receive pressure sharply different from each other: in gas mix – to 10 *MPa*, and in liquid or strong substance – 105 *MPa* and above [10-12].

The solution to problems of dynamics of two-speed currents of disperse environments on the example of gas suspension when the movement of phases relatively from each other due to distinction of density of these substances takes place, can be put to use in the calculation of processes of destruction, taking place according to the cyclonic way, in which a process is realised, in which medium temperature subsonic gas streams, carrying firm abrasive material particles form a twist[3].

Existence of resonators in cyclones strengthens the destruction process. The acoustic theory of calculation of distribution of weak indignations in gas-suspensions and steam drop environments, and also the weighed particles' dynamics are considered at vibration influence in acoustic fields. For the description of processes of destruction of objects, using the cyclone method, of use can be the research of multiphase body flow with significant mass concentration of particles/ droplets, which pose an an impact on the distribution of parameters of high-supersonic gas flow near the body during intensive bombing of particles and droplets.

Positive effects of the multiphase character of streams, especially in the presence of capillary-porous coatings, fully reflected on the fields of mass and vibration forces and manifested themselves most extensively in the propagation of waves of tension and compression that can be managed in the developed porous elliptic systems. The analytical solution of distribution of waves in two-phase vapour-liquid mixes, where features of the movement of waves in gas mixes with drops or particles are taken into consideration, is important for the heat of gas traps and heat exchangers [6] offered by us in the elliptic porous multiphase.

A feature of wave currents in vapour-liquid streams is that except the smeared waves, characteristic for gas-suspensions (gas, particles, drops), waves with oscillation structure with the collapsing and split up bubbles which arise from - for radial pulsations of bubbles take place and strongly depend on nature of processes of a heat and mass transfer. Besides, at a filtration of multiphase liquids, there are kinematic waves.

Bases of the theory of nonlinear oscillations show that due to the impact of vibration on multiphase liquids processes of heat mass transfer, especially in the resonant modes, are repeatedly intensified [2].

2. METHODOLOGY

The main areas of practical application of capillary–porous systems are protected by us patents and copyright certificates for the invention [2-4, 6].

Introduction of the equipment and technological processes in engineering has to be made, first of all, from ecological and economic grounds. The offered development of capillary and porous systems will propagate carrying out processes, significantly improving and preserving the environment.

Capillary–porous systems allow to reach amongst others an economy of fuel, of raw materials, of air, water and warmth. Those systems also increase the reliability of cooling and the fire safety of the equipment, as well as promote highly effective destruction of rocks, concrete, metals. With regard to the latter, they also reduce the low-temperature corrosion of surfaces and the pollution of the biosphere from poisonous gases, dust, heat. Another important aspect to be taken into consideration is that they pose positive substantial economic and social effects in the field of ecology and labour protection.

The main advantages of capillary – porous systems are high intensity, large heat-transmitting ability, increased reliability, compactness, simplicity in production and operation; they improve both the regime and the technological indicators and offer high capital and lower operational costs. In figure 1 research of various factors of influence on capillary–porous structures in relation to elements of the thermal power stations (TPS) [2,5,7-12] are presented.

Pilot studies on boiling of liquid were conducted on a tube with an outer diameter of 0,021 m covered with mesh porous structures and on flat heaters, 0,15 hight … 0,7 m and length 0,3 m. The supply of water was carried out from a tank of constant level. Needle valves provide sufficiently accurate adjustment of the flow rate. A liquid drain was also provided [2,5,9].

Heating of a wall was conducted by means of electric heaters, or haloid quartz lamps.

Porous structure smooth brass and corrosion-proof grids with the width of cells in light $(0,08…1)\cdot10^{-3}$ *m* were applied. Experiments were made with one, two and three layers of various grids.

The greatest possible margin of error in the measurement of electric power is ± 1,6%. The liquid temperature (cooling, drain, circulating) was measured by mercury thermometers with an accuracy of $0,1^{0}C$. The steam and wall temperature – chromel-copel thermocouple (CCT) with a diameter wire of $0,2\cdot10^{-3}$ *m*.

Expenses of cooling liquid and circulating water were defined by electric manual arc welding (MAW) rotameters.

The greatest possible margin of error didn't exceed ± 3%.

The discrepancy, summed up by heat current and heat reserved circulation and excessive water loss through the insulation, does not exceed ±12%, and the residual material balance is ±10%.

At the set thermal stream the temperature of a wall had the smallest value for single-layer structure. For the area developed bubble boiling significant effect of coolant flow rate in the range equal to $(1...14).m_n$, for all investigated structures was not found.

The cooling of a surface of heating is studied from minimum possible flow of fluid at which ,having merged, equaled to zero, to an excess of fluid consumption 14 times of the generated steam consumption. Necessary change of a consumption of liquid is determined by violation of uniformity in distribution of temperature on a surface of the cooled wall. Thus reliable heat removal due to preservation of the steady pulsing liquid film is provided that favourably distinguishes the considered cooling system from thin-film evaporators, in which there is a rupture of the flowing-down liquid film and hence there is a need for significant increase in a consumption of liquid (in 100 … 1000 times) [2]. However, even with such large irrigation densities, loss of stability of the layer, the latter disintegrates into separate streams is observed, accompanied by exposure of the heated surface.

The temperature distribution along the height of the cooling surface for bubble boiling area shows that in the upper and lower parts has roughly the same value for all investigated heat fluxes and structures. In a middle part of a surface wall temperature not some degrees was higher almost in all experiences. Probably, here structures adjoin to a wall worse. On extreme sites influence of regional effects takes place.

For cooling of surfaces, having sufficient height (up to 0,7 m), the raised cooler expenses that tightens alignment of temperature of a wall at low and moderate thermal loadings are required. Therefore, in the generalising dependencies the coefficient of heat exchange is expressed through wall height as $\alpha \sim h^{0,26}$ [2].

3. ANALYSIS

For the area close to critical, significant increase in a consumption of liquid has no impact on heat exchange processes.

The optimum flow rate of the coolant is calculated by the following formulas:

for $b_h \leq 0{,}28 \cdot 10^{-3}$ m:

$$Q_{opt} = \frac{(1\ldots1{,}3).q}{r} \quad \text{for} \quad q \leq 10 \cdot 10^4 \text{ W/m}^2; \tag{1}$$

$$Q_{opt} = \frac{(1{,}3\ldots2).q}{r} \quad \text{for} \quad q > 10 \cdot 10^4 \text{ W/m}^2; \tag{2}$$

for $b_h \cdot\ 0{,}28 \cdot 10^{-3}$ m:

$$Q_{opt} = \frac{(1{,}1\ldots1{,}5).q}{r} \quad \text{for} \quad q \leq 10 \cdot 10^4 \text{ W/m}^2; \tag{3}$$

$$Q_{opt} = \frac{(1{,}5\ldots2{,}5).q}{r} \quad \text{for} \quad q > 10 \cdot 10^4 \text{ W/m}^2; \tag{4}$$

The raised cooler expense for structures with $b_h > 0{,}28 \cdot 10^{-3}$ m is connected to a reduction of the capillary forces influencing uniformity of distribution of liquid (especially at its small expenses).

Thus, at the developed bubble boiling the specific density of a thermal stream has the main impact on heat exchange. The influence of density on irrigation is much less, than in the case of the transitional superficial boiling, proceeding in the initial area [6], though at great values of the Reynolds' numbers, the heat conductivity of the film increases, as the arising whirlwinds lead to increase in viscosity, stabilization of the film thickness, which leads to additional stability to boiling crisis.

As shown, the optical methods of research, executed by high-speed filming and a holographic interferometry [2,3,5], at small thermal loadings with growth of parameter $\widetilde{m}$ the detachable (destroyed) diameter of steam bubbles decreases, their lifespan increases and density of the centres of generation is reduced.

At large values of q the increased excess of liquid facilitates the delivery of fresh portions of a cooler to the vicinity of the centres of generation, which improves the hydrodynamic picture in the two-phase boiling superheated interface, however, in the warmth transfer mechanism the defining role belongs to the steam formation process that is a feature of the process of boiling in mesh porous structures for the studied interval of change of parameter $\widetilde{m}$,in comparison with the process of bubble boiling in the conditions of the directed movement of liquid on surfaces without porous coverings. At large excess of liquid and small thermal loadings the intensity of heat exchange starts to decrease as liquid film thickness increases, density of the active centres of steam formation decreases, and the existing centres of generation of steam work "inertly" and can't make an additional contribution to turbulisation of an interface at total selection of heat steam formation and an excess enthalpy of superheated liquid.

Reduction of excess of liquid displaces the area of work of system towards big thermal streams when the mode, determined by steam formation process, is set. Again, the new centres of generation of steam start being initiated. Thus, the increased thermal streams compensate for the effects, which lead to decrease in size $\widetilde{n}$ and growth of turbulent component single-phase treacle.

Hence, the relation $\widetilde{m}$ in the examined porous system establishes a limit, when the heat transfer in the single-phase environment would contribute in the general mechanism of a heat transfer a substantially smaller value, than the one, which the process, determined by warmth of steam formation of liquid, in steam bubbles would.

The excess of liquid leads not only to increase in speed of a stream, but also liquid underheating. In a two-phase, the border layer would be heated to the saturation temperature, however beyond its limits, both in the porous structure and on its external surface, on which in this case there can be a partial movement of a stream, liquid of a sub cooled up to the saturation temperature. Conditions of superficial boiling are created (boiling with under heating). Boiling of the overcooled liquid is realized in close proximity to a wall superheated zone. The top part of the bubbles, which can adjoin to sub cooled liquid, starts being condensed partially. On records the increase in lifespan of steam bubbles for those cases when the balance of inflow of heat from a wall and superheated liquid and its drain by means of warmth of condensation in a kernel of the flowing-down sub cooled stream is established. Growth of the steam bubbles ceases, their size don’t alter, and there are fluctuations of bubbles within a cell, which, in general, prolongs their lifespan.

Another feature of the studied system is that processes of a heat mass exchange proceed in thin layers of liquid, the expense and speed of a stream have small sizes, and liquid in structure begins to boil, practically at once on the point of entry in a heat exchange surface. However, at large liquid excess on a structure’s surface there was a current of a stream of sub cooled liquid ,whose expense could exceed a liquid consumption in a wall superheated layer. It allows for more cold fluid from the core flow to penetrate the near-wall layer, to oust the latter, reducing the thickness of the superheated layer, and therefore the rate of evaporation, and due to the increased temperature gradient to influence the rate of condensation of the steam bubble, which was outside of the superheated zone, although remaining within the thickness of the porous structure.

Compared to boiling of liquid on surfaces without porous coverings, in the studied system bubbles don't slide on a heating surface, and fluctuate within a cell of mesh porous structure. Sizes of speed and under-heating of the liquid have smaller values, from which it follows that the detachable diameter of a bubble doesn’t not wholly depend on excess of liquid. It is necessary to expect a higher content of steam in the volume of a porous structure, than when boiling sub cooled liquid in smooth pipes.

The analysis of skilled and settlement dependencies shows [3-5] that growth of excess of liquid (speed and under heating) until establishment of the developed bubble boiling leads to turbulisation of a two-phase boundary (wall) layer, respectively to their thinning, and at the developed boiling intensity of a heat mass transfer of an auto-modelling concerning parameter. The ratio of thickness of the two-phase boiling layer and wall (superheated) layer in porous structures is characterized by a filling coefficient. With growth of thermal loading and increase in the optimum excess of liquid, corresponding to it (see formulas 1-4), thickness of a wall (superheated) layer idisappears, as well as micro, a layer under steam bubbles, and thickness of a two-phase layer increases to some value q corresponding to crisis area when the volume of steam of the contents reaches a critical value. With further growth of size q the excess expense of a cooler doesn't allow heat exchange process to operate, which in turn leads to crisis of the heat transfer.

4. CONCLUSIONS

In the porous cooling system reduction of excess of liquid (underheating of a stream) displaces a site of thermal and hydrodynamic stabilization towards the feeding artery. The unsteady site where growth of temperature of a wall in process of removal from a liquid supply branch pipe is observed, contains much less than active steam germs and length of this site makes some percent from all length of the cooled wall. The mechanism of the process is similar to the mechanism of convective heat exchange in a single-phase stream. Compared to boiling of liquids at the compelled current, in smooth pipes (large volume) the size of this site is much smaller, and for practical calculations it is possible to consider that the zone of the developed superficial boiling begins at once in the top part of the heat giving surface, adjoining the feeding artery. Wall temperature in this zone remains constant.

The influence of a consumption of liquid on heat exchange in the porous cooling system, working at joint action of capillary and gravitational forces from various factors, is investigated. Experimental data for an optimum consumption of liquid by means of high-speed filming and a holographic interferometry are obtained, a model is constructed and the heat exchange mechanism at steam formation is explained.

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EXHAUST HEAT RECOVERY USING ORGANIC RANKINE CYCLE

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Abstract

Low-grade thermal energy recovery has attained a renewed relevance, driven by the desire to improve system efficiency and reduce the carbon footprint of power generation. Various technologies have been suggested to exploit low-temperature thermal energy sources, otherwise difficult to access using conventional power generation systems. In this paper, the authors review the most recent advances and challenges for the exploitation of low grade thermal energy resources, with particular emphasis on ORC systems, based on information gathered from the technical literature.

Nomenclature		Subscripts	
		0	environmental state
E	exergy (kJ/s)	1,2,2a,2s,3,4,4a,4s	state point
h	enthalpy (kJ/kg)	CND	condenser
I	exergy loss (kJ/s)	Exg	exergy
m	mass flow rate of working fluid (kg/s)	EVP	evaporator
p	pressure (MPa)	i	each state point
Q	heat addition of working fluid, (kg/s)	IHE	internal heat exchanger
s	entropy (J/K)	in	waste heat
T	temperature (K)	input	system input
W	power (kW)	out	exhaust
		output	system output
Greek symbols		PUMP	pump
η	efficiency	TBN	turbine
		thm	thermal

1. INTRODUCTION

In recent years, there has been a great deal of waste heat energy being released into the environment, such as exhaust gases from turbines and engines and waste heat from industrial plants, which lead to serious environmental pollution. In addition, there are also abundant geothermal resources and solar energy available in the world. These heat sources are classified as low grade heat sources. Therefore, more and more attention has been paid to the utilization of low grade waste heat nowadays for its potential in reducing fossil fuel consumption and alleviating environmental problems. The Organic Rankine Cycle (ORC) is a cost efficient and proven method of converting low temperature waste heat to mechanical and/or electrical energy. This opens up the possibility to exploit low-grade heat that otherwise would be wasted. It can play an important role to improve the energy efficiency of new or existing energy-intensive applications.

2. CONVERSION TECHNOLOGIES FOR LOW GRADE THERMAL ENERGY RECOVERY (LGTE)

There is a wide range of technologies and design options for the recovery of LGTE for power production and Combined Heat and Power (CHP) applications [1]. Suitable thermodynamic cycles include organic Rankine cycle (ORC), supercritical Rankine cycle, Kalina cycle and trilateral flash cycle (TFC) [2], as well as, Stirling engines and new concepts such as thermo-acoustic engine (TAE) and inverted Bryton cycle.

Even though there are potentially different alternative conversion technologies for LGTE recovery, in practice, ORCs are the most prevalent, mainly because of their simplicity and off-the-shelf availability of their components. Despite these benefits, the design and modeling of ORCs can be challenging, especially for transient conditions, e.g. when the load demand or the supply thermal energy exhibits abrupt changes, but yet the working conditions of the systems have to remain within acceptable ranges to avoid unfavorable off-design conditions or temperature shocks.

3. ORGANIC RANKINE CYCLE

The ORC system represents a simple Rankine cycle in which the water is replaced by organic mediums that boil at low temperatures . The layout of an ORC simple cycle layout and typical T–s diagrams of both subcritical and transcritical cycles are reported in Fig. 1. Over the years, the ORC systems have gained a moderate level of maturity and reliability, allowing heat recovery from different sources, as documented by Branchini et al. [3].

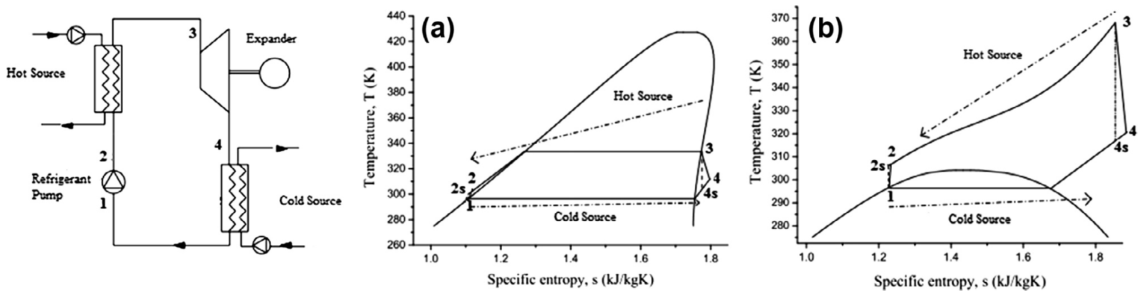

Figure 1. ORC simple cycle layout and T–s diagrams of subcritical (a) and transcritical (b) cycles (adapted from [4]).

The technical feasibility of ORC applications for LGTE recovery has already been investigated and validated [5–7]. In fact, medium to high temperature ORCs are successfully used in several applications, such as geothermal resources [8], waste thermal energy recovery from gas turbines or internal combustion engines [9–13] and biomass-based CHP plants [14–16].

4. THERMODYNAMIC ANALYSIS OF ORGANIC RANKINE CYCLE

The ORC can be classified in two groups according to the level of turbine inlet pressure, including supercritical ORCs and sub-critical ORCs. The sub-critical ORCs are different types according to the shape of the saturated vapor curve in the temperature versus entropy diagram as shown in Figs. 2–5. In the below cycles, if the temperature t_4 is markedly higher than the temperature t_1, it may be rewarding to implement an internal heat exchanger (IHE) into the cycles as shown in Fig. 6. This heat exchanger is also represented in Figs. 3–5 by the additional state points 4a and 2a. The turbine exhaust flows into the internal heat exchanger and cools in the heat exchanger in the process (4–4a) by transferring heat to the compressed liquid that is heated in the process (2–2a).

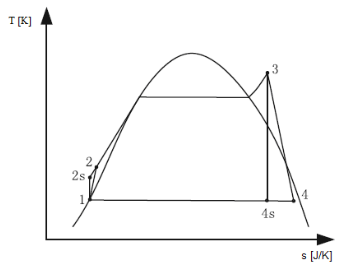

Figure 2. A type of ORC with negative slope of saturated vapor curve and wet vapor at the turbine outlet.

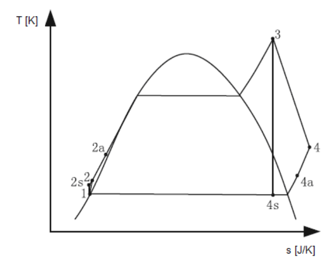

Figure 3. B type of ORC with negative slope of saturated vapor curve and superheated vapor at the turbine inlet.

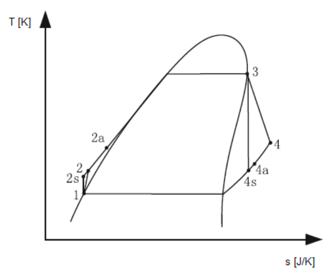

Figure 4. C type of ORC with non-negative slope of saturated vapor curve and saturated vapor at the turbine inlet.

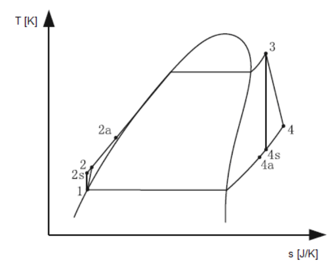

Figure 5. D type of ORC with non-negative slope of saturated vapor curve and superheated vapor at the turbine inlet.

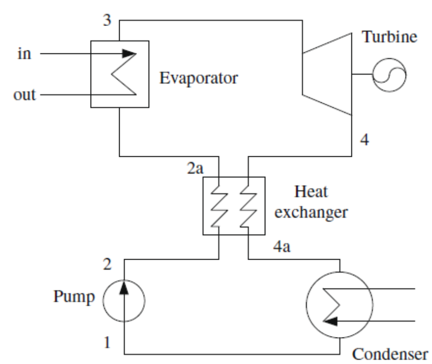

Figure 6. The ORC system with internal heat exchanger

For the cycle performance simulation, it was assumed that the system reaches a steady state, and pipe pressure drop and heat losses to the environment in the evaporator, condenser, turbine and pump are neglected. Because of the thermodynamic irreversibility occurring in each of the components, such as non-isentropic expansion, non-isentropic compression and heat transfer over a finite temperature difference, the exergy analysis method is employed to evaluate the performance for low grade waste heat recovery. Consider p_0 and T_0 to be the ambient pressure and temperature as the specified dead reference state. The exergy of the state point can be considered as:

$$E_i = m[(h_1 - h_0) - T_0(s_i - s_0)] \qquad (1)$$

Each process in the ORC can be described as follows:

Process 1 to 2: This is a non-isentropic compression process in the liquid pump. The isentropic efficiency of the pump can be expressed as:

$$\eta_{PUMP} = \frac{h_{2s} - h_1}{h_2 - h_1} \qquad (2)$$

The work input by the pump is:

$$W_{PUMP} = m(h_2 - h_1) \quad (3)$$

The exergy loss in the pump can be given as:

$$I_{PUMP} = W_{PUMP} + E_1 - E_2 \quad (4)$$

Process 2 to 3: This is the constant pressure heat absorption in the evaporator. The heat transferred from the waste heat to the working fluid is:

$$Q = m(h_3 - h_2) \quad (5)$$

If the internal heat exchanger is added, the amount of heat transfer is presented by:

$$Q = m(h_3 - h_{2a}) \quad (6)$$

The exergy loss in the evaporator can be given as:

$$I_{EVP} = E_{in} + E_2 - E_{out} - E_3 \quad (7)$$

Process 3 to 4: This is a non-isentropic expansion process in the turbine. Ideally, this is an isentropic process 3–4s. However, the efficiency of the energy transformation in the turbine never reaches 100%, and the state of the working fluid at the turbine outlet is indicated by state point 4. The isentropic efficiency of the turbine can be expressed as:

$$\eta_{TBN} = \frac{h_3 - h_4}{h_3 - h_{4s}} \quad (8)$$

The power generated by the turbine can be given as:

$$W_{TBN} = m(h_3 - h_4) \quad (9)$$

The exergy loss in the turbine can be given as:

$$I_{TBN} = E_3 - W_{TBN} - E_4 \quad (10)$$

Process 4 to 1: This is a constant pressure heat rejection process in the condenser. The exergy loss in the condenser can be given as:

$$I_{CDN} = E_4 - E_1 \quad (11)$$

The thermal efficiency of the ORC is defined on the basis of the first law of thermodynamics as the ratio of the net power output to the heat addition.

$$\eta_{thm} = \frac{W_{TBM} - W_{PUMP}}{Q} \quad (12)$$

The thermal efficiency cannot reflect the ability to convert energy from low grade waste heat into usable work. Therefore, we need to consider the exergy efficiency, which can evaluate the performance for waste heat recovery. The exergy efficiency of the ORC system can be given as:

$$\eta_{exg} = \frac{E_{in} - \sum I - E_{out}}{E_{in}} \quad (13)$$

5. HEAT POTENTIAN ESTIMATION

For a successful application of an ORC system the availability of an adequate heat source is crucial. In principal every heat generating process, such as burning fossil fuel, can be taken as heat source for ORC. However, the aim is to improve the energy efficiency and sustainability of new or existing applications with the focus on waste heat and renewable energy sources.

The energy-intensive sectors have been identified using online databases and available data on primary energy usage per sector and per country, see Figure 7. Three sectors have been identified as holding potential for the application of ORC power generation:

• The electricity and heat generation sector is the biggest consumer of primary energy (~38% of the world's total consumption) as well as the biggest emitter of waste energy (almost 50% of the world's rejected heat).

• The industrial sector (30%) closely follows, having the second biggest energy consumption. However the use of energy in the industry is more efficient than in other sectors, which in fine limits the waste heat.

• The transportation sector, although being the third biggest consumer of energy, is the second most important producer of waste heat. This is explained by the low efficiency of engines as well as the reduced load and usage factor of vehicles.

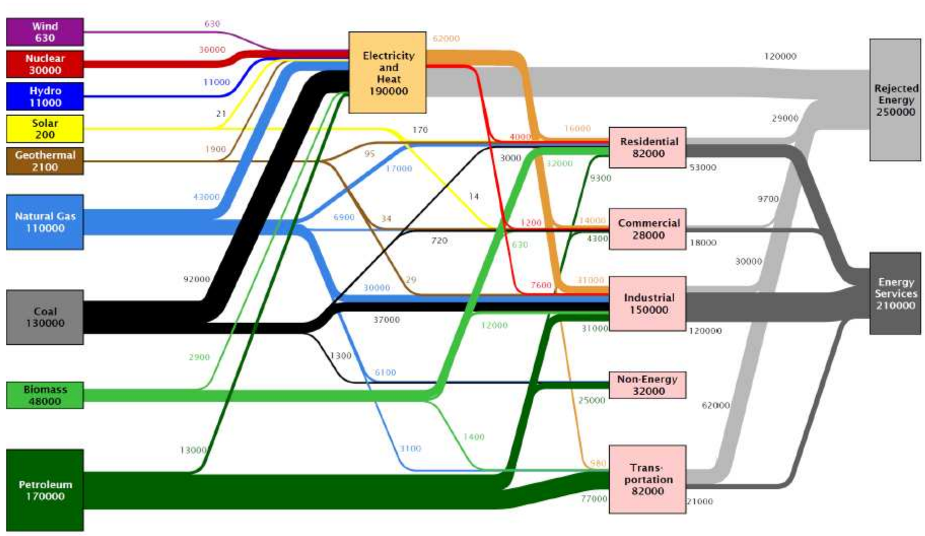

Figure 7. World energy flows (~490'000 PJ) [17]

6. CONCLUSIONS

There are several advantages in using an ORC to recover low grade waste heat, including economical utilization of energy resources, smaller systems and reduced emissions of CO, CO2, NOx and other atmospheric pollutants.

As one of the promising technologies of converting low-grade waste heat into electricity, the ORC system has been studied from different aspects. Working fluids researches [18-20] mainly focus on diverse screening and assessment criteria for dozens of organic fluid on performance of ORC system; performance analysis [21-23] focus on usable percentage of heat, output expansion power, recovery efficiency and exergy efficiency et al; System designs [24-25] based on scroll expanders, vapor injectors and dual loop ORCs; optimizations [17, 26-28] on parameters of turbine inlet pressure, evaporating temperature, pinch point temperature, heat transfer area et al.

Among all the existed waste heat recovery technologies, the Organic Rankine Cycle (ORC) is getting increasing attention with high efficiency, reliability and flexibility.

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ENERGY SAVING IN A HEATING BOILER

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ABSTRACT

Heating boilers loses much of the heat developed by the combustion evacuating flue gas at high temperatures. To recover as much of this heat, flue gas has to be cooled below the dew temperature using different systems. Selection of the heat recovery systems requires a thermodynamic and economic analysis. The most important parameters influencing the choice are: type of fuel, temperature of exhaust gases and boiler operating time. Heat recovery from the flue gas of a 2000 kW boiler using a heat pump with mechanical vapor compression increases the energy efficiency from 87% to 94% that means reduction of fuel consumption by 8.28%. The payback period is about 3.82 years.

1. INTRODUCTION

In 2009 the European Council made the objective for the EU to decarbonise its energy system to at least 80% below the 1990 level by 2050, without affecting general economic growth. A number of measures and technologies could contribute to these goals. Lowering the energy consumption in buildings combined with energy efficiency increase is essential. Reducing the total heat demand in Europe by approximately 30-50% leads to a price of sustainable heat supply lower than the price of further heat savings [1].

In Romania, the district heating systems based on cogeneration are used increasingly less due to the economic difficulties of citizens, being more and more used the individual heating systems and centralized heating systems that use boilers. It is known that these boilers have a low thermal efficiency due to loss of heat contained in the flue gas. Most boilers discharged flue gas at a temperature of (150-200)°C to avoid corrosion caused by condensation of water vapour present in the flue gas. In biomass boilers, flue gas condensation raises also the problem of fouling. By using materials like ceramic, aluminium, PTFE and stainless steel in condenser manufacturing the corrosion is avoided. Most of the heat exchangers must be cleaned periodically due to deposits [2, 3 and 4].

For an efficient heat recovery, combustion gases have to be cooled below the dew temperature of flue gas to recover as much of the latent heat, and sensible heat of the flue gas. The sensible heat varies almost linearly with the gas temperature. The latent heat can be recovered only if the flue gases are cooled below the dew temperature of the flue gas (Fig. 1).

The heat recovery systems with condensation are classified in passive condensation systems and active condensation systems [5]. As the cooling of flue gas below the temperature dew is not always possible due to the high temperature of the boiler return water, a heat pump is used which takes the low-temperature heat from combustion gases and transfers it at a higher temperature to return water. This system is called active because the additional energy input is necessary.

The flue gas condensers may be divided in indirect contact condenser, direct contact condenser, and recently developed transport membrane condenser. Indirect contact condensers recover the latent heat by passing flue gas through heat exchangers with condensation (pipe condenser, lamella condenser, combi condenser). In direct contact condensers cold water is sprayed into the flue gas to be condensed the contained water vapours losing their latent heat of vaporization, hence, vapours transfer their heat into water and the water becomes hot [6].

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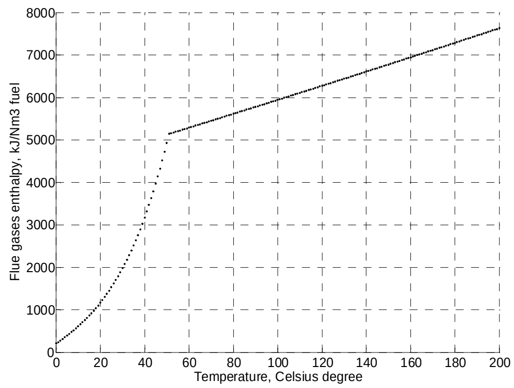

Figure 1: Enthalpy of flue gas vs. temperature (natural gas, air excess λ=1.15).

The energy efficiency can be increased by (10-15)% which leads to cost/energy saving of about 15% and a corresponding reduction in CO_2 emissions. The heat flux for a unit heat transfer area in the condensing heat exchanger is around (1.5-2.5) kW/m^2 depending on the material (stainless steel or carbon steel covered with polypropylene) [6].

2. THERMODYNAMIC MODEL

The flue gases enthalpy is calculated with the following equations:

- for temperatures above dew point:

$$h_{fg}(T) = m_{CO_2} h_{CO_2}(T) + m_{N_2} h_{N_2}(T) + m_{O_2} h_{O_2}(T) + m_{H_2O}\left[h_{H_2O}(T) + h_l\right] \text{ [kJ/Nm}^3\text{ fuel]} \quad (1)$$

- for temperatures below dew point:

$$h_{fg}(T) = m_{CO_2} h_{CO_2}(T) + m_{N_2} h_{N_2}(T) + m_{O_2} h_{O_2}(T) + m_{H_2Osat}\left[h_{H_2O}(T) + h_l\right] + \left(m_{H_2O} - m_{H_2Osat}\right) c_{pW} \cdot T \text{, [kJ/Nm}^3\text{ fuel]} \quad (2)$$

where: $m_{CO_2}, m_{H_2O}, m_{N_2}, m_{O_2}$ - mass of CO_2, H_2O, N_2 and O_2 in flue gas, [kg/Nm^3 fuel]; $h_{CO_2}(T)$, $h_{H_2O}(T)$, $h_{N_2}(T)$, $h_{O_2}(T)$ – enthalpy of CO_2, H_2O, N_2 and O_2 corresponding to the temperature T, [kJ/kg]; h_l – latent heat of water vapour, [kJ/kg]; h_l = 2502 kJ/kg;

m_{H_2Osat} - mass of water vapour in flue gas at saturation temperature T_s:

$$m_{H_2Osat} = x_{fgs} \cdot m_{fgd} \text{ [kg water/ Nm}^3\text{ fuel]} \quad (3)$$

$$m_{fgd} = m_{CO_2} + m_{O_2} + m_{N_2} \text{ [kg dfg/Nm}^3\text{ fuel]} \quad (4)$$

x_{fgs} – absolute humidity of flue gas at saturation:

$$x_{fgs} = 0.622 \frac{p_s}{p_{dfg}} \quad (5)$$

$$p_{dfg} = 1.013 \cdot 10^5 \frac{V_{CO2} + V_{O2} + V_{N2}}{V_{ga}} \quad (6)$$

$$p_s = 610.78 \cdot e^{17.2694 \frac{t}{(t+238.3)}} \quad (7)$$

c_{pw} – specific heat of liquid water, [kJ/kg·K]:

$$c_{pw} = 2820 + 11.82 \cdot T - 0.03502 \cdot T^2 + 0.00003599 \cdot T^3 \quad (8)$$

The dew temperature of flue gas can be calculated by the following equation [1]:

$$T_d = 1000/\left[2.20732 - 2.117187\cdot 10^{-1}\ln m - 2.166605\cdot 10^{-3}(\ln m)^2 + \right.$$
$$\left. +1.619692\cdot 10^{-4}(\ln m)^3 + 4.8998\cdot 10^{-5}(\ln m)^4 + 3.691725\cdot 10^{-6}(\ln m)^5\right] \quad [\mathrm{K}] \quad (9)$$

$$m = \frac{p_{H_2O}}{10};\ p_{H_2O} = 1.013\cdot 10^5 \frac{V_{H_2O}}{V_{ga}} \quad (10)$$

3. HEAT RECOVERY OF 2000 KW GAS BOILER BY COMPRESSION HEAT PUMP

The heating boiler with heat recovery system is schematically shown in Fig. 2. It comprises the combustion chamber, air fan, feed water pump and the high temperature heat pump as heat-recovery system. The fuel used is natural gas with higher heating value 39780kJ/Nm^3. The heating boiler power is 2000 kW. Its operation parameters without heat recovery are shown in Table 1.

Table 1: Operation data of the heating boiler.

Parameter	Value
Natural gas flow rate	0.0641 Nm^3/s
Combustion air flow rate	0.65 Nm^3/s
Air fan power, W_{AF}	4.5 kW
Feed water pump power, W_{FP}	10 kW
Water pressure	4 bar
Hot water temperature	95 °C
Return water temperature	65°C
Excess air	1.15
Flue gas temperature	140°C

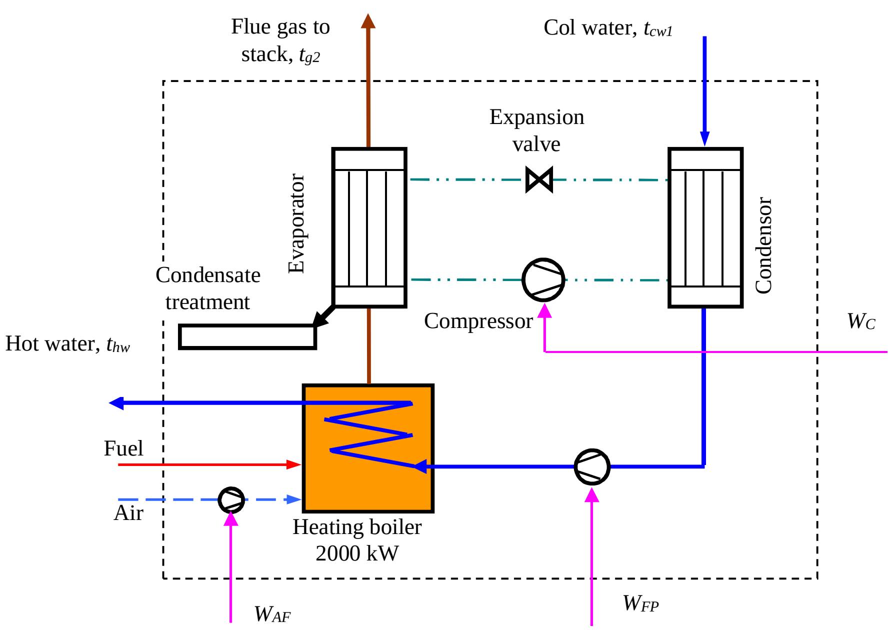

Figure 2: Schematic diagram of heating boiler with flue gas heat recovery.

Neglecting the loss in the environment, the equation of thermal balance of the pump can be written as follow:

$$\dot{Q}_{hp} = \dot{Q}_r + P_{hp} \quad (11)$$

where: $\dot{Q}_{hp}$ - heat flow rate transferred to return water; $\dot{Q}_r$ - heat flow rate recovered from the flue gas; P_{hp} – power of the heat pump.

The heat recovered from the flue gas by condensation is given by:

$$\dot{Q}_r = B\left[h_{fg}\left(T_{g1}\right) - h_{fg}\left(T_{g2}\right)\right], \text{ [kW]} \tag{12}$$

where: B – fuel flow rate, Nm³/s; $h_{fg}(T_{g1})$, $h_{fg}(T_{g2})$ – enthalpy of flue gas corresponding to the temperature T_{g1} at vaporiser inlet, and to the temperature T_{g2} at vaporiser outlet, respectively, kJ/Nm³ fuel. The enthalpy of flue gas corresponding to the temperature at boiler exit and stack is given in Tab. 2.

Table 2: Flue gas properties.

Temperature, °C	Flue gas enthalpy, kJ/kg	Absolute humidity, kg/kg
140	3990.91	0.080
40	1423.46	0.048

Temperature variation of water and flue gas is shown in Fig. 3.

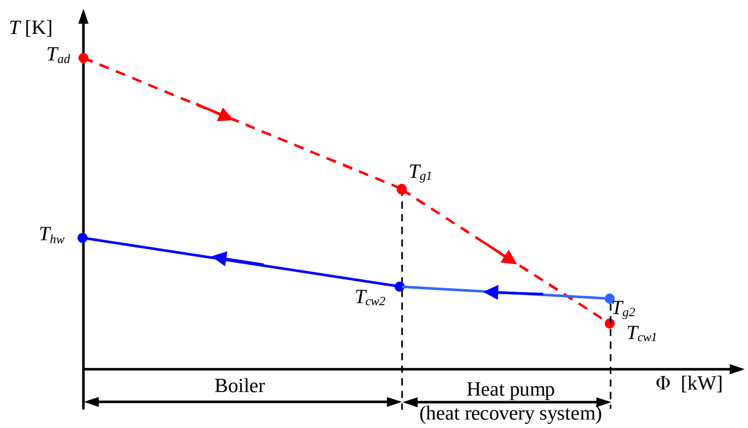

Figure 3. Temperature variation of flue gas and boiler water respectively.

The water temperature increase in heat pump can be found from the equation:

$$\dot{Q}_{hp} = \dot{m}_w\left[h_w\left(T_{cw2}\right) - h_w\left(T_{cw1}\right)\right] \tag{13}$$

where: T_{cw2} – temperature of return water at boiler inlet.

The performance coefficient of heat pump ($COP = \dfrac{\dot{Q}_{hp}}{P_{hp}}$) was chosen from Fig. 4 [17].

The calculation results are given in Tab. 3.

Table 3. Boiler performance.

Temperature of flue gas at stack (°C)	Boiler thermal efficiency (%)	Fuel flow rate, B (Nm³/s)	Heat flow rate recovered from flue gas (kW)
140	87.50	0.0641	0
40	94.16	0.0592	164.57

In Figures 5 and 6 are shown the exergy flows in boiler and boiler with heat recovery.

Considering the boiler operation period of 2186 hours per year (13.33 hours/day, 6.89 days/week, 5.91months /year) the saved gas is 38 561 Nm³/year and the saved cost is 6654.75EUR/year (difference between the saved cost with fuel and the supplementary cost with electricity for heat pump drive).

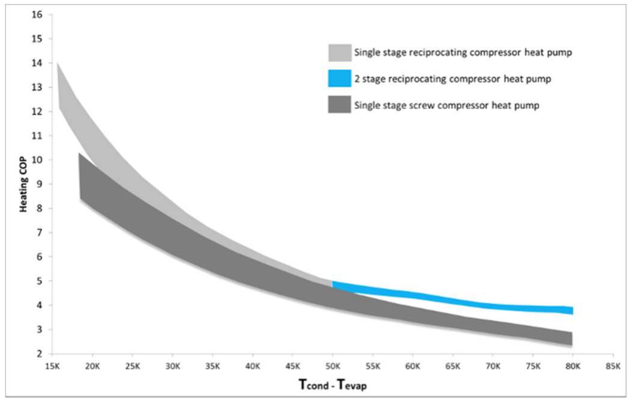

Figure 4. Heating coefficient of performance [16].

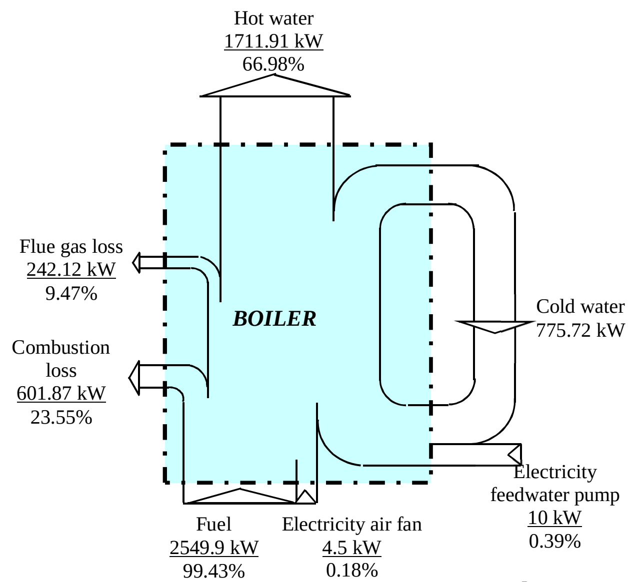

Figure 5. Exergy flows in boiler – Grassmann diagram.

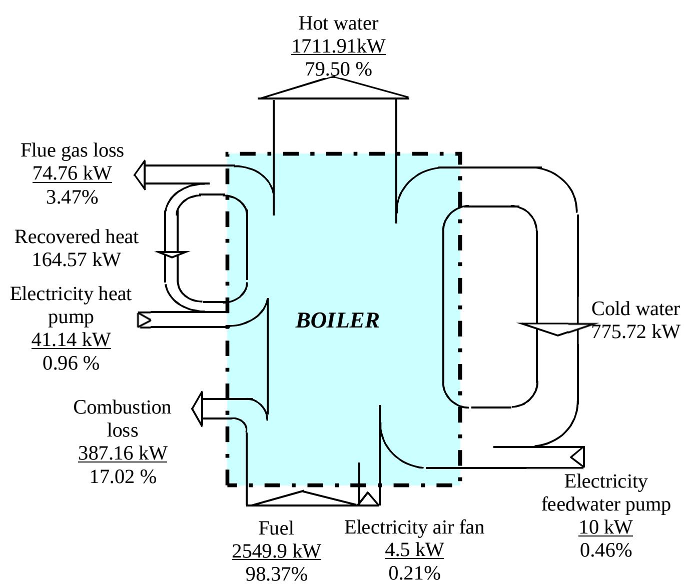

Figure 6: Exergy flows in boiler with flue gas condensation –Grassmann diagram.

There some information on the cost of residential heat pump and very few on industrial heat pumps. In paper [19] the cost of industrial pumps is estimated at 620 EUR/kW and the maintenance at 7 EUR/kW. In these conditions the payback period is about 3.82 years.

4. CONCLUSIONS

In order to choose the heat recovery system of a heating boiler, a thermodynamic and economic analysis is necessary. For the studied case, the use of heat pump with mechanical compression of vapours increases the energy efficiency from 87% to 94.16%, leading to fuel savings of 8.28%. The payback period is about 3.82 years.

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EXPERIMENTAL ANALYZE OF THE HYDROGEN IMPACT OF SOLID BIOMASS COMBUSTION FOR THE DEVELOPMENT OF INNOVATIVE EFFICIENT TECHNOLOGIES

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ABSTRACT

The paper deals with experimental tests of hydrogen (pure or mixed) injection in the combustion of solid biomass. The researches regard the development of innovative efficient technologies for solid biomass combustion.

Keywords: biomass, hydrogen diffusion, combustion, experimental tests.

1. INTRODUCTION

Research and development of a more sustainable energy economy (sources, carriers and storage) is one of the most important tasks in the scientific world. The hydrogen economy is considered by many to be a possible approach to satisfy the future energy needs [1]. The characteristics of hydrogen (virtually inexhaustible, no harmful emissions and various methods for its production) make it a promising option. The utilization of hydrogen (pure or mixed) to the biomass combustion has the role to improve the combustion conditions and to increases the reaction rate. Furthermore, this fact influences the CO, SO_2 and NO_x concentrations [2]. The biomass studied in the paper is: sawdust, chopped wood, straw briquette, ropes of wine and cobs corn.

2. EXPERIMENTAL TESTS

With all the technological progress of the last period, the burning of biomass solid presents still a drawback related to high emissions of CO. In this phase of researches the gas is injected directly into the boiler system, in primary air. Combustion tests have been realized on the 2 MW (thermal) pilot furnaces belonging to the Politehnica University of Bucharest (Figure 1). In this case was used a mixture of hydrogen, named hydrogen enriched gas (HRG) for making the transition to real conditions and lower costs. The hydrogen enriched gas (HRG) is produced by an electrolytic system (Figure 2). This electrolytic system is a dynamic one, keeping the fluid in a permanent flow and it is producing a quasi-stoechiometric gaseous mixture of hydrogen and oxygen. In fact this gas consists of a mixture of hydrogen and oxygen molecules, almost respecting the stoechiometric water ratio [3]. HRG is a gas with a high degree of reactivity which, by adsorption, diffuses into the biomass. Thus, the ignition and combustion rate are improved and the pollutant emissions are reduced. HRG is a colorless gas which has a density of 0.503 kg/m^3, molecular weight 12.3 kg/kmol, auto-ignition temperature 591 - 605 °C and flammability limit concentration between 7.3 – 100 %. The free diffusion process (equation Legendre) is the basis for HRG/porous biomass combustion technology. Maximum capacity of producing HRG is 1500 litters/h. Electricity consumed to produce 1000 litters of HRG is between 3 – 3.5 kWh. This means approximately 0.4 Euro/1000 litters.

This injection, follow that through very high speed burning hydrogen to improve the combustion of solid phase kinetics, with direct control over the oxidation of carbon monoxide. HRG injection in solid biomass contributes to reducing the carbon monoxide concentration (OH radical having leading role) by reactions [4]:

$$CO + OH \rightarrow CO_2 + H; \quad H + O_2 \rightarrow OH + O; \quad O + H_2O \rightarrow 2OH. \tag{1}$$

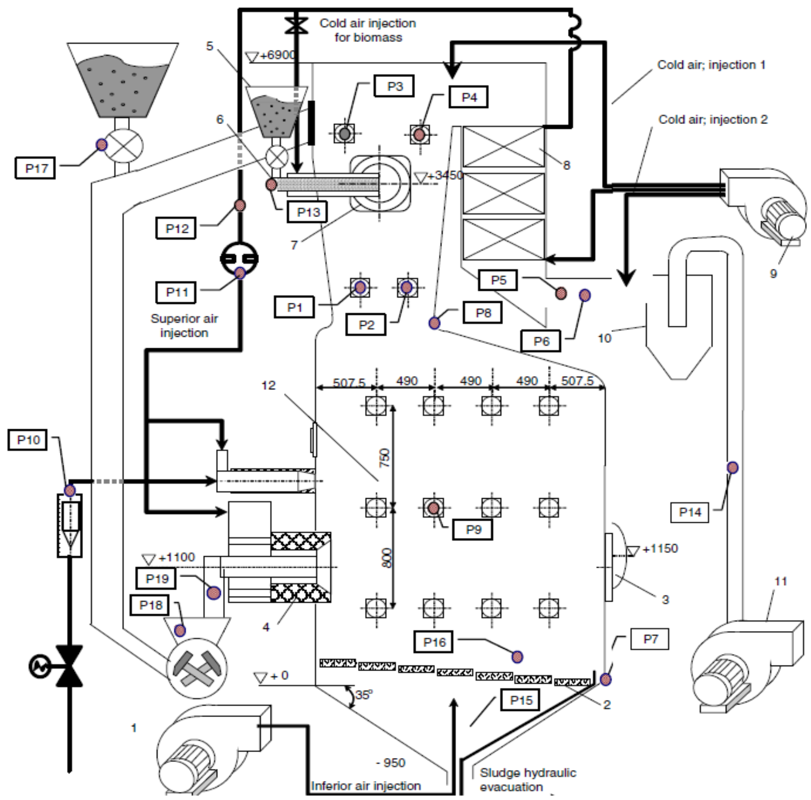

Figure 1. Pilot installation of 2 MWt used to test the co-combustion process:
1, cold air ventilator; 2, post combustion grate; 3, visit hole; 4, main burner; 5, biomass bunker; 6, biomass feeding installation (screw feeder); 7, biomass feeding orifice; 8, tubular air preheated; 9, main air ventilator; 10, flying ash; separator; 11, flue gas ventilator; 12, furnace; P10, natural gas injection; P2, P5, P9, test tubes; P1, P3, P4, P6, P7, P8, P11…P19, measurement points (flow, temperature, pressure).

Figure 2. HRG gas generator

Figure 3. HRG injection in primary air of biomass combustion

This research follows the dynamics of combustion on the grid of various qualities of solid biomass, under the influence of the introduction of the gas HRG in the primary air blew under the grill. The grate was built with fixed bars and is located in the cold funnel of furnace [5]. The air introduction under the grate is made with a special fan. The injection of HRG was made on the primary air entry, as shows Fig. 3.

3. RESULTS

The researches were conducted in the following order: 1- sawdust; 2- chopped wood; 3- straw briquette; 4- ropes of wine; 5- cobs corn. The main energetic characteristics of the studied type of solid biomass (the calorific power Q_i^i, the moisture W_t^i and the ash A^i) are presented in Table 1. During the experiments was kept a thermal power of the boiler of 400 kW, achieved by variations of the fuel flow. The interval of fuel flow it was included between 0.22 kg/s for fuel no.1 and 0.030 kg/s for fuel no.5 depending on the calorific power. Pollutant emissions were measured with a gas analyzer (HORIBA PG 250) positioned at 1.5 m above the grate and with MULTILYSER analyzer set after flue gas fan (at the end of boiler), Figures 4.

Table 1.The main characteristics of type of solid biomass

Biomass type	**Parameter**	**Value**
1-Sawdust	Q_i^i (kJ/kg)	16,500
	W_t^i (%)	14
	A^i (%)	2.5
2- Chopped wood	Q_i^i (kJ/kg)	17,500
	W_t^i (%)	10.5
	A^i (%)	

		0.5
3- Straw briquette	Q_i^i (kJ/kg) W_t^i (%) A^i (%)	14,700 10.2 4.7
4- Ropes of wine	Q_i^i (kJ/kg) W_t^i (%) A^i (%)	13,600 16.1 4.9
5- Cobs corn	Q_i^i (kJ/kg) W_t^i (%) A^i (%)	13,150 8 5

Figure 4. Location of HORIBA gas analyzer (above the grate)

Figure 5. Location of MULTILYSER gas analyzer (end of the boiler)

4. CONCLUSIONS

All experimental tests have had initially a phase oh combustion without HRG injection and a phase with HRH injection. Following the assessment made in this paper it can concluded:

- a reduction of CO emission from 1,556 to 980 ppm for fuel no.1; the boiler efficiency, η=76-81%;
- a reduction of CO emission from 890 to 158 ppm for fuel no.2; the boiler efficiency, η=86.9-91.2%;
- a reduction of CO emission from 2,370 to 1,700 ppm for fuel no.3; the boiler efficiency, η=63.4-67.7%;
- a reduction of CO emission from 2,530 to 1,790 ppm for fuel no.4; the boiler efficiency, η=76.7-78.6%;
- a reduction of CO emission from 2,500 to 1,300 ppm for fuel no.5; the boiler efficiency, η=70.5-74.8%.

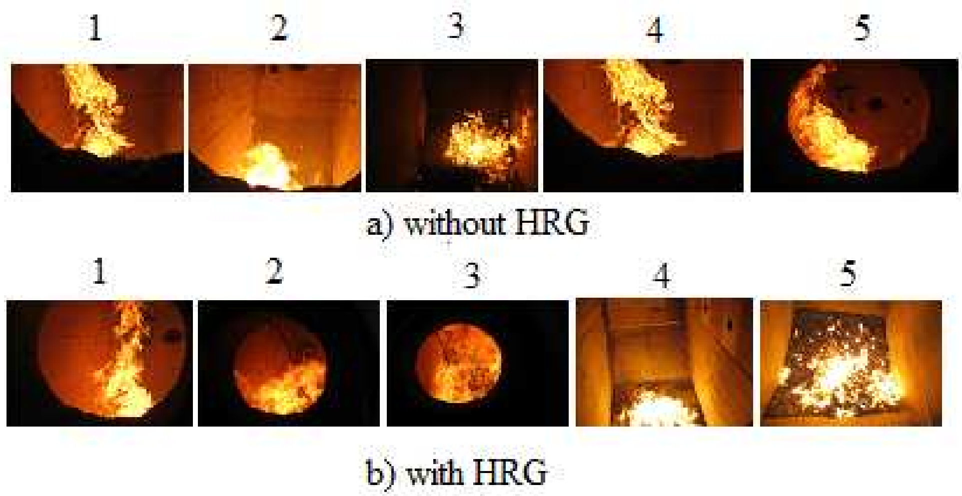

Figure 5. The combustion flame for different solid biomass

It is noted that significant emission reductions of CO is for the using of solid fuels wood derivates, where the results are spectacular. In Figure 5 is shown the aspect of the flame in situation without injection and with HRG injection. Order figures follow the order of combustion fuels. It observe a decrease in the length of flames in case of HRH injection, explicable by increasing the intensity of combustion processes in the area of the layer fuel, hydrogen being characterized by a very high speed of combustion.

ACKNOWLEDGEMENTS

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INVESTIGATION OF REFRIGERANT MASS FLOW RATE EFFECT ON ORGANIC RANKINE CYCLE PERFORMANCE

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ABSTRACT

In this paper, the effect of refrigerant mass flow rate on performance of an Organic Rankine cycle system (ORC) is investigated. The waste heat from Diesel engine is used as a heat source in ORC. The heat source simulates the operation of an electric generator equipped with an internal combustion engine (ICE). The heat rate value is 9.872 kW for 50% load, 14.58 kW for 75% load and 20.25 kW for 100% load. R245fa is selected as the working fluid. The results show that there is optimum refrigerant mass flow rate for each heat source. The refrigerant mass flow rate values are 0.03106, 0.04571 and 0.06327 kg/s for 50%, 75% and 100% load respectively. The optimum value of thermal efficiency for ORC is 12.13%.

1. INTRODUCTION

The use of waste heat is a method to improve the efficiency of thermal systems, especially of internal combustion engines. Many studies analyzing the ORC performances have been conducted recently [1–7]. The mass flow rate of refrigerant is one of the most important parameters in the operation of an ORC system. In these studies is not dealt with this parameter. So, the study in this paper is focused on this point. This paper is a complement study to previous work [8]. Mathematical model is developed to study the effect of referigerint mass flow rate varation on ORC performance.

2. SYSTEM DESCRIPTION

The schematic of an ORC for exhaust heat recovery of a diesel engine is shown in Figure 1a. The pressure of fresh air is increased by the compressor. Then, the air enters the engine cylinders, which combusts with the injected fuel. After expanding in the cylinders, the high temperature gas is exhausted to the turbine to be expanded further. In the turbine outlet, the temperature of the exhaust gas is still high between 320 °C and 480 °C depending on the load variations [8]. This high-temperature waste heat can be used as a heat source for ORC, for evaporating the working fluid in the evaporator. The evaporator, which will be used in this study, is a counter - flow type. Figure 1b shows T-s diagram for ORC.

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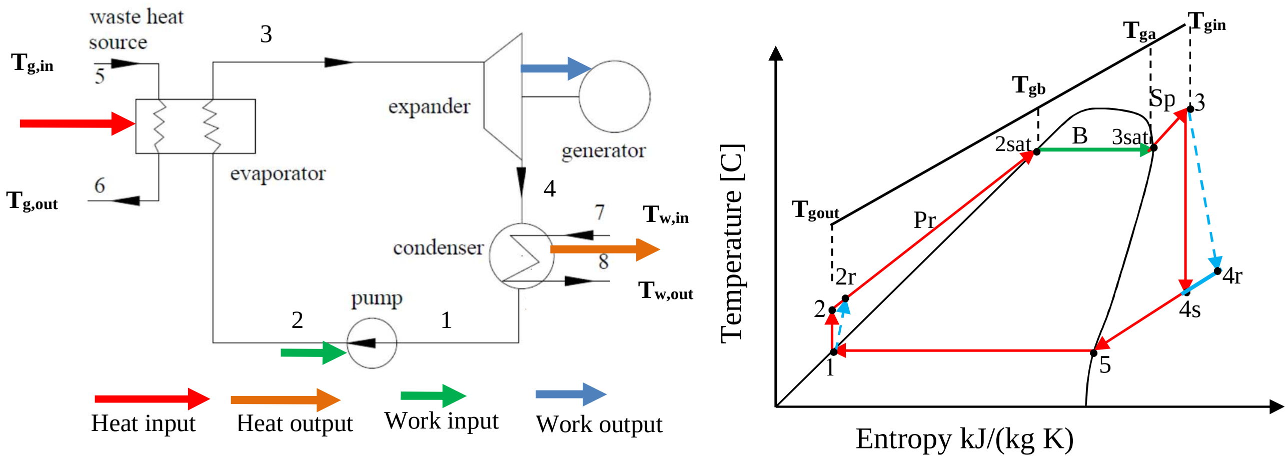

a) b)

Figure 1. a) Schematic diagram of the ORC system and b) T-s diagram for ORC.

3. MATHEMATICAL MODEL

The mathematical model was developed based on a set of thermodynamic equations written for ORC system. Firstly, the thermodynamic properties of the exhaust gas are calculated depending on the temperature of exhaust gas and percentage of components for flue gas [9]. Secondly, all properties of points (1 to 5) are obtained depending on thermodynamics equation [10].

According to the energy balance, the heat rates of preheater, boiler and superheater zone are calculated as follows:

$$\dot{Q}_{pr} = \dot{m}_{ref}\left(h_{2sat} - h_2\right) = \dot{m}_g\, cp_g\left(T_{gb} - T_{gout}\right) \quad (1)$$

$$\dot{Q}_{b} = \dot{m}_{ref}\left(h_{3sat} - h_{2sat}\right) = \dot{m}_g\, cp_g\left(T_{ga} - T_{gb}\right) \quad (2)$$

$$\dot{Q}_{sp} = \dot{m}_{ref}\left(h_3 - h_{3sat}\right) = \dot{m}_g\, cp_g\left(T_{gin} - T_{ga}\right) \quad (3)$$

where $\dot{m}_{ref}$ is the refrigerant mass flow rate, $\dot{m}_g$ is the heat source mass flow rate, c_{pg} is the specific heat of exhaust gas, T_{gin}, T_{gout}, T_{ga} and T_{gb} are temperature of exhaust gas at inlet, outlet, point (a) and point (b) respectively. h_2, h_{2sat}, h_{3sat} and h_3 enthalpy of point (2), (2sat), (3sat) and (3) respectively (see Figure 1). The ORC model parameters are shown in table1.

Table (1) ORC model parameters.

Parameter	Symbol	Value	Units
Optimum evaporation pressure	P_3	32.57	Bar
Evaporator area	A_e	2.189	m^2
Condenser area	A_c	2.458	m^2
Exhaust gas mass flow rate	$\dot{m}_g$	0.0475-0.053	kg/h
Inlet exhaust gas temperature	T_{gin}	327-477	°C
outlet exhaust gas temperature	T_{gout}	140	°C
Expander efficiency	η_{ex}	0.7	—
Pump efficiency	η_p	0.8	—
Mass fraction for (CO2)	g_{CO2}	9.1	%
Mass fraction for (H2O)	g_{H2O}	7.4	%
Mass fraction for (O2)	g_{O2}	9.3	%
Mass fraction for (N2)	g_{N2}	74.2	%

The heat rate for each load is calculated by summation of heat rate in each zone for evaporator as follows equation:

$$\dot{Q}_{add} = \dot{Q}_{pr} + \dot{Q}_{b} + \dot{Q}_{sp} \tag{4}$$

where $\dot{Q}_{add}$ is the total heat rate for evaporator, $\dot{Q}_{pr}$ is the heat rate for the preheater zone, $\dot{Q}_{b}$ is the heat rate for the boiler zone, $\dot{Q}_{sp}$ is the heat rate for the superheater zone.
The turbine work can be expressed as:

$$W_t = \eta_{ex} \cdot \dot{m}_{ref} \cdot (h_3 - h_4) \tag{5}$$

where W_t is the turbine power, η_{ex} is the expander efficiency, h_3 and h_4 are the enthalpies of inlet and outlet turbine respectively.
The pump work can be expressed as:

$$W_p = \dot{m}_{ref} \cdot \frac{(h_2 - h_1)}{\eta_p} \tag{6}$$

Where W_p is the pump power, η_p is the pump efficiency, h_1 and h_2 are the enthalpies of inlet and outlet pump respectively.
The work net can be calculated by:

$$W_{net} = W_t - W_p \tag{7}$$

Where W_{net} is the net power of ORC.
Thermal efficiency can be expressed as:

$$\eta_{th} = \frac{W_{net}}{\dot{Q}_{add}} \cdot 100 \tag{8}$$

Where η_{th} is the thermal efficiency of ORC.
Finally, the heat rejected can be calculated by:

$$\dot{Q}_{rej} = \dot{m}_{ref} (h_{4r} - h_1) \tag{9}$$

Where $\dot{Q}_{rej}$ is the heat rejected in the condenser, h_{4r} and h_1 are the enthalpies of inlet and outlet condenser respectively.

3. RESULTS

Based on the mathematical model, a program has been developed in EES [10]. The program input data is from Table 1. The results are presented in Figures (2-10). From Figures 2, 3 and 4, it can be observed that the work net value has optimum value. Depending on the load the refrigerant mass flow rate values are 0.03106 kg/s, 0.04571 kg/s and 0.06327 kg/s for 50% load, 75% load and 100% load respectively.

Figures 5, 6 and 7 show effect of refrigerant mass flow rate on heat rejected. The minimum value for heat rejected in condenser was according to the optimum values for refrigerant mass flow rate.

Thermal efficiency of ORC as shown in Figures 8, 9 and 10 has been a value of 12.13% for all loads for the same optimum values of refrigerant mass flow rate.

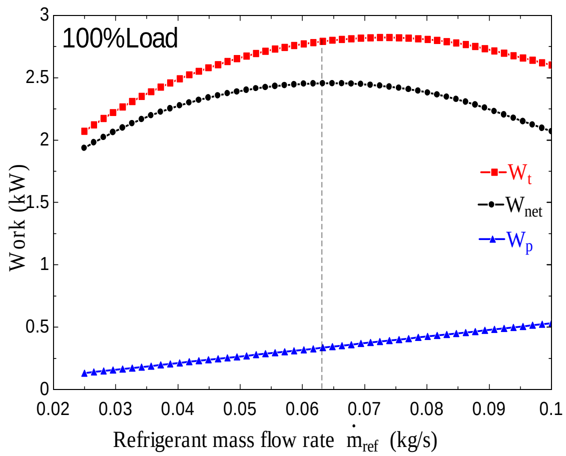

Figure 2: Turbine work, work net and pump work for 100% load.

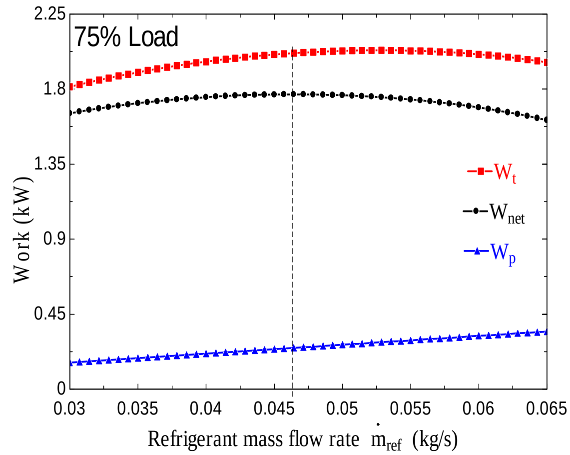

Figure 3: Turbine work, work net and pump work for 75% load.

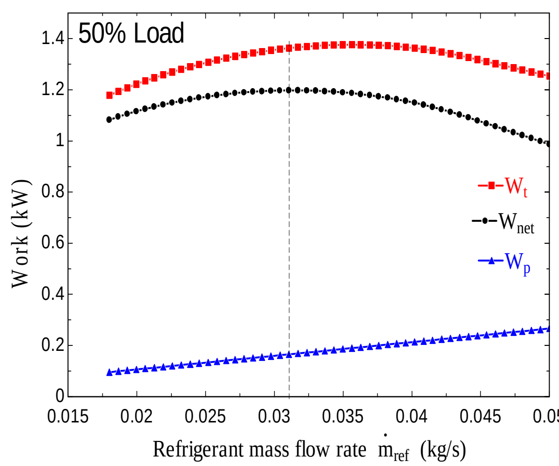

Figure 4: Turbine work, work net and pump work for 50% load.

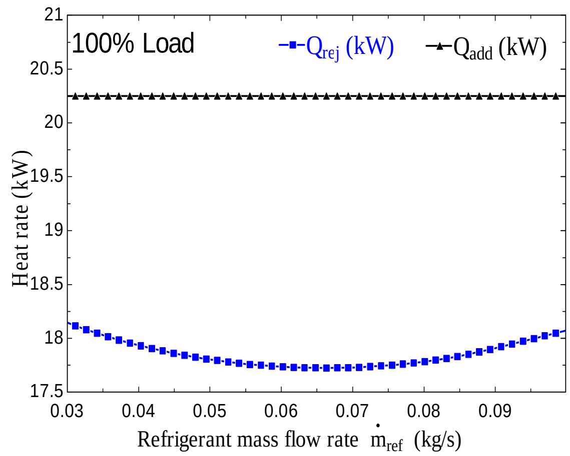

Figure 5: Heat rate add to the evaporator and heat rate rejected for 100% load.

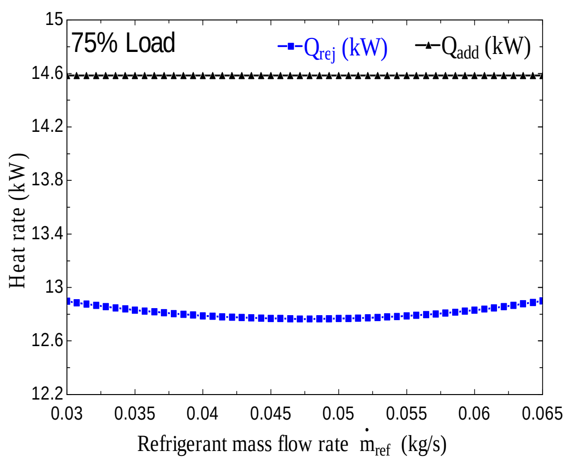

Figure 6: Heat rate add to the evaporator and heat rate rejected for 75% load.

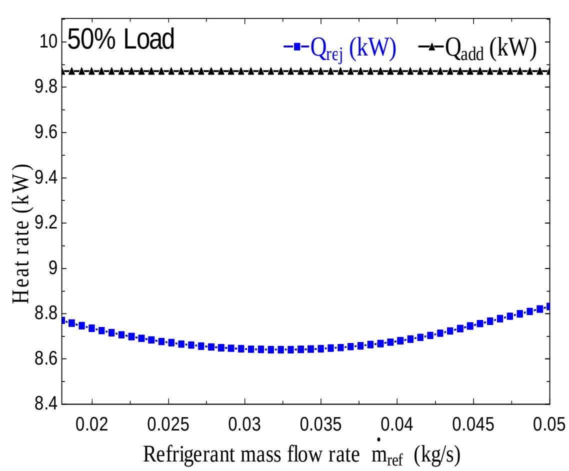

Figure 7: Heat rate add to the evaporator and heat rate rejected for 50% load.

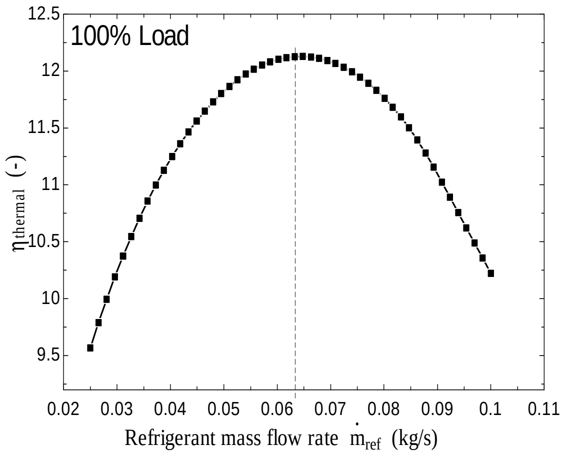

Figure 8: Thermal efficiency for 100% load.

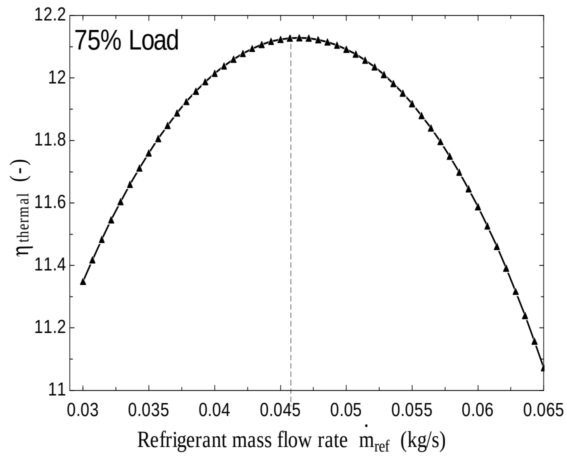

Figure 9: Thermal efficiency for 75% load.

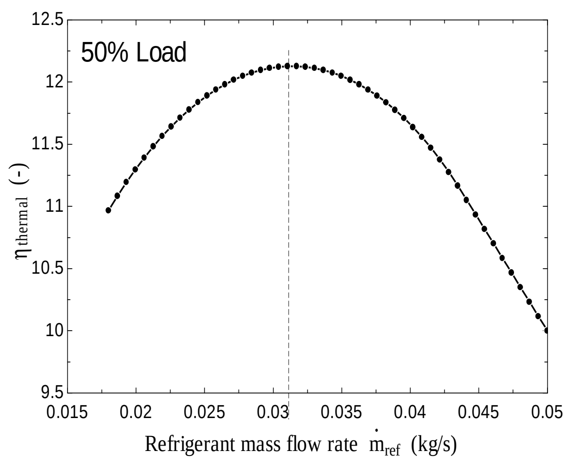

Figure 10: Thermal efficiency for 50% load.

4. CONCLUSIONS

Effect of refrigerant mass flow rate variations on ORC performance is investigated in this paper. The investigation included 50% load, 75% load and 100% load. The results show that there is optimum value for mass flow rate for refrigerant depending on load percentage. The value of mass flow rate for refrigerant between 0.03106 and 0.06327 kg/s. Thermal efficiency of ORC was not affected by mass flow rate variations. The optimum thermal efficiency value is 12.13%.

Acknowledgments

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SIMULATION COMPARISON OF THE PLUME RISE USING ANSYS CFD-CFX AND AERMOD MODEL

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ABSTRACT

Different types of models can be used to simulate the pollutants dispersion into the atmosphere. This work presents a comparison between two dispersion models of pollutants in the atmosphere, from stationary emission sources, namely AERMOD Model and ANSYS CFX. Air quality model can be an adequate tool for future air quality prediction, also atmospheric observation supporting and emission control strategies responders.

1. INTRODUCTION

Air Quality Modeling is an attempt to predict or simulate the ambient concentrations of contaminants in the atmosphere. These models are used primarily as a quantitative tool to correlate cause and effect of concentration levels found in an area. They are also used to support laws and/or regulations designed to protect air quality. The models have been the subjects of extensive evaluation to determine their performance under a variety of meteorological conditions [1], [2]. Meteorology plays an important role in the dispersion of effluents. Various meteorological factors affect the dispersion of emission into the atmosphere in a variety of ways. One of the most important meteorological variables responsible for high ground level concentrations is the height of convective boundary layer (or mixing height) [3], [4].

2. MARERIALS AND METHODS

2.1. AERMOD Model

The AERMOD Gaussian model is a steady-state plume model. In the stable boundary layer, it assumes the concentration distribution to be Gaussian in both the vertical and horizontal. In the convective boundary layer, the horizontal distribution is also assumed to be Gaussian, but the vertical distribution is described with a bi-Gaussian probability density function. The AERMOD incorporates current concepts about flow and dispersion in complex terrain [5]. AERMOD is a steady-state plume model. In the stable boundary layer (SBL), it assumes the concentration distribution to be Gaussian in both the vertical and horizontal. In the convective boundary layer (CBL), the horizontal distribution is also assumed to be Gaussian, but the vertical distribution is described with a bi-Gaussian probability density function (pdf) [6], [7].

Using a relatively simple approach, AERMOD incorporates current concepts about flow and dispersion in complex terrain. Where appropriate the plume is modeled as either impacting and/or following the terrain. This approach has been designed to be physically realistic and

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simple to implement while avoiding the need to distinguish among simple, intermediate and complex terrain, as required by other regulatory models. As a result, AERMOD removes the need for defining complex terrain regimes. All terrain is handled in a consistent and continuous manner while considering the dividing streamline concept in stably stratified conditions [8]. Gaussian plume models for predicting pollutants concentrations from point and are sources can be described by the following equations [9]:

For point source:

$$C = \frac{Q_p}{\pi \sigma_y \sigma_z u} exp\left(-\frac{y^2}{2\sigma_y^2}\right) exp\left(-\frac{H^2}{2\sigma_z^2}\right) \tag{1}$$

For area source:

$$C = \frac{Q_A}{2\pi u} \int \frac{V}{\sigma_y \sigma_z} \left(\int exp\left[-\frac{1}{2}\left(\frac{y}{\sigma_y}\right)^2 \right] dy \right) dx \tag{2}$$

whereC is the downwind pollutants concentration, Q_p the point source pollutants emission rate, Q_a the area source pollutant emission rate, σ_z, σ_y, the Pasquill-Gifford plume spread parameters based on stability class, u the average wind speed at pollutant release height, H the effective height above ground of emission source, V the vertical term used to describe vertical distribution of the plume, x the upwind direction, and y the cross wind direction.

2.2.ANSYS CFX Model

ANSYS CFX software is able to solving complex and diverse three-dimensional fluid flow problems. To describe the fundamental processes of momentum, mass transfer and heat, it used the Navier-Stokes equations. The software contains a number of mathematical models that can be used with Navier-Stokes equations to describe other chemical or physical processes, such as combustion, turbulence or radiation. It uses a finite volume approach to convert partial differential equations in a discrete system of algebraic equations by discretizing the computational domain into finite elements. These equations lead to a solution with specified domain boundary conditions. For a transient simulation, initial conditions are also required to numerically close the equations. One of the most important features of CFX is that it uses a coupled solution requiring less iteration to achieve convergence solution [10], [11].

The Navier-Stokes equations are as follows:

-Navier-Stokes equation (by function k) in the x direction

$$\begin{aligned} \frac{\partial \rho U}{\partial t} + \frac{\partial(\rho UU)}{\partial x} + \frac{\partial(\rho UV)}{\partial y} + \frac{\partial(\rho UW)}{\partial z} &= \frac{\partial p}{\partial x} + \frac{\partial}{\partial x}\mu_e \frac{\partial U}{\partial x} + \frac{\partial}{\partial y}\mu_e \frac{\partial U}{\partial y} + \frac{\partial}{\partial z}\mu_e \frac{\partial U}{\partial z} + \frac{\partial}{\partial x}\mu_e \frac{\partial U}{\partial x} + \frac{\partial}{\partial y}\mu_e \frac{\partial V}{\partial x} \\ &+ \frac{\partial}{\partial z}\mu_e \frac{\partial W}{\partial x} - \frac{\partial}{\partial x}\frac{2}{3}\rho k \end{aligned} \tag{3}$$

- Navier-Stokes equation (by function k) in the y direction

$$\frac{\partial \rho V}{\partial t}+\frac{\partial(\rho UV)}{\partial x}+\frac{\partial(\rho VV)}{\partial y}+\frac{\partial(\rho WV)}{\partial z} \tag{4}$$
$$=\frac{\partial p}{\partial y}+\frac{\partial}{\partial x}\mu_e\frac{\partial U}{\partial x}+\frac{\partial}{\partial y}\mu_e\frac{\partial U}{\partial y}+\frac{\partial}{\partial y}\mu_e\frac{\partial U}{\partial z}+\frac{\partial}{\partial x}\mu_e\frac{\partial U}{\partial y}+\frac{\partial}{\partial y}\mu_e\frac{\partial V}{\partial y}$$
$$+\frac{\partial}{\partial z}\mu_e\frac{\partial W}{\partial y}-\frac{\partial}{\partial y}\frac{2}{3}\rho k$$

- Navier-Stokes equation (by function k) in the z direction

$$\frac{\partial \rho W}{\partial t}+\frac{\partial(\rho UW)}{\partial x}+\frac{\partial(\rho VW)}{\partial y}+\frac{\partial(\rho WW)}{\partial z} \tag{5}$$
$$=\frac{\partial p}{\partial Z}+\frac{\partial}{\partial x}\mu_e\frac{\partial U}{\partial x}+\frac{\partial}{\partial y}\mu_e\frac{\partial U}{\partial y}+\frac{\partial}{\partial x}\mu_e\frac{\partial U}{\partial z}+\frac{\partial}{\partial y}\mu_e\frac{\partial U}{\partial z}+\frac{\partial}{\partial z}\mu_e\frac{\partial V}{\partial x}$$
$$+\frac{\partial}{\partial z}\mu_e\frac{\partial W}{\partial x}-\frac{\partial}{\partial x}\frac{2}{3}\rho k$$

3. RESULTS

3.1. ANSYS CFX simulation

For modeling the dispersion of the pollutants in the atmosphere by a chimney with ANSYS CFX five steps are required. Table 1 present the simulation steps.

Table 1: ANSYS CFX simulation steps

Components	Parameters
Geometry creation	3D geometry (CHP and obstacles)
Meshing	Mesh shape and size
Pre-processing domain	Fluid properties
	Turbulence model
Pre-processing atmosphere boundary	Fluid compositions
	Wind direction and velocity profile
	Temperature profile
	Turbulence profile
Pre-processing CHP chimney boundary	Fluid composition
	Gases evacuation velocity
	Gases temperature
	Turbulence
Pre-processing ground boundary	Influence
	Surface

In Figure 1 and Figure 2 are presented the evolution of the plume in post-processing step. The five steps for modeling the dispersion of pollutants in the atmosphere are: creating the geometry, meshing, pre-processing, solving and post-processing. To configure the simulation only the first three steps are considered. In post-processing can simulate rise of the plume, vectors contour, velocity and pressure distribution gradient, volume rendering, and there is virtually no limit to the post-processing possibilities in ANSYS CFD-Post. For a continuous view of the evolution and rise of the plume can export the simulation by creating a video using the animation function, where can set up the animation speed by increasing or decreasing the number of frames. To a better view is recommended to set the animation speed to a larger number of frames.

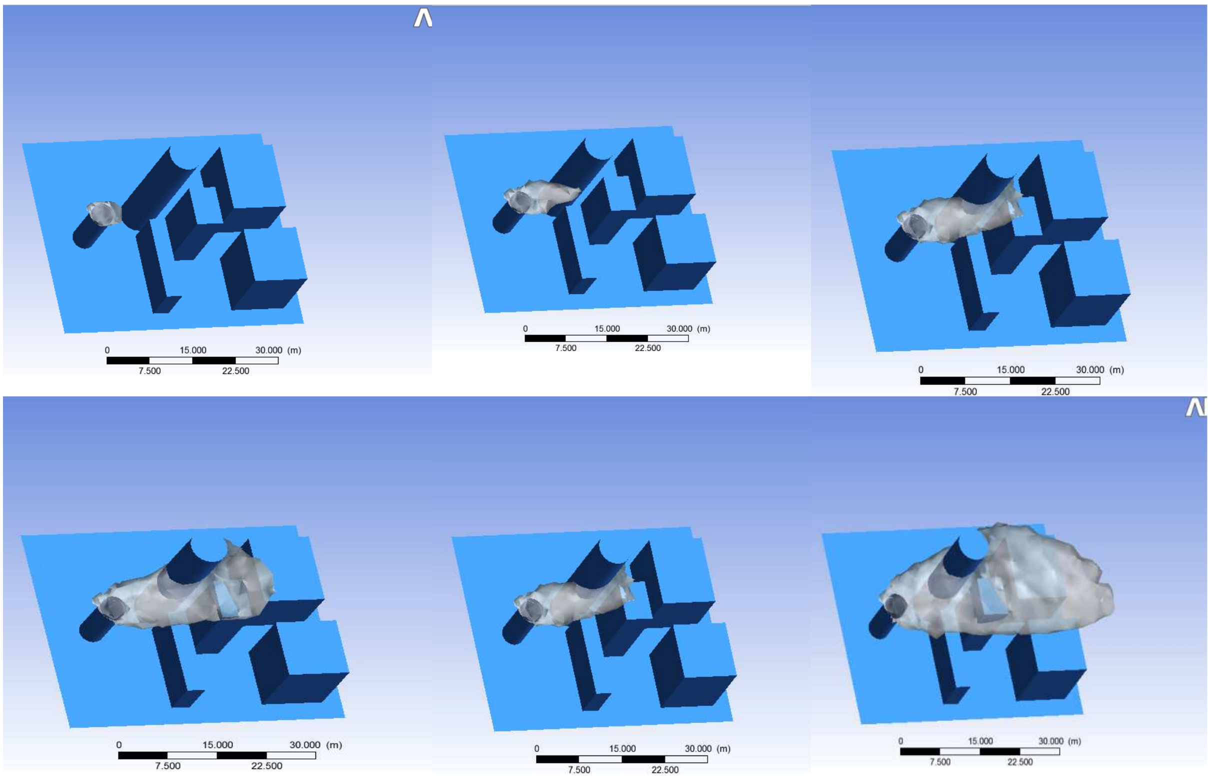

Figure 1: Evolution of the plume- view 1

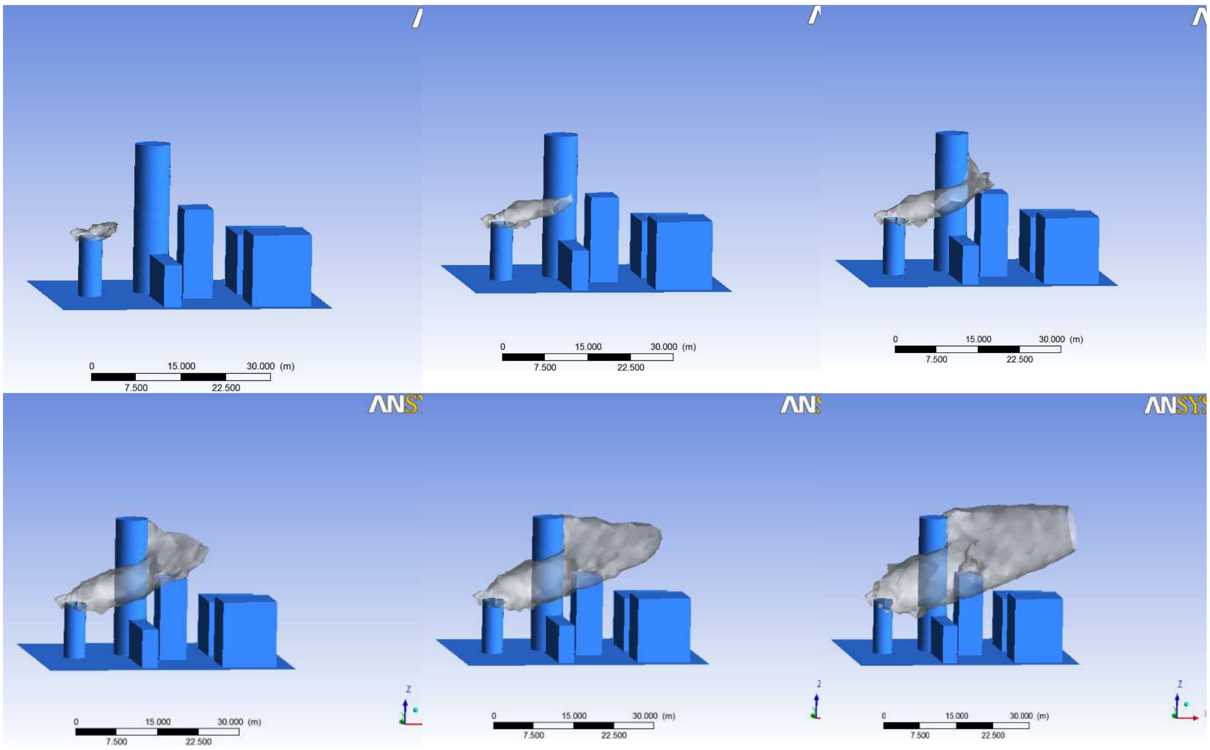

Figure 2: Evolution of plume- view 2

3.2. AERMOD Simulation

The module AERMET uses meteorological data and surface characteristics to calculate boundary layer parameters such as mixing height and friction velocity, needed by AERMOD. Data must be representative of the meteorology in the modeling domain irrespective of whether it is on-site or off-site data. The modeling may be performed using the usual x-y coordinate system or the Universal Transverse Mercator (UTM) system. A typical x-y coordinate system is not based on a geographic standard. Figure 3 represents the simulation of the plume.

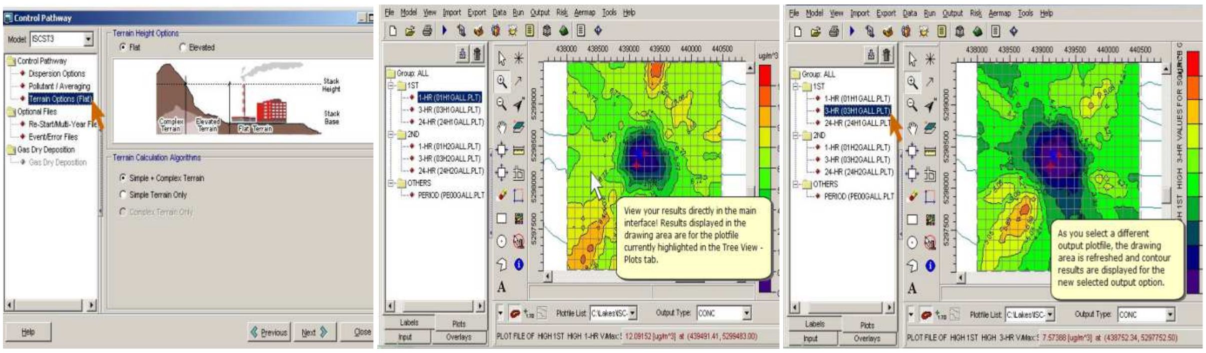

Figure 3: Evolution of pollutants dispersion

4. CONCLUSION

The AERMOD model is the most used model to modeling the pollutants in the atmosphere, is easy to use and the system requirements are not very high. ANSYS CFD-CFX is complex software and to a better simulation result and a quick computing time is recommended to use a performing system.

Acknowledgment

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BURNER RETROFIT SOLUTION FROM CHP ISALNITA FOR STAGGERED COMBUSTION WITH LOW EMISSION OF NOx

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A. Adam, Cr. Mândrean, I. Bărbieru, V. Gherghina

Following the positive results on reducing NOx emission obtained by testing the combustion of coal dust by combustion theory in steps, it could be detached the final solution for retrofitting of the existing industrial burners.

The boiler of 525 t/h construction MAN has 6 slots burners tangential mounted to the firebox. Each burner is connected with a mill-fan in a direct injection system. For drying the coal, the grinding system includes one pre-drying tower for each mill - burner ensemble, the drying being carried out based on flue gas recirculation at the end of the firebox.

The burner retrofit solution is based on previous research results, materialized in the construction of an experimental model burner of 400 kW, which was tested at coal combustion from Oltenia basin on a pilot boiler from UPB. The pilot burner had two slots coal and two air intakes, secondary and tertiary respectively, thus simulating an industrial burner module - fig.1

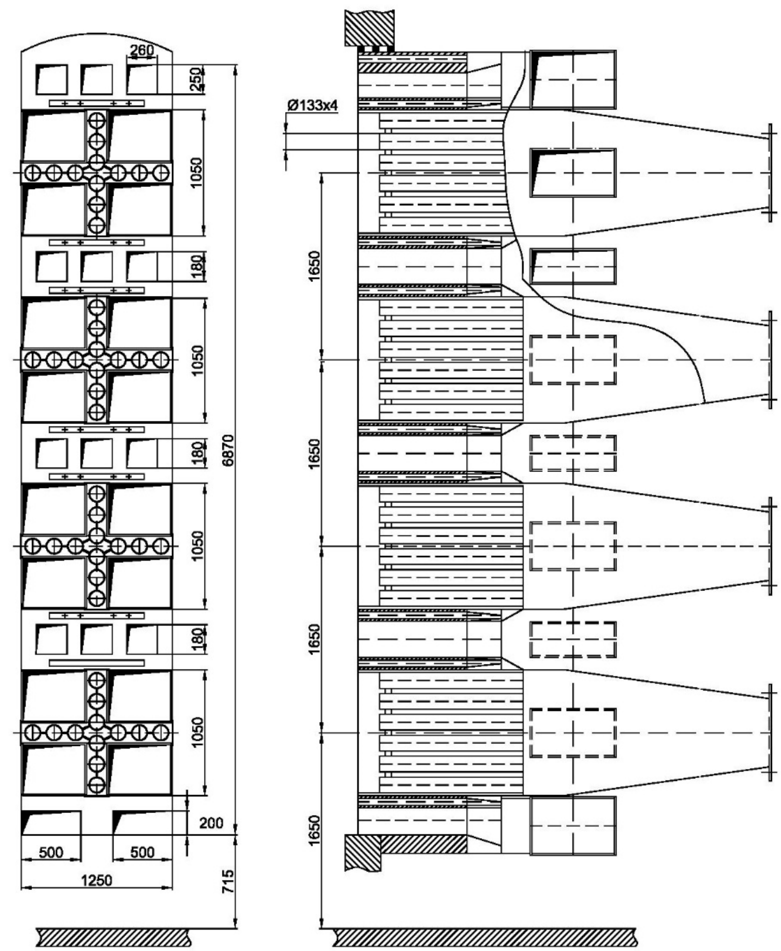

Fig.1.The burner of coal dust from boilers 525 t / h SE Isalnita

Constructive, the retrofitting starts from the burner modular design concept – fig.1, this having 4 modules of four slacking slots, two vertical and two horizontal, and secondary intermediate air blown through pipes forming a cross framing the four slacking slots - fig.2

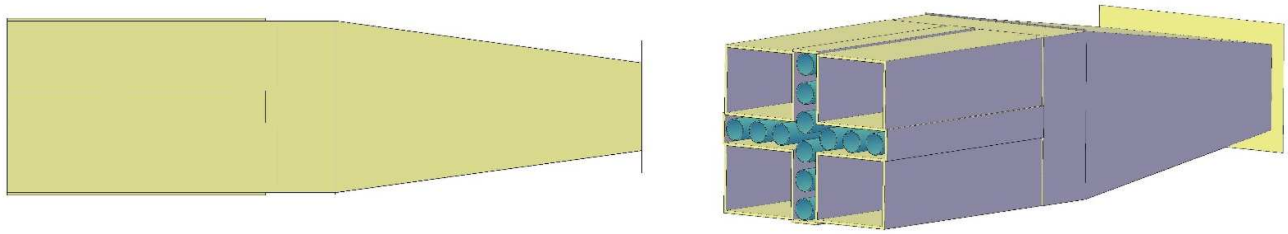

Fig.2.The burner module subjected to retrofitting

The implementation concept of stepwise combustion for burner module, includes a sequential routing of jets penetration in the furnace space, for the maintenance with secondary air to be realized towards the firebox core, the deficit of air in the first sequence of combustion limiting the emission of oxides of nitrogen.

This will be achieved by shifting the length of the inlet channel for routing the coal dust and the intermediate secondary air. As a result, a burner module will have channels of different lengths , arranged between them so that the air – gasodynamic control be more beneficial to low NOx combustion .

The modular construction performed will be repeated four times at the height of the firebox.

Retrofitting will achieve:

- maintaining the output speeds for both primary air and coal dust and secondary air;
- framing the new burner construction in embrasure boiler ;
- the compatibility of slacking circuits and secondary air with networks around the burner ;

Modification constructive solution of the burner keeps the following aerodynamic characteristics for nominal regime:

- The primary air and coal dust velocity ;
- The secondary air velocity; 45 m / s;
- The secondary air pulse on a burner module 300 kgm / s;
- The primary air power, coal dust for a slot: 96 kgm2 / s3;
- The secondary air power on a burner module: 700 kgm2 / s3.

The impulse was determined by the relationship, $I=\rho F w^{2,}$ and the energy by the relationship $E=0.5Iw$ (where ρthe density in kg / m3, and w is is the velocity of the fluid).

The change, conceptual and geometrical, is based on the experimental researches achieved with a pilot burner on a wind tunnel and on an experimental boiler at the Polytechnic University of Bucharest.

As a result, the new geometry will include:

- The maintaining of the channels represented by the lower slots of coal dust of the same length as the original burner ;

- The extension of the second air channels represented by the 6 lower pipes of the same length as the original burner;
- The extension of the rest of the secondary air of the burner module with a length of 180 mm ;

In Figure 3, it is presented the structural modification for a burner module.

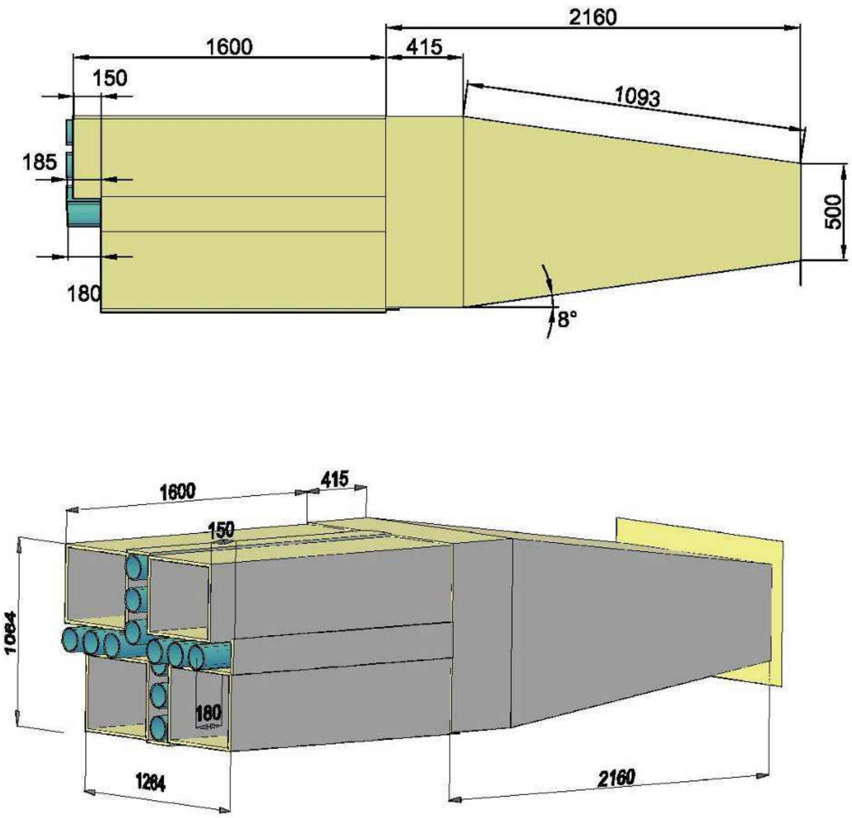

Fig.3 The burner module retrofits detail

Retrofitting does not include the removal from the assembly of the burner; the changes could be made at a time of stopping of the installation. The materials used will have a high temperature resistance but the welded assembly to be easily achievable.
It should be mentioned that secondary air pipes are less cooled by air with temperatures above 2500C, than the primary air channels and coal dust that has temperature below 1200C.

However, by their large size 0.5 x 0.5 m, the primary air channels and coal dust will receive more heat by radiation from the flame, so that it requires a heat resistant metal.

Upper and lower secondary air does not change the output support, of considerations:

- Cooling the periphery of flame
- Control of combustible material which falls to funnel cold of the firebox.

4. ACKNOWLEDGMENT

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ASPECTS OF THE HYDROGEN USE AT A TRUCK COMPRESSION IGNITION ENGINE

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ABSTRACT

The use of hydrogen, due to its good combustion proprieties, ensures continuous improvement of the energetic performance and pollution of internal combustion engines. The paper presents the results of experimental researches conducted on a truck compression ignition engine fuelled with diesel fuel and hydrogen in addition in different proportions at engine load of 70% and speed of 1400 rpm. The hydrogen is injected into the intake manifold. The presented experimental results show that the engine fuelled with hydrogen in addition at fuel diesel has better energetic and pollution performance than the standard diesel engine. Are shown the influences of hydrogen addition on engine operate.

1. INTRODUCTION

Special attention is given to reducing pollutant emissions; these emissions are the effect of fuel combustion imperfection. The main pollutants of diesel engine are: unburned hydrocarbons, HC, carbon monoxide CO, nitrogen oxides, NO_x, particles, PM, smoke and carbon dioxide CO_2 which has greenhouse effect. A special legislation is promoted today to limit the pollutants emissions by implementing of new active and passive control methods. The strategies used for reducing environmental pollution led to straitening the researcher's attention to using alternative fuels [1-3], like hydrogen.

The hydrogen does not contain sulfur and carbon in its composition, this lowering pollutants emission considerably, in particular at small and medium engine loads. Hydrogen has high resistance to self ignition, which prevents its use as fuel unique in diesel engine, a ignition source being required [4-7]. One of the methods of hydrogen use recommended for diesel engines is the diesel-gas method.

The hydrogen is injected into the intake manifold, the hydrogen-air mixture with a great homogeneity being ignited by the flame initiated by self ignition of diesel fuel injected into the cylinder.

The experimental researches conducted on compression ignition engine fuelled with hydrogen and diesel highlighted some specific aspects compared to diesel fuelled engines: the engine specific power increases with 10-15% compared to using only diesel fuel, [8]; the efficiency increases at partial engine loads with about 5% to using diesel fuel [8]; pollutants emissions decrease. The results of experimental research show so the engine operate improvement at the amount of hydrogen increase that replaces the diesel fuel, due to homogenization of air-fuel mixture, as so an increase of the maximum pressure during combustion, without that their level to reach high values that would jeopardize the security and silence of engine running [9].

At the hydrogen-gas oil fuelled engine operate CO, HC and smoke emissions level has a lower level than the standard diesel engine because of a better combustion, the lower carbon content in air-fuel mixture and higher homogeneity of air-hydrogen mixture [8]; the emissions level of CO2 has a slight increase [10],[11]. Naber explains the increasing concentration of CO_2, through the condensation of water vapour which result from the hydrogen burning in greater quantities, on the exhaust way, decreasing the total flow of exhaust gas assessed.

NO_x emissions level grows at the increase hydrogen addition in particular at high loads because the temperature in the engine cylinder is bigger than NO_x formation temperature [12]. N. Saravanan [12] and M. Younkins [13] have found that NO_x emissions level decreases with about 14% at the engine fuelling with hydrogen in small quantities (up to 15% energetic of replace of diesel fuel) at small engine loads, because of the shorter duration of the high temperatures developed in the engine cylinder, avoiding the formation of NO_x emissions. At bigger amounts of hydrogen use, the NO_x emissions level increases compared to the level of emissions of a standard diesel engine because of the maintenance in time of high temperatures in the cylinder.

In this paper are presented the some results of experimental researches done on a diesel engine truck, powered by adding hydrogen at load of 70% and speed 1400 rpm.

2. EXPERIMENTAL RESEARCH

The experimental research has been followed on the D2156 MTN8 engine at the operating regimen of 70% load - 84 ±2% kW - engine speed of 1400 ±2% rpm and normal thermal regimen (80 - 90 ^{0}C cooling agent temperature). The engine was mounted on a test bench equipped with an eddy-current dynamometer and appropriately instrumented with: data acquisition system, thermometers, thermocouples, thermo resistances and manometers monitoring the engine functional parameters, air flow meter, hydrogen flow meter, gas-oil consumption device and gas analyzer.

3. RESULTS AND DISCUSSIONS

The engine was fuelled firstly only fuel diesel, then with diesel fuel and hydrogen in addition at different rate between 9.9 L/min and 39.7 L/min corresponding some percents of substitute energetic ratios of diesel fuel by hydrogen of 0.8%, 1.61%, 2.42% and 3.15%.

The percents of diesel fuel substitute ratios with hydrogen being small, the maximum pressure slightly increases fig.1 due to the increase of the amount of fuel which burns in the pre mixed combustion faze and of the auto ignition delay decrease comparison to diesel fuel engine. The minimum brake specific energetic consumption is smaller than one of diesel fuel engine with ~6.5%, fig 2, due to combustion improvement.

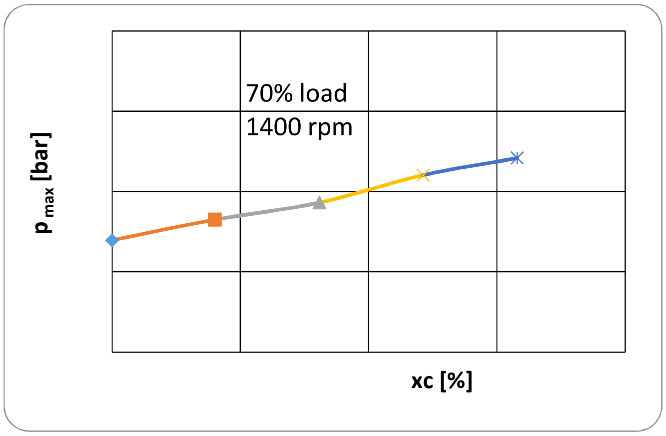

Fig. 1 Maximum pressure vs. different substitute ratios **x_c**

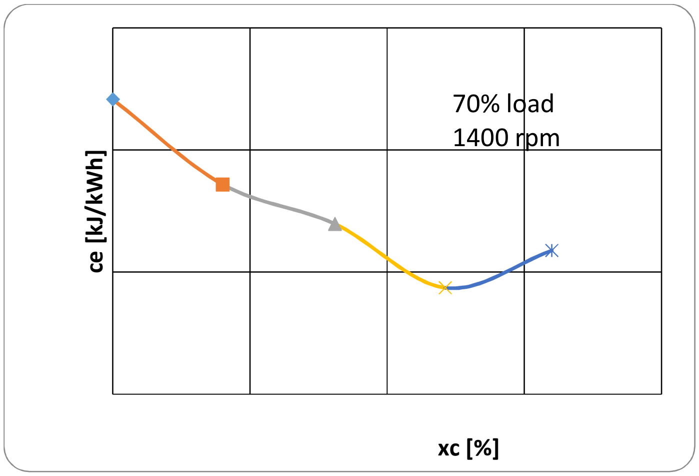

Fig. 2 Break Specific Energetic Consumption vs. different substitute ratios **x_c**

Fig. 3 shows the variation of NO_x emissions level. With hydrogen-diesel oil dual fuelling operation mode NO_x emissions level decreases with 10% comparative to diesel engine at 70% load for a 1.61% percent of substitute ratio of diesel fuel by hydrogen. Similar results were obtained and by other researchers. Thus, Tomita et al [11] have reported considerable reductions in NO_x emissions level at the engine operate with hydrogen addition.

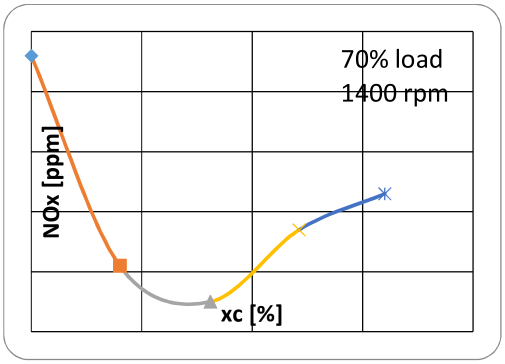

Fig.3 NO_x emission level vs. different substitute ratios **x_c**

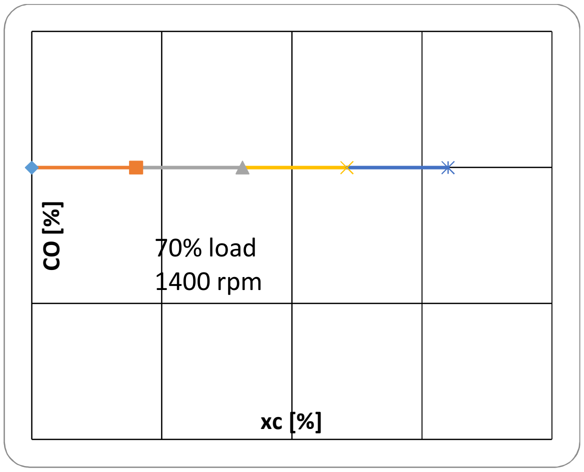

Fig.4 CO emission level vs. different substitute ratios $\mathbf{x_c}$

The authors explication regarding the NO_x emissions level decrease at the engine operate with small hydrogen quantities in addition is the fact that though the hydrogen burns fast and the temperature increases is avoided NO_x emissions formation due to a shorter duration of the combustion and high temperatures are registered only for short time ~2 ms.

The variation of carbon monoxide emissions level with different substitute ratios is shown in fig. 4, emission level being constant.

The variation of HC and smoke emissions level is shown in fig. 5, 6. The HC and smoke emissions level slowly decreases comparative to diesel fuelled engine due to combustion improvement and better homogeneous fuel-air mixture.

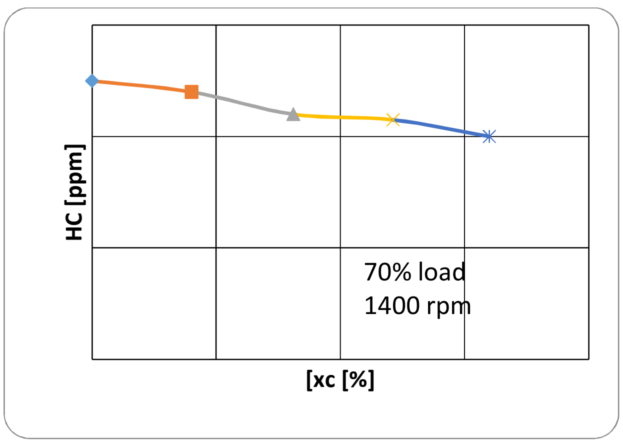

Fig. 5 HC emission level vs. different substitute ratios $\mathbf{x_c}$

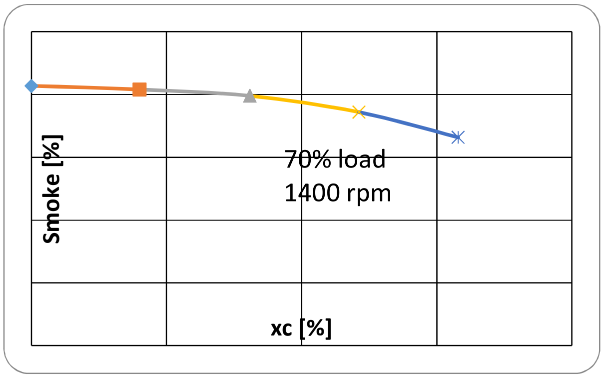

Fig. 6 Smoke emission level vs. different substitute ratios $\mathbf{x_c}$

Fig. 7 CO_2 emission level vs. different substitute ratios $\mathbf{x_c}$

The variation of carbon dioxide emission level with different substitute ratios is shown in fig. 7, emission level being near constant, at the same value diesel engine specific.

4. CONCLUSIONS

Experimental investigations were conducted on a truck diesel engine with hydrogen in addition injected in the intake manifold, under constant load and speed engine operation (70% load and 1400 rpm). The engine was fuelled with diesel fuel and hydrogen at different rate between 9.9 L/min and 39.7 L/min representing percents of substitute energetic ratios of diesel fuel by hydrogen of 0.8%, 1.612%, 2.42% and 3.15%.

The following conclusions could be formulated:

- the decrease of the minimum brake specific energetic consumption by about 8 % compared to standard diesel engine
- decrease with 12% of NO_x emissions level comparative to diesel engine for a 1.61% percent of substitute ratio of diesel fuel by hydrogen
- smoke emission level slowly decreases at the hydrogen addition increase compared to standard diesel engine
- HC emissions level increases at the hydrogen addition increase compared to standard diesel engine
- hydrogen in addition at diesel fuel is a promising alternative fuel for compression ignition engines

Acknowledgements

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INFLUENCE THE METHOD TO REGULATE THE COLD POWER AND EXTERNAL CONDITIONS ON THE EFFICIENCY OF TWO-STAGE REFRIGERATION COMPRESSORS

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ABSTRACT

In modern conditions of development segment economic activity, which uses artificial cooling, often arise situations where refrigeration for long enough function in modes other than nominal. This, as a rule, linked to the nature of implementation and commissioning of the facility, including, refrigeration plant. For large objects (industrial, commercial, residential, administrative) the volume of investments is large, which economically significantly - lucrative investment is phased investment in construction. In this case, situations arise when between the time of initial commissioning of the equipment and the full completion of the construction work goes a long time.

1. INTRODUCTION

At the present time, the following ways of regulating cold generation of refrigeration compressors:

- Amendment effective swept volume (excluding cylinders);
- Regulation by он - off the compressor;
- Throttling suction refrigerant vapor;
- Amending the frequency of rotation of the motor (frequency regulation).

Evaluate the effectiveness of regulation cold generation is through construction dependency changes relative power indicator on the compressor of its relative performance. At the same time it is taken into account only the energy performance of the subject, namely, the power indicator and the indicator efficiency, which allows to evaluate the thermodynamic perfection of one or another way of regulating, but not taking into account the change of capital and operating costs, and other factors, for example, increased exports of equipment and, as a consequence, an abbreviation of the term of operation, features technological regimes for specific users of artificial cooling. In this connection, evaluation regulating cold generation in the way "start - stop" and frequency regulation constitutes inappropriate for the following reasons:

- In the case of the use frequency control substantially increased capital cost, this is associated with the installation of additional equipment for the speed variation of rotation of the motor. Furthermore, this method has a significant drawback - deviation of the county rate of optimum value, especially in Lower speeds, i.e. in a small performance. When this increase in relative losses as volumetric and the energy performance of the compressor
- In the regulation by on - off the compressor is decreased the duration of operation of the motor, which is related to the frequent impact of the windings of the higher starting currents. Also, in this method of adjustment is not always possible to accurately maintain the temperature regimes with fewer loads independent of the thermal inertia of the system.

2. METHODOLOGY

The equations describing the thermodynamic state of the working medium in the compressor during the work cycle $p/d\varphi 1=p(\varphi 1)$, $dT/d\varphi 1=T(\varphi 1)$ и $dT_м/d\varphi 1=T_м(\varphi 1)$ [2] conducted floodgate regulation and regulation by throttling the suction vapor refrigerant from the low pressure cylinder:

To determine cold generation of the compressor can be represented in the following form:

$$Q_0 = G.q_0 = \frac{\lambda.V_m}{v_1}.q_0\,, \qquad (1)$$

where Q_0 - production of cold power compressor kW;

G - mass flow of refrigerant in the compressor, kg/s;

q_o - production of cold-specific for the given cycle, kJ/kg;

λ - coefficient of submission of the compressor;

V_m - theoretical volumetric flow compressor, m^3/s;

v_1 - specific volume of vapor suction, m^3/kg.

As seen from the formula (1) in regulating cold power is amended importance of cash flow mass flow of refrigerant in the compressor at the same time the value of the specific production of cold remains unchanged as it is characteristic of the thermodynamic cycle, not only for the compressor.

Meaning for adjusting a throttle of the intake consists in the fact that artificially lowering the pressure at the inlet to the compressor. This actually leads to a reduction coefficient of submission of the compressor and to increase the specific volume of vapor suction. When the value of the theoretical volumetric flow rate remains constant V_m = const, since it is a design feature of the compressor. On the coefficient of filing, it decreased significantly from overheating the collected steam from missed field compression in the regulatory process.

On figures 1 and 2 are presented dependencies of change indicator of the relative power of the compressor by adjusting the degree of cold generation for two ways of regulation in different modes of operation of the refrigeration machine based on the developed mathematical model [3]. Furthermore, this provides the ideal case of regulation, where a reduction in capacity of the compressor corresponds to a reduction in its productivity.

As seen from the figures adduced, during operation of the low-temperature mode, the effectiveness of suction throttling increases. To see the reasons for this, imagine the power indicator on the compressor in the following form:

$$N_i = \frac{N_S}{\eta_i} = \frac{G.l_S}{\eta_i} = \frac{\lambda.V_m.l_S}{v_1.\eta_i} \qquad (2)$$

where l_s - specific izoentropy (adiabatic) power to compress refrigerant vapor, kJ/(kg.K);

η_i - indicator efficiency of the compressor.

As is known in lowering the suction pressure increases specific izoentropy work for compression and specific volume of vapor suction and coefficient of filing and efficiency indicator decreased.

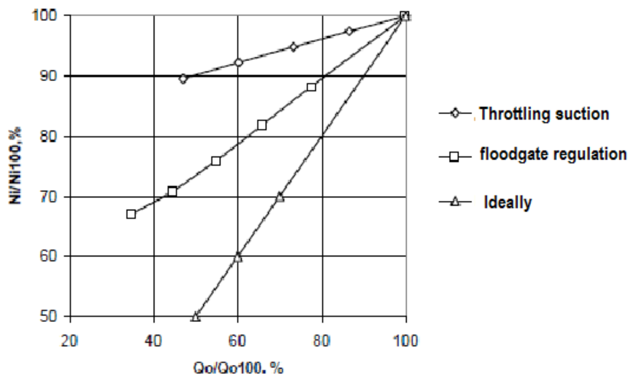

Fig.1 Depending on the relative power indicator of the f the two-stage production of cold refrigerant compressor in different ways to regulate: t_0 =-6,5 °C, T_K = 36.3 °C, ε_G = 3,0

Relative reduction of power indicator in regulation:

$$\frac{N_i}{N_{i,100}} = \frac{\lambda . l_S}{\nu_1 . \eta_i} \cdot \frac{\nu_{1,100} . \eta_{i,100}}{\lambda_{100} . l_{S,100}} = \frac{\lambda}{\lambda_{100}} \cdot \frac{l_S}{L_{S,100}} \cdot \frac{\nu_{1,100}}{\nu_1} \cdot \frac{\eta_{i,100}}{\eta_i} \tag{3}$$

Relative decrease cold power

$$\frac{Q_0}{Q_{0,100}} = \frac{\lambda}{\nu_1} . \frac{\nu_{1,100}}{\lambda_{100}} = \frac{\lambda}{\lambda_{100}} . \frac{\nu_{1,100}}{\nu_1} \tag{4}$$

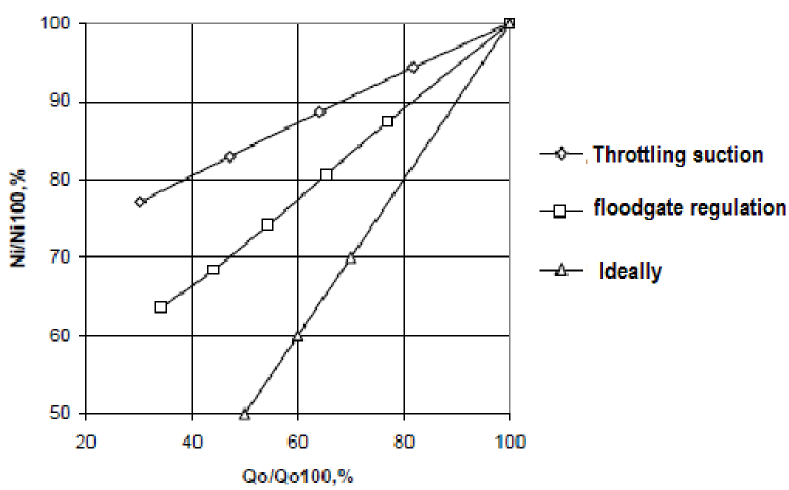

Fig.2 Depending on the relative power indicator of the f the two-stage production of cold refrigerant compressor in different ways to regulate: t_0 = -14,5 ºC, t_K=37 ºC, ε_G = 4,0

The degree of thermodynamic perfection adjustable cold generation can be estimated using the relationship of the magnitudes ($N_i/N_{i,100}$) and ($Q_0/Q_{0,100}$). Moreover, as the low - this respect, the better - less power is consumed when operating below full capacity, i.e. increase the effectiveness of the adjustment. Parameter k_R = 1 for the ideal case of regulation, where a reduction in the productivity corresponds to the reduction capacity of the compressor, and - large values in the other cases.

$$k_R = \left(\frac{N_i}{N_{i,100}}\right) / \left(\frac{Q_0}{Q_{0,100}}\right) = \frac{l_S}{l_{S,100}} . \frac{\eta_{i,100}}{\eta_i} \tag{5}$$

Analysis of data on the thermodynamic properties of refrigerants shows that the suction pressure ratio of izoentropy work to thicken the partial performance of the same magnitude at full performance also decreases. Indicator of efficiency of the compressor also reduces the computational results when adjusting productivity regimes presented in Fig. 1 and 2, for example equal. Therefore attitude k_R decreases decrease the suction pressure.

Such a case, the efficiency of the regulation of cold power by throttling the suction increases with decreasing the suction pressure.

As seen from Fig.1 and 2, the effectiveness of the slide valve adjustment for the corresponding modes also increases with a reduction in the suction pressure, but significantly - than in the previous cases. This is explained by the fact that izoentropy work to thicken in this case remains constant, and the ratio of the tracer efficiency at full load and adjustment decreased by 1-2% with a decrease of the suction pressure, which leads to a reduction in the ratio k_R.

Influence the suction pressure on the efficiency of the regulatory

As noted, in real conditions during operation are possible such mode of operation of the refrigeration system, in which the pressure of internal compression does not coincide with the pressure of condensation. Furthermore, the very principle of the gate valve regulating sold power inevitably implies a reduction of the geometric compression ratio ε_G,, which means, and internal pressure increase π_A .

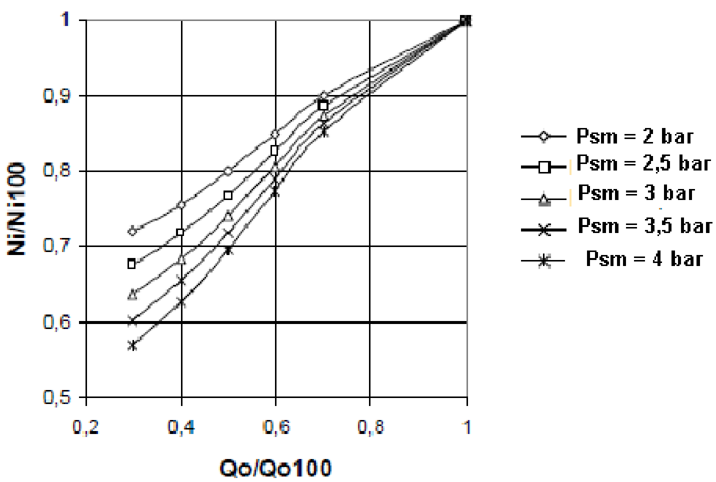

Fig.3 Depending on the relative power indicator of the relative production of cold of the two-stage compressor with different values of suction pressure and a fixed compression pressure p_k = 14.5 bar

Figure 3 and 4 are presented dependencies amendment respectively absolute and relative power indicator at different values of the suction pressure and constant pressure compression. Geometric compression ratio also remains fixed

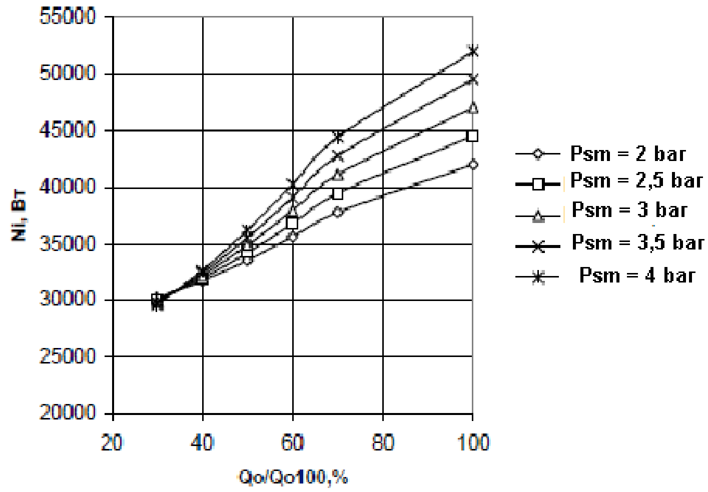

Fig.4 Sensitivity of the power indicator output of the two-stage compressor by the relative production of cold at different values of the suction pressure and a fixed pressure compression p_K = 14,5 bar

As shown throughout the drawings, the effectiveness of the slide valve adjustment increases with increase in the suction pressure. This is conditioned by the fact that by reducing the suction pressure increases the coefficient of mode $\kappa_p=p_H/p_A$, ie increased losses associated with not to compression working substance in the compressor. In regulating cold generation by disabling the operation of cylinders k_R ratio is increasing. At the same time reduce the suction pressure decreases and the big difference between the coefficient cr in full and partial performance, ie degree of not to compression. As a result, the power indicator output of the compressor during operation with reduced flow rate, reduces significantly lower when operating in modes with high not to compression.

With further increase of the suction pressure compressor with full load there is overheating of the working substance, ie $p_A > p_H$. In this case, the regulation of performance is useful in terms of the pressure balance at the end of the internal compression and hence, reducing the losses associated with overheating of the working substance. By - further reduction volumetric productivity results in not to compression working substance in connection with a substantial reduction of the effective length of the screw, but the degree of not to compression in this case is substantially less than in the mode with a low suction pressure, and therefore less loss and a correspondingly high efficiency of capacity control.

In practice, the temperature of the low temperature source in most cases remained approximately constant, which is related to the characteristics of the processes of users cold. Changing the temperature of the cooling medium is usually associated with changing technological mode of production, which is quite rare, or not happening at all.

However, in installations that operate under peak loads, operating mode of the compressor in suction pressure can vary due to periodic increases the temperature of the cooling object.

Influence pressure compression ratio on the efficiency of the regulatory

Otherwise the influence of the high temperature source which depends on the pressure of condensation, and hence the pressure of the compression ratio, and thus a direct impact on the operating cycle of the compressor. Reason for hesitation pressure condensation is seasonal and daily variations in ambient temperature. Furthermore, these changes affect the air-cooled and evaporative condensers. It should be noted that due to the significant price increases water pipes in these conditions in the refrigeration machines with medium and large capacities are virtually not used encased condensers of running water. In this case, using equipment of this type by providing a circulating water condenser, including atmospheric cooler that uses dry or wet cooling tower. In this case, using the capacitors of all of the most common in present times types, namely, air, evaporative, and encased plate condensing pressure largely depends on the ambient temperature.

Control algorithms pressure fused into most modern controllers for refrigeration is equal: switch - off the fan air condenser, depending on the deviation of the current pressure value of the set. In such an algorithm, the control is possible at a relatively large pressure variation of condensation during operation of the refrigeration machine with variable load, in particular the low-temperature environment. In case of exceeding the value of the adjustable parameter and differential gradually include fans. In terms of working part-load pressure relatively quickly reduced, which leads to the exclusion of fans. Whereby some time pressure continues to fall from the thermal inertia of the system, then starts again. At full load these fluctuations practically disappear, and refrigerating machine working routines. Therefore, in the production of cold part is relatively difficult to maintain the condensing pressure constant. In connection with this current evaluation is the effectiveness of regulation in cold generation fixed suction pressure and variable pressure pumping.

3. CONCLUSIONS

- Comparison of the slide valve adjustment and regulation by throttling of the collected money shows that lowering the temperature of the boiling performance of the slide valve adjustment is increased, but less than the throttling.
- The relative power indicator for handling incomplete production of cold is most significantly reduced mode with a high boiling point and low temperature of the condensation at a fixed compression ratio.
- Considering that the two-stage compressors are widely used in low temperature refrigeration systems that have little efficiency ratio, increase the effectiveness of their work in part-load regimes will lead to significant (especially for large installations) to reduce operating costs for the production of artificial cold.

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BROWN GAS GENERATORS SOURCED WITH SOLAR ENERGY

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ABSTRACT

The vast fossil fuel consumption and decreasing oil reserves and natural resources, enforce much more need of finding decision for renewable energies and development of constructions for using so called green resources. One solution of this problem is combination of established already solar based sources and brown gas cell construction. Brown gas cell production is based on electrolysis of pure water and as a result generating a real gas fuel. This production can find large utility in different usages.

1. INTRODUCTION

The brown gas generators actually are electrolysers which electrolyte is potassium hydroxide solution of water. Its production is gas mixture of oxygen and hydrogen. This mixture of gases is often called brown gas. It's known that chemical reaction between this both gases is exothermic and them mixture is more explosive.

$$H_2 + \frac{1}{2}O_2 \rightarrow H_2O + 242{,}5kJ \tag{1}$$

This energy can be used for heating in different conditions. The result of this is pure water, without any carbon emissions and pollutions. Needed energy for electrolysis can also be natural, using solar energy. Thus the entire cycle of energy could be not harmful for nature.

Solar energy can be supplied either directly from solar panels or from solar installation with inverter [1, 2]. In the first case the brown gas cells can operate in low DC voltages 12V, 24V or 48V. In the second, invertor deliver 220V AC voltage and rectifier is needed for electrolysis. The advantage in the first way is simplicity and safety operating voltages, but the installation is highly dependent from variation of the solar radiation during the day. This variant can't give stability of fuel production and system can't work at night. Second way is actually well known off-grid system of the solar installation. It's more complicated and high cost, but gives stability and opportunity of operating during the dark hours of the day.

In this report is represented one diagram of solar installation of using solar energy for feeding brown gas generator. It's offered a construction of such generator that can be used for fuel gas production. This generator is fed directly from inverter of off-grid solar installation. It's calculated the gain of the entire installation and effectiveness of the generator for heating.

2. STATEMENT

One of the ways to construct the electrolysers is with serial placed metal plates. The examined construction consists of stainless steel (316L type) plates mounted on the furrowed plate in a plexiglass container. The electrolyser's construction, shown in figure 1, has two electrodes (anode and cathode) which feed all of the cells made from serial plates. The whole number of the cells is 53, fixed with 54 plates.

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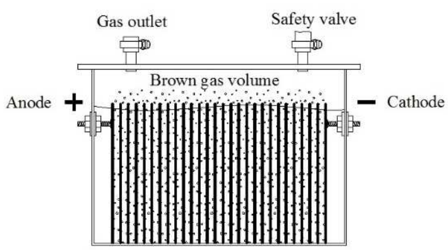

Figure 1: Brown gas generator with serialplates (316L type).

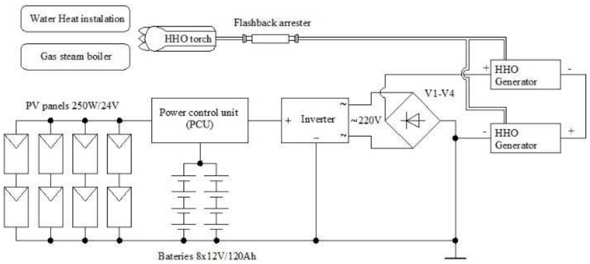

Figure 2: Diagram of the brown gas generator sourced with solar system.

Applied voltage on the each formed cell depends on value of the voltage between both electrodes and number of the plates. It can be calculated with:

$$U_C = \frac{U_S}{n-1}, \qquad (2)$$

where U_C is cell's voltage and U_S is source voltage on the main electrodes.

Theoretically, the minimum voltage on one cell must be at least 1,23V, in order to dissociate water's molecule. Then for this construction the needed voltage is 65,16V. Because of losses in the electrolyte, actually optimum drop of the voltage upon each cell is between 1,8V - 2,0V and the whole voltage then must be from 95,5V to 106V.

The losses depend on volume of electrolyte between electrodes and respectively the main parameter for this construction is distance between them. From one side of view it must be small - for minimum losses in the electrolyte, but from other it mustn't be too small due to the adhesion on the electrodes of the produced gases. The smaller distances the harder will be releasing of produced gases [3].

Electrical current of each cell was restricted to flow only in its own volume. This was reached by insolation of cell's edges from furrowed plate and decreasing level of the electrolyte to be set below from upper edge of the cell. In these way current flows only in one cell and losses depends on distance between electrodes and they appear like heat in electrolyte.

Source of the energy for electrolyser is off-grid solar installation. Its own parameters are given below. The main of them are: operating AC and DC voltages, output power and current, efficiency [4].

Tabel 1: Inverter's parameters

Active output power [kW]	2200
Input DC voltage [V]	24/48
Output AC voltage [V]	110V/230V
Output current [A]	11,5A
Efficiency [%]	95

The diagram of the entire installation: source - off-grid solar system, load – brown gas generator and heating installation is given on the figure 2. Because of nominal voltage of brown gas generators (106V) and AC output of the inverter (230V), must be connected two brown gas generators in serial at the output of the inverter.

For reaching maximum output power, characteristics of the inverter must be coordinated with current-voltage characteristic of the brown gas generator and if system is directly sourced from PV array – with its own output characteristic. In table 2 and figure 3 are shown data for output characteristic of used brown gas generator.

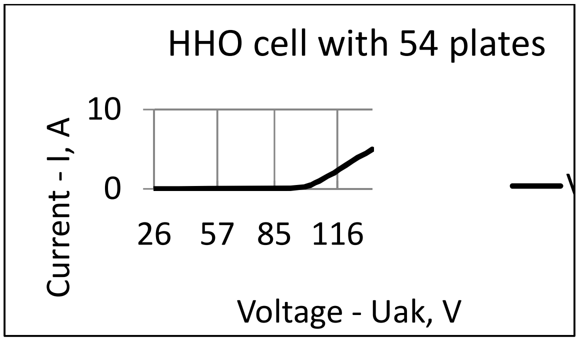

Figure 3. Curent-voltage characteristic of the generator.

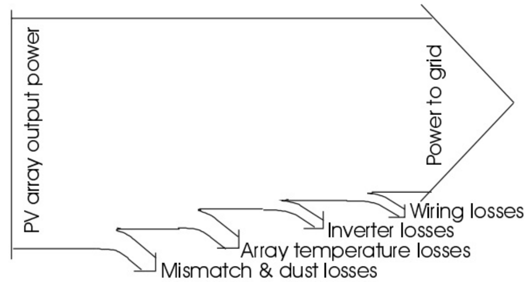

Figure 4. Losses in solar system.

Table 2: Current-voltage characteristic of brown gas generator

I(A)	0,76	1	1,6	2	2,5	3	3,5	4	4,5	5
U_{AK}(V)	105,7	107,6	111,6	114,4	117,1	120,6	123,6	126,6	130,2	133,5

3. EFFICIENCY

For efficiency calculations of the system for heating is needed data for efficiency of its main modules – solar panels, inverter and brown gas generator.

$$\eta_{PV} = \frac{P_{DC}}{E.A_{PV}}, \tag{3}$$

where - η_{PV} is efficiency of the photovoltaic cell (for last models is reached 45%), P_{DC} [W] is its output power, A_{PV} [m^2] is total effective area and E [W/m^2] is sun radiation density. For inverter efficiency:

$$\eta_I = \frac{P_{out}}{P_{inv}}, \tag{4}$$

where P_{out} is output AC power of the inverter and P_{inv} is input DC power, commonly this value is between 88%-98%. Total efficiency of the solar system is formed with a few more system's conditions like: panel's dust, load's mismatches, wiring losses etc. This is shown on the figure 4. For domestic heating wire losses not exceed 0,5% and mismatch is minimized to 3-4%. Thus the whole losses of solar system conditions are no more than 5-6% for small domestic centrals. Thus can be assumed that $P_{DC} \approx P_{in}$.

Efficiency of the brown gas generator is:

$$\eta_G = \frac{E_Q}{E_{gen}} = \frac{t.q.Q_G}{t.P_{gen}} = \frac{q.Q_G}{P_{gen}}, \tag{5}$$

where E_Q, is amount of energy in produced gas, E_{gen} is input energy for definite time.
E_Q depends on Q_G [m^3/min.] – gas flow during the time - t and calorific value of the mixture - q =10104[kJ/m^3]. E_{gen} is proportional of the input power P_{gen} and the same time t.

Regarding brown gas generator's efficiency and inverter's data must be mentioned that brown gas cell is working by power factor between 0,7-0,9, and invertor by 0,9-0,95.

Calculating efficiency of this system for heating usages more important are losses in outer DC cables, losses in mismatch and dust and power factor of the solar system and generator.

Losses in all electrical components and electrolyte appear as a heat and therefore can be calculated as a benefit. Taking into account of power factors and total amount of losses in PV system – L_1 (approximately L_1=5%) and also losses in rectifier – L_2=19%, the entire efficiency can be expressed with equation:

$$\eta = \frac{P_{DC}.(1-L_1)}{E.A_{PV}}.\frac{P_{out}PF_{inv}.(1-L_2)}{P_{inv}}.\frac{q.Q_G.PF_{gen}}{P_{gen}} = \frac{(1-L_1)(1-L_2).q.Q_G.PF_{gen}.PF_{inv}}{E.A_{PV}}. \quad (6)$$

In upper expression is assumed: P_{DC} =P_{inv} and P_{out} =P_{gen}. Therefore the total efficiency of the system is expressed with coefficients of losses, power factors of modules and physical sizes. Practically for solar system without tracking devises effective area can be reduced to 40% than physical surface of the panel (A_{PV}=0,6A_T). Average sun radiation is E=1200W/m^2 for 41°- 43° latitude. The efficiency of solar system is known not too high in comparison with total radiation. It’s interested what is efficiency of the brown gas generator. A condition of gas mixture production is given in table 3.

Table 3: Brow gas productions. Energy conditions

Input voltage - U_{AK} [V]	108,4
Input current - I [A]	6,6
Gas flow - Q_G [m^3/sec]x10^{-5}	5,83
Power factor – PF[-]	0,8
Active power – P [W]	575
Apparent power – S[VA]	715,4
Caloric value – q[kJ/m^3]	10104
Efficiency - η [%]	81,5

These calculations concern the total heat efficiency and take into account power factor of the cell, which has capacitive character.

3. CONCLUSIONS

Offered system for combined solar power and brown gas generator is a way to reducing carbon emissions. As a whole it has low efficiency with respect of total radiated solar energy due to small efficiency of PV (45%) panels and rectifier (81%). Examined brown gas generator separately gave high total heat efficiency with approximately 82% with comparison of input apparent power. This main parameter can be approved with increasing of power factor of the cell. This could be made either with electrical compensation or with decreasing inherent capacity of the generator changing shape and sizes of the construction.

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OPTIMIZATION OF THE FLASH PRESSURE OF A GEOTHERMAL PLANT

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ABSTRACT

At the end of 2013, the total geothermal capacity was about 12000 MW, generating more than 76 TWh. The conversion of the geothermal energy into electricity is mainly performed by steam expansion in a turbine driving an electric generator. However, the quality of the geothermal fluid is rarely superheated or saturated steam but mostly a mixture of water and steam, or even pressurised water. The pressure of the fluid is reduced by a throttling valve and then the water and the steam are separated in a vessel. This operation technique is called "flash". The steam is introduced in the turbine, while the water can be used for heating purposes, sent to the injection well or flashed again for more steam extraction. The purpose of the paper is to optimise the flashing pressure according to the fluid initial conditions (enthalpy and vapour fraction) in order to obtain the maximal electrical power

1. INTRODUCTION

According to [1], the geothermal resources are classified as:

- High temperature resources (t > 225 °C): liquid, vapor, or mixture;
- Average temperature resources (t = 125-225 °C): mainly liquids, possible biphasic on top of the well;
- Low temperature resources (t < 125 °C): liquid.

While the pressure of the reservoir depends of the depth of the well and the nature of the surrounding rocks, the couple pressure-temperature defines the fluid enthalpy level, which is crucial in the steam turbine dimensioning. Geothermal power plants are classified as:

- Plants using saturated dry steam;
- Plants with one flash;
- Plants with two flashes;
- Plants using binary fluids.

We will now present the components of the one-flash plant, presented in figure 1. Through the main pipe of the well, the saturated liquid or a mixture (1) with the vapor fraction lower than 25 % is throttled by the valve VL and introduced in the separator S. The liquid phase (3) is re-injected in the reservoir, while the vapor phase (4) is expanding in the turbine T. The steam exhausted from the turbine is condensed and sent to the injection well.

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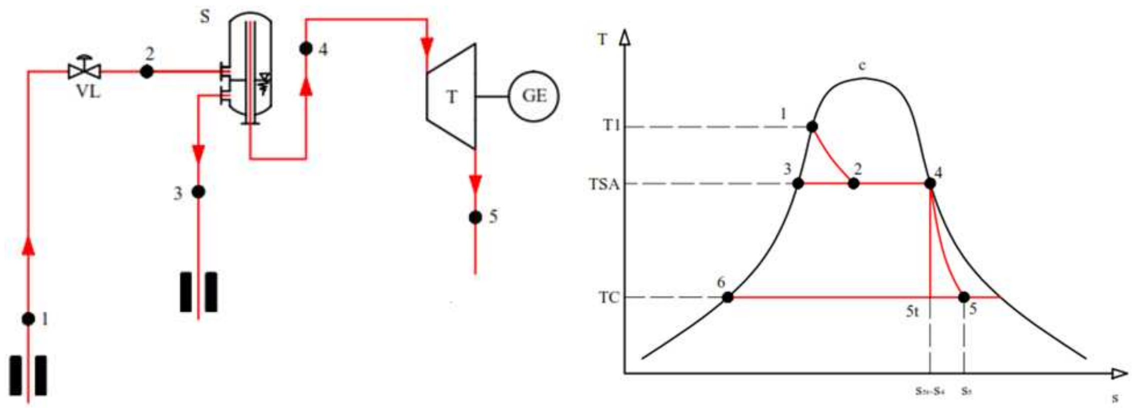

Figure 1 The one-flash geothermal power plant

2. METHODOLOGY AND CASE STUDY

In order to establish the model of the plant, several hypotheses are required:

- The fluid from the reservoir is a saturated liquid with the temperature of 250 °C;
- The fluid mass-flow in order to obtain 1 MW_e is 20 kg/s [2];
- The exhausted steam (5) temperature is equal to 70 °C and it's vapor fraction should be higher than 88 %, in order to avoid last stage erosion;
- The efficiency of the dry expansion in the turbine is 80 %;

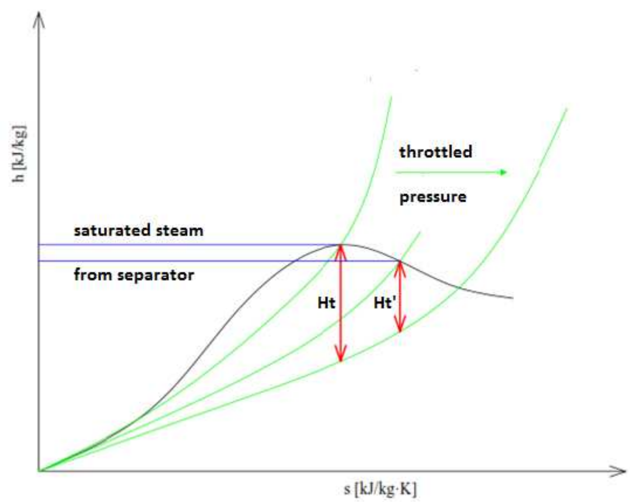

Figure 2 The decrease of the isentropic drop during throttling

Figure 2 shows how the isentropic enthalpy drop H_t decreases while the pressure after the throttling valve decreases too. Meanwhile, the separated steam mass-flow $\dot{m}_4$ increases. The purpose of the work is then to find the flash pressure where the electrical output P_{bg} of the turbine-generator is maximal, while this output is proportional with $\dot{m}_4 \cdot H_t$. The liquid from the geothermal reservoir has the following thermodynamic parameters:

$t_1 = 250$ °C; $p_1 = 39.76$ bar; $h_1 = 1085.7\ \frac{\text{kJ}}{\text{kg}}$; $x_1 = 0$. The condensation temperature is $t_5 = 70$ °C, with the corresponding saturation pressure $p_5 = f(t_5) = 0.312$ bar.

The point (2) represents the throttled (flashed) fluid (mixture of liquid and vapor). In order to optimize the process, we will give decreasing values of the throttling pressure p_2, between p_1 and p_5. For each value of p_2, following parameters are calculated:

a) vapor fraction of the throttled fluid: $x_2 = f(p_2, h_2)$

b) vapor fraction of the separated steam: $x_4 = 1$ (imposed)

c) enthalpy of the dry saturated steam (4): $h_4 = f(p_2, x_4)$;

d) entropy of the dry saturated steam (4): $s_4 = f(p_2, h_4)$;

e) theoretical enthalpy of the steam in the condenser (5t): $h_{5t} = f(p_5, s_{5t})$; where the process 4-5t represents the adiabatic expansion of the steam ($s_4 = s_{5t}$).

f) isentropic enthalpy drop in the turbine: $H_t = h_4 - h_{5t}$;

g) dry saturated steam mass-flow that expands in the turbine: $\dot{m}_4 = x_2 \cdot \dot{m}_1$;

h) internal (dry) efficiency of the turbine: $\eta_{id} = 0.8$ (imposed);

i) internal enthalpy drop in the turbine: $H_i = \eta_{id} \cdot H_t$;

j) real enthalpy of the steam in the condenser (5): $h_5 = h_4 - H_i$;

k) vapor fraction of the steam at turbine exhaust: $x_5 = f(p_5, h_5)$

l) internal power of the turbine: $P_i = \dot{m}_4 \cdot H_i$;

m) mechanical efficiency: $\eta_m = 0.96$

n) electric generator efficiency: $\eta_g = 0.94$

o) electric power at generator: $P_{bg} = \eta_m \cdot \eta_g \cdot P_i$;

A recalculation of the internal efficiency according to the steam moisture is then performed and, of course, an iterative recalculation of all parameters from i) to o):

p) $\eta_{ih} = \eta_{id} \cdot \left(\frac{x_4 + x_5}{2} \right)$.

In figure 3 are represented the evolutions of steam flow rate and real enthalpy drop. While the enthalpy drop decreases with the flash pressure, the mass rate increased. In this opposite behavior, the electric power is a subject of optimization. In figure 4 it is shown that the maximum of the electric power of 1283 kW is generated at flash pressure of 6 bar.

Meanwhile, the vapor fraction of exhausted steam is 90,2 %, meaning that is no serious danger of erosion for the last stage of the turbine.

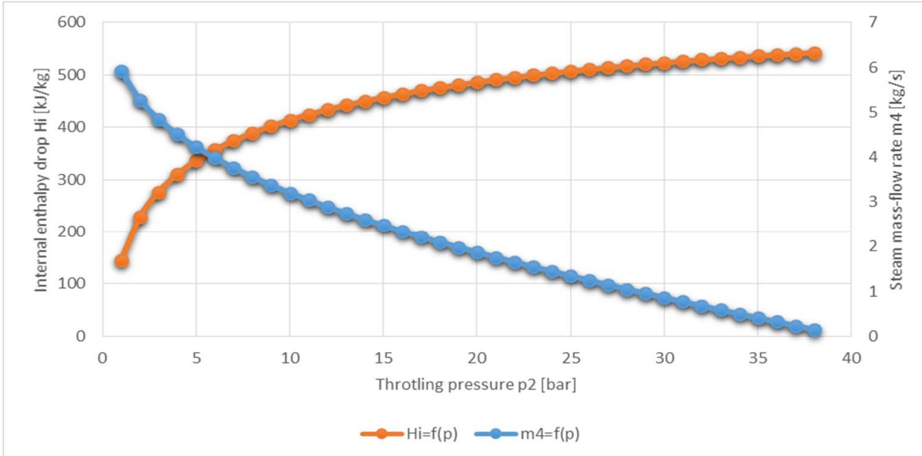

Figure 3 Evolution of the internal enthalpy drop and steam flow rate versus flash pressure

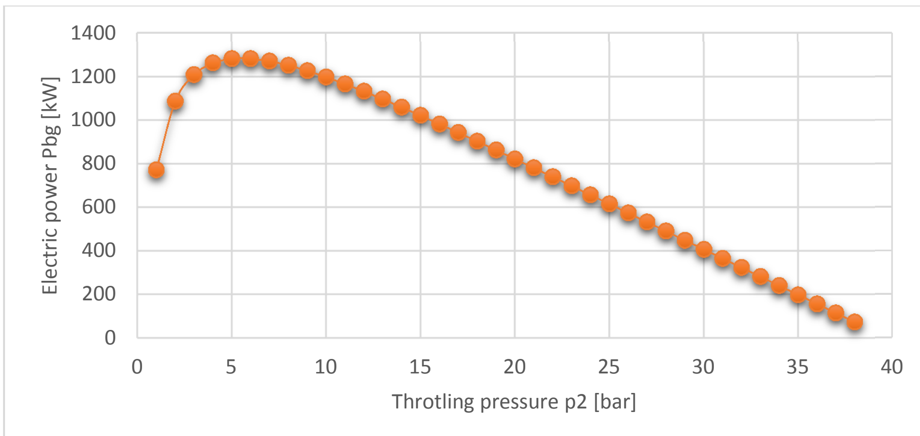

Figure 4 Evolution of the electric power versus flash pressure

4. CONCLUSION

In order to maximize the power produced in a geothermal plant with one flash, we have created a model of the plant that allows the variation of the flash pressure. For imposed initial data (well parameters and condensing pressure), the optimal flash pressure is obtained when the electric power is maximal.

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ECONOMIC STUDIES ON PRODUCING ENERGY FROM SEED OIL

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1. NATIONAL PRODUCTION OF OLEAGINOUS PLANTS

Cultivating a hectare of sunflower using the latest technology will addmittedly result in a 2,5 t/ha crop and 1200 kg of oil, 800 kg of grit (300 kg of proteins), 500 kg of shells (70 kg of yeasts), 1500 kg of calathidium (1000 kg of high quality hay).

The market value of seeds has been dramatically increasing over the last years, from 0,84 lei/kg in 2007 to 1,2 lei/kg in 2014.

Approximately 1000-1075 kg of raw oil can be obtained by processing sunflower seeds, which represents a 43 - 44% proportion.

In Romania there are around 800000 hectares of seeded sunflower, with an annual production of 1600000 – 2000000 tonnes of seeds. Approximately 300000 t/year go to the food industry, while the rest is exported or is utilised for other industrial purposes.

Rape culture is estimated to approximately 800000 – 1000000 hectares in Romania. The average production is 2700 kg/ha (including last year). Seeds are priced at 1,2 lei/kg. The most substantial part of the seed oil production is used mainly for obtaining biofuel, but also for generating energy.

Expenses for produsing oleginous plants in 2014 consist of (data gathered from the Agricultural Office Dambovita) :

- For sunflower crops :

a) Ploughing, shaping and seeding, c 600 lei/ha;
b) Fertilising, c 700 lei/ha;
c) Seeds, c 200 lei/ha;
d) Harvesting, c 200 lei/ha.

The average price of these tasks is 1700 lei/ha.

According to this data, the final products will be :

a) Seed oil average priced, around 4000 lei/ha (the production has been estimated at 40% of the seed output and the selling price at 4 lei/l)
b) Scrotum, 400 lei/ha.

- For rape, the same agricultural processes represent 1500 lei/ha :
  a) Ploughing, shaping and seeding, 600 lei/ha;
  b) Chemical treatments, 300 lei/ha;
  c) Seeds, 400 lei/ha;
  d) Harvesting, 200 lei/ha.

After evaluating only the seed price, a value of 3240 lei/ha would emerge (with the mention that stems do not posses an energetic value, thus they are chopped and left as a natural fertiliser).

2. ECONOMIC ASPECTS REGARDING THE USE OF SEED OIL IN PRODUCING ENERGY

According to the teoretic data and experiments, the scheme of using raw seed oil to produce energy is :

- Direct burning at low-power electric plants, especially for obtaining household-oriented heat;
- Direct burning at mediun-power electric plants, mainly for residential heating or technological operations;
- Direct burning together with liquid fossil fuels, with a maximum seed oil proportion of 40%.

Rape oil represents a key component of new liquid fuels used in transport errands, therefore only sunflower oil is considered as a fuel which provides energy.

A – Economic Efficiency of Using Seed Oils Compared to Low-Power Gas Instalations

Calculations show that the average house (with an area of 100 m^2) uses annually 2100-2400 m^3_N gas. The heat resulted from combusting gas with a capability of 90% is calculated using the following formula :

$$Q = \eta \cdot Q_i^i \cdot B\ [kJ/an]$$

, where : η is the capability, Q_i^i the caloricity of the gas (measured in kJ/m^3_N), B the fuel quantity (valued in m^3/year). The inferior caloricity of natural gas is 37500 kJ/m^3_N. In our case, the calculations will be :

$$Q_1 = 0{,}9 \cdot 37500 \cdot 2100 = 70{,}87\ GJ/an = 19586 kWh/an\ ;$$
$$Q_2 = 0{,}9 \cdot 37500 \cdot 2400 = 81\ GJ/an = 22500\ kWh/an$$

For an 1,5 lei/m^3_N expense, the cost of the gas will vary form 3150 and 3600 lei/year.

The same amount of energy is obtained by burning the following quantity of raw seed oil :

$$B_{1,2} = \frac{Q_{1,2}}{\eta \cdot Q^i_{i\,ulei}} \quad [kg/s]$$

For the calculations we consider Q_{ulei}^i = 38500 kJ/kg and the capability η = 0,85 :

$$B_2 = \frac{81 \cdot 10^6}{0{,}85 \cdot 38500} = 2475 kg/an \qquad B_2 = \frac{81 \cdot 10^6}{0{,}85 \cdot 38500} = 2475 kg/an$$

The fuel considered as factory-priced and valued at 3,3 lei/l = 4,1 lei/kg (the density has been set at 800 kg/m^3) will be :

$$C_{c_1} = 4{,}1 \cdot 2165 = 8876 lei/an \qquad C_{c_2} = 4{,}1 \cdot 2475 = 10147 lei/an$$

The gas process is clearly more rentable, thus the seed oil is used at its full potential only when it is part of the own production.

$$C_{ec,,ulei} = P_{gaz\,natural} \cdot \frac{Q^i_{gaz\,natural}}{Q_{i\,ulei}}$$
$$C_{ec,ulei} = 1{,}5 \frac{37500}{38500} = 1{,}46 lei/kg = 1{,}8 lei/l$$

This price can be considered as economic compared to the one of the gas results. If possible, it will be analysed only in case it is obtained by the pressing technology.

Considerating an average annual seed production of 2500 lei/ha and the recovered oil as 33% for an automatic household technology to obtain oil only by compressing operations, an unit of oil would cost 1,79 lei/l.

This cost is smaller than the 1,8 lei/kg which was calculated earlier, and thus it justifies the initiative to replace gas with low-power heat instalations.

B – Economic Efficiency of Using Seed Oils Compared to Light Fossil Fuels for Low-Power Heat Instalations

This analysis will take into consideration the differences of price and caloricity.

If a light fossil fuel type M is utilised, its caloricity will be Q^i_i = 39500 kJ/kg. The average consumption for a 80% capability instalation, considering a production of 70,87 and 80 GJ/year will be :

$$B_{l_1} = \frac{70{,}87 \cdot 10^6}{0{,}85 \cdot 39500} = 2110\, kg/an \qquad B_{l_2} = \frac{81 \cdot 10^6}{0{,}85 \cdot 39500} = 2412\, kg/an$$

The cost for CLU – type M was 3,4 lei/kg in 2014 = 4,25 lei/kg, therefore the fuel expenses will be :

$$C_{c,l_1} = 4{,}25 \cdot 2110 = 8970\, lei/an \quad C_{c,l_2} = 4{,}25 \cdot 2412 = 10253\, lei/an$$

Compared to the raw seed oil obtained from pressing, the economic advantage is totally in favour of the latter because of the difference of expense per unit of fuel's value :

$$\Delta C_{comb} = 4{,}25 - 1{,}79 = 2{,}46\, lei/l$$

As for generating the heat taken into account, it will result in the following financial economy : $\Delta C_1 = (2165 \div 2475) \cdot 2{,}46 = 5326 \div 6088\, lei/an$

C – Economic Efficiency of Using Seed Oils for Electric Plants

As regards the electricity production, the calculations will be considered for the combustion of 30% seed oil and black oil, as well as for pollution taxes related to CO_2 emissions and green certificates. Only factory - produced oil has been taken into consideration, as quantities utilised in this care are the most significant. The prices of the two types of fuel can be regarded as rather equal.

Calculations will be made for a 1 MWh electricity production, with a capability of 40%. The caloricity of the considered mix will be :

$$Q_i^i = 0{,}7 \cdot 39900 + 0{,}3 \cdot 38500 = 38850\, kJ/kg$$

The fuel consumption will be :

$$B = \frac{3600000}{0{,}4 \cdot 38500} = 233{,}7\, kg/h$$

The expenses of the fuel (the black oil's market value has been set at 4 lei/kg) :

$$c_{c,\,mixaj} = 0{,}7 \cdot 4 + 0{,}3 \cdot 4{,}25 = 4{,}07\, lei/kg$$
$$C_{c,\,mixaj} = 4{,}07 \cdot 233{,}7 = 951{,}16\, lei/h = 0{,}951\, lei/kwh = 47{,}31\, Eu/MWh$$

As 0,3 MWh have been produced, 0,3 green certificates will be paid, which (at an estimative price of 10 euro/MWh) produce a profit of 3 euro/h.

For a black oil sulphuric content of 0,4% #, the SO_2 emission per kg of black oil combusted will be :

$$E_{SO_2} = 2{,}1 \cdot \frac{S_c^i}{100} \left[kg/kgcomb\right] \qquad E_{SO_2} = 2{,}1 \cdot \frac{0{,}4}{100} = 0{,}0084\, kg/kgcomb$$

In order to obtain the desired 1 MWh electricity production, the balck oil consumption must be $0{,}7 \cdot B + 0{,}7 \cdot 233{,}7 = 163{,}6$ kg/h,
Considering an emission tax of 50 lei/SO_2 kg, the value of the environment tax will be :

$$C_{E,\,SO_2} = 0{,}0084 \cdot 163{,}6 \cdot 50 = 68{,}70\, lei/h$$

Considering a consumption based only on black oil, the same tax will value :

$$C^*_{E,\,SO_2}\, 0{,}0084 \cdot 233{,}7 \cdot 50 = 98{,}15\, lei/h$$

A saving of 30 lei/h emerges for this tax alone. The combustion of the above considered mix of black oil and seed oil is more rentable, as it assures a total save of 43,5 lei (a 9,35% decrease in the production costs), from 951,1 to 907,6 lei/MWh.

INCREASING THE EFFICIENCY OF HIGH POWER TPP WITH STEAM CYCLE THROUGH LOWERING THE COLD SOURCE AVERAGE TEMPERATURE, BY SERIALIZING THE CONDENSERS COOLING CIRCUITS

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ABSTRACT

Due to low temperatures at cold source, close to the ambient, $T_{mi} \cong T_c$, the cycles with Ultra Super Critical (USC) steam parameters reach efficiencies of 50%. The main limitations on T_c [K] are given by: 1) the cold water temperature, t_{r1} [°C]; 2) the mass flow rate of cooling water, D_R [kg/s], and 3) the global coefficient of heat exchange at condenser, $K_{tr\,Q}$ [kW/K]. The paper analyzes the possibility of lowering the T_{mi}, at high power Steam Turbines (ST), for the same values of t_{R1}, D_R and $K_{tr\,Q}$: serial connection of cooling circuits.

A correct assessment on effects of the improved design, on T_{mi}, and power at the generator terminals, P_{bg}, could be done only by case analysis, for a set of imposed input data. For establish the basic cycle performances, was taken as reference a ST with a parallel connection of water circuits at condensers. Then we computed the new design, in the same boundary conditions. By comparing the results we show that by this method is possible to produce more power than in the basic case, without supplemental expenses.

1. INTRODUCTION. CLASSICAL DESIGN (PARALLEL LINK OF THE COOLING CIRCUITS): MODELING AND RESULTS ANALYSIS

Thermal diagram shown in Fig. 1 refers to a high power unit having USC parameters, reheat and 9 regenerative water heaters. For its numerical modeling we identified, by similitude with Kirchoff theorems for electric circuits, two types of elements:

- "Points", permitting to identify the intensive parameters. They can be: a) “intermediate points” (no splitting), and b) "hubs" (when meet, or divide mass flow rates).
- "Sides", linking points. Ex: pipes, pumps, S.T.’s stages or groups of stages, sections of heat exchangers, etc... They allow identifying the mass flow rates.

The main boundary conditions are the same in the base design, and in the improved one:

- Steam Generator (SG) heat flow rate - $P_{th\,0}$=1,400,000 kW $_{th}$;
- main steam parameters - p_0=30 MPa, t_0=600°C;
- reheated steam parameters - p_{reh}=4.025 MPa, t_{reh}=610°C;
- number of flows in High Pressure Cylinder (HPC) = 1, and in Intermediate PC (IPC)=2;
- number of Low Pressure Cylinders (LPC) = 2 and number of flows in each LPC = 4;
- length of the LPC final blades = 1,219 mm;
- cooling water temperature - $t_{c\,w}$=15°C;
- condenser’s cooling water mass flow rate=19,500 kg/s;
- condenser’s overall heat transfer coefficient UA=100,000 kW $_{th}$/K.

The main physical and mathematical relations of the model are:

- Continuity equations for points, hubs and zones;
- Heat balance equations for heat exchangers [1];
- Balance equations for pumps and turbines [2, 3].
- The second principle of thermodynamics in ideal & real adiabatic [4, 5];
- General energy balance by components groups.

Supplementary were imposed values, in the typical field for the analyzed units [6 to 8], on parameters as: **a)** pipes enthalpy losses; **b)** pressure loss in pipes and heat exchangers; **c)** main

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pumps efficiencies; **d)** characteristic temperature differences in the pre-heating regenerative heat exchangers; **e)** steam exhaust speeds from the HPC and IPC, etc.. Note that:

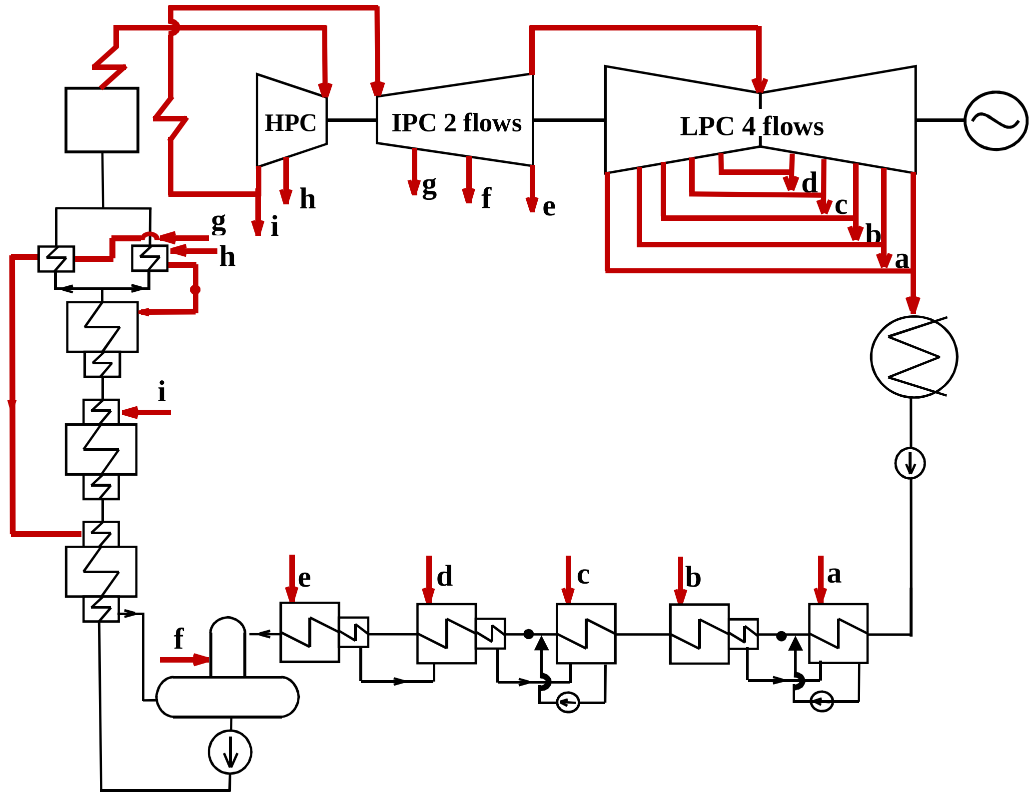


Figure 1: ST's cycle in the reference design

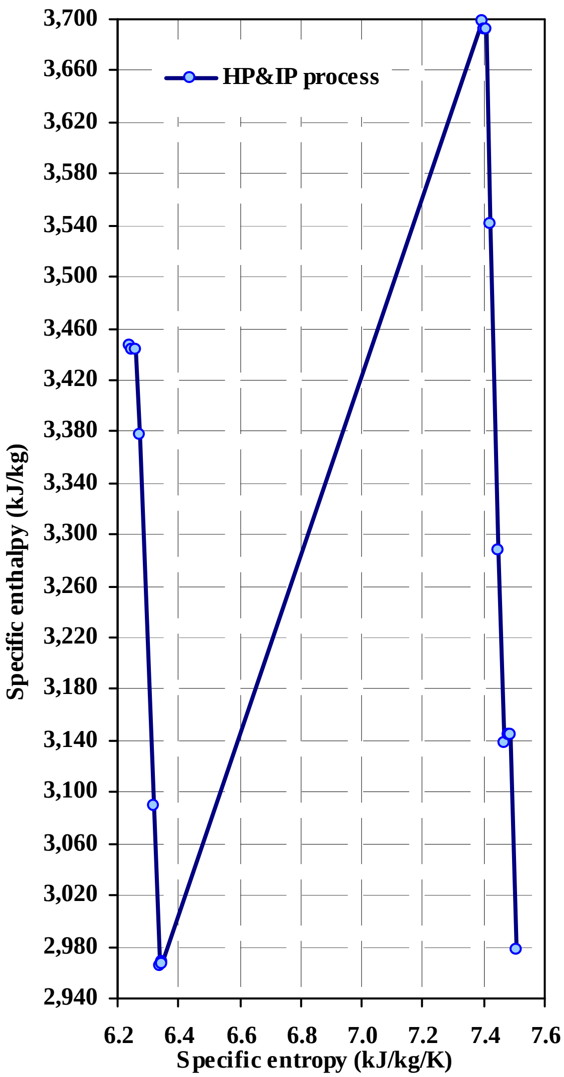
- Internal efficiency by sections of the turbine, mechanical and generator losses, and others, were determined with semi-empirical formulas taken from [2, 3], and set by authors, based on data from different sources, such as [9].
- The increases of temperature in regenerative WH fed with steam downstream the reheater are equals, while the one of the HP WH, supplied with steam upstream the reheater is 5/4 times higher than these [10 to 13].

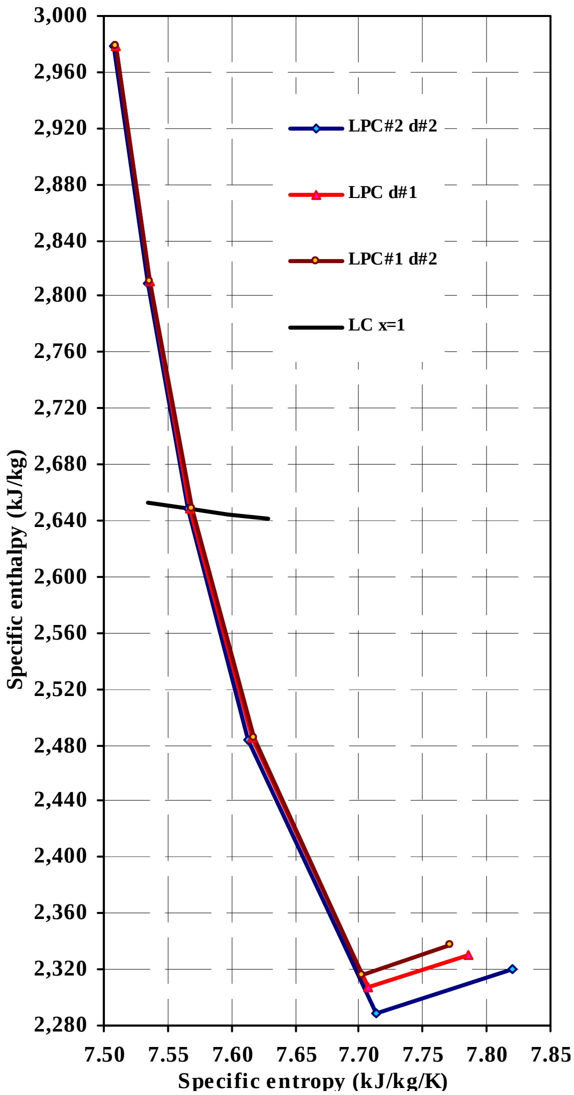
Compared with the analytical "linear" models, input → output, our algorithm is numerical and iterative. The reason is that a series of equations describing the modeled phenomena are transcendent. Ex. the water-steam properties were calculated with formulas from [14].

The first step is to assume values of the following parameters: **a)** the internal efficiency of HPC, **b)** pre-heating rates of steam and **c)** the enthalpy of the feed water of SG. They allow, in a first approximation, computing the steam flow rates, internal efficiencies, steams enthalpies in points, steam quotas extracted from the turbine for WH and heat exhausted to the condenser. Then were determined the main temperature differences at the condenser, the condensation temperature and pressure. Data outputs from the first iteration become inputs for the second one and so on... The model converges: after $j \leq 32$ iterations results in step "j", are less than 1 ppm different from those in step "j-1".

Fig. 2 represents the enthalpy-entropy diagram of the steam expansion process in the turbine. The left area shows the expansion process from the HPC, IPC, and from the first expansion stage of LPC. This diagram is the same in both designs: basic and improved.

The right area shows the expansion process in the last four stages of LPC. The base design case corresponds to the intermediate line, marked with triangles. The main results obtained from modeling of base design structure are shown in the left column of Table 1.





HP&IP process, both designs — LP process for different LPC

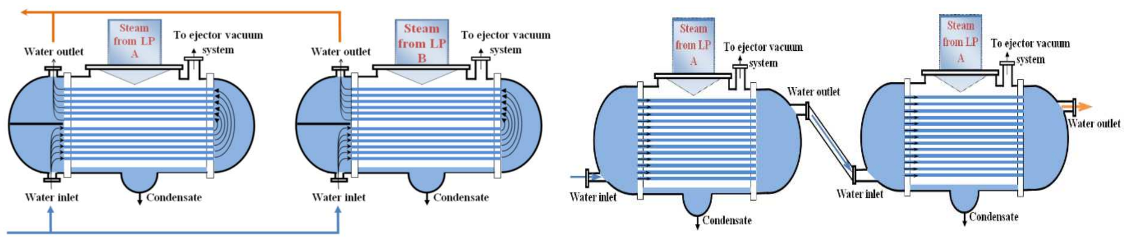
Figure 2: The h-s diagram for the steam expansion process in ST

Table 1 Comparative analysis of flow rates, parameters, and performance data for the USC ST

Flow rates, parameters, and performance data	Units	Numerical values		
		Base design	Improved design	
main steam mass flow rate	kg/s	502.120		
reheated steam mass flow rate	kg/s	458.633		
feed water temperature		289.84		
power at generator's clamps	MW	716,395	716,938	
heat rate of ST & generator, as a whole	kJ_{th}/kWh_{el}	7,035	7,030	
Distribution per LPC in the improved design			LPC1	LPC2
steam mass flow rate to each condenser	kg/s	154.672	153.929	155.078
heat flow rate at each condenser	kW	341,331	339,885	342,250
rise of water temperature at each condenser	°C	8.362	4.181	4.181
min. temp. difference at each condenser	°C	3.4787	4.9483	4.9483
$LMTD_c$ at each condenser	°C	6.82662	6.82662	6.82662
steam condensing temperature and pressure	°C/kPa	26.840/3.535	24.129/3.009	28.310/3.851
steam velocity at LPC outlet	m/s	234.39	270.09	217.34

2. IMPROVED DESIGN, WITH SERIAL CONNECTION OF THE WATER CIRCUITS: MODELING AND RESULTS ANALYSIS, CONCLUSIONS

When the steam condensers have two paths, their serial connection could be done without changing the tubes number and the water speed in them, respectively maintaining the same D_R, $K_{tr\,Q}$, and pressure loss on the water side (see Fig.3.). The connection of the Steam Turbine at the two condensers and to the water heaters is shown in Fig. 4.



Parallel connection of the water circuits Serial connection of the water circuits

Figure 3: Connections between cooling water circuits of steam condensers

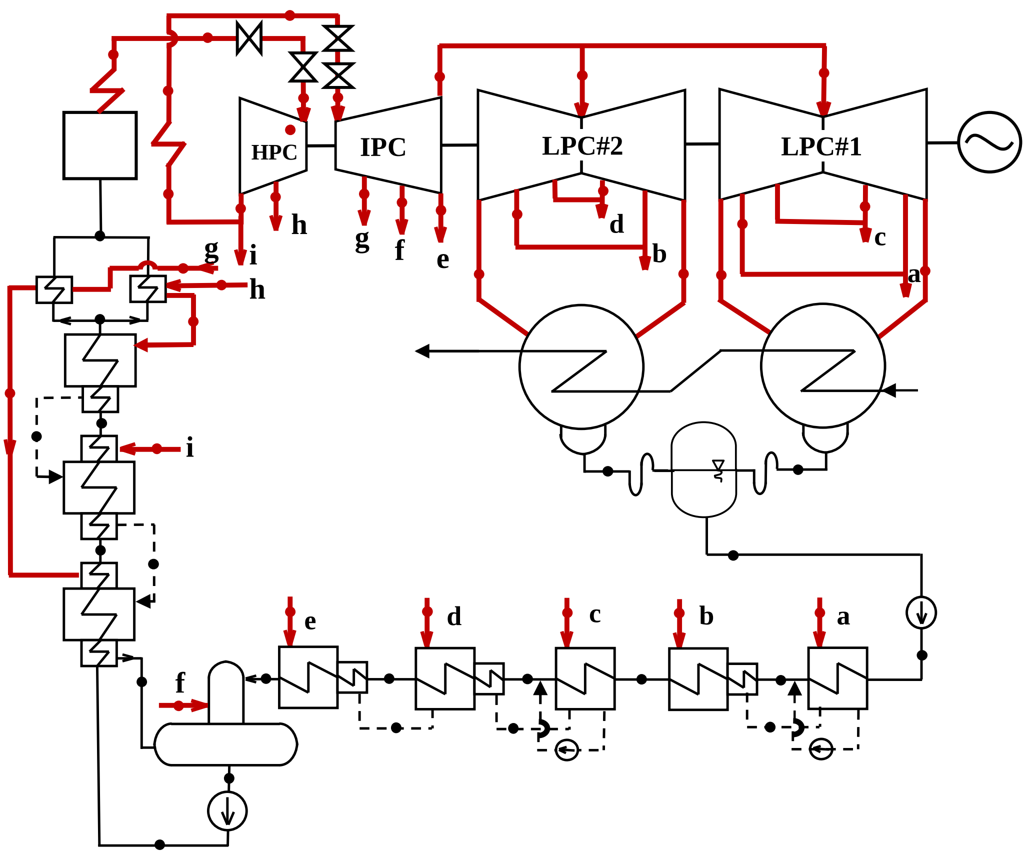
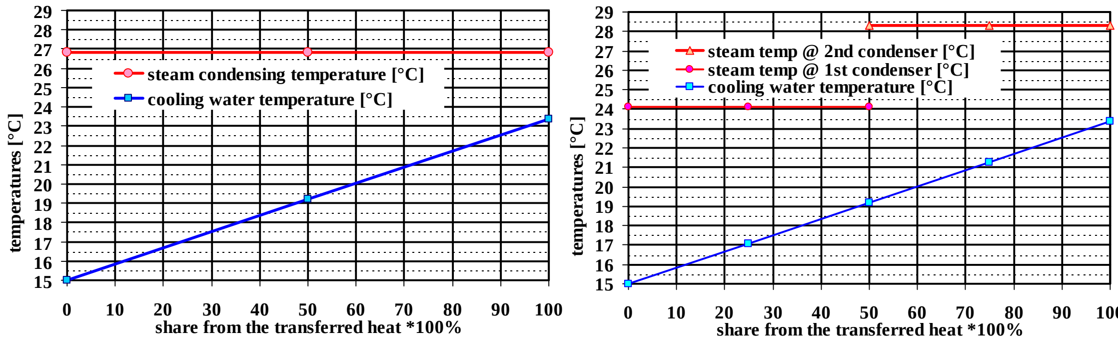


Figure 4: ST's cycle in the improved design

And this algorithm is numerical and iterative. With the initial mass flow rates, the steam pressures in various points are calculated according to Stodola's relations [2, 3, 15, 16], taking into account the new heat balance for condensers and water heaters. Further, the turbine process was remodeled, by correcting its adiabatic efficiencies, and were calculated the new steam mass flow rates. Based on the new mass flows, and on new enthalpies, we calculated the new heat flow rate evacuated by each LPC to condenser. With this values were computed: the characteristic temperature differences at condensers, and the condensing pressures.

The first iteration’s results give a new set of input data for the second, etc. And this model proved to be convergent.



Parallel connection of the water circuits — Serial connection of the water circuits

Figure 5: The heat transfer diagrams of the condensers

Figure 5 allows comparing the heat transfer processes at condensers, in the base design (left side) with those in the improved one, having the two condensers connected in series on the water side (right side). It could be observed that, in the improved design, the condensation process is closer to the water heating one than in the base design. This fact diminishes the destruction of exergy in the heat transfer process.

The main results obtained by modeling the improved design scheme are shown in the central column and in the left column of Table 1. The expansion processes in LPC 1 and LPC2 are shown in the right area of figure 2 (the lines marked with circles, for LPC1, and diamonds, for LPC2). Note that, in the improved design:

- LPC1, having a lower condensing pressure than in the base design, offers a higher steam expansion, but has a higher exhaust residual steam speed, corresponding to higher losses through residual kinetic energy.
- LPC2, with a higher condensing pressure than in the base design, achieves a lower steam expansion, but has and a smaller residual steam speed at exhaust, equivalent to smaller losses through residual kinetic energy.

Overall, the USC unit that develops in the basic design $P_{bg}\cong715{,}000$ kW$_{el}$, could develop, in the improved scheme, for the same input heat flow rate, and the same cooling water mass flow rate, an additional power of $\Delta P_{bg}\cong550$ kW, representing about 0.1% of reference power, and ensuring a reduction of specific heat for producing electricity of about 5kJ$_{th}$/kWh$_{el}$.

3. AUTHORS' CONTRIBUTIONS AND ENVISAGED DEVELOPMENTS

Using numerical modeling of steam cycle, the paper demonstrates that replacing the classical parallel connection of water cooling circuits at condensers, with the serial one, has a positive effect on steam Thermal Power Plants (TPP) efficiency.

The main original elements of the work are:

- attainment of a physical and mathematical model to compute the USC steam cycles of TPP in different connection schemes between their elements;
- establishing a set of boundary conditions allowing that: **a)** the growth of power delivered to be equal with the growth of power at the generator terminals, and **b)** the expenses for energy generation to remain constant;
- conceiving of functions, procedures and their interconnection in our software, for modeling the reference design, and the improved one;
- quantification the influence of replacing the classical parallel connection of condensers water cooling circuits, with the serial one, on: **a)** the Power Plants parameters, **b)** the mass and energy flows rates, and **c)** the energy conversion efficiency;

- computing the real expansion line of ST, by determining the adiabatic efficiencies in the turbine by sections (typically, the efficiency is determined per turbine cylinders).

In a future work, we intend to analyze, through a similar approach, the effects due to growth on: 1) cooling water mass flow rate and 2) the overall heat transfer coefficient at condensers. The analysis will be done for both previous designs. First the effects of these factors will be separately analyzed, and then in simultaneous manner.

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EXPERIMENTAL STUDY OF LIQUEFIED PETROLEUM GAS USE TO FUEL A TRUCK DIESEL ENGINE

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ABSTRACT

In this paper was investigated fuelling of a truck diesel engine with liquefied petroleum gas, using the diesel-gas method, which consist in gaseous LPG injection in the intake manifold of the engine. Several energetic substitute ratios of diesel fuel with LPG are investigated, x_c=[7.75, 13.6, 19, 23.22], and the major interest was to observe what is happening with the brake specific energetic consumption and with pollutant emissions. The brake specific energetic consumption decreased and was with 2% lower than in the case of standard diesel engine for the substitute ratio x_c=19 %. The nitrogen oxides and smoke emissions were lower than in the case of diesel fuel and decreased with ~8 %, respectively 9%. The carbon monoxide and unburned hydrocarbons emissions increased for all the investigated cases and the carbon dioxide emission maintained approximately at the same level like in the case of the standard engine.

1. INTRODUCTION

Reducing the operating costs of the old machinery engines and reducing the pollutant emissions, especially smoke emission and nitric oxides emissions, very dangerous for the enviroment, requires finding of new effective methodes to fuel these engines. Given the low price of liquefied petroleum gas and its good burning properties, liquefied petroleum gas is a viable solution for internal combustion engines fuelling.

In the table 1 are presented some liquefied petroleum gas properties, comparative with the diesel fuel properties.

Table 1. Liquefied petroleum gas properties, comparative with diesel fuel properties [1].

Properties	Diesel fuel	Propane	Butane
Density [kg/m³]	800-840	503	500
Self ignition [ºC]	225	481	544
Stoichiometric A/F ratio [kg/kg]	15	15.71	15.49
Lowe r heating value[MJ/kg]	42.5	46.34	45.55
Cetane number	40-55	-2	-2
Flame temperature	2054	1900	-

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From the table it can be seen that LPG has the lower heating value higher than diesel fuel lower heating value, liquid density is lower than diesel fuel, require a greater amount of air for stoichiometric combustion and autoignition properties are worse than those of diesel fuel .

We therefore have adopted method of LPG supply to the engine so as not to be adversely affected its functioning. In this paper the diesel-LPG method was adopted to fuel the diesel engine, method which consist of injection of liquefied petroleum gas in gaseous state in the engine intake manifold .

This method has been applied by Tariq Miqdam in [2]. The author has obtained good results liquefied petroleum gas engine fueling, the brake specific energetic consumption being lower than with diesel fuel supply and emissions being also lower. In the paper [3] the author has experienced liquefied petroleum gas fuelling of a diesel engine that equips a road vehicle using diesel-gas method, experiments leading to price reduction of operating that vehicle. In the paper [4], the authors obtained by fuelling a single cylinder diesel engine electric generator fuel consumption reduction specifically for small degrees of substitution of diesel fuel with liquefied petroleum gas, in exchange for higher degrees of substitution the brake energetic specific consumption was higher than the standard diesel engine. In the same paper are also presented pollutant emissions of the LPG fuelled electric generator diesel engine. Nitric oxides and smoke emissions decreased, but unburned hydrocarbons emission increased, because in the valve overlap period some of the admitted air-LPG mixture is lost from the cylinder and another cause is the extinguish of the flame in the air-LPG mixture due to poor dosage [4]. A reduction of emissions was achieved by Pali Rosha et al., in [5] , by LPG fuelling a single cylinder diesel engine and using exhaust gas recirculation. Emissions of nitrogen oxides and carbon dioxide decreased compared to standard diesel engine case, while emissions of unburned hydrocarbons and carbon monoxide increased, especially in the partial load. In order to reduce these emissions the authors used a percentage of recycled exhaust gas, for example, at 60 % load the emissions of hydrocarbons and carbon monoxide was reduced with 46.9 %, 27.4 % respectively, with LPG using and16% EGR. Another example of a liquefied petroleum gas diesel engine fuelling is introduced in the paper [6] . The authors used liquefied petroleum gas injection into the engine's intake manifold and as fuel for the pilot injection was used rapeseed oil. The degree of substitution maximum used of rapeseed oil with LPG was 60 %, degree to which the engine cyclic variability was within acceptable limits, led to to a reduction in the emission of unburned hydrocarbons and carbon monoxide, but also to an increased emission of nitrogen oxides. To reduce the emission of nitrogen oxides authors used exhaust gas recirculation .

Our paper presents some results of experimental investigations obtained on a truck compression ignition engine fueled with liquefied petroleum gas using the diesel-gas method.

The engine is located in one of the test beds of the Department of Thermotechnics, Engines, Thermal Equipments and Refrigeration instalations .

2. EXPERIMENTAL STUDY

The experimental study was carried out on a compression ignition engine type Roman D2156 MTN 8, with 6 cylinders in line. The main specification and performances of the engine are presented in the table 2 [7].

The test bed consist of: the diesel engine with the code above, Hofman eddy current dyno, AVL data aquisition system, Kistler piezoelectric pressure transducer, AVL Dicom 4000 gas analyser and opacimeter, Optimass masic fuel flow meter, Meriam volumic air flow meter, thermocouples and thermoresistences for temperature measuring, gravimetric system for diesel fuel consumption measuring, gas leak detector. All the equipments were calibrated prior to measurements. The investigated regimen was 55% engine load and 1750 rpm.

Table 2. Specifications and performances of the engine D 2156 MTN 8.

Number of cylinders	6
Bore [mm]	121
Stroke [mm]	150
Displacement [L]	10.34
Compression ratio	17
Rated power [kW]	188
Maximum torque [Nm]	900
Admision type	turbocharged

First time was determined the reference, fuelling the engine only with diesel fuel, then the diesel fuel was partially substituted with liquefied petroleum gas, having regard to maintain the same engine power like in the standard case, because the power was conserved. Therefore, for each substitute ratio investigated, the diesel fuel cycle dose was reduced and the LPG cycle dose was increased to obtain the initial engine power. The energetic substitute ratio was calculated with the folowing relation:

$$x_c = \frac{m_{LPG} H_{i_{LPG}}}{m_{LPG} H_{i_{LPG}} + m_{dieselfuel} H_{i_{dieselfuel}}} \qquad (1)$$

Where:
m_{LPG}- the LPG dose;
$m_{dieselfuel}$-the diesel fuel dose;
H_i- the caloric heating value.

3. RESULTS AND DISCUSIONS

The engine was firstly fuelled with diesel fuel then with diesel fuel and LPG at diferent rate between 1.47 kg/h and 4.23 kg/h, representing percents of substitute energetic ratios of diesel fuel by LPG of: 7.75, 13.6, 19, 23.22 %. Are presented energetic and pollution results of the liquefied petroleum gas fuelled diesel engine using the method diesel-gas. The figure 1 presents the variation of the brake specific energetic consumption with the substitute ratio. It can be observed that the brake specific energetic consumption decreased with 2% than in the case when the engine was fuelled only with diesel fuel for the substitute ratio x_c=19.

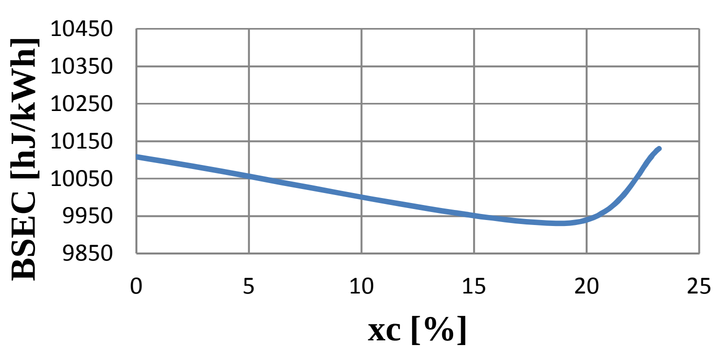

Fig. 1. The variation of the brake specific energetic consumption with the substitute ratio.

The pollution performances of the LPG fuelled diesel engine are presented in the figures below. In the figure 2 is presented the nitrogen oxides emission variation, and in the figure 3 is presented the smoke emission variation evaluated by the opacity of the exhaust gases, both measured with the AVL Dicom 4000 gas analyser. It can be observed that the nitrogen oxides emission decreased for all the substitute ratios smaller than 19 and after 19 the emission increased because of the temperature increase.

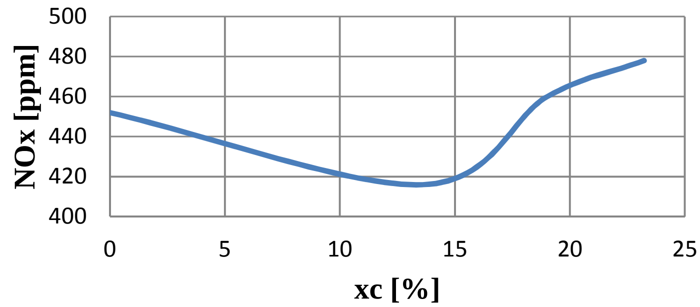

Fig. 2. The nitrogen oxides emission versus the substitute ratio.

The smoke emission decreased for all the substitute ratios smaller than 19, because the number of carbon atoms decreased and because the liquefied petroleum gas has good burning properties. For substitute ratios grater than 19 the smoke emission increased, because of the air filling cylinder worsening, the gas being injected into the intake manifold and replacing a part of air.

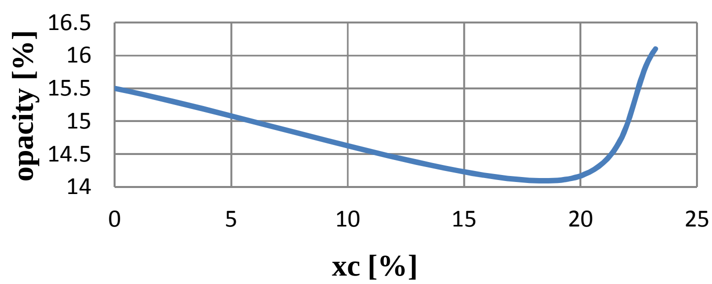

Fig. 3. The smoke emission, evaluated by the opacity of the exhaust gases.

The carbon monoxide emission increased for all the investigated substitute ratios, because the mixture was richer when the engine was fuelled with LPG. The figure 4 presents the carbon monoxide emission.

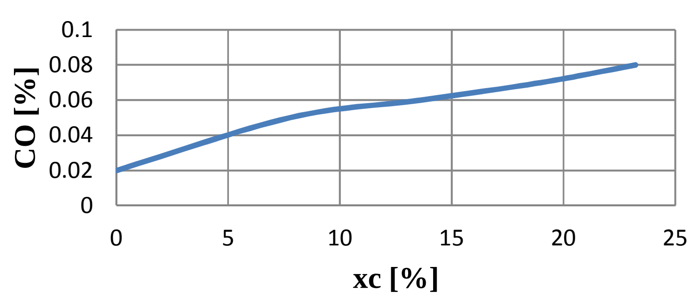

Fig. 4. The carbon monoxide emission versus the substitute ratio.

Regarding unburned hydrocarbons emission, this increased for all the investigated substitute ratios, also because the mixture was richer when the engine was LPG fuelled and because in the valve overlap period some of the admitted air-LPG mixture is lost from the cylinder. In the figure 5 is presented the emission of unburned hydrocarbons versus the substitute ratio x_c, emission measured with the AVL Dicom 4000 gas analyser.

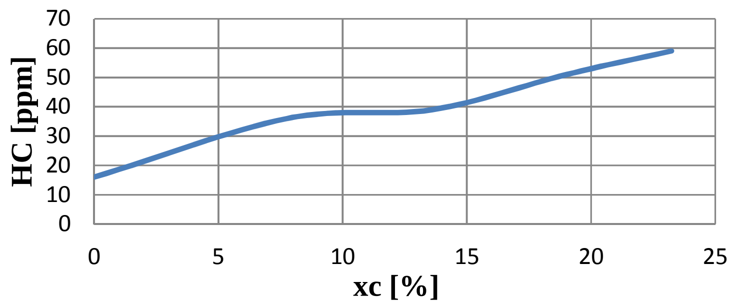

Fig. 5. Unburned hydrocarbon emission.

The carbon dioxide emissioin maintained approximately at the same level like in the case of the standard engine fuelled only with diesel fuel. The figure 6 presents the carbon dioxide emission.

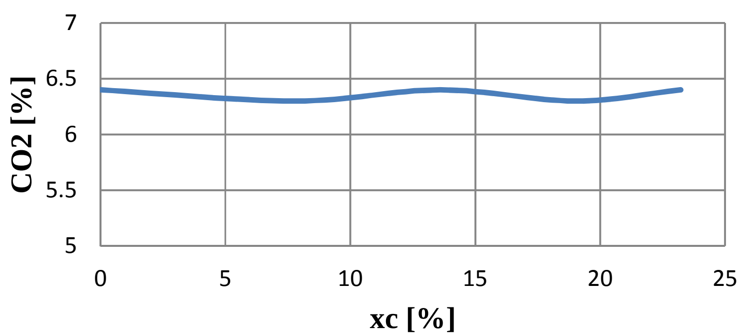

Fig. 6. The carbon dioxide emission.

4. CONCLUSIONS

At the LPG engine fuelling with rate of 1.47 kg/h-4.23 kg/h, in its operating were observed the following:

1. The brake specific energetic consumption decreased with ~2% than in the case of the standard engine.
2. The nitrogen oxides emission decreased with ~8% for the substitute ratio x_c=19, after this substitute ratio the emission increasing.
3. The smoke emission decreased with ~9% for substitute ratios smaller than 19, after that increased because of the air cylinder filling worsening, the gaseous fuel being injected in the intake manifold and replacing a part of the intake air.
4. The carbon monoxide emission increased for all the substitute ratio, having the maximum for the substitute ratio x_c=23.22.
5. The unburned hydrocarbons emission increased for all the substitute ratios.

6. The carbon dioxide emission maintained approximately at the same level like in the case of the standard engine fuelled only with diesel fuel.

5. ACKNOWLEDGEMENTS

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STEAM TURBINES FOR ADVANCED ULTRA-SUPERCRITICAL CYCLES

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ABSTRACT

Supercritical and ultra-supercritical are the answer of the coal-based power plants to the high performances of combined cycles using natural gas and other liquid fuels. An important number of ultra-supercritical units operate in Europe and Japan to 32 MPa and 600/610° C and their availability is comparable to that of subcritical plants. Current state-of-the-art advanced ultra-supercritical energy generation involves 35-38 MPa and 700-720 °C, resulting in a generating efficiency of about 47% and a best opportunity for CO_2 mitigation. The characteristics of the steam turbine for advanced ultra-supercritical domain are analyzed in this paper.

1. INTRODUCTION

Coal is a major fuel for power generation in the world. The emissions and environmental impact of coal-fired power plants was improved using supercritical and ultra-supercritical domain in such a manner that offers competitiveness against combined cycles. An important number of ultra-supercritical units operate in Europe and Japan to 32 MPa and 600/610° C and their availability is comparable to that of subcritical plants. Current state-of-the-art advanced ultra-supercritical energy generation involves 35-38 MPa and 700-720° C, resulting in a generating efficiency of about 47-49% and a best opportunity for CO_2 mitigation. Steam turbines operate at substantially higher pressures and temperatures in advanced ultra-supercritical (A-USC) domain based on advanced materials, innovative thermal cycles and constructive solutions. Current supercritical power plants have 2% higher installation cost high efficiency, fuel cost lower and the same level operating costs than subcritical plants.

2. ADVANCED ULTRA-SUPERCRITICAL CYCLES

Advanced ultra-supercritical power plants operate above 27.5 MPa and main/reheat temperature of 700°C. The supercritical steam conditions involve three types of cycles shown in Table 1 and figure 1, quite is no clear definition of these. Many ultra-supercritical power plants ranging 350MW to 1000MW are under operation in the world with a good availability and reliability. Research programs in Europe (Thermie 700 Advanced Power Plant), Japan (EPDC and CRIEPI), and the United States (EPRI and DOE) are being develop the problems of the USC power.

Table 1: Type of supercritical cycles

Cycle (power plant) type	Steam conditions		Typical efficiency [%]	No. of reheat	CO2 Reduction [%]
	p [MPa]	*t* [^{0}C]			
Subcritical	< 22.1	< 600	33 - 38	1	basis
SC	24 -25	< 600	38 - 40	1	12
USC	27	600 - 700	42 - 45	1 - 2	28
A-USC	> 30	700 - 760	46 - 50	1 - 2	41

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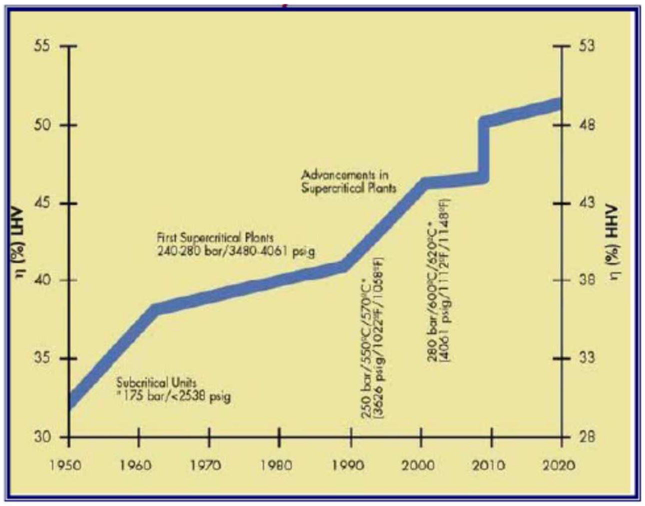

Figure 1: Steam conditions evolution [8]

At present, the ultimate stage of development is fixed to live steam conditions up to 37.5 MPa / 700°C / 720°C [2] with an expected efficiency above 50%. The achievement of the goals of EPRI program shall produce the capability to develop a demonstrative project to A-USC conditions of 760°C and 35 MPa, coming into service in around 2020.

The thermal cycle analysis indicates that higher efficiency is associated with higher operating pressures and temperatures for the main steam as well as the reheat steam. While the influence of the temperature is much more significant than that of the pressure, any rise of the main steam temperature must be accompanied by an appropriate increase of the pressure, which is needed to achieve the optimum exhaust steam dryness conditions. In this case the opportunities of double reheat must by study.

The high temperature of the reheated steam (to 720_C) brings to the large difference between the bleed steam and the heated water temperatures in feed water heaters fed with bleeds from the intermediate pressure turbine, which are situated right after the steam reheater. In order to solve this problem, the company Elsam [2] patented an innovative cycle named "Master Cycle". The main idea is to shift the bleeds from the intermediate pressure part of the main turbine to a separate extraction backpressure turbine fed from the turbine high pressure turbine outlet before the first reheat.

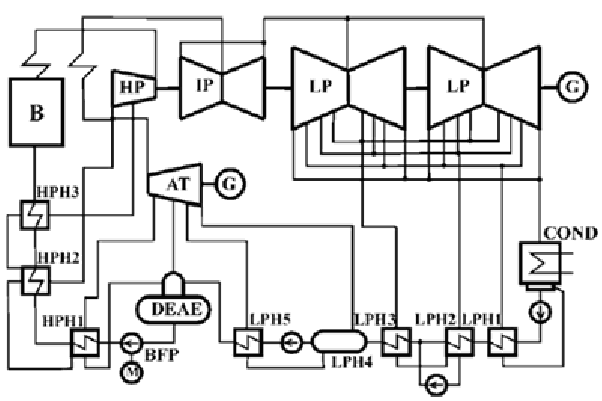

Figure 1: "Master cycle" diagram of an A-USC power unit
with single reheat and AT (auxiliary Turbine) [6]

Tipical efficiencies and costs for the supercritical power plants, are indicated in table 2.

Table 2: Tipical efficiencies and costs of supercritical power plants

	Subcritical	Supercritical	USC	A-USC
Efficiency (% HHVnet)	35 – 38	38 – 40	42 – 45	46 – 50
Capital ($/kW)	1300 – 1500	1350 – 1550	1450 – 1650	NA
Fixed O&M ($/kW-yr)	40.5	40.8	41.1	NA
Variable O&M ($/MWh)	1.7	1.65	1.6	NA

3. ADVANCED MATERIAL

The significant rise of steam condition for A-USC power plants can only be achieved with completely new materials with higher creep strength and improved oxidation resistance. The major targets of research programs were development of austenitic materials and nickel-based superalloys for the hottest sections of boilers, steam lines and turbines. Current materials research and development is targeting steam cycle operating conditions of 36.5 to 38.5 MPa and temperatures of 700-720° C. The experience of heavy–duty gas turbine operating at high temperatures is utilized.

Steam conditions up to 30 MPa/600ºC/620ºC were achieved using steel with 12% chromium content, up to 31.5 MPa/620ºC/620ºC needs Austenite that is an expensive alloy and 35 MPa/700ºC/720ºC could be reached with Nickel-based alloys. The high pressure and high temperature materials are presented in table 3 [4]

Table 3: High Pressure and High Temperature Materials for HP Turbines

Component	565 ºC	620 ºC	700 ºC	760 ºC
Casings (shells, valves, steam chests, nozzles)	CrMoV (cast) 10CrMoVMb	9–10% Cr (W) 12CrW (Co) CrMoWVNbN	CF8C-Plus CCA617, Inconel 625, In 718, Nimonic 263	CCA617 Inconel 740 CF8C-Plus
Bolting	422 9–12% CrMoV Nimonic 80A In 718	9–12% CrMoV 12 CrMoWVNbN	Nimonic 105, Nimonic 115 In 718, Waspaloy Allvac 718Plus	Nimonic 105 Nimonic 115 U700, U710 U720
Rotors/Discs	1CrMoV 12CrMoVNbN 26NiCrMoV11 5	9–12 % CrWCo 12CrMoWVNbN	CCA617, Inconel 625 Inconel 740, Hynes 230	CCA617 Inconel 740
Nozzles/Blades	422 10CrMoVNbN	9–12% CrWCo 10CrMoVCbN	Wrought Ni-based	Wrought Ni-based
Piping	P22	P92	CCA617	Inconel 740

4. STEAM TURBINE DESIGN FEATURES

The turbine design for advanced steam conditions must response to the high thermal and mechanical stress, to the high and finally economic viability.

A particular attention was given to the high pressure and intermediate pressure turbine components that operate at high temperature and are suppose to mechanical stress. A complex 3-D stage flow analysis was developed to achieve an optimized geometry with minimum losses of the blades and the nozzles. The optimized bent and twisted blades design ensure a stage efficiency improvement of approximately 2 percent.

Another important decision refers to the solution of separate or integral HP/IP modules arrangement. For cost and schedule reasons the use of a single, opposite-flow combined HP/IP module for even higher overall power output of around 800 MW can be a better solution. The separate arrangement offers O&M facilities, an easily access for assemble and disassemble interconnecting pipes, thus reducing outage time.

To minimize thermal and operational stresses, HP sections of A-USC equipment can use triple-shell construction. In the hottest regions of the casing new cooling measures are applied. Temperature conditioning steam flows are introduced from within the HP and IP turbine casings to ensure that steady state metal temperatures remain within acceptable limits. In this manner, while the advanced steam conditions, the thermal stress is reduced and could be performed in short time.

A welded rotor construction is foreseen for A-USC turbine, welding nickel-based alloy for the middle of the rotor and ferrite steel for the ends. This solution minimizes the use of expensive nickel-based alloy and avoids the difficulties in producing a large ingot for mono-block nickel-based alloy rotors.

The sealing is based on some new solutions, such as brush seals and abradable coating, which has been tested with success in gas turbine. In comparison with the conventional labyrinths seals the brush seals ensure a 50 % reduction of leakage flow and the abradable coating can reduce the leakage flow by 20%. The new sealing solutions can improve the turbine efficiency by 0.5%.

Concerning to the improving of the last long blades the efforts were the same with conventional steam turbine design, in order to achieve a longer, efficient and high tensile profile. New methods were proposed for protecting against erosion of the last blades as the laser hardening instead of traditional Stellite strips brazed to the blade surface.

5. CONCLUSIONS

World over, many Ultra supercritical power plants ranging 350 MW to 1000 MW are under operation/construction.

Substantial improvements of the materials, advanced austenitic stainless steels and Ni base superalloys, make possible a live steam temperature above 700 ^{0}C. The high steam condition, optimal thermal cycles and improved equipments design could raise the power plants efficiency of about 48-50%.

The new A-USC power plants use the coal efficiently and clean. A-USC power plants could achieve a significant reduction of carbon-dioxide emissions and a lower cost of electricity in spite of their higher capital cost.

The steam turbines for A-USC need new materials and constructive solution in order to get a better efficiency and reliability.

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AN EXPERIMENTAL COMPARISON BETWEEN CORRUGATED AND POROUS PLATES OF SOLAR AIR HEATERS AT VARIOUS FLOW RATES

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ABSTRACT

Solar air heater systems are used both for domestic and industrial applications. Efficient solar heaters are depending basically on the absorber plate type and shape and the air mass flow rate. The present paper presents some experimental results on two solar air collectors: one with porous absorber and the second with one corrugated absorber. The two collectors have identical geometry. The tests were made in climatic conditions of Bucharest - Romania (44° 26' 0" N / 26° 6' 0" E). The parameters were sampled for both collectors in the same time, in order to obtain a direct comparison between their behavior. The measurements of ambient temperature, solar irradiance, wind speed, absorbing plate temperature and the inlet and outlet air temperature were performed for various air flow rates throughout the collector. The result shows that the efficiency of the collector with porous absorber is higher than the one with corrugated absorber for the same air flow rates and in the same outdoor conditions.
Keywords: Solar air collector, Thermal efficiency, Porous absorber, Corrugated absorber

1. INTRODUCTION

The solar energy technologies have a relatively low cost and are environmentally friendly. One of these technologies is referring to solar air heater system. They are simple devices that heats air by utilizing solar energy from the sun. There are various factors affecting the air heater efficiency like the type of the absorber plate, glass cover, air mass flow rate, collector size, wind speed, air inlet temperature, etc. Among all, the absorber plate shape factor is the most important parameter in the design of any type of air heater. Several designs for solar air heaters have been proposed and some of them provided good performance. Research was performed in order to experimentally investigate the efficiency of a single and double pass solar air heater having fins attached and using a steel wire mesh as absorber plate [1]. The study reported higher efficiency values for double pass collector in comparison with single pass ones by 7–19.4%. Other researcher investigated the case of porous baffles with different thicknesses soldered on the collectors' back [2]. The results indicated that the highest collector efficiency and air outlet temperature are achieved by solar air heating system with a thickness porous baffles of 6 mm and an air mass flow rate of 0.025 kg/s. Both experimentally and numerically investigation are known for the thermal efficiency of the single pass solar air collector with offset strip fins attached on a plate in the air flow pass [3].
Another study experimentally investigated the thermal performance of double and single flow for three types of solar air collectors, namely flat plate, finned and "V" corrugated [4]. The

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double pass operation of the collector leads to further improvement of the efficiency compared to the single pass of operation in all three types.
In [5] it is presented an experimental investigation on the thermal performance of a solar air heater with three different shapes of obstacles and without obstacles. The test results always yield higher efficiency values for the type with obstacles than for the type without obstacles flat plate collector. The obstacles ensure a good air flow over and under the absorber plates, educe the dead zones in the collector and create the turbulence. Experimental research was performed to determine the effect of an artificial roughness on a surface on the heat transfer to fluid flow in the duct of a solar air heater [6]. The absorber plate is the most important component due to its role in a solar collector for air heating. The thermal efficiency of the solar thermal collector is increased by increasing the absorber area. Different modifications have been suggested and applied to increase the surface area of the absorber plate [7 , 8].

The first objective of this research was to experimentally determine the performances of two different solar air collectors. In this study were analyzed two types of solar air collectors with high thermal performance suitable for air heating:- first one with porous absorber made of soft steel and the second with U-corrugated absorber made of aluminum. The second objective of the research was to provide a comparison between the performances of these two types of solar air collectors at various air flow rates.

2. COLLECTORS DESCRIPTION AND EXPERIMENTAL SETUP

The two geometrically similar collectors, one with a porous absorber plate, and the other with "U"- corrugated absorber are presented in figure no. 1. The dimensions of two collectors are 1.4 m × 0.7 m × 0.08 m. Two types of absorber plates were used the first one was made of soft steel with two layers of a mesh wire and the second one was made of aluminum. The dimension and plate thickness for all two collectors were 1.52 m × 0.7 m × 0.0007 m and 1.4 m × 1.13 m × 0.00035 m respectively. Normal window glass of 4 mm thickness was used as glazing. Single cover glass was used for each of the two collectors.

The air flow throughout the collectors according to their structure was as follows: in the case of the porous plate, consisting of a doubled wire network arranged in a "V" configuration, the air current was directly oriented from the inlet to the outlet of the collector and in the case of single pass "U" corrugated absorber there were placed three baffles – figure no.1. The collectors were tested under different weather conditions; an experimental setup is constructed and tested in the Politehnica University of Bucharest, Romania.

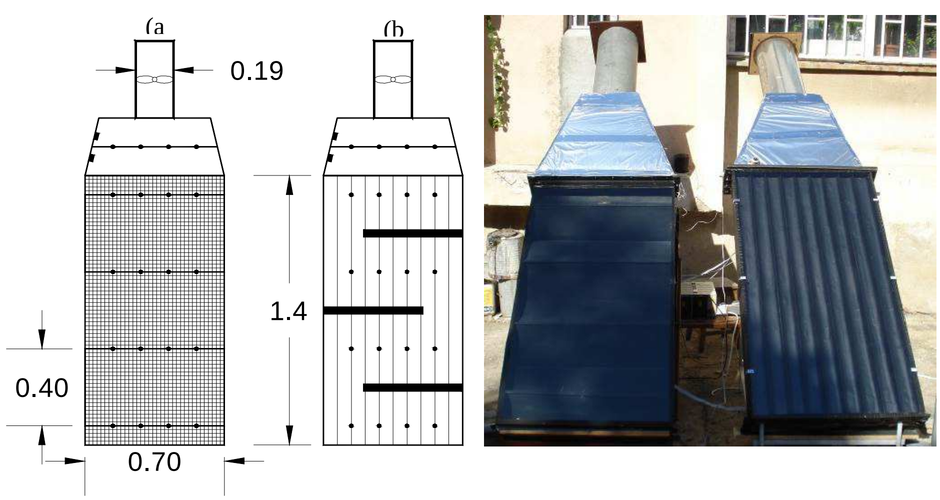

Figure 1: The experimental set-up and a schematic assembly of the solar air heater with (a) mesh absorber and (b) "U"- corrugated absorber. (all dimensions in m).

The parameters to be measured was: inlet, outlet, outdoor and indoor air temperatures, wind velocities, pressure and air flow, as well as solar irradiance intensity on the collecting area. There were used 32 thermal transducers distributed evenly, on the bottom surface of the absorber plates, at identical positions along the direction of flow for each collector. Inlet air temperatures were measured by two well insulated thermal transducers. To measure the outlet air temperatures four thermal transducers were fixed at the end section of each collector. The ambient temperature and humidity was measured by an electronic thermo-hygrometer placed behind the collectors' body. The total solar radiation incident on the surface of the collectors was measured by a pyranometer placed adjacent to the glazing cover of the collectors; all the measurement devices were connected to a computer. The measured variables were recorded at time intervals of 10 sec. and includes: absorber plate temperature at several selected locations, inlet and outlet temperatures of the air circulating throughout the collectors, ambient temperature and air flow rates. The air flow was provided by axial fans placed at the outlet of the collectors.

3. THERMAL ANALYSIS

The useful power supplied by the collector is the quantity of heat transferred to the air and can be obtained by computing the air temperature variation according to the following equation [9]:

$$Q_u = \dot{m}\, C_p\, (T_{a,out} - T_{a,in}) \tag{1}$$

where: $\dot{m}$ is the mass flow rate of air in [kg/s], given by equation (2):

$$\dot{m} = \rho \dot{V} = \rho v \frac{\pi . d^2}{4} \tag{2}$$

where: $\dot{V}$ is the volume of the air leaving the collector by the duct with diameter *d*, *v* is the air speed in [m/s] and ρ is the density of air in [kg/m^3].

The specific heat of air is assumed to vary linearly with temperature (ºC) by [10]:

$$C_p = 0.0057 + 0.000066(T - 27) \tag{3}$$

where: $(T_{a,out} - T_{a,in})$ is the air temperature increase between collector inlet and outlet.

The solar energy absorbed by the solar collector surface is given by:

$$Q_s = (\tau\alpha)\, I_T\, A_c \tag{4}$$

where I_T is the rate of incidence of radiation per unit area of the tilted collector surface [W/m^2], A_c the collector area [m^2] and $(\tau\alpha)$ the effective product transmittance– absorptance. The term $(\tau\alpha)$ represents the fraction of the solar radiation absorbed by the collectors and depends mainly on the transmittance of the transparent glass cover and on the absorbance of the absorbent. It can be evaluated by using the following equation:

$$(\tau\alpha) = \frac{\tau\alpha}{1 - (1-\alpha)\rho_g} \tag{5}$$

The thermal efficiency of a solar air collector is defined as the ratio of the power supplied by the collector to the total energy absorbed by the solar collector surface, efficiency of a collector is expressed as [9]:

$$\eta = \frac{\dot{m}\, C_p\, (T_{a,out} - T_{a,in})}{A_c (\tau\alpha) I_T} \tag{6}$$

After measuring the ambient temperature that is equal with inlet air temperature, the outlet temperatures, solar radiation, outlet air velocity and timing the intervals, the heating characteristic of the collector, the air flow rate, the heat flux and finally the conversion efficiency of solar energy in thermal energy were computed.

4. RESUALTS AND DISCUTION

Two different types of solar air collectors described in the previous sections were tested under the same outdoor conditions in the 2014. In the table no.1 are presented the average air temperatures measured during the day for each of the 4 lines inside the solar collector where thermal transducers was mounted and for a flow rate of 0.33kg/s: $T_{s,1}$, $T_{s,2}$, $T_{s,3}$, $T_{s,4}$- air temperatures for the first, second, third and fourth lines respectively of the collector with mesh absorber and $T_{a,1}$, $T_{a,2}$, $T_{a,3}$, $T_{a,4}$- air temperatures for the first, second, third and fourth lines respectively of the collector with “U”- corrugated absorber. Also $T_{s,o}$ and $T_{a,o}$ -outlet temperature - for mesh and “U”- corrugated absorber respectively was measured..

Table 1. Average air temperature on 01-10-2014

Time (min)	$T_{s,1}$	$T_{s,2}$	$T_{s,3}$	$T_{s,4}$	$T_{s,o}$	$T_{a,1}$	$T_{a,2}$	$T_{a,3}$	$T_{a,4}$	$T_{a,o}$
0	25	29	31	34	46	24	25	28	32	32
5	28	39	42	50	46	27	29	35	39	39
10	29	41	47	57	45	30	32	39	43	43
15	29	42	49	59	45	30	32	41	46	45
20	31	43	51	61	46	32	34	43	48	47

Figure no. 2 shows the efficiency of “U”-corrugated and porous collectors - as single pass and through-pass modes at 935 W/m^2 solar irradiation. It can be seen that the efficiency of the air collectors is strongly dependent on the air flow rate. The thermal efficiencies of both air collectors increased constantly up to 0.7 kg/s and then tend to approach a constant value. This figure clearly shows that the porous collector is more efficient than the corrugated plate. The air flow passing throughout the holes of the porous collector contribute to increase the surface per unit volume ratio and therefore increase the thermal efficiency in comparison with the “U”-corrugated collector. The “U”-corrugated collector has the significant advantage of absorbing a greater quantity of solar radiation than porous collector because of multiple absorption and reflections of incident radiation. This study shows that the porous collector is 2–10% more efficient than the “U”-corrugated plate collector. These two collectors were tested in the same experimental facility and under the same meteorological conditions, the comparison is considered to be a true reflection of the performance.

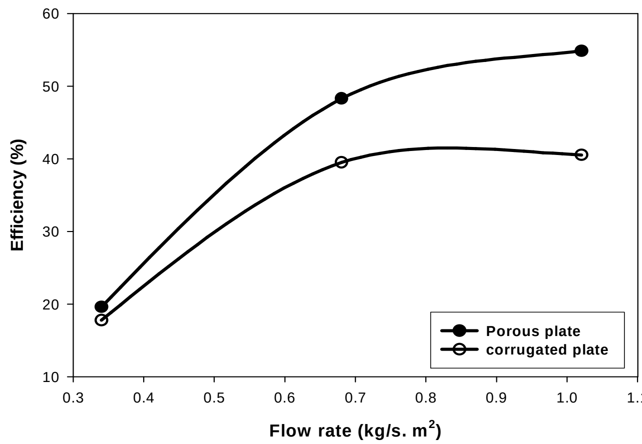

Figure 2: Comparison of two collector efficiency at the same flow rate.

In figure no. 3 is presented the temperature spectrum inside the collectors at three different air flow rate 0.33, 0.66 and 1 kg/s (0.34, 0.68 and 1.02 kg/s m^2). Figure no. 3a indicates that the high temperature zone exactly corresponds to the porous absorber while the low temperature zone corresponds to the corrugated absorber -as shown in figure no. 3b. The high temperature zone is caused by the large area contact between the air and network holes. From figure no. 3a and b, the results shows that by increasing the mass flow rate simultaneously the air temperature drops in collectors.

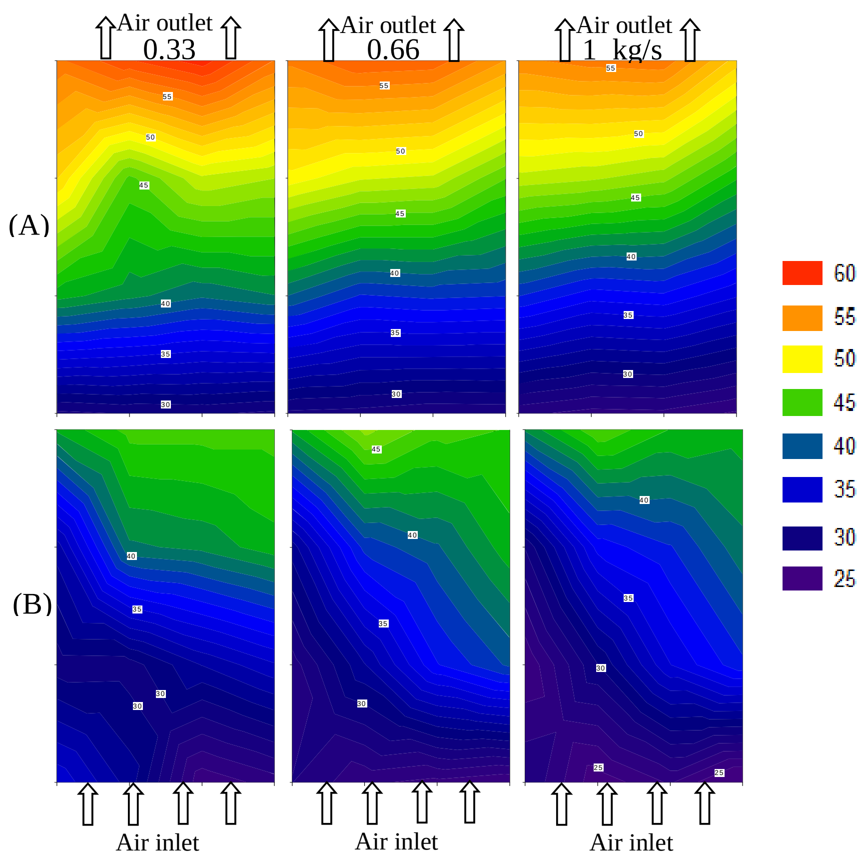

Figure 3. Temperature distribution of the absorber plat at different flow rate; A) porous absorber plate and B) "U" corrugated absorber plate.

5. CONCLUSION

Two types of solar air heat collectors with porous absorber and with “U”- corrugated absorber were studied comparatively in order to assess their performances. The test results showed that the efficiency of solar air collectors can be improved by using porous media. Also the results shows that the average performance of the solar air heater with porous absorber is approximately 6% higher than the collector with “U”- corrugated absorber. The effects of the air mass flow rate to the efficiency of collector were investigated and the collectors were tested in three different mass flow rates 0.33, 0.66 and 1 kg/s (0.34, 0.68 and 1.02 kg/s m^2). The thermal efficiency of the heater improves with increasing air flow rates due to an enhanced heat transfer to the air flow and an optimum value was obtained.

Acknowledgments

The author (Qhtan A. Abed) thanks the Ministry of Higher Education in Iraq.

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A POSSIBILITY TO IMPROVE THE EFFICIENCY OF A HOUSEHOLD NATURAL GAS BOILER BASED ON THE WASTE HEAT RECOVERY OF THE EXHAUST GASES

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ABSTRACT

The paper highlights one of the methods applied in order to increase the efficiency of a natural gas instant boiler designed to prepare the hot water for the purposes of a household. The method consists in the usage of a buffered thermo-stated water tank filled by a secondary water circuit heated by the waste thermal energy of the exhaust gases delivered by the main gas boiler operation.

1. INTRODUCTION

Based on the opportunity to recover the waste heat of the exhaust gases produced by an instantaneous gas boiler in order to prevent its abnormal operation and looking forward to increase the efficiency of the hot water preparation system, a model of an extended installation has been proposed.

Serving this purpose, a secondary water heating loop has been considered, consisting in a water buffer tank, filled with the water heated by a heat exchanger using the waste energy of the principal instant boiler exhaust gases.

Authors would like to highlight the fact that even in the situation in which the instant boiler manufacturer delivers the basic schematic of the boiler operation without any waste heat recovery systems, a certain reserve of heat potential could be supplementary used to save more energy and costs in terms of a rational boiler usage, avoiding its malfunctioning when condensing.

After the validation of the simulation results, the obvious following step would be the proposal of a more economic operation of the gas boiler, referring to the decrease of the gas consumption and of the maximum heating power.

2. THE SCHEMATIC OF THE INSTALLATION

The schematic of the proposed solution (see Fig.1) is based on the gas instant boiler, a Ferolli-Zefiro 11 type [1], with one heating circuit, providing the following features:

- Heating power, from 8.1 to 21.1 kW;
- Effective power from 7.1 to 18.9 kW;
- Water flow from 6.5 to 10.8 l/min at 40 °C and from 2.4 to 5.4 l/min at 65 °C, if the water network has 20 °C temperature;
- Gas (G20) consumption from 0.86 to 2.23 m^3_N/h;
- Exhaust gases mass flow from 45.1 to 60.7 kg/h;
- Minimum exhaust gas temperature in order to avoid condensation is 80 °C;

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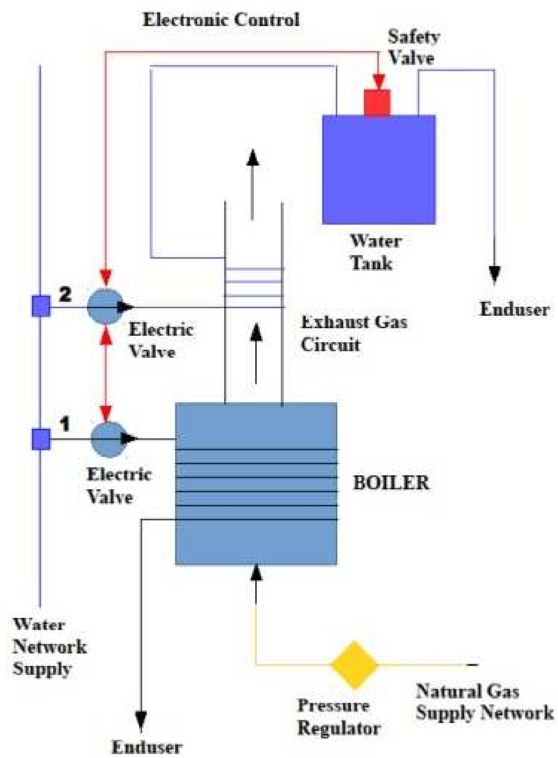

Figure 1: A possible schematic of the extended installation

Initially, this study started with the modelling of the instant gas boiler. The gas burner of the boiler has a variable natural gas flow and a relative air-fuel ratio (λ) equal to 2, and the gas temperature in the burner outlet is 1700 K. The gas flow varies with the water flow and with the water desirable temperature. The control of the inlet gas flow is realized by integrating the function of the temperature difference between the value set by the user and that of the heated water. For a water flow of 4.8 l/min and a water temperature of 65 °C, the exhaust gas flow is 54.3 kg/h, corresponding to a fueling gas flow of 2.14 $m^3{}_N/h$. Thus, for an operation period of 800 s with a water flow of 4.8 l/min at 65 °C setting temperature, the variation in time of the consumable water temperature is shown in Fig.2

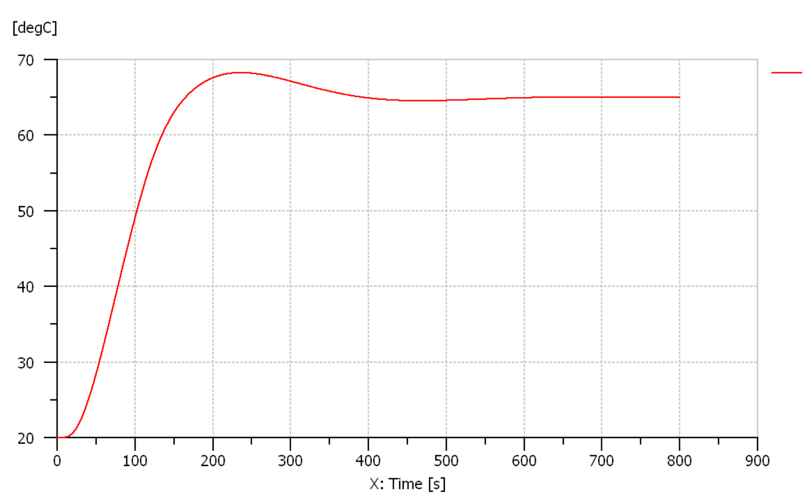

Figure 1: Water temperature variation at constant water flow (65 °C set temperature)

The variation of the exhaust gas flow is plotted in Figure 3. As is can be remarked, in approx. 100 s first it grows to a maximum value, than oscillates, and after 500 s from the start it stabilizes.

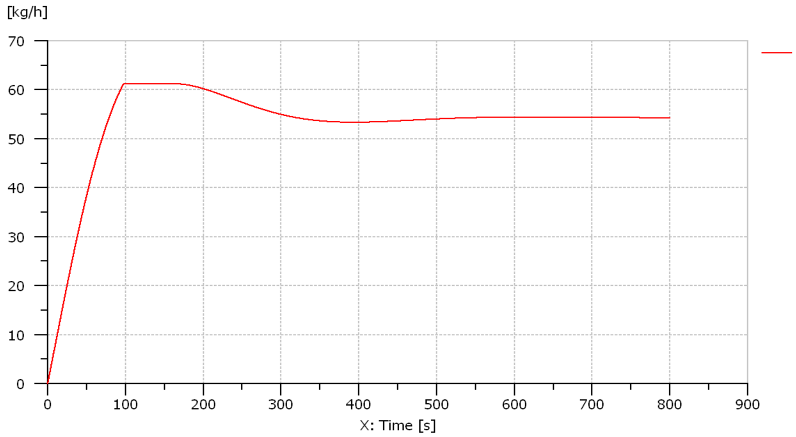

Figure 3: Exhaust gas flow variation at constant water flow (65 °C set temperature)

It becomes very interesting to study the system behavior when varying the consumption water flow. For a natural gas flow variation in time like that presented in Figure 4, the heated water temperature and the exhaust gas flow have a variation as highlighted in Figure 5.

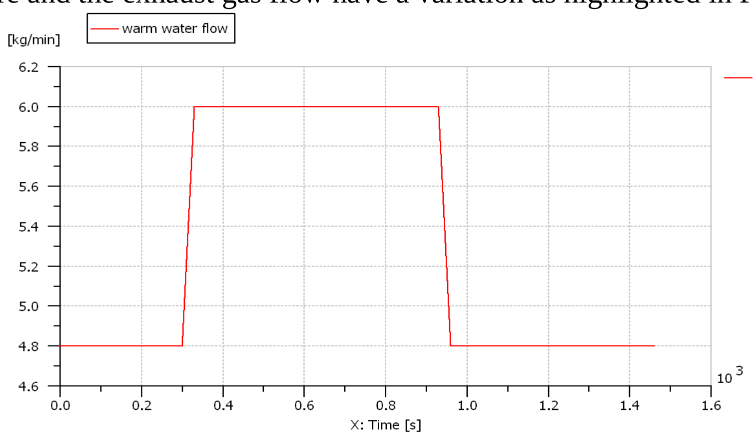

Figure 2: The variation of heated water flow

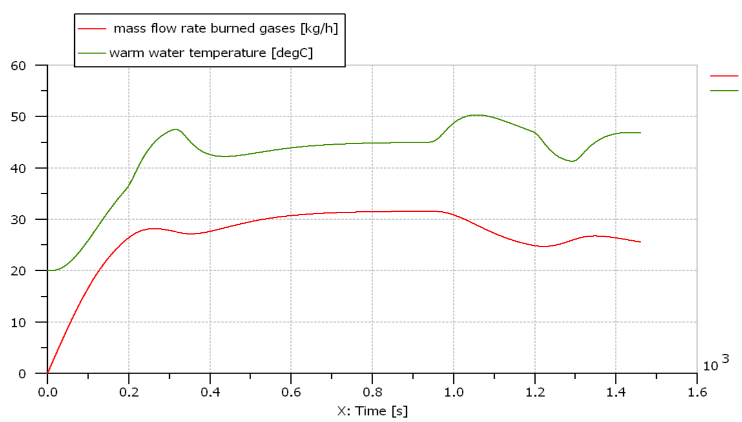

Figure 5: Variation of exhaust gas flow and heated water temperature

3. INCREASING THE SYSTEM EFFICIENCY

To increase the system efficiency, in terms of reducing the natural gas consumption, a secondary water circuit has been chosen, heated from the final length of the burned gas outlet circuit and delivering the water directly to the user, or buffering it inside of a 100 l maximum capacity water tank (see Fig.1). The openings of the two heating water circuits must be simultaneous, controlled by an electronic unit, with connection also to a safety valve mounted on the water tank.

A comparative study between the initial case and the extended optimized configuration has been completed for a heated water flow of 4.8 l/min at 65 °C set temperature. The results are shown in Figure 7. It is revealing that after approx. 200 s of natural gas fueling, for which both consumptions are relatively identical (period in which the water temperature reaches its set temperature), the gas flow has stabilized at 9.54 in first case and at 9.26 g/s in the second case, meaning a decrease of about 3% when burning 1.3 m^3_N of natural gas.

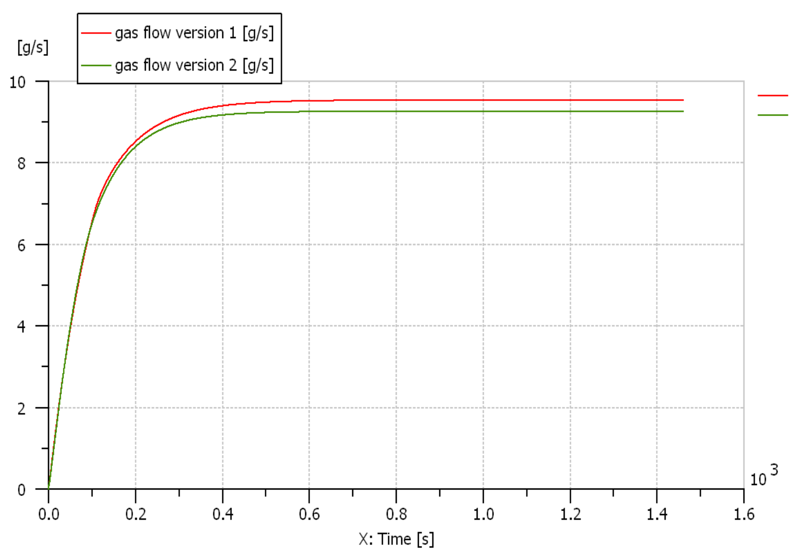

Figure 3: The variation of the gas mass flow

The presented results indicated the increase of the boiler performances in the second configuration for a certain regime of heated water flow and water temperature [2]. The interest to continue the comparison between the two cases for other regimes extends the research of the boiler efficiency potential.

Figure 8 shows the boiler behavior when considering a 500 s usage period, the water temperature set at 60 °C and a water flow up to 5 l/min, all defining a high operating load. The gas consumption for this period is in-between 0.08 and 0.16 m^3_N, and to maintain the heated water temperature, the maximum gas flow is about 1.4 m^3_N. For the whole wide of simulation range, the increase of the system efficiency is about 3%.

Another simulation is related to the situation of water heating at 40 °C, in which situation the water flow varies between 2 and 9 l/min, according to the boiler documentation. The conclusion of gaining at least 3% economy of gas consumption is available in this scenario either (see Fig.9).

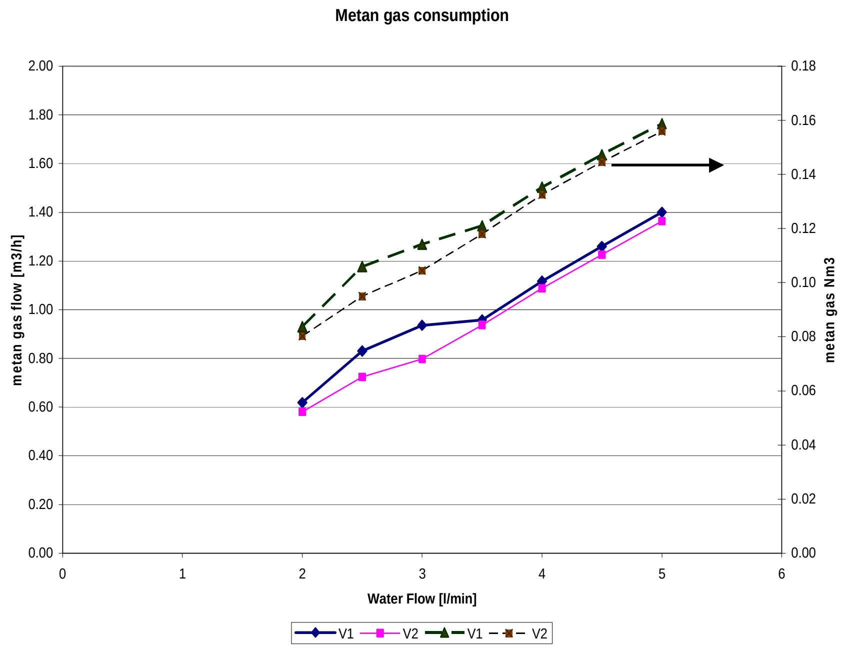

Figure 4: Gas parameters at 60 °C heated water temperature

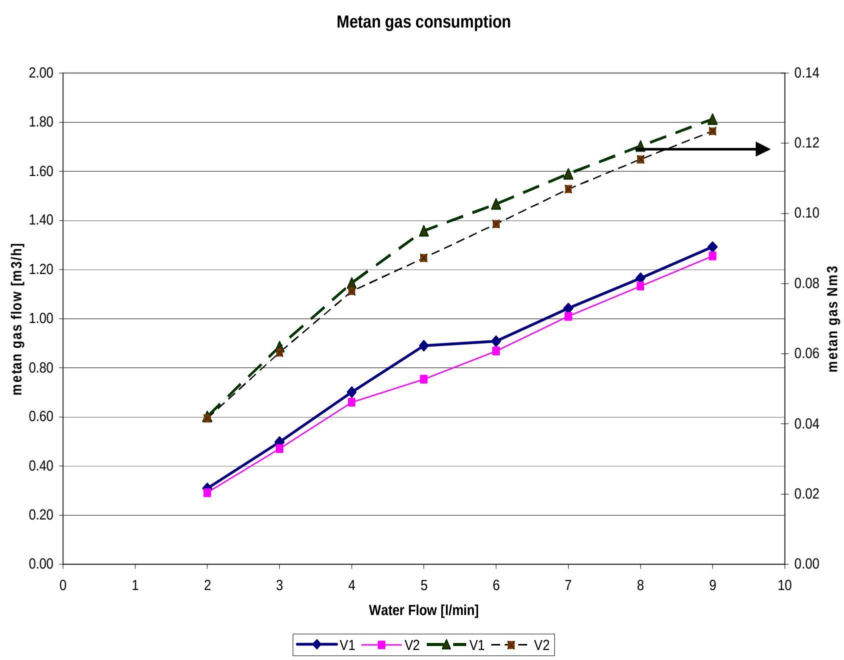

Figure 9: Gas parameters at 40 °C heated water temperature

4. CONCLUSIONS

Starting from the idea of stating that the efficiency of a household boiler could be improved by adding a new water circuit exchanging heat with the final outlet circuit of the exhaust gases in order to gain the much possible of the their waste heat recovery, the authors have tried a modeling for both configurations: with and without waste heat exchange system. Setting in a certain way the parameters values, a 3% decrease of the gas consumption could be reached, covering the whole range of the operation domain.

Trying some other technical configurations and choosing other interesting values for the gas flow and for the water temperature, with impact on the system operation, higher increasing values of fuel economy could theoretically be highlighted.

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ELECTRO HYDRAULIC INSTALLATION FOR ACTUATING THE BRUSH OF A MACHINE FOR WASHING PV PANELS

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ABSTRACT

Global investment in renewable energies have increased in recent years. These investments help reduce CO_2 emissions. It is known that deposits of dust or dirt on the photovoltaic panels may decrease , through shading effect, energy production even up to 50% [4]. To maintain performance of energy production from solar power plants is required periodic cleaning of photovoltaic panels. In the world are used different methods or facilities for washing photovoltaic panels. The paper presents the realization of an installation for actuation of the brush of a machine for washing photovoltaic panels. The installation is mounted on a 4x4 truck, along with a water reservoir. The installation consists of a frame on which are mounted: oil tank, electro hydraulic equipments, combustion engine hydraulic pump, water tank, an arm with washing brush and control cabinet. The driver operates the installation via a console from car cabin.

1. INTRODUCTION

The efficiency of washing of photovoltaic panels with rotating brush which slides on panels surface and water jet is 70-80%, and the cost per kWh is average compared to other methods. Hydraulic system along with mechanical structure composed from a column with an arm which support the washing brush, are set to be installed in a 4x4 truck car. Thus results a very affordable machine for washing photovoltaic solar panels. When there is no need to wash PV panels the 4x4 car truck can be used for travels or to transport some materials. The installation can be downloaded from truck, easily, by disconnecting the electrical cables and loosening the bolts that binds the frame in the truck pail.
In Figure 1 there is a picture of the car during tests at a power plant with photovoltaic panels.

Figure 1: Washing machine for photovoltaic panels during testing

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The column with an arm which support the washing brush can be rotated with 90 degrees, from rest position, in the left or right side of the car, for wasing the panels on the right or left side of the car. Thus the car can travel meandering between the panel rows and starts the washing process from one beginning of the row or the other one beginning of the row. The rotation of the column in done with a toothed rack mechanism. The toothed rack is driven by a hydraulic cylinder. At the upper end of the column is mounted an arm which has at his end an articulated support which can be rotated by means of levers by a 2nd hydraulic cylinder.
On articulated support is mounted the frame that supports the brush. To tilt the arm is used another hydraulic cylinder. Rotation of the brush is provided by a rotary hydraulic motor. On the brush holder are mounted nozzles that provide water jets for washing and rinsing the PV panels.

The hydraulic cylinder for lifting the arm, performs vertical positionig of the brush and the hydraulic cylinder that rotates the suport with frame that holds the brush, performs positioning of the brush in parallel with PV panels. This hydraulic cylinders must correct permanently the vertical and angular position of the brush, because of mounting height irregularities of sections of panels or because of terrain irregularities that are meet during car travel between rows with PV panels.

On the same utility vehicle is loaded water pump hydraulically driven, hydraulic station for driving hydraulic motors, the combustion engine which act the hydraulic pumps and the water tank for washing.

The heat engine that provides energy for hydraulic station is a 4.5 kW diesel engine with 2200 rev / min.

2. HYDRAULIC DIAGRAM

Hydraulic station of which diagram is shown in the Figure 2 is composed of:

- Hydraulic tank of 100 l with return filter and oil cooling system. Solenoid valve **(20.2)** turns on or off, depending on the command received from a thermostat, the coolant. Washing water circuit is used as a coolant.
- Pumping group (Figure 3) comprising a triple pump driven by a combustion engine of 4.5 kW. The first section of the pumping unit has parameters of 14 l / min and 100 bar feed a pressure bus of which with hydraulic directional valves **10.1, 10.2** and **10.3** are supplied hydraulic cylinders **17,18** and **19** providing vertical positioning of the brush, angular motion or rotating the pivot.

The second section of the pumping group with parameters 4.5 l / min and 60 bar, act through the directional valve **(11)** the hydraulic motor for rotating the brush in direction left or direction right with speed of 125 rev / min.

The third pumping section with parameters 7,5 l/min and 50 bar, act through directional valve **(12** the hydraulic motor for water pump at a speed of 2800 rev / min.
With the directional valve (6) it connects the pressure in circuit only when is needed for movement of the rod of hydraulic cylinders. In the scheme was provided and a 2-way flow regulator (8) to adjust the travel speed of the rod of hydraulic cylinders.

For accidental situation when heat engine is defective in work field, to execute movements for folding the mechanism in the rest position in order to move the vehicle, was set a hydraulic electric pump (26) with parameters of 350 W, 2.5 l / min and 100 bar supplied with electric power from the vehicle's electrical system (12 V).

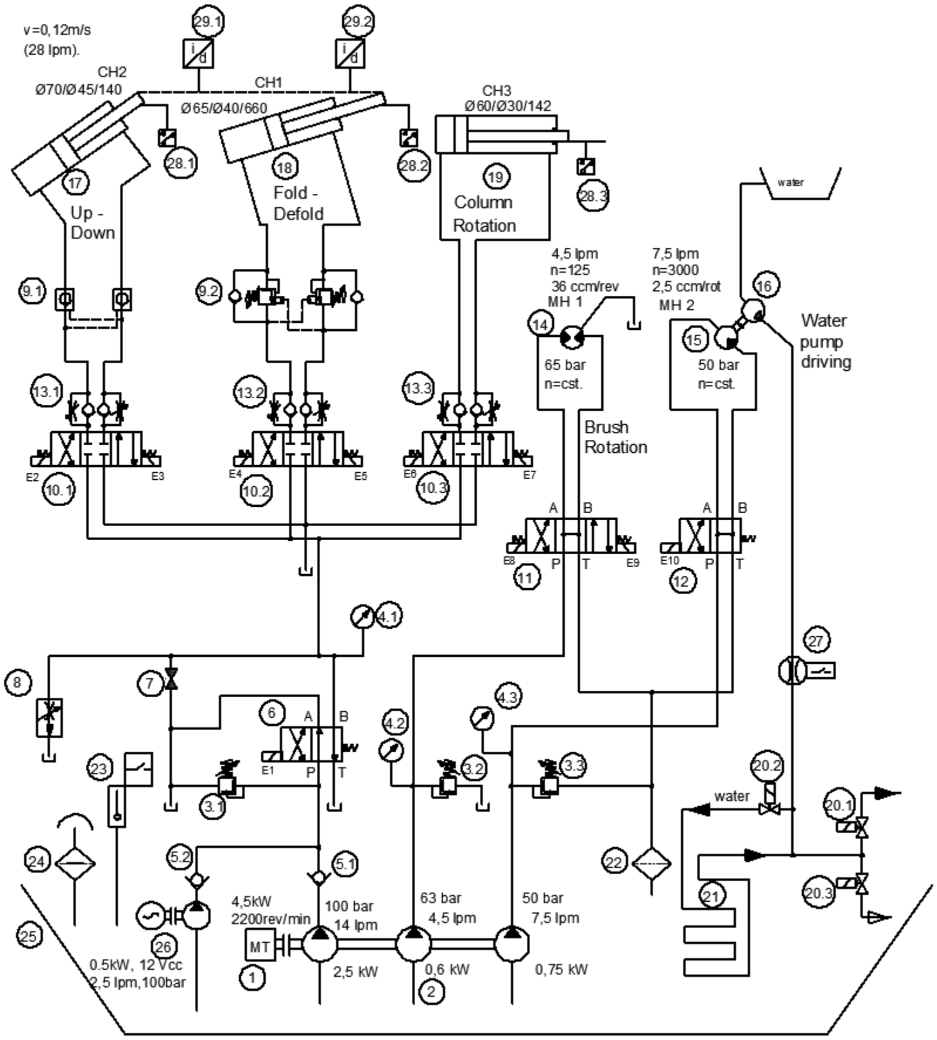

Figure 2: Hydraulic diagram of the installation

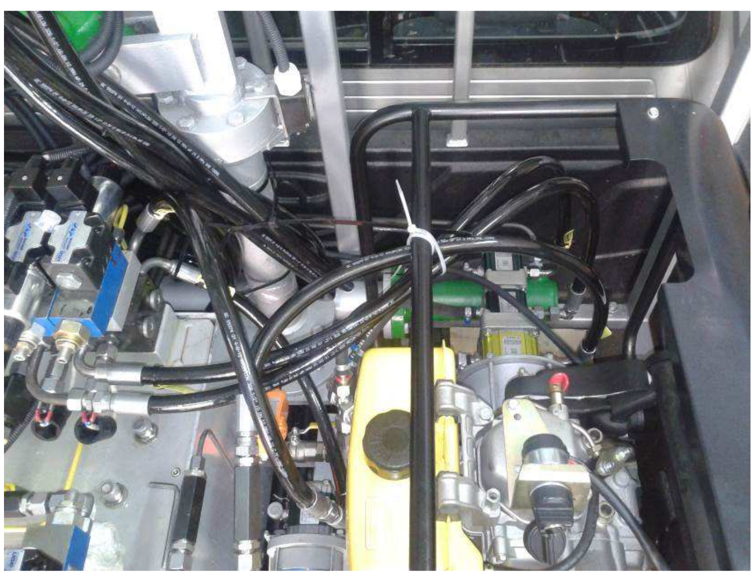

Figure 3: Triple pump connected to the shaft of diesel engine

3. CONTROL SYSTEM

Controlling of the installation is based on a microcontroller unit that receives information from sensors, from contacts limiter, thermostat and gives commands to the valves coils for making various movements. To automate the installation, was implemented a software as a state machine. Electrical commands are given through high side switches. Commands received by the valves enable a mechanisms movements such as rotating column, arm tilt, brush angle adjustment and controlling valves for washing on the left side, on the right side or cooling circuit. To keep the brush approximatelly parallel with solar panels was implemented a on-off controller with two ultrasonic distance transducers. Distance of the brush from panels is maintained, with a specific error by using two hydraulic cylinders acting in tandem to keep the brush parallel to the panels. Distance does not need to be perfectly equal on both ends because the difference is taken by flattening or lengthening of the the brush bristles.

In Figure 4 it can be seen how the controller works according to the variation of height of terrain or height of mounting of panels sections. For the system not to enter in oscillation, speed of the hydraulic cylinder rod is adjusted to a low value.

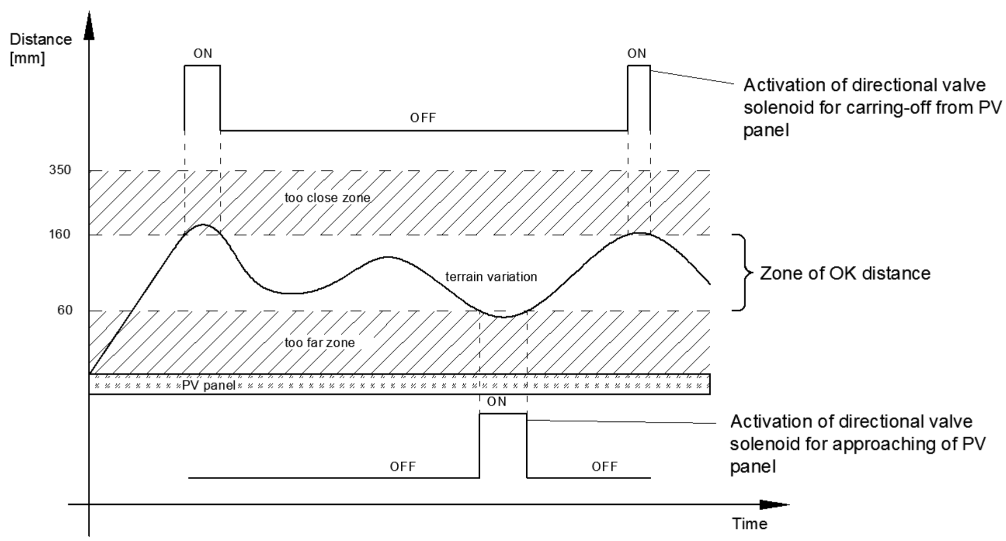

Figure 4: Controller functioning

Block diagram with equipments connected to the control unit is found in Figure 5.

Operator has an operating console, connected by a serial cable with control unit. For a good wash process productivity were implemented a series of automatic sequences. One of the sequences is rotating column in working positions, in left or right of the car. Rotating of the column is made up to reach a roller lever switch by a cam. A number of interlocks are written in software to allow movements only in a certain sequence. An interlock does allow brush unfolding only with arm rotated in working position. Rotation of the column is not performed unless the switch that confirm arm horizontality is closed. If the arm is not horizontal, the operator must command horizontalization of the arm up to confirmation by lighting a LED. By operating a toggle switch is performed unfolding of the brush until is received a signal from a proximity sensor.

In Figure 6 there is a picture during tests in which can be seen that the distance of the brush from the PV panels is maintained pretty good.

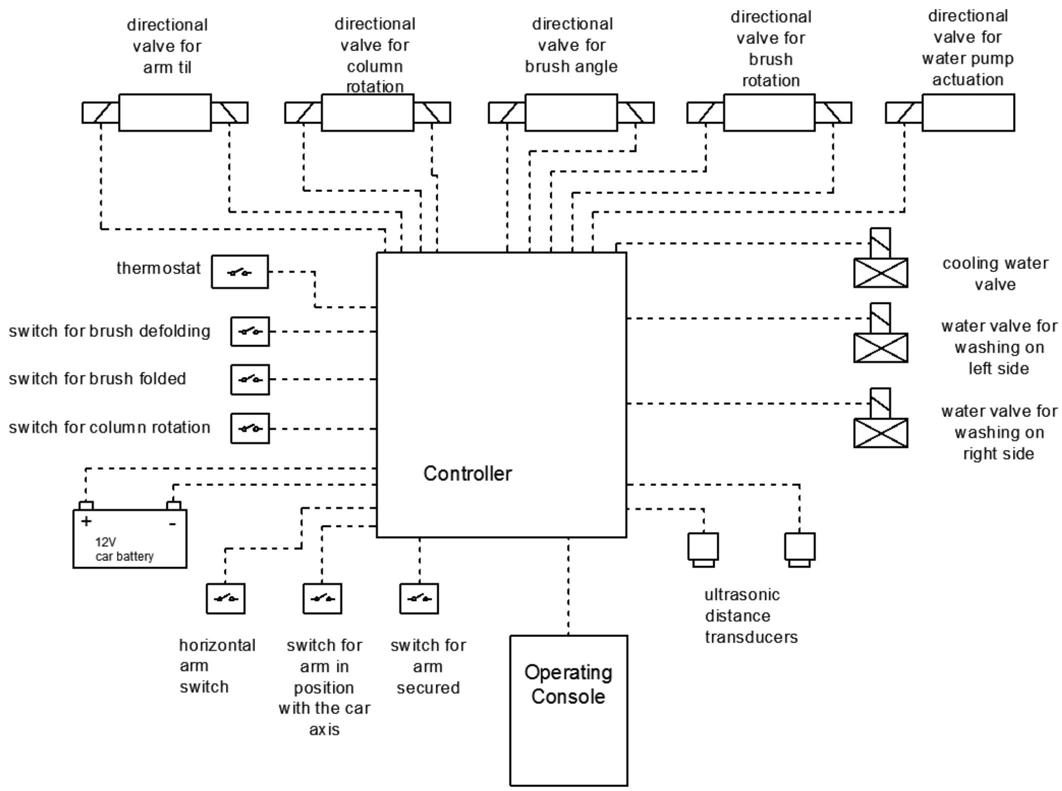

Figure 5: Diagram with equipments connected at the controller

When is completed the row of panels, the wash stops automatically and the operator, by operating a toggle switch, starts the sequence for folding the brush. After folding of the brush, by pressing a button, column with arm and folded brush rotating at 90 degree along the car, position in which the car can move to the next row of panels.

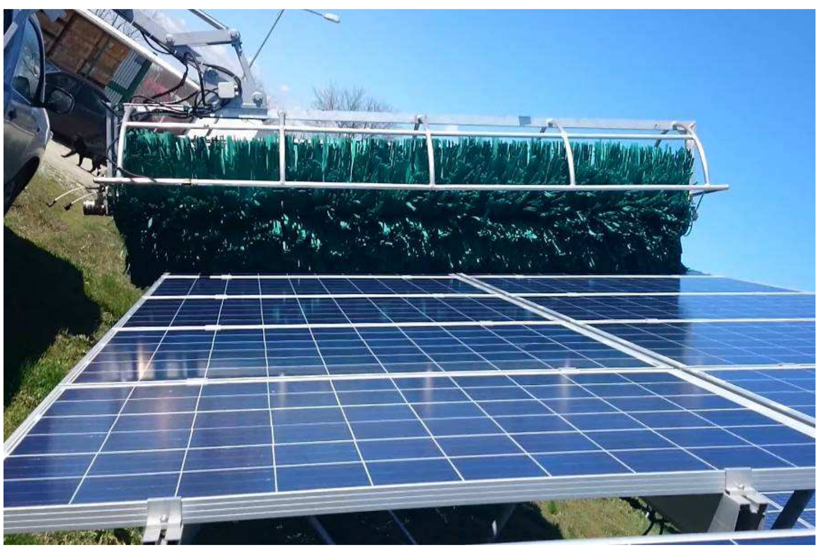

Figure 6: The brush maintained in parallel with PV panels

4. CONCLUSIONS

This type of mobile installation that can be fitted in a 4x4 pickup truck, is an affordable solution for entrepreneurs who want to provide services to wash solar panels or for owners of photovoltaic power plants.

Productivity of the installation is very good because washing is done in a single pass for the entire width of the row of panels which is 3 meters.

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PRACTICAL PSYCHOMANAGERIAL APPLICATION IN ORDER TO BUILD A BEHAVIORAL HOLISTIC MODEL OF ECO-AWARENESS BASED ON ORDER PSYCHOLOGY-QUANTUM PSYCHOLOGY® (POPQ®)

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Training and Development Centre Perfect Bucuresti

ABSTRACT

The study subject to our research, seen from the perspective of management and applied psychology within Sucursala Electrocentrale Craiova, Isalnita Facility, in order to increase the quality of life, has a holistic and eco-ergonomic nature, the relation between man and equipment being characterized by the synergetic role of the environment in validating such relation.
It was created: a general holistic model of eco-awareness built on the basis of sustainable development principles included in the Rio Statement and a behavioural holistic model of eco-awareness based on Order psychology - Quantum psychology® (POPQ®)[19].

Key words: behavioural holistic model, Curve of knowledge, eco-awareness, Order Psychology-Quantum Psychology

Acknowledgments
This work was supported by a grant of Romanian National Authority for Scientific Research CNDI-UEFISCDI, project number PN-II-PT-PCCA-2011-3.2-1292, HOLGRUP.

1. Introduction

In the social field experts noted in time a more individualized social reality. The need to protect Human, the essential factor of the preservation and evolution of species, requires an adaptation of methodologies and methods of knowledge for an intervention in favor of keeping life at higher levels of evolution of matter, at leading information existing in science.
Our research is based on original methodology and instrument of Order psychology - Quantum psychology® (Configuration method, Curve of knowledge or POPQ scale).

2. **Representative sample**

The field research has been performed within the exploitation section – 104 persons.

Seniority	***0-7 years***	***7-16 years***	***16-24 years***	***24-33 years***	***over 33 years***	**TOTAL**
Subjects with higher education	2	3	10	14	2	31
Subject with high school education	6	0	16	35	16	73
TOTAL						**104**

Significance of age stages in terms of the relation between the procurement of the professional action model and the certainty level (on POPQ scale) of the potential of achieving professional goals

Stages of organizational age	Significance
0-7 years	The stage of **risk and uncertainty**. Between the subject and its work tasks there are still forms of distress and misunderstanding which sometimes reach the parameters proper to conflict. The occurrence of the adverse event is an expected reality. It may occur, according to Heisenberg's principle, anywhere, at any time, anyhow. Most of the time such an event originates in the subject's inappropriate professional behavior. It corresponds to grades **7, 6** and **5**.
7-16 years	The stage of the first two forms of certainty: **limit certainty and guaranteed certainty.** Between the subject and its work task there is a beneficial, creative tensional relation. The occurrence of an adverse event is a surprising reality for those in the subject's environment. At this level of professional development, the occurrence of an adverse event has external causes, independent from the subject. It corresponds to grades **9** and **8**.
16-24 years	It is the highest point on the curve of procurement of the professional action model for professions and occupations in the exploitation sector. It is the stage of **performing certainty** in which between the subject and his/her work task there is a quasi-identity relation, and the occurrence of the adverse event is relatively impossible. It corresponds to grade **10**.
24-33 years	It is the stage of biological regression, because of the memory retention phenomenon. In terms of professional performance, this stage is equivalent to stage 7-16 years, including the degrees **guaranteed and limit certainty**. It corresponds to grades 9 and 8.
over 33 years	It is equivalent to stage 0-7 years (**risk and uncertainty**) – grades: 7, 6 and 5.

3. RESULTS OBTAINED

3.1. General Holistic Model of Awareness built on the basis of sustainable development principles included in the Rio Statement

ECO-AWARENESS MODEL					
Perspective on the relation with nature	**Perspective on life in general**	**Type of necessity satisfied / unsatisfied by the relation with nature**	**POPQ scale**	**Type of emotion caused by nature understood in broad terms**	**Attitudes towards natures and environment**
Integration in nature Solophilia	Spiritual	Ideality, stable balance	Performant certainty	Ecstasy/ happiness	Attachment
Love for nature Solastalgia	Moral	Harmony with the world, with the others, morality	Guaranty certainty	Joy	Empathy
Wisdom in the relations with nature (Rationality)	Rational-utilitarian	Need for usefulness	Limit certainty	Pleasure	Sympathy
DETACHMENT					
Ambiguous towards nature (schizoid)	Emotional-negative, dynamic balance	Inner disharmony, uncertainty	Uncertainty	Unconcern	Antipathy
Vengeful on nature (sadistic-paranoid)	Antagonist-conflicting	The feeling of losing identity	Risk	Defiance	Hatred
Negativist (catatonic)	Depressive	Losing the sense of existence	Chaos	Apathy	Indifference

3.2. Relation with nature

One has addressed the following **criteria:**

1. Perspective on the relation with nature
2. Perspective on life in general

3. Type of necessity satisfied/unsatisfied by the relation with nature
4. Type of emotion caused by nature understood in broad terms
5. Attitudes towards nature and environment

CONCLUSIONS

Criterion	Subjects with higher education		Subjects with high school	
	Ratio	Comments	Ratio	Comments
1	**93%**	They consider themselves as integrated in nature	**94%**	They consider themselves as integrated in nature
2	**95%**	One reports rationally, general optimist answers	**92%**	One reports rationally, general optimistic answers
3	**94%**	Satisfied-the necessities related to freedom and ideality generating the feeling of power and uniqueness	**75%**	Satisfied-the necessities of morality, causing the feeling of perfection, harmony
4	**60%**	They feel no emotion for nature (age-over 40 years)	**67%**	Positive emotions for nature
5	The reaction varies depending on the professional age. If subjects with the professional age of 7-16 years have a totally positive attitude towards the environment, subjects belonging to the category 0-7 are reluctant, assessing the environment in which they carry out their activity at the level of limit certainty, which means the existence of a distress in the relation between the subjects and work environment. For the categories of age 16-24, respectively 24-33-categories which suppose a wide experience in the context of the current work environment, the trend is over the ceiling between limit certainty and uncertainty, which emphasizes forms of slight to major distress, evolving to conflict between the subject and his/her work environment		An uncertain reference to the environment is obvious. The attitude towards the environment ranges between appreciation and disappointment, even if the latter is not directly expressed, but indirectly, by the refusal to assess the attitude towards the work place by a certainty grade (8, 9 or 10).	

3.3. Behavioral Holistic Model of Eco-awareness based on Order psychology-Quantum psychology® (POPQ®)

The POPQ® human behavior model [19] has been created based on experiment. This experiment has involved over ten years more than 5,000 subjects. We have developed a human behavior model that we will use also in the context of this study for creating the eco-awareness behavioral model. Eight fundamental models have resulted: MMR – male-male rational = competitive, MFR – male-female rational=expert, FMR – female-male rational = altruist, FFR – female-female rational=perfectionist, MMI – male-male irrational = hero, MFI – male-female irrational = Innovator, FMI – female-male irrational = energetic, FFI – female-female irrational = pacifist.

Each having 4 levels of manifestation: higher, medium, lower and regressive. E.g.: for MMR:

Higher eco-awareness: Authentic behavior, focused on finding efficient solutions in the relations with nature; sympathy for nature

Medium Eco-awareness: Pragmatic, adaptable, wanting to excel, conditioning the involvement in actions with environment or nature on a gain brought to his/her own image

Lower Eco-awareness: Unscrupulous, aggressive and conventional behavior; insincerity in the attitude towards environment and nature

Regressive/pathological eco-awareness: Sadistic behavior, lack of feelings and inner emptiness in relation to nature, neurotic reaction towards nature

CONCLUSIONS regarding the behavioral holistic model of eco-awareness built based on the methodology of Order Psychology - Quantum Psychology® (POPQ®)

The aim has been to determine by higher, medium, regressive and pathologic levels, the forms of behavior that make up the behavioral eco-awareness model with S.E.Isalnita.

Behavior level	Subjects with higher education		Subjects with high school education	
	Personality type	Ratio of subjects	Personality type	Ratio of subjects
Higher	***Hero*** -sacrifice spirit in the relation with nature and environment -it occurs in difficult situations -it defines subjects with a high awareness of the world	11%	***Perfectionist*** - Highly accountable behavior, based on attachment towards nature; - specific behavior in critical, difficult, catastrophic situations.	16%
Medium	***Energetic*** - Bohemian, relatively unfocused and distracted behavior, a little excessive in manifestations yet efficient. –it occurred in ordinary, normal situations -proper to subject in whom the self-awareness and the awareness of the worlds are equiprobable.	69%	***Competitive*** - Pragmatic, adaptable, wanting to excel, conditioning the involvement in actions with environment or nature on a gain brought to his/her own. –it occurs in ordinary, normal situations.	67%
Lower	***Expert*** -The subject is disconnected from everything around him/her and concerned about his/her problems only, -the self-awareness is dominant.	18%	***Energetic*** - Imprudence in the relation with environment and nature - individual behaviors, based on personal disappointments and frustrations.	14%
Regressive	***Pacifist*** - Depressive disorder, extreme denial of environment and nature, obstinacy and rejection of helping efforts -he/she is highly present in cases of social and economic crisis.	2%	***Expert*** - Schizoid behavior, with full loss of interest in the world, environment and nature. Such outbreaks occur especially during crisis and social and economic uncertainty periods.	3%

The methodological model developed in the context of the research work is a genuine model placing in a consistent relation: MAN - TECHNIQUE – ENVIRONMENT. The behavioral holistic model of eco-awareness can be used as a start point for managerial solutions in order to increasing the level of eco-awareness and of quality of life.

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RESULTS FROM AN ENERGY AUDIT OF MUNICIPAL BUILDINGS IN THE MUNICIPALITY OF SLIVEN

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ABSTRACT

The article presents the results of energy audits of six municipal buildings (two nursery schools, three kindergartens and an old people house) in the municipality of Sliven. An analysis of the present state of the buildings envelope and heat consumption was done. Proposed measures for reducing of energy consumption and the expected results after their implementation are presented.

The techno-economic analysis was performed. It was found that the annual energy consumption for heating in the audited buildings could be reduced with 1 853.91 MWh/year.

The ecological equivalent of expected annual reduction of heating energy consumption shows that the reduced CO_2 emissions are 319 tons per year.

1. INTRODUCTION

The issue of energy consumption in buildings stands in the heart of the EU policy on energy efficiency. The energy consumption in the building sector has the largest share in the total energy consumption and the CO_2 emissions released into the environment [20]. Large part of this energy could be saved by renovation of the existing buildings and implementation of profitable ESM's.

In Bulgaria a number of authors carried out research related to energy efficiency in buildings. Kalojanov and others analyze alternatives for energy savings in public buildings [3,4,5]. Research for increasing the energy efficiency in the school buildings of University of Food Technologies - Plovdiv are made in [1,2,19]. Kamburova and co-authors [6] analyze the heat transfer characteristics of 6 of the school buildings of University of Ruse. Nazarski and others [7,8,9] examined the possibility of improving the energy economy of the existing buildings through renovation. They are reported and the social impact of the energy renovation of buildings though implementation of thermal insulation systems in buildings [17,18].

The issue of improving the energy efficiency of buildings is a basic one into the energy strategies of EU Members in the implementation of the Directive 2012/27/EU [21] in their national energy policies.

The audit for energy efficiency in buildings gives a real assessment about the potential to reduce energy consumption and the corresponding possible cost-effective ESM's. The results of the energy audit are presented in a report, which is provided to the owner of the building and to the contracting authority [10].

The aim of this paper is to analyze the results of the energy audits of six municipal buildings (two Nursery schools, three Kindergartens and an Old people house) as well as the provided ESM's.

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2. METHODOLOGY

Data of the main constructive characteristics of the audited six municipal buildings and the year of their placing in service are presented in table 1.

Table 1: Constructive characteristics of the audited buildings

Name of the building	Year of placing in service	Built area, m^2	Total built area, m^2	Heated area, m^2	Gross volume, m^3	Heated volume, m^3
Nursery school № 6	1963	366	1100	732	2415	1932
Nursery school № 15	1975	1100	1906	1906	5336	4620
Kindergarten “Zdravets”	1934	460	860	460	1932	1450
Kindergarten branch	1966	513	1026	1026	3848	3463
Kindergarten “Edelvais”	1979	1017	1728	1728	5184	4484
Old people house	1973	1438	5168	4864	13619	12017

The analysis of the building envelope (exterior walls, doors and windows, floors and roofs) was made at the carried out energy audits. The values of the overall heat transfer coefficient through the individual enclosing components are calculated, taking in consideration the coefficients of thermal conductivity of used building materials and coefficients of convection heat transfer from the outside and the inside of the building elements (table 2).

Table 2: Average overall heat transfer coefficients (U) and area (A) of the building envelope

Name of the building	Characteristic, Unit	Walls	Floors	Roofs	Windows
Nursery school № 6	U, W/(m^2.K)	1.77	0.91	1.82	2.87
	A, m^2	308.68	366	366	232.26
Nursery school № 15	U, W/(m^2.K)	1.37	0.5	1.82	2.7
	A, m^2	1197.2	1100	1100	524.44
Kindergarten “Zdravets”	U, W/(m^2.K)	1.86	1.06	1.56	2.49
	A, m^2	2537.62	1460	1460	821.38
Kindergarten branch “Sinchets”	U, W/(m^2.K)	1.86	0.48	1.82	2.88
	A, m^2	641.02	513	513	285.98
Kindergarten “Edelvais”	U, W/(m^2.K)	1.37	051	1.82	2.63
	A, m^2	818.44	1020	1020	483.56
Old people house	U, W/(m^2.K)	1.37	0.35	1.36	2.89
	A, m^2	1553.1	1286	1286	785.9

The overall heat transfer coefficients of the external walls vary from 1.37 W/(m^2.K) to 1.86 W/(m^2.K). This small difference is due to the fact that the walls of all audited buildings are constructed of perforated or compact bricks, bilateral plastered with lime and sand plaster and only a small part of them have a reinforced concrete structure.

It is established that the integrity of the plaster is damaged in many places in all the studied buildings. The comparison between the calculated values of overall heat transfer coefficients and the reference values in force at the time of the energy audit shows that the actual values of overall heat transfer coefficients are from 3.5 to 5.3 times higher than the reference ones. It is therefore necessary to be heat-insulated all external walls of buildings and in all energy audits are foreseen energy-saving measures "Isolation of external walls".

The average value of the overall heat transfer coefficients of the floors of two of studied buildings - Kindergarten "Zdravets" [15] and Nursery school № 6 [12] are 1.06 W/(m^2.K) and 0.91 W/(m^2.K) respectively and they both are higher than the reference values. In the energy audits of these buildings is foreseen energy-saving measure "Isolation of floors".

The values of the overall heat transfer coefficients of the roofs of all buildings are from 1.36 W/(m^2.K) to 1.82 W/(m^2.K) and they significantly exceed the reference values. That's why for all the audited buildings are foreseen energy-saving measures "Isolation of roofs".

3. RESULTS AND DISCUSSION

The analysis of the results and the comparison between the parameters, reflecting the actual condition of buildings and the normative values of the same parameters show that there is a potential to reduce energy consumption in:

- ✓ Heat transfer through the external walls (overall heat transfer coefficients are higher than the reference values);
- ✓ Heat transfer and infiltration through the doors and windows (overall heat transfer coefficients are significantly higher than the reference values);
- ✓ Heat transfer through the roofs (overall heat transfer coefficients are higher than the reference values);
- ✓ Automatic control of the heat supply;
- ✓ Balance of the heating system;
- ✓ Increase the efficiency of heat supply.

To reduce the consumption of thermal energy in all buildings the next energy saving measures (ESM) are foreseen:

- ❈ Replacement of wooden and metal doors and windows by plastic (PVC) ones with double glazed windows and "k" glasses (table 3);

Table 3: Replacement of wooden and metal doors and windows by PVC ones

Name of the building	PVC	Existing situation	After ESM	Expected savings		Payback period
	m^2	kWh/year	kWh/year	kWh/year	%	
Nursery school № 6	232	203 815	169 978	33 837	17	9.3
Nursery school № 15	524	364 322	292 214	72 108	20	22.1
Kindergarten "Zdravets"	44	119 782	109 276	10 506	9	11.7
Kindergarten branch "Sinchets"	286	295 324	225 269	70 055	24	5.1
Kindergarten "Edelvais"	484	245 400	156 853	88 547	36	12.8
Old people house	786	818 068	552 904	265 164	32	4

- ❈ Thermal isolation of the external walls with expanded foam polystyrene (EPS) – table 4;

Table 4: Thermal isolation of the external walls

Name of the building	Area	Thickness of insulation	Existing situation	After ESM	Expected savings		Payback period
	m^2	m	kWh/year	kWh/year	kWh/year	%	
Nursery school № 6	429	0.06	203 815	160 064	43 751	21	3.1
Nursery school № 15	945	0.06	364 322	297 871	66 451	18	12.6
Kindergarten "Zdravets"	478	0.08	119 782	81 802	37 980	32	8.8
Kindergarten branch "Sinchets"	641	0.06	295 324	228 193	67 131	23	3
Kindergarten "Edelvais"	818	0.06	245 400	197 565	47 835	19	10
Old people house	1553	0.06	818 068	689 510	128 558	16	3.7

❋ Thermal isolation of roofs with expanded foam polystyrene (EPS) – table 5;

Table 5: Thermal isolation of roofs

Name of the building	Area	Thickness of insulation	Existing situation	After ESM	Expected savings		Payback period
	m^2	m	kWh/year	kWh/year	kWh/year	%	
Nursery school № 6	366	0.1	203 815	162 534	41 281	20	3.9
Nursery school № 15	1100	0.1	364 322	271 435	92 887	25	11.6
Kindergarten “Zdravets”	460	0.1	119 782	88 066	31 716	26	11.7
Kindergarten branch “Sinchets”	513	0.12	295 324	239 794	55 530	19	4
Kindergarten “Edelvais”	1020	0.1	245 400	153 838	91 562	37	7.3
Old people house	1286	0.12	818 068	658 220	159 848	20	3.5

❋ Thermal isolation of floors – for two of the buildings [11; 14] with extruded foam polystyrene – table 6;

Table 6: Thermal isolation of floors

Name of the building	Area	Thickness of insulation	Existing situation	After ESM	Expected savings		Payback period
	m^2	m	kWh/year	kWh/year	kWh/year	%	
Nursery school № 6	366	0.05	203 815	190 368	13 447	7	6.5
Kindergarten “Zdravets”	400	0.05	119 782	103 797	15 985	13	13.2

✓ Renovation and balance of the heating system – for the four of buildings [11,12,13,14];
✓ Installing of combined system for domestic hot water – for the four of buildings [11,13,14,15];
✓ Installing of system for automatic control of the heat supply.

Reconstruction Measures:
✓ Installing of a local heating system – for two of the buildings [15; 16].

The energy efficiency is assessed on the basis of technical and economical indicators. The techno-economic analysis was performed on the basis of the ESM, foreseen in the energy audits. It was found that the annual energy consumption for heating in the audited buildings, at ensured indoor thermal comfort could be reduced with 1 853.91 MWh/year.

The expected annual reduction of heating energy consumption for of studied buildings and the ecological equivalent of the reduced emissions of CO_2 are presented in table 7.

Table 7: Annual reduction of heating energy consumption and CO_2 emissions.

Name of the building	Reduced heat consumption, kWh/year	Reduced CO_2, emissions, t/year
Nursery school № 6	183 039	57
Nursery school № 15	312 650	77
Kindergarten “Zdravets”	112 884	25
Kindergarten branch “Sinchets”	257 127	80
Kindergarten “Edelvais”	211 125	56
Old people house	777 084	24

4. CONCLUSIONS

The analysis of energy audits of six municipal buildings in the municipality of Sliven, Bulgaria, carried out during the period between 2007-2008 years, found that:

- ✓ The specific energy consumption for all audited buildings are significantly higher than the reference energy consumption determined by the current regulations in the field of energy efficiency at the time of carrying out energy audits;
- ✓ In all audited buildings, the maintenance of normative thermal comfort leads to excess energy consumption for heating;
- ✓ Energy audits show that the higher overall heat transfer coefficients of the building envelope for all audited buildings result in higher consumption of thermal energy;
- ✓ Energy audits also show that the reasons for the higher energy consumption in all the audited buildings are morally and physically outdated boilers, burners and pumps, as well as the lack of automatic control and regulation of the temperature in rooms.
- ✓ In order to reduce the energy consumption for heating and bring the energy performance of buildings in accordance with the regulations for all buildings, the following ESM's are identified:
  - Replacement of wooden and metal doors and windows by PVC ones with double glazed windows and "k" glasses;
  - Thermal isolation of the external walls with expanded foam polystyrene (EPS);
  - Thermal isolation of roofs with expanded foam polystyrene (EPS);
  - Thermal isolation of floors – for two of the buildings [11; 14] with extruded foam polystyrene;
  - Renovation and balance of the heating system – for the four of buildings [11,12,13,14];
  - Installing of combined system for domestic hot water – for the four of buildings [11,13,14,15];
  - Installing of system for automatic control of the heat supply;
  - Installing of a local heating system – for two of the buildings [15; 16].
- ✓ The consumption of energy for heating in all buildings is reduced after the implementation of the planned ESM's. It was found that the annual energy consumption for heating in the audited buildings could be reduced with 1 853.91 MWh/year. The ecological equivalent of expected annual reduction of heating energy consumption shows that the reduced CO_2 emissions are 319 tons per year. The financial analysis shows that the proposed ESM's are profitable.

Considering the fact that the object of these audits are municipal buildings and the municipality does not have the necessary financial resources to fund the proposed ESM's, it is recommended that the municipality should use the opportunities of European funds to finance all provided ESM's.

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ECOLOGICAL BURNING OF GAS FUEL

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ABSTRACT

The article presents the results of the impact assessment of the level of temperature and residence time in the combustion zone at the level of formation of thermal nitrogen oxides. The results obtained from the calculation of the thermodynamical equilibrial processes can be utilised in the conduction of ecologically clean burning processes.

1. INTRODUCTION

TPP, according to the degree of influence among the industrial facilities, affect the biosphere in the most negative fashion [1]. Possible a significant increase in the consumption of energy in the foreseeable future predetermine further intensive increase in the variety of impacts on all components of the environment on a global scale. The impact of energy on the environment is extremely manifold and is determined by the following factors: type of plant, type of fuel combusted, installed capacity, availability of gas cleaning devices and the level of implementation of measures to combat harmful emissions. It is the latter that account for 32,6% of all the atmospheric emissions. That is insignificantly more, compared to those emitted from metallurgy (27%) and the coal industry (23,1%). Nitrogen oxides (NO, NO_2, N_2O and others), sulfur oxides (SO_2, SO_3 and others), carbon oxides (CO and CO_2), firm particles, heavy metals and their derivatives, hydrocarbons (CH_4, etc.). are released into the atmosphere by the thermal power plants. According to some estimates, the level of CO_2 emissions in the atmosphere, resulting from human activity has seen an increase by 40% in the last 250 years. The level of formation of CO_2 reflects the completeness of the burning of fuel. In this regard the decrease in these emissions is possible only on the account of their removal from combustion gases (cleaning, transfer to other compounds and others) which, taking into account the enormous sizes of their formation, will demand substantial expenses that, perhaps are even comparable to the cost of construction of a thermal power plant. In this regard, in fact, decrease in gaseous emissions from thermal power plant it is reduced to decrease in concentration of nitrogen oxides and sulphurs in combustion gases. In addition to that, when burning fuel oil, vanadium compounds could be formed. Nonetheless, there are practically no devices or technologies nowadays to decrease their concentration in combustion gases.

2. METHODOLOGY

The methods of decrease in the atmospheric emissions of nitrogen and Sulphur oxides, which are extensively applied in thermal power plants, now differ considerably. In particular, a decrease in the emissions of Sulphur oxides is, as a rule, reached either through the

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purification of combustion gases (retention, binding and others), or through a cutback in the content of Sulphur present in the initial fuel (removal, binding and others). In order to reduce the emissions of nitrogen oxides, the most widely used methods are as follows- furnace methods of suppressing the level of formation, and the decomposition of the formed nitrous oxides (catalytic, non-catalytic, etc.). Therefore formation suppression methods differ considerably for nitrous oxides, contingent on the prevailing mechanism of their formation (thermal or fuel).

In Kazakhstan, the primary part of the Thermal Power Plants use coal from the Ekibastuz land deposit. Only about 7% of electricity is produced by oil or gas powered thermal power plants [2]. In recent years, however, Kazakhstan has put in place a program for an exception of burning of associated gas and the production of electric energy from gas turbines of average and low power. However, in recent years in the republic the program of an exception of burning of associated gas in open torches and productions of electric energy on the basis of their burning on gas-turbine installations of average and low power is accepted. In this regard, routing to reduce formation of nitrogen oxides during the combustion gases (thermal) is becoming quite popular.

Y. B. Zeldovich, D. A. Frank-Kamenetsky, P. J. Sadovnikov [4] have found that the reaction, resulting in the formation of nitrogen oxides during combustion (explosion) of the gas mixture, has a thermal property. Thus, the formation level of an oxide of nitrogen is defined by the following:

- Temperature;
- Concentration of oxygen in a burning zone;
- length of time of the occurrence of gases at high temperatures.

It is supposed that the reaction of formation of oxides of nitrogen takes place in conformity with the following chain mechanism:

$$\left.\begin{aligned} O + N_2 &\leftrightarrow NO + N - 47\,\frac{kcal}{mol} \\ N + O_2 &\leftrightarrow NO + O + 4\,\frac{kcal}{mol} \\ O_2 + N_2 &\leftrightarrow 2NO - 43\,\frac{kcal}{mol} \end{aligned}\right\} \qquad (1)$$

Atomic oxygen, required for the reaction, is formed by the dissociation of oxygen:

$$O_2 + M \leftrightarrow 2O + M \qquad (2)$$

The reaction rate of the oxidation of nitrogen is given by the equation:

$$\frac{dNO}{dt} = \frac{5\cdot 10^2}{\sqrt{O_2}}\, e^{-\frac{86000}{RT}} \left\{ O_2 \cdot N_2 \cdot \frac{64}{3} e^{-\frac{43000}{RT}} - NO^2 \right\} \qquad (3)$$

Where, O_2, N_2, NO- instantaneous concentration of the component, *mol/l*;
t - Time, *s*
R - Absolute gas constant, *kJ/(kg.K)*;
T - The temperature in the reaction zone, *K.*

At the present time the so-called extended Zeldovich [4] mechanism can be considered as conventional,

$$OH + N \leftrightarrow NO + H \qquad (4)$$

In the most general case in parallel, there is also the reverse reaction of decomposition of the formed nitrous oxides.

When the temperature of the combustion products, typical for modern furnaces and boilers, as well as the speed of the decomposition reaction is low, the influence of the reverse reaction of the decomposition of oxidation of nitrogen on their general level of formation is low [4].

When the kinetic mode of combustion gases (with high heating value) the formation of nitrogen oxides takes place after the burning of the larger part of the fuel, which guarantees the highest possible temperature in the furnace.

According to [5] the time required to reach the equilibrium concentration, is given by the equation:

$$\tau_{NO} = \frac{2{,}06 \cdot 10^{-12}}{\sqrt{N_2}} e^{\frac{107500}{RT}} \tag{5}$$

Where, *T*- the maximum temperature, *K*,

On the basis of these reactions a mathematical model of the flow was constructed, in which the formation of nitrogen oxides during the combustion gas [2] and calculation scheme is developed [2].

Calculations showed that for the actual furnace temperature time to reach the equilibrium concentration depends strongly on temperature (see Table 1), and when the temperature increases from 1600 *K* to 2200 *K* it has increased almost threefold.

Table 1. The Results of calculation model

T, K	800	1000	1200	1400	1600	1800	2000	2200
t_{NO}, s	0	0	$2{,}518*10^{-15}$	$5{,}436*10^{-15}$	$9{,}682*10^{-15}$	$1{,}172*10^{-14}$	$2{,}172*10^{-14}$	$2{,}915*10^{-14}$
NO, mol/l	1,519	2,899	4,461	6,069	7,645	9,149	10,562	11,88

Another factor, whose distinct impact on the level of formation of thermal NOx should not be forsaken, is the residence time in the zone of high temperatures (see Fig. 1). As it can be obtained from the given data, a fivefold increase in residence time results in a twofold rise in the levels of formation of nitrogen oxides. It should be noted that this dependence has the form close to the asymptote. The calculations allowed us to determine quantitative relationships of known quality [2] and the influence of the maximum temperature and residence time on the formation level of nitrogen oxides during the combustion of gaseous fuel.

The obtained results are in good agreement with data of other authors, under comparable conditions [2], which, to some extent, can be used to prove the acceptable reliability of the mathematical model [2] ,and ,when used in calculation schemes, the level of formation of thermal nitrogen oxides during the combustion of gaseous fuels [2]. In this regard, the mathematical model and calculation scheme can be employed to determine the influence of other parameters of the combustion process of the gas fuel on the level of formation of thermal NOx. Furthermore, when the specific combustion is taken into consideration, the model can be generalized, so as to also pertain to the case of the combustion of coal dust.

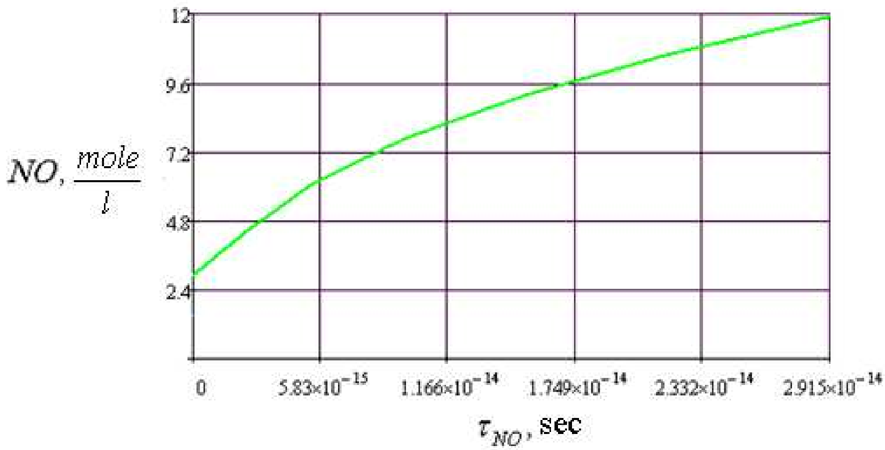


Figure 1 Dependence of NO and residence time in the zone of high temperatures

At higher concentrations of coal, dust ought to consider the response of the *NO* recovery to the carbon surface,

$$C + NO \rightarrow CO + \frac{1}{2}N_2, \tag{6}$$

the speed, which (*mol/s*) [6]:

$$\frac{dNO}{d\tau} = 40{,}992 \cdot 10^8 \cdot e^{-\frac{34{,}7}{RT}} A_E \cdot P_{NO}, \tag{7}$$

where, A_E- the outside surface of the coke particles, m^2;

P_{NO}- the partial pressure of nitrogen oxides, *Pa*.

The activation energy here is given in *kcal*.

The kinetic equations of a recombination and oxidation of the emitted fuel nitrogen respectively have the following form [7, 8]

$$\frac{dN_2^C}{d\tau} = \left(\frac{N_C}{T}\right)^2 K_{OR} \cdot e^{-\frac{E_P}{RT}}, \tag{8}$$

$$\frac{dNO^C}{d\tau} = N_C \left(\frac{O_2}{T}\right)^n K_O \cdot e^{-\frac{E_o}{RT}}, \tag{9}$$

where, N_2 and N_C- respectively current concentration of molecular and atomic nitrogen;

K_{OR} and E_R- kinetic constants of recombination;

T - gas temperature, *K*;

NO and O_2- accordingly the concentration of the fuel oxides and oxygen in gases;

K_0 and E_0- kinetic constants of the oxidation process;

n- order of a reaction.

Constraint equations

$$N_C = N_C^{out} - N_2^C - \frac{14}{30} NO^C \tag{10}$$

The formation of air oxides accounted for *J. B. Zeldovich* [4]:

$$\frac{dNO^A}{d\tau} = 3{,}34 \cdot 10^{13} \left(N_2^A + N_2^C\right)\left(\frac{O_2}{T}\right)^{0{,}5} \cdot e^{-\frac{64500}{T}} \tag{11}$$

If the reaction of formation of nitrogen oxides present in the form of

$$N_2 + 2O = 2NO, \tag{12}$$

then the reaction rate can be represented by the mass action law in the form

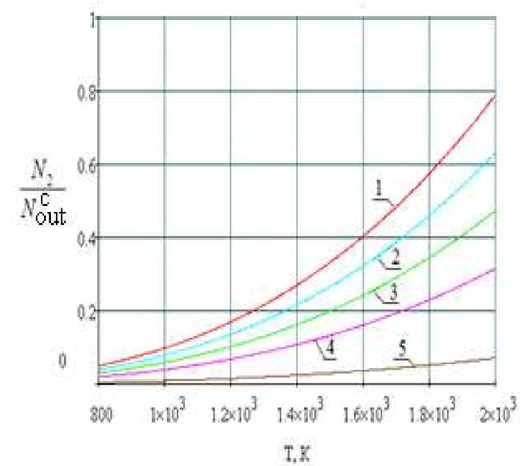
$$\frac{dC_{NO}}{d\tau} = kC_O^2 C_{N_2}, \tag{13}$$

where, k- rate constant of the reaction;

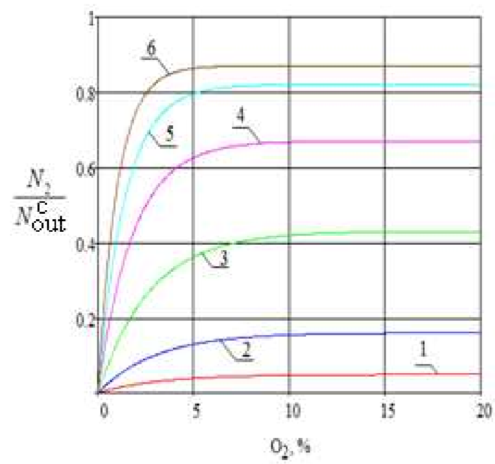
C_0, C_{N2} - the concentration of the atom atomic oxygen and molecular nitrogen in the flame.

A specific challenge is the calculation of the concentration of atomic oxygen, as in the flame of the actual concentration of atomic oxygen and hydrogen, owing to the fact hydroxyl significantly exceed the values found from the condition of thermodynamic equilibrium. The differences between the actual values and the ones in the equilibrium, is that the former values are greater than the lower flame temperature.

Special experiments have shown that below 2000 ^{0}C temperature has little effect on the actual concentration of atomic hydrogen, which remains constant, and its equilibrium concentration decreases sharply, following a decrease in temperature. This applies to the concentration of atomic oxygen as well, as the concentrations of these radicals are interdependent and thus change mutually.



a)



b)

Figure 2. Recombination N and N_2 at various O_2

Condition of oxidized nitrogen in the air is the dissociation of the molecules of oxygen $t \cong 2000\ ^0C$ and nitrogen t≅3000 ^{0}C

In furnace conditions, the dissociation of oxygen is dominant. It goes with absorption of heat:

Triggering

$$O_2^{+M} \leftrightarrow O + O^{+M} - 495\,\frac{kJ}{kmol} \tag{14}$$

Atomic oxygen reacts with one molecule of nitrogen and form atomic nitrogen:

$$N_2 + O \leftrightarrow NO + N - 314\,\frac{kJ}{kmol} \tag{15}$$

Breaking of circuit

$$O + O + M \leftrightarrow O_2 + M \tag{16}$$

Atomic nitrogen reacts with oxygen molecule

$$O_2 + N = NO + N + 314\ \frac{kJ}{kmol} \tag{17}$$

In the end, we have the overall reaction for the formation of nitric oxide in the furnace:

$$N_2 + O_2 = 2NO - 180\ \frac{kJ}{kmol} \tag{18}$$

Figure 2 shows graphs of the thermal output of atomic nitrogen from fuel and recombination in molecular nitrogen at different values of oxygen concentration and temperature of the process. The curve numbered 1, in figure 2 shows that in the absence of oxygen, atomic nitrogen is completely recombinases in an inert under conditions of temperature and energy furnace processes, molecular nitrogen and transferred to the nitrogen of the air. And air oxides of nitrogen at very large values O_2 = 14% and T = 2000 K, as it is shown from the appendix [9], is less than 0,7%.

Figure 2 b shows that the higher the temperature of the process, the faster the release of atomic nitrogen and its recombination into molecular nitrogen. At the same time there is an intensive formation of nitric oxide, and this recombination ends at low oxygen concentrations (see curved line 6 in figure 2, b).

3. CONCLUSIONS

The results of the calculation of thermodynamic equilibrium processes of the output of nitrogen, containing volatile coal dust, and the recombination of atomic nitrogen to molecular nitrogen, as well as the kinetics of formation of nitric oxide can be made use of in environmentally friendly combustion processes.

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ASPECTS ON BIOMASS TO GAS FUEL CONVERSION USING DIFFERENT GASIFYING AGENTS

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ABSTRACT

The paper presents an analysis of main aspects related to biomass air/vapour gasification process with respect to: process parameters, gasifying agent, carbon conversion efficiency and global process energy efficiency. The paper addresses to current power generation trends using biomass products as renewable primary energy source for low – medium scale applications. Different literature available date covering various biomass types and process configurations was used in this analysis for an extended overview on the subject. The results proved that usual common data related to the process run is not sufficient for biomass gasification conversion understanding and optimizing. Complex thermal – chemical conversion mechanisms are required for process complete characterisation.

1. INTRODUCTION

Energy represents a valuable asset and one of the biggest XXI century problems is provide the access to clean energy at reasonable costs [1].

Biomass represents the main renewable energy source both in terms of potential and possibilities for continuous - stable usage. From all the renewable energy sources, biomass has similar advantages to those from fossil sources: high specific energy content, storage capabilities, transport at long distances (limited only by low specific mass) and conversion into other energy forms - thermal, mechanical, electrical. Also biomass can be used to produce derived biofuels [1].

The conversion of biomass into energy can be achieved through one of three major paths: biochemical, physical-chemical and thermochemical. The thermochemical conversion provides certain advantages with respect to units specific capacity (load) and run time (very fast processes). Two processes are currently used for thermal-chemical conversion of biomass: combustion and gasification. Another process - pyrolysis – is also used as pre-treatment stage separately or integrated with the other two (usually for raw product combustible properties enhancement) [1, 2, 3].

Every of these processes are characterized by complex mechanisms reactions. Nevertheless gasification and pyrolysis processes co-exist within combustion as well defined sequences that develop simultaneously and consecutive during main process run [4, 5].

The gasification process is characterized by advanced instability due to equilibrium shift between oxidative and reduction reactions [1]. Usually the main process parameters of a thermal-chemical conversion are the temperature and the pressure [2]. Other parameters have also a major influence on the process run: residence time, heating rate, equivalent air ratio etc. [6]. The present study aimed to reveal the influence of theses parameters on biomass gasification process.

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2. METHODOLOGY

Usually the gasification process reaction product is related as syngas. The synthesis gas is a mixture of carbon monoxide (CO) and hydrogen (H_2). For biomass conversion where additional reactants are present other gaseous species are also present in the syngas: carbon dioxide, methane, nitrogen, etc. The composition of the produced gas fuel is also influenced by the gasifier operating parameters as well as of the feedstock characteristics. Among these parameters, the temperature and the pressure have the greatest effect on the product composition [2, 4, 7]. Two gasifying agents where analysed: air, and air + steam. Both are currently used in industrial operated gasifying units. Oxygen is also used but its application is reduced due to technical and economical restrictions.

2.1. Gasifying medium and feedstock characteristics

The gasifying medium (air, pure oxygen, steam or a mixture thereof) is essential for the biomass conversion process. The gasifying agents react with the solid carbon and heavier hydrocarbons in the feed, and convert them into low molecular weight gases as CO and H_2. The choice of the gasifying medium influences the process kinetics and the reaction products formation and properties (Table 1).

Table 1: Heating values for syngas based on gasifying agents [2]

Gasifying agent	High Heating Value of the syngas [MJ/Nm^3]
Air	4 - 7
Steam	10 – 18
Oxygen	12 – 28

An important parameter of the biomass feedstock is represented by the product volatile matter and fixed carbon content revealed through the primary analysis. Higher volatile fraction leads to more reactive product that can be easily converted into gas [7].

Biomass feedstock, such as wood has a high volatile matter content (~ 75% on a dry basis) therefore is highly reactive and produces relatively small amounts of char [7].

The inert fraction of the fuel has a limited influence on the gasification process and the gas composition, nevertheless recent publications revealed the influence of certain components as catalysts on process run. With respect to industrial operation the ash mainly affects only the mechanical operation of the gasifier. Also, the ash properties (fusion and melting temperature) influence the product gas composition indirectly, by imposing limits to the process temperature [7].

Evaporation and the chemical reaction of steam with char is endothermic, therefore a feedstock with high moisture content decreases the temperature inside the gasifier [2, 7].

2.2. Gasification process

The gasification process usually follows the next sequence of stages: drying or preheating, devolatilization, char gasification and oxidation. Between these steps there is no clear boundary and they repeatedly overlap [2].

The gasification stage gathers reactions between: hydrocarbons in fuel, water vapours, fixed carbon, carbon dioxide, oxygen, hydrogen, along with other chemical reactions among the evolved gaseous species. The process speed is given by the slowest reaction that usually involves the solid carbon in the fuel. Consequently the char gasification reactions are the most important [2].

Char gasification involves several reactions between the solid carbon and the gasifying agents; these reactions will be described below.

$$C^s + O_2 \rightarrow CO_2 \text{ and } CO \quad (1)$$

$$C^s + CO_2 \rightarrow CO \quad (2)$$

$$C^s + H_2O \rightarrow CH_4 \text{ and } CO \quad (3)$$

Water-gas, or steam, reaction is likely the most important reaction for gasification. Depending on process parameters the products may also be CO and H_2 and not CH_4 and CO.

$$C^s + H_2 \rightarrow CH_4 \quad (4)$$

The char gasification reaction rate depends on char reactivity, in terms of specific surface and size and distribution of the pores, and the gasifying agent. The presence of hydrogen, for example, has a strong inhibiting effect on the char gasification rate in H_2O, while oxygen is the most active, followed by steam and carbon dioxide. The relative rates, R, for equations 1 – 4 are related as is shown:

$$R_{(1)} \gg R_{(3)} > R_{(2)} \gg R_{(4)} \quad (5)$$

To insure the endothermic conditions required by most of gasification reactions as well as the heating, drying, and devolatilization stages, partial or complete combustion reaction of a fuel fraction is conducted in the reactor. For example, the reactions of carbon with oxygen and hydrogen are exothermic, whereas those with carbon dioxide and steam are endothermic [2].

2.3.Results and discussion

For the development of this research, the input data were obtained through a literature comprehensive analysis on former experimental studies made on biomass and waste gasification [8].

In a gasification process it is very important the presence of an oxidant to maintain the partial oxidation reactions. The oxidant, or the gasifying medium, might be, as I mention before, air, pure oxygen or steam. The type of the gasifying medium and the equivalence ratio, as well as the process temperature and pressure, influences the quality and the quantity of the producer gas [2].

Equivalence Ratio (ER) is defined as the ratio of actual air fuel ratio to the stoichiometric air fuel ratio [7].

Carbon dioxide and nitrogen represent the major non-combustible gas fractions in the syngas. It is very important to keep the CO_2 ration as low as possible and to maximize the CO fraction. For oxygen operated gasifiers the nitrogen is missing from the syngas and the carbon dioxide becomes the major inert gas component. In Figure 1 the influence of CO_2 concentration in the product gas is presented depending on process air equivalence ratio.

Mostly gasification reactions are endothermic, for example those between carbon and carbon dioxide or steam, but as well some of them can be exothermic, like those involving carbon and oxygen or hydrogen.

Water-gas gasification reaction or the reaction between solid carbon and steam is an endothermic reaction. Contrariwise reactions between solid carbon and oxygen from the air are exothermic, and lead to formation of CO and CO_2 (their proportion depends on temperature). Since water-gas reaction is endothermic and CO_2 production is favoured by low temperatures, it can be explained the higher CO_2 concentration in the case of steam gasification, 10-12% unlike 8% for air gasification [8].

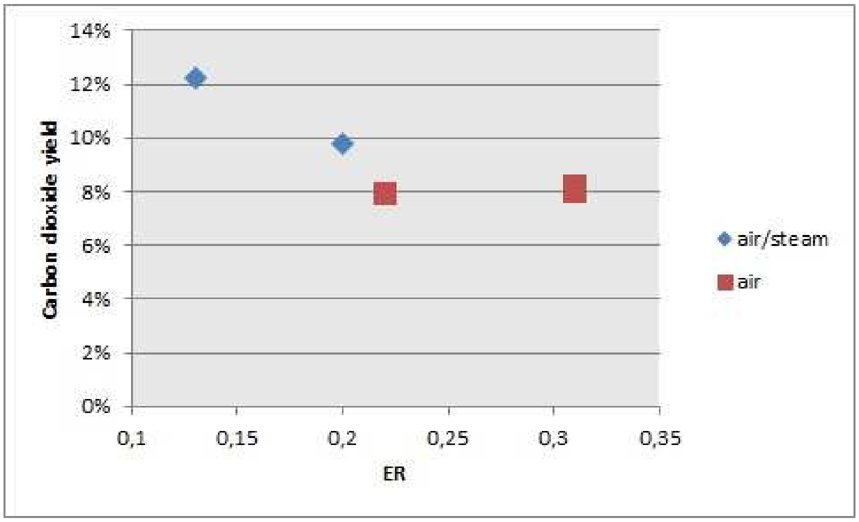

Figure 1: CO_2 concentration in the product gas with ER

Figure 2 presents the variation of syngas Lower Heating Value vs. air ER. The main purpose of gasifier constructors and operators is to obtain a "quality" syngas in terms of specific energy content, low tar fraction and high energy efficiency conversion. Consequently the syngas LHV represents the main energetic characteristics and is being addressed accordingly.

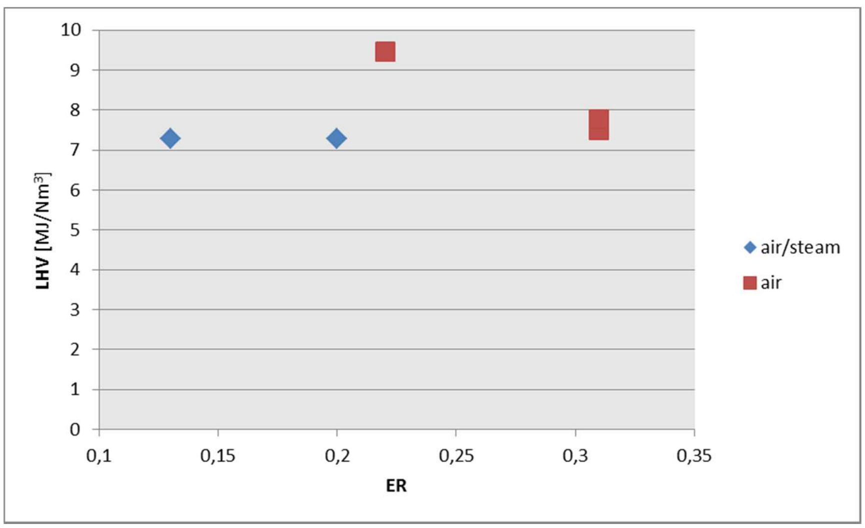

Figure 2: Low heating value of the product gas variation with ER

In contradiction to the scientific literature (Table 1), the Low Heating Value (LHV) of the produced gas (in this particular case) is higher for air gasification (7.5 – 9.5 MJ/Nm^3) than air/steam gasification (7.3 MJ/Nm^3). This can be explained by the higher concentration of the CO_2 which "dilutes" the gas [8].

Different methods for gasification efficiency quantification are used based either on carbon conversion efficiency (CCE) or cold / hot gas efficiency (CGE / HGE). The choice for one of these methods resides in further applications of the syngas. If the syngas is valorised into a reciprocating sparkling engine where the fuel must be introduced close to ambient temperature (due to detonation restrictions) the cold gas efficiency is used. In the figure bellow all three criteria were applied to quantify the biomass gasification efficiency.

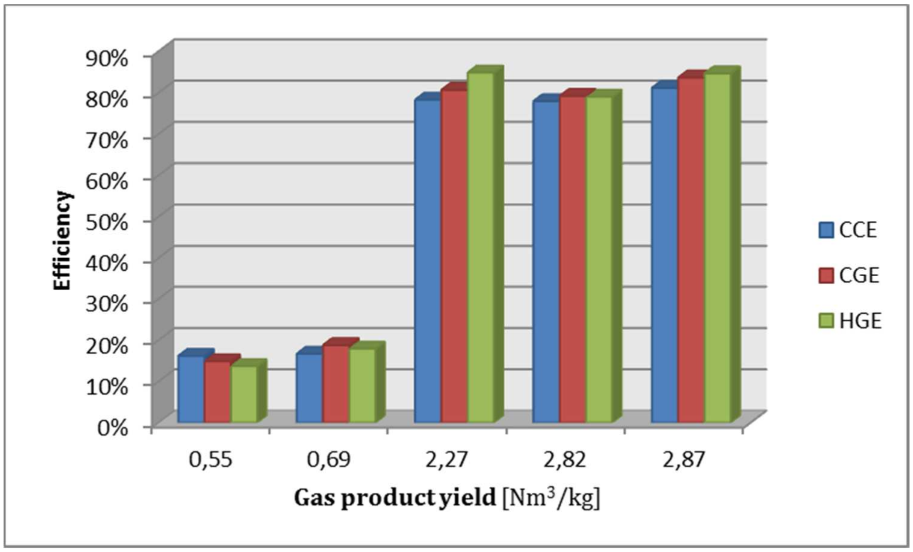

Figure 3: Process energy efficiency and Carbon conversion efficiency vs. Gas product yield

The rate of gasification is given by the slowest reaction in the gasifier and it depends on char reactivity and gasifying agent reaction potential. Char reaction with oxygen is faster than water-gas reaction, therefore if air is used as the gasifying medium, reactions proceed faster and the feeding rate should also be faster relative to steam gasification. If the feeding rate is maintained constant independent of the gasifying medium (as in this case), the gas product yield and therefore the process efficiency decreases from about 2.5 Nm^3/kg for air gasification to 0.6 Nm^3/kg for air/steam gasification, respective 90% to 15% (Figure 3) [8].

The air equivalence ratio governs the reactants input and the process run with respect to gas species formation. It also conditions the process temperature and the gasification reactions equilibrium. Figure 4 presents the influence of ER on syngas components yield.

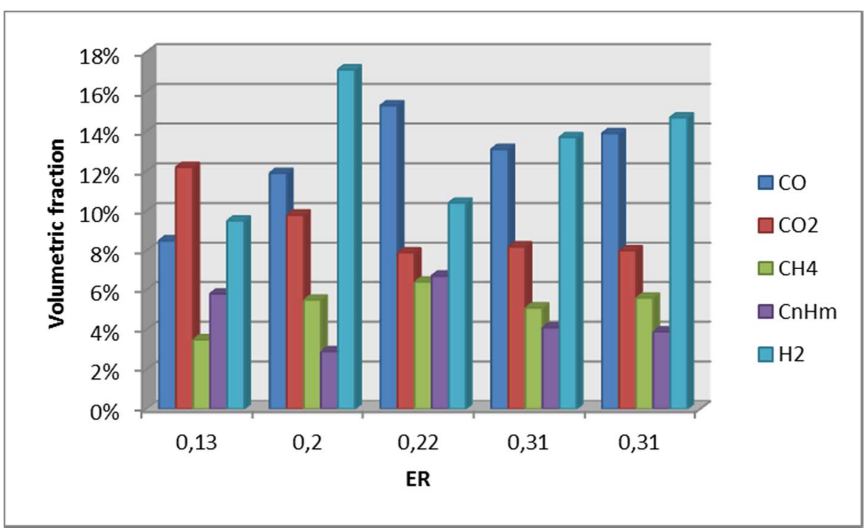

Figure 4: Influence of ER on gas components yield

For air gasification at ER = 0.22 the highest CO to CO_2 ratio is obtained and also the highest CH_4 and C_nH_m concentration, (about 6%). The concentration of hydrogen in the produced gas increases with the ER (0.22 – 0.31), for air gasification, from 10% to 14%. A higher concentration of H_2 of 17% can be observed in the case of air/steam gasification. If the air to steam ratio is too small (ER = 0.13) the H_2 concentration drops to almost 9% which concludes it is an optimal value for air to steam ratio [8].

3. CONCLUSIONS

Biomass gasification is an unstable process being hard to predict. Experimental data from the literature are insufficient to characterize a fair trial; therefore it always requires the analysis of each process studies.

The syngas LHV is higher for air gasification (7.5 – 9.5 MJ/Nm^3 average) compared to air/steam gasification (7.3 MJ/Nm^3 average).

The concentration of hydrogen in the produced gas increases with the ER (0.22 – 0.31), for air gasification, from 10% to 14%.

The process parameters, reactants mass ratios and experimental conditions have a major influence to products, carbon conversion efficiency and overall efficiency of the process. Every process is defined by an optimum point, were the type of gasifying agent, ER and process temperature must be correlated with the fuel to obtain best results in terms of syngas quality and process energy efficiency.

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ECONOMIC STUDY ON PRODUCING ENERGY FROM AGRICULTURAL BIOMASS

PhD student Eng. Mihai Toader

1. ECONOMIC STUDY ON PRODUCING ENERGY USING STRAW BRIQUETTES

The study was conducted in the case of a 150 kW boiler, which produces a heating energy for agricultural complexes.

The economic calculation depends on the straw briquettes price. From this point of view, two situations will be taken into consideration:

- Self-production cost level
- Cost at coming into being market level

For this calorific power, the fuel consumption will be determined using the formula:

$$B = \frac{P_t}{\eta \cdot H_i^i} \quad [kg/s]$$

Where P_t is the heating power in kW, H^i_i = 15000 kJ/kg (calorific power) and η the efficiency.

For the self-production briquettes, the calorific power was considered H^i_i = 15000 kJ/kg resulting 90% efficiency of the boiler.

$$B = \frac{150}{0{,}9 \cdot 15000} = 0{,}011 kg/s = 40 kg/h$$

In both cases, the boiler operation is considered to be 7000 hours/year. The operating personnel expenses are zero, the boiler being completely automated.

The annual expenses, C in this case, will represent fuel expenses C_c, electricity expense C_e and maintenance expenses C_m

$$C = C_c + C_e + C_m \quad [lei/an]$$

The cost of the briquettes resulted from direct labor operations is 90 lei/t (c_c = 90 lei/t). This sum is represented by the straw harvesting cost, balling cost, storing and briquetting cost. For this cost of the briquettes, the annual fuel cost is:

$$C_c = c \cdot \tau = 90 \cdot 7000 \cdot 40 \cdot 10^{-3} = 25200\, lei/an$$

Annual fuel consumption is 280 t/year.

The power consumption for the boiler's functioning is given by a number of 6 electrical engines, representing the primary and secondary air fan, combustion gas fan, two ash evacuation areas and supply system. The measured simultaneity factor indicated an average consumed power of 140 W.

For an electricity price of 0.55 lei/kW, the electricity expenses will become:

$$C_e = 0{,}55 \cdot 0{,}14 \cdot 7000 = 540\, lei / an$$

Maintenance expenses are estimated to 10% of the fuel expenses:

$$C_m = 0{,}1 \cdot C_c = 0{,}1 \cdot 25200 = 2520 lei / an$$

For the presented structure, annual expenses will be: *C = 28260 lei/an*

Heating power annually produced will be: *1050 MWh = 905 Gcal*

For the heating power price considered to be 200 lei/Gcal, the revenues C_{et} will be:

$$C_{et} = 200 \cdot 905 = 181000\ lei / an$$

We can distinguish the positive economical aspect for heating power production, the annual profit becoming: $B_{an} = C_{et} - C = 181000 - 28260 = 152740 lei / an$

The I investment cost can be paid from the resulted profit, representing the boiler price of 20000 Euro and the cost of the building and montage estimated to 6000 Euro (I=117000 lei)

It follows that in approximately one year of functioning, the investment will be recovered, not exceeding two years for a loan.

For the use of straws at a market price of 400 lei/t with a calorific power higher than 6500 kJ/kg, the calculations indicate:

Fuel consumption:

$$B = \frac{150}{0{,}9 \cdot 16500} = 0{,}0 / kg / s = 36 kg / h \quad (252\, t / an)$$

The electricity expenses are maintained: , $C_e = 540\, lei / an$

Maintenance expenses are: $C_m = 10000\, lei / an$

Annual expenses: $C = C_c + C_e + C_m = 111340\, lei / an$

For the same heating power price, the profit will be:

$$B_{an} = C_{et} - C = 181000 - 111340 = 69600\, lei / an$$

These result in a period of 2-3 years for the investment retrieval. It is noted that in order to obtain the necessary annual fuel in the case of a straw production for briquettes of 2 t/ha, a crop of approximately 140 ha is necessary.

2. ANALYSIS ON FINANCIAL POSSIBILITIES OF PRODUCING ELECTRICITY FROM ENERGETIC WILLOW

Electricity can be produced in condensation or CHP (cogeneration).

The minimum electrical power for producing energy in condensation was considered 1 MW, due to the existence of technical and economical competitive equipment, including the steam turbine.

Calculations considered obtaining three green certificates in the production of one MWh of electricity.

a. 1 MW condensation plant

The fuel was considered to have an inferior calorific power of 16000 kJ/kg (H^i_i = 16000 kJ/kg).

For a thermoelectric plant in condensation with steam turbine, with a maximum steam pressure of 35 bar and overheating temperature under 280˚C, the efficiency was η = 13,9% (boiler efficiency 90%).

There were considered 7000 working hours/year. The resulted annual fuel consumption was 13000 t. Fuel cost 90 lei/t (producer's price).

Crop year 1	12 – 15 t/ha
Crop year 2	30 – 35 t/ha
Crop year31	40 – 45 t/ha
Life expectacy of the plantation	25years

Investment cost: 3000 Euro/kW.

If the price of a green certificate is considered 40 Euro and the electricity price 60 Euro/MWh, the outdated recovery time is 9,5 years. In this case the business would be profitable after 10 years the least and highly influenced by the green certificates value.

If the energetic willow production is considered to be 50t/ha at harvesting humidity, it is equivalent with 31,2 t/ha at 20% humidity, required for a calorific power of 16000kJ/kg. As a result, an annual consume of 13000 t will require a harvesting over an area of 417 ha. As the harvesting for the considered production requires a growth period of approximately 2,5 years, the energetic willow acreage must be 1040 ha.

b. 1 MW energetic CHP plant

The execution of such plant depends on the existence of certain heating energy consumers such as industrial halls, offices, greenhouses, etc.

The considered fuel is from self-production with the price of 20 Euro/t. The number of annual production hours was set at 7000 hours. The electricity price is 60 Euro/MWh and delivery price of the heating energy 180 lei/mWh. For the electricity production three green certificates with a unit value of 40 Euro were considered.

The investment cost was: 3000 Euro/kW.

The ratio between the electrical power and heating power and the efficiency variation is presented in the following chart:

Nr. valoare	P_e MW	P_t MW	η %
1	1	0	23,24
2	0,831	1	42,56
3	0,662	2	61,88

It is notable that the electricity decreases along with the CHP increase and simultaneously with the increasing plant efficiency.

Internal rate of the update for the three situations rose up to the following values:

18,04 (for the first value), 19,6 (for the second value) and 21 (for the third value).

The values regarding the recovery time are: 6,9 years, respectively 5,5 years, while for the updated time are 9,3 years, 8,6 years and 7,2 years.

For a production per hectare of 31,2 t, there is necessary a crop of 218 ha and for a harvest performed every 2,5 years, a crop of 543 ha.

The CHP production is therefore net profitable by shortening the period of time for the investment recovery and as equally important by a considerable decrease of the necessary area for the energetic willow crop.

THE EFFECT OF THE AIR EXTRACTION SYSTEM QUALITY, ON SIZING THE EQUIPMENT FOR MAINTAINING THE VACUUM IN STEAM TURBINE CONDENSERS

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ABSTRACT

A proper steam condenser running has a significant impact on Thermal Power Plants performances. It could be reached by cleaning the tubes and extracting the air infiltrations. Regarding the second aspect, it is important to note that from condenser is not extracted only air, but an air-steam mixture. The air quota in this mixture depends of air extraction system quality. As a consequence, this feature has influences on: 1) the mass flow rate of the mixture that should be ejected from the condenser, for extracting 1 kg of air, 2) the mechanical work consumed for compressing the mixture, and 3) the cooling quantity required for dissipating the heat. The paper shows a numerical modeling of thermodynamic processes associated with the phenomena qualitatively identified above, presents graphically the results and discusses them.

1. INTRODUCTION

The analysis of technical performances of Steam Turbine Power Plants (STPP) show that an important reason for decreasing the thermal cycle efficiency is the worsening of vacuum at condensers. This may be due to different reasons such as: higher air infiltration, dirty tubes, etc. [1 to 3]. In the first case there were instances when the "Vacuum Maintaining Equipment" (VME) adopted by the initial design were insufficient. We remind that VME: 1) extracts from the condenser, together with the air, a significant steam quota; 2) consumes (directly or indirectly) mechanical work, that fact involves energy optimization; 3) require extracting heat during the compression. A correct sizing of VME, and of condensers air extraction region, requires not only knowing the amplitude of air infiltration, but also the steam quota into the extracted mixture. As we will show in the paper, the last aspect significantly influences the consumption of mechanical work and the amount of heat that should be extracted.

2. NUMERICAL MODELING OF STEAM-AIR MIXTURE COMPOSITION: METHODOLOGY, COMPUTATION AND COMMENTS ON RESULTS

First we accomplished a numerical modeling on the composition of the mixture that must be extracted, considered as a humid air, [4 to 6] and characterized by: 1) its absolute pressure, $p_{asp} \in [3.2 \div 10]$ kPa, 2) its dry bulb temperature $t_{dry}=t_{saturation}(p_{asp})$, and 3) the temperature difference $\delta t=t_{dry}-t_{hum} \in [2.5 \div 5.5]$ K [7, 8], between t_{dry} and wet bulb temperature, t_{hum}. The properties of water steam have been numerically modeled using formulas from [9].

We considered the steam extracted once with air, as little overheated and with partial pressure (p_{st}) equal to the corresponding saturation pressure, t_{dry}-δt. By default, the partial pressure of the air is, as in [4 to 6], $p_{air}=p_{asp}-p_{st}$. Knowing the molar masses of the two gases and their partial pressures we determined their molar participations in the extracted mixture (Fig. 1) and the equivalent molar mass of the mixture (Fig. 2).

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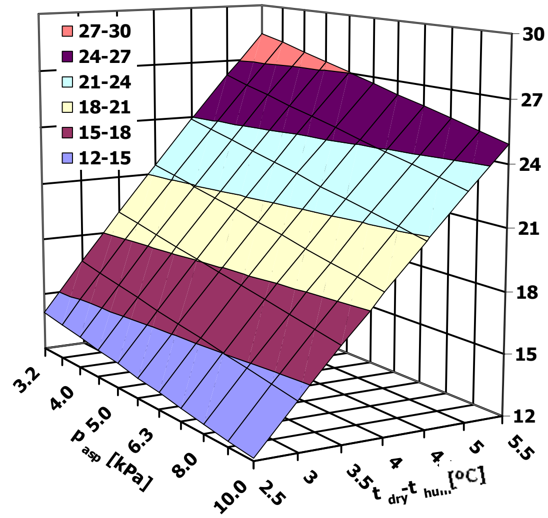

Figure 1: Variation of molar air participation in the extracted mixture, with p_{asp} and t_{dry}-t_{hum}

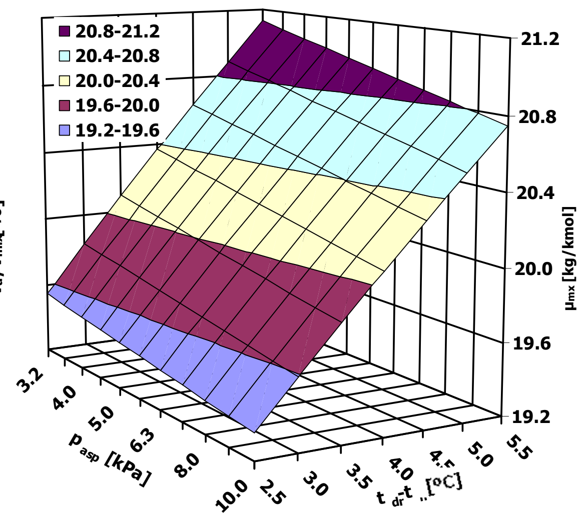

Figure 2: Variation of the extracted mixture molar mass, with p_{asp} and t_{dry}-t_{hum}

It may be noted that:

- The molar quota of air in the mixture varies between 12.1% and 28.5%. It rapidly increases with δt and slowly decreases with the increase of p_{asp}, which means that the δt influence on the air molar participation is greater than the p_{asp} influence.
- Due to the high molar quota of steam in the extracted mixture, the equivalent molar mass of the mixture is closer to that of steam than to the air molar mass.

Next, we computed the mass participations in the mixture of the two gases [4 to 6], required to determine the mass of gas to be extracted, to retrieve in it 1 kg of steam penetrated through leakages. The results presented graphically in Figures 3 and 4 show that:

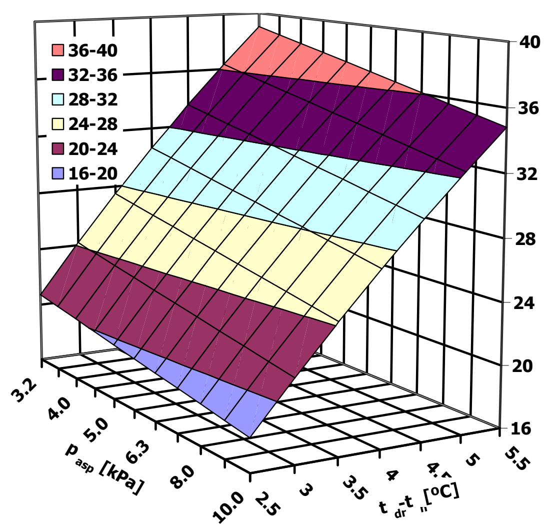

Figure 3: Air mass participation in the extracted mixture, with p_{asp} and t_{dry}-t_{hum}

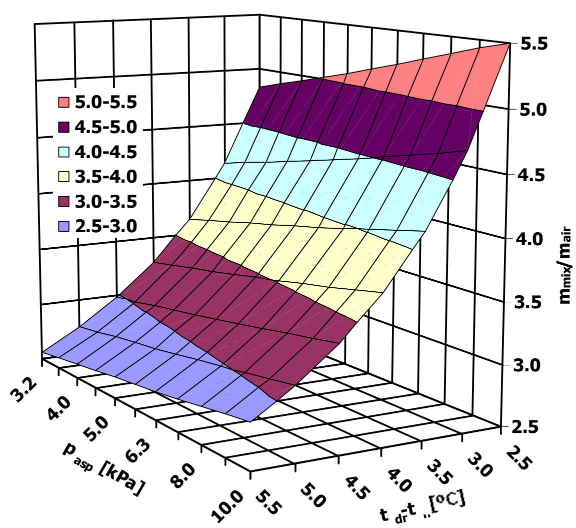

Figure 4: Extracted mixture mass required to extract 1 kg of dry air, with p_{asp} and t_{dry}-t_{hum}

- The air share in the mixture, in kg air per kg mixture, with values between 18.1% and 39%, respects the trends of the molar quota, but is higher that it (Fig. 3) mainly because the air molar mass is higher than the steam molar mass. Consequently the steam has in the mixture a smaller masic share than the molar share.

- Thereby, decreasing the t_{dry} minus t_{hum} temperature difference, from 5.5 K to 2.5 K, leads to increasing, of 2.56 to 5.52 times, of the masic ratio between the mixture flow rate and the air flow rate, m_{mix}/m_{air} (Fig. 4).

3. NUMERICAL MODELING OF STEAM-AIR MIXTURE ISOTHERMAL COMPRESSION: METHODOLOGY, COMPUTATION AND RESULTS

In this chapter we accomplished a numerical modeling of the steam-air mixture compression in a quasi-stationary isothermal process (close to that of water ejector) from p_{asp} to the atmospheric pressure (p_{atm}). Note that in the definition relation of compression ratio $\varepsilon_k=(p_{atm}/p_{asp})$, the numerator is constant, consequently the value of ε_k depends only on p_{asp}.

Figure 5 shows the variation of consumed mechanical work (in module) $|W_K|$ for an ideal isothermal compression of 1kg of dry air from p_{asp} to p_{atm}, depending on p_{asp}.

In this area of parameters, the air behaves as a quasi perfect gas. Therefore, $|W_K|$ is numerically equal to the heat exhausted from the process, $|Q_d|$, also measured in absolute value. We can observe that $|W_K|=|Q_d|$ value decreases laniary with the compression ratio logarithm, $\varepsilon_k=(p_{atm}/p_{asp})$. Decreasing ε_k from 32 to 10 leads to the decrease of $|W_K|=|Q_d|$ from 0.8 MJ/kg $_{dry\ air}$ to 0.57 MJ/kg $_{dry\ air}$.

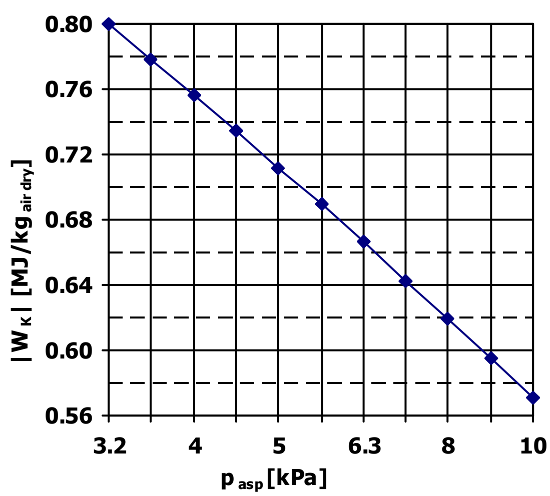

Figure 5: Mechanical work in module needed for the isothermal compression of 1 kg $_{dry\ air}$ from p_{asp} to p_{atm}, depending on p_{asp}

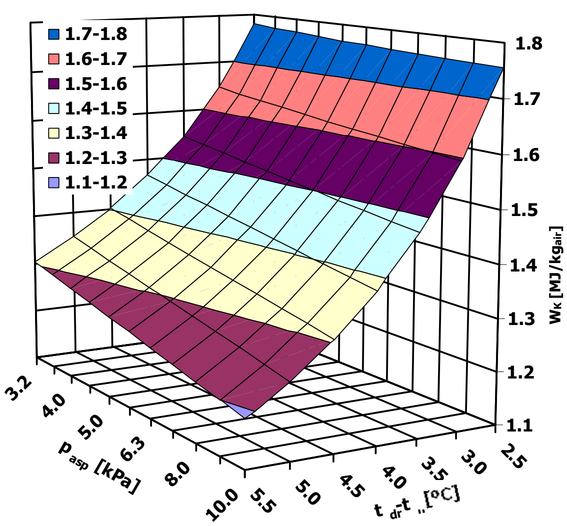

Figure 6: Mechanical work in module needed for the isothermal compression of an air-steam mixture containing 1 kg $_{dry\ air}$, $|W_k|$, depending on p_{asp} and t_{dry}-t_{hum}

The situation differs in the case of isothermal compression of an air-steam mixture, since:

- Extracting 1 kg of dry air, entered through the condenser' leaks, requires compressing a mass flow rate of mixture which is 2.56 to 5.52 times greater.
- The mixture is not a perfect gas. As a result, a large quota from the steam existing in mixture condenses during the isothermal compression.

It results the need of modeling the mixture compression process by numerical integration. The quantities $|W_K|$ and $|Q_{discharged}|$, relative to 1 kg of extracted air, and not to 1 kg of mixture, are shown in Fig. 6, 7 and 8. It can be observed that, while the temperature difference t_{dry}-t_{hum} decreases on the same interval:

- $|W_{K\ per\ kg\ air}|$ increases 1.36÷1.48 times, and $|Q_{dis\ per\ kg\ air}|$ increases 2.41÷2.45 times.
- $|Q_{d\ per\ kg\ air}|$ is 2.93÷6.16 times greater than $|L_{K\ per\ kg\ air}|$. The ratio $|Q_d|/|W_k|$ increases

relatively slow with the growth of p_{asp}, but doubles with the decrease of t_{dry}-t_{hum}.

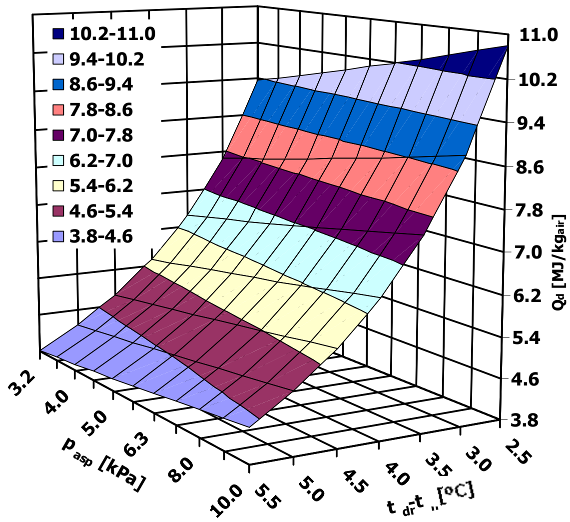

Figure 7: Heat amount in module exhausted during the isothermal compression of an air-steam mixture containing 1 kg $_{\text{dry air}}$, $|Q_d|$, depending on p $_{asp}$ and t $_{dry}$-t $_{hum}$

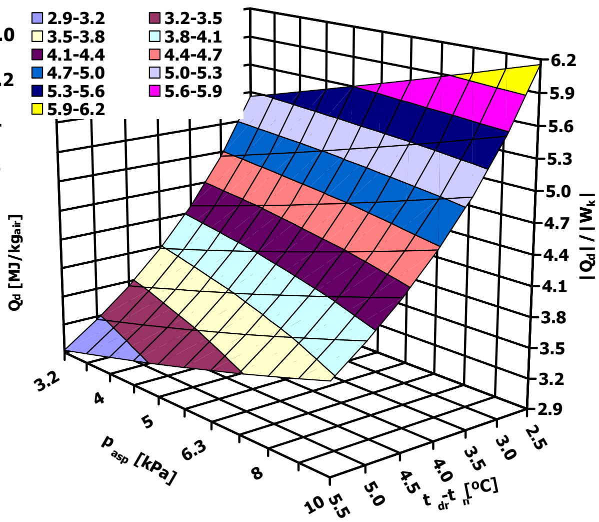

Figure 8: $|Q_d|/|W_k|$ ratio, for an isothermal compression of an air-steam mixture containing 1 kg $_{\text{dry air}}$, depending on p $_{asp}$ and t $_{dry}$-t $_{hum}$

4. NUMERICAL MODELING OF STEAM-AIR MIXTURE ISENTROPIC COMPRESSION: METHODOLOGY, COMPUTATION AND RESULTS

For comparison, we numerically modeled an ideal adiabatic (isentropic) compression (close to that in a "dry vacuum pump" process), for an air-steam mixture containing 1 kg $_{\text{dry air}}$, from p $_{asp}$ up to p $_{atm}$.

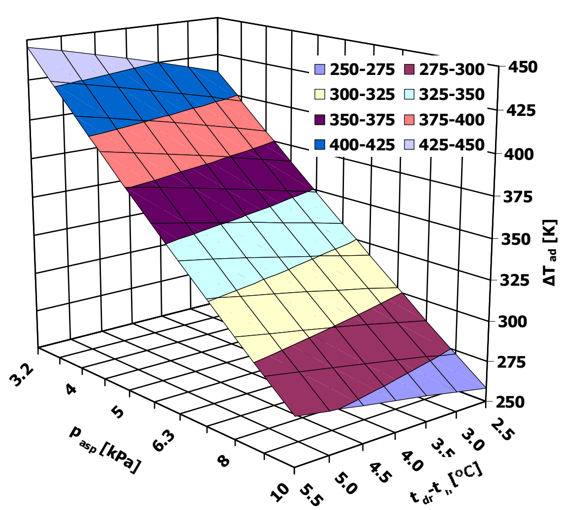

Figure 9: The temperature rise during an adiabatic compression of an air-steam mixture containing 1 kg $_{\text{dry air}}$, depending on p $_{asp}$, and t $_{dry}$-t $_{hum}$

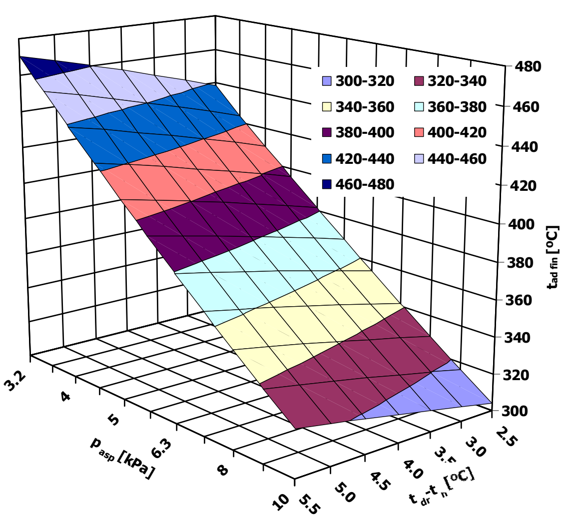

Figure 10: The final temperature after an adiabatic compression of an air-steam mixture containing 1 kg $_{\text{dry air}}$, depending on p $_{asp}$, and t $_{dry}$-t $_{hum}$

Figure 9 indicates the variation of the temperature rise during the adiabatic compression of an air-steam mixture containing 1 kg $_{\text{dry air}}$, depending on p $_{asp}$, and t $_{dry}$-t $_{hum}$, and Figure 10 shows the final temperature after this kind of compression depending on the same parameters. We notice that both sizes depend mainly on p_{asp}, which determines the compression ratio $\varepsilon_k=(p_{atm}/p_{asp})$, and much less on the temperature difference, t_{dry}-t_{hum}.

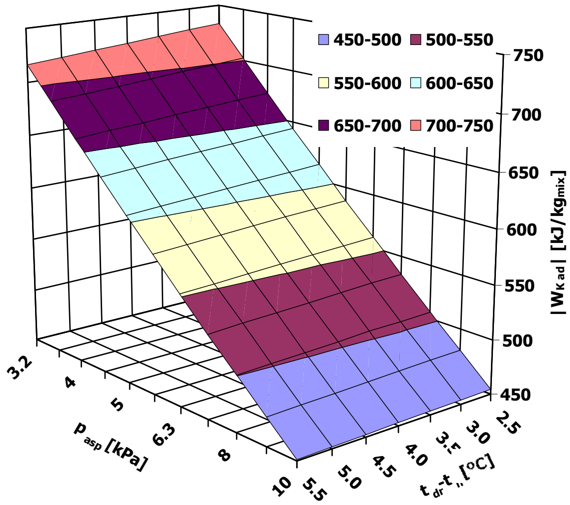

Figure 11: Mechanical work in module needed for an adiabatic compression of 1 kg air & steam mixture, depending on p_{asp} and t_{dry}-t_{hum}

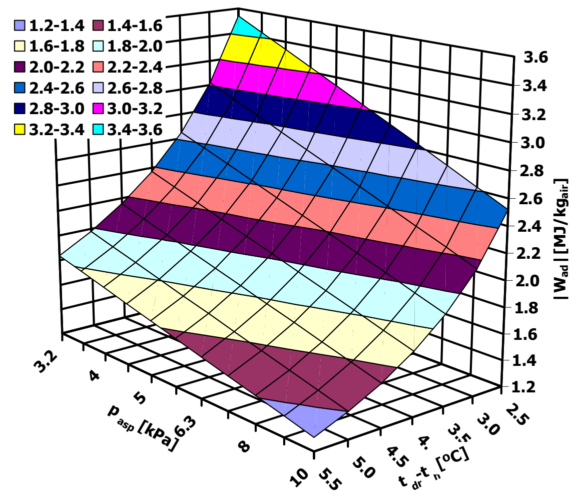

Figure 12: Mechanical work in module needed for an adiabatic compression of a mass flow rate of mixture which contains 1 kg dry air, depending on p_{asp} and t_{dry}-t_{hum}

Figure 11 shows the variation of the mechanical work, in module, needed for an adiabatic compression of 1 kg air & steam mixture, depending on p_{asp} and t_{dry}-t_{hum}. As in the previous case, it depend mainly on p_{asp}, and much less on the temperature difference, t_{dry}-t_{hum}.

The values of $|W_{ad\ per\ 1\ kg\ air}|$, relative to 1 kg of dry air in mixture, are graphically presented in Figure 12. Comparing with the above results it is observed that $|W_{ad\ per\ 1\ kg\ air}|$:

- Has a small fall, while p_{asp} rises, but grows rapidly with the decrease of t_{dry}-t_{hum}.
- Reaches extreme values for the same pairs of value, p_{asp} and t_{dry}-t_{hum}, as $|W_{K\ per\ kg\ air}|$ at isothermal compression.
- Has a minimum value comparable to $|W_{K\ per\ kg\ air\ min}|$ at isothermal compression of the mixture, but the maximal value is practically double relative to $|W_{K\ per\ kg\ air\ max}|$ in the isothermal process.
- Represents approximately a half from $|Q_d|$ at isothermal compression.

5. AUTHORS' ORIGINAL CONTRIBUTIONS. CONCLUSIONS.

The main authors' original contributions are:

- We considered the extracted mixture as a humid air, characterized by: 1) its absolute pressure, 2) dry bulb temperature (the saturation temperature at the above pressure) and 3) the difference between the dry bulb temperature and the wet bulb one.
- We numerically modeled the molar structure for the extracted steam-air mixture and the massic quotas of components.
- With these data, we numerically modeled two ideal compression processes for these mixtures, up to the atmospheric pressure: 1) isothermal compression, and 2) adiabatic compression. In the first case, we determined by numerical computation the values of: 1) the necessary mechanical work; and 2) the dissipated heat during the process. For the second one, we computed the necessary mechanical work. These values were calculated per 1 kg of mixture, and then they were reported per 1 kg of extracted dry

air.

- The obtained values were analyzed, compared, and commented.

The main conclusions of the paper are:

- For the same composition and the same pressure of the extracted mixture, the mechanical work needed for isothermal compression is significantly lower than for the adiabatic one.
- The main reason is that during the isothermal compression of the mixture steam + air, the steam condenses thereby reducing its volume of several thousand times.
- During the isothermal compression of steam + air mixture, it is necessary to extract a large amount of heat for condensing steam. This one is several times greater than the mechanical work absorbed in the process.
- In both analyzed compression processes, the augment of the temperature difference, t_{dry}-t_{hum}, determines a decrease of the needed mechanical work. This is because the intensive cooling of the mixture in the air extraction area reduces the steam quota in the mixture. On the other hand, the air mass flow rate to be extracted is constant and equal to the air suction through infiltrations. By condensing the steam, the mass flow rate that must be extracted, in order to evacuate 1 kg of dry air, diminishes, and consumption of mechanical work required for this purpose, too.

The results presented in this paper are useful in designing new equipment for the cold steam cycle power plants area (Maintaining Vacuum Equipment, air extraction area from condensers, etc.). Also correlated with measurements in operation, they may be used in the case of retrofitting existing plants.

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SIMULATION OF A PASSIVE HOUSE FOR THERMAL COMFORT-ANALYSIS

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ABSTRACT

Global current trend is to increase thermal comfort in all kinds of buildings, residential and non residential. At the same time, energy consumption minimization and building sustainability must be achieved. Only precise calculation can keep the balance between maximizing the comfort and minimizing the energy consumption. The thermal comfort theory embraces two major approaches, the Fanger model, known as the classical model and the adaptive model. The Fanger model considers human thermal comfort depends on indoor climates parameters. In this paper, a field survey was accomplished in summer, in a passive office building, situated in Romania. Comfort parameters were measured inside the building. The classical thermal comfort indexes, Predicted Mean Vote (PMV) and Predicted Percent of Dissatisfied (PPD), were calculated by using measured variables. At the same time, a thermal simulation of whole building, using Simergy and E+ software, was done. The same thermal comfort indexes, obtained by simulation, are compared with those obtained by measured data. The aim of this paper is to propose buildings improvement solutions in order to maximize the human thermal comfort and reduce building energy consumption.

1. INTRODUCTION

In recent decades, a wide variety of building energy simulation programs have been developed, enhanced and are in use throughout the building energy community. The central tools of the Building Energy Simulation (BES) programs are the whole-building energy simulation, which give users key building performance parameters such as energy use and demand, cost, temperature, and humidity. An overview of the twenty widely used programs can be found in [1]. It can be mentioned software like, DeST, DOE-2.1E, EnergyPlus, ESP-R, TRNSYS. In [2] an alphabetical list of over 400 BES programs can be found. It is provided by U.S. Department of Energy, Energy Efficiency & Renewable Energy. Comparative studies of most used BES programs are provided in [3], [4], [5]. In [3] it can be found a comparison between DeST, DOE-2.1E, EnergyPlus. There are found little difference between simulation results in spite of important differences in heating balance algorithm.

Building energy consumption and thermal comfort are the main issues of interest in thermal evaluation of buildings.

BES software usually uses conventional human thermal comfort theories to make decisions. It is used the predicted mean vote (PMV) model of thermal comfort, created by Fanger in the late 1960s [6]. Fanger based his model on college-aged students' responses in

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invariant environmental conditions, in air-conditioned chambers. This model considers that human comfort depends on the quantitative, combined influence of six parameters (air temperature, mean radiant temperature, water vapour pressure, air velocity, closing level and metabolic rate).

The Passive building is a special category, low energy consumption building that fulfil special requirements according to Passivhaus Institute [7]. The literature is scarce in studies about adaptive comfort in passive buildings. In order to evaluate the energy performance of passive houses [7] it have been developed a software of building simulation named PHPP [8]. It is a steady state simulation program; that means it considers invariable conditions during one month. We intended to use widely used dynamic simulation software, in order to calculate thermal comfort parameters, PMV, PPD which changes from hour to hour.

The aim of this paper is to analyze thermal comfort in a passive building using measurements and a software of building energy simulation in summer. In this season the energy consumption for cooling from conventional sources are almost zero. The problem which remains is thermal comfort. Some thermal comfort optimization solution will be proposed after the validation of the software with measurements.

2. METHOD AND PROCEDURE

2.1. AMVIC BUILDING PRESENTATION

Amvic is a passive office-building, located in Bragadiru (latitude 44.4°N), a small town 10 km south of Bucharest, Romania. It is a ground floor and four levels office building inaugurated in February 2009. For details consult [9], [10], [11].

2.2. MEASUREMENTS SURVEYS

The thermal comfort parameters were evaluated with the ComfortSense device, a system for measuremet according to International Standard ISO 7730, fig. 1. The ComfortSense system consists of a main frame with build in A/D converter and USB 2.0 interface. The measured and processed parameters resulting from the measurement were: Operative Temperature, Relative Humidity, Temperature, Velocity, Turbulence Intensity, Draught Rate, Predicted Mean Vote, Predicted Percent of Dissatisfied and Mean Radiant Temperature.

Figure 1: ComfortSense system with the probes positioned on the tripod inside the AMVIC building (author's archive)

The measurements procedure consists of replacing the chair of some workstations by the measurement station. The measurement was completed after 5 minutes and the measuring equipment was moved to the next work station on the list. The measurements with ComfortSense at Amvic building took place on July 9 and July 11, 2013.

2.3. BUILDING ENERGY SIMULATION SOFTWARE

According to [12], EnergyPlus is one of the most robust building energy analysis and thermal load simulation tools available today and it has become the de facto whole building simulation tool supported by the U.S. Department of Energy. In [13] it is found that in California, CEC-California Energy Commission is significantly revising the building energy efficiency standards. One key component of this revision is switching from procedures based directly on the DOE-2 simulation engine to some using EnergyPlus as the reference model. EnergyPlus is more accurate and transparent, involves fewer workarounds, and enables the analysis of innovative and complex mechanical system and building design energy use. At the same time a comprehensive graphical user interface – Simergy – has been developed for the U.S. Department of Energy's whole building energy simulation program, EnergyPlus. In Crawley paper [1] it is said the EnergyPlus building systems simulation module, with a variable time step, calculates heating and cooling system and plant and electrical system response. This integrated solution provides more accurate space temperature prediction-crucial for system and plant sizing, occupant comfort and occupant health calculations.

For the work in this paper we choose to realize a BES with the engine EnergyPlus program and its graphical user interface – Simergy. In fig. 1a) it can be seen AMVIC building model in Simergy and in fig. 2b) some modifications to simplify the model are undertaken at the roof level.

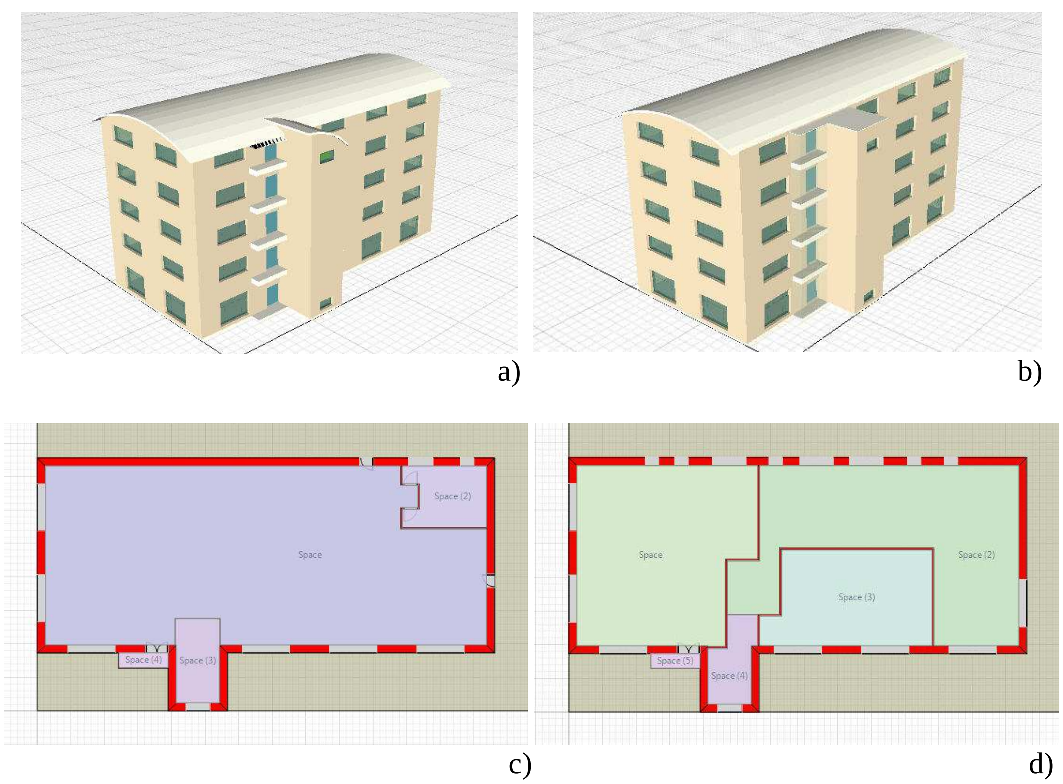

Figure 2: a) AMVIC building model in Simergy; b) simplified model; c) thermal zones on ground floor; d) thermal zones on fourth floor;

We introduced as input data in Simergy the AMVIC building construction and its constituent materials, the windows materials and glazing system components. The building cardinal orientation was established and a weather file specific to building region was chosen in Simergy program. Inside the building, thermal zones were created from the building interior spaces, fig. 2b) and c). One thermal zone contains spaces with similar comportment: air temperature, internal gains and so on.

It was necessary to be replicated the summer conditions in AMVIC building. In this passive building in summer season an earth tube had been working in order to cool the building. It was night ventilation, specific to passive buildings, at the same time. The internal gains at the time of measurements were estimated. Air infiltration was established too.

The building is provided with exterior blinds which are closed during the day time an open by night. They are an important aspect of the building. In Simergy it was created a schedule to simulate the blinds day and night program.

3. RESULTS AND DISCUSSIONS

In tab. 1 and tab. 2 are presented the building simulation result compared with measurements. It is observed a little tendency to warm in simulation values. The cause could be the difference between climatic data of representative year used in simulation and real climatic data in the measurement days. Or the unequal points number of measurement in all spacing and building floors or any other approximation used in simulation model.

July is the most important month of calculation in the summer. It is observed, fig. 4, that for real building, shaded with exterior blinds, the tendency is to “cold”. So, had been tried to find solutions for reduce the internal air temperature and implicit the comfort parameter, predicted mean vote (PMV). For that purpose, we changed the building shading from exterior blinds to exterior shades. For shades with transmittance zero, it had been found the values from fig. 4. In fig. 4 it is show the interior air temperature variation for the cases of building with exterior blinds and shades. At the same graph the exterior air temperature is plotted. The interior air temperatures follow the exterior air temperature but with attenuated amplitude.

Table 1: Interior air temperature mean per floor, simulation and measurements values

	Interior air temperature mean per floor [°C]					
	P	E1	E2	E3	E4	mean/building
calculated	24.20	25.29	25.81	26.27	27.27	25.77
sp area						
measured	23.60	25.20	26.00		27.44	25.56
DIFF ca/me	0.60	0.09	-0.19		-0.17	0.21

Table 2: PMV mean per floor, simulation and measurements values

	PMV mean per floor					
	P	E1	E2	E3	E4	mean/building
calculated	-0.33	0.04	0.22	0.39	0.72	0.21
sp area						
measured	-0.65	-0.15	0.06		0.53	-0.05
DIFF ca/me	0.32	0.19	0.16		0.19	0.26

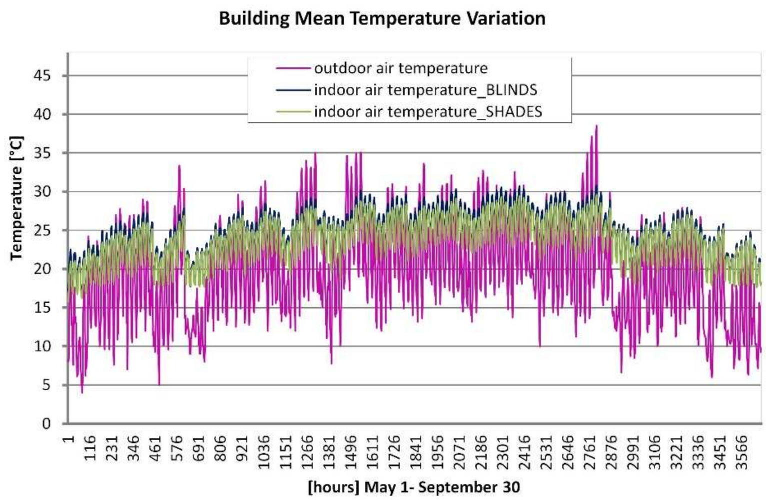

Figure 3: Building mean temperature variation in summer and adjacent months

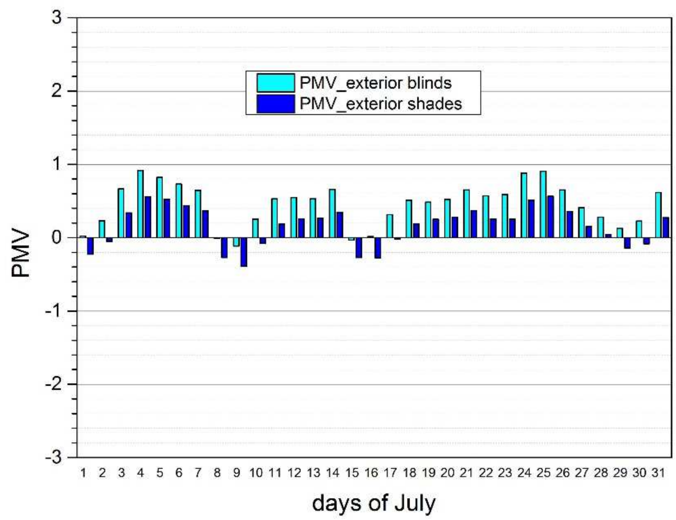

Figure 4: Building mean PMV variation in July

Table 3: PMV variation in different time intervals

PMV mean per building

	Jul mean	May-Sept mean	Jun-Aug mean
BLINDS	0.46	-0.22	0.27
SHADES	0.16	-0.48	-0.01

4. CONCLUSIONS

In this paper are realized a dynamic simulation for a passive office building in Energy Plus program. The simulation results are validated with measured data. After that a thermal comfort optimization is undertaken and a new shaded method for building is found.

In tab. 3 are presented a PMV mean value for different time intervals. It is observed that in summer season (June-August) the PMV mean value has optimum value around zero. We can conclude that the solution found is the best, it is not necessary to find a new device to lower the temperature.

We must continue this work in future in order to realize a complete year simulation of AMVIC building and find new comfort and energy consumption optimization solutions.

Acknowledgements

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ENERGY EFFICIENCY PROJECT FOR A FACTORY PRODUCING SWEETS AND BAKED GOODS

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ABSTRACT

The proposed energy efficiency project is part of a modernization investment to improve an industrial process at a bakery. The main registered business activities of the company include production of sweets and baked goods. The project consists of replacing an electric tunnel oven with a modern natural gas fired oven well suited to the firm’s products (waffles and biscuits). As a result of the investment, primary energy use and CO_2 emissions will decline by 63%.

1. INTRODUCTION

Climate change and security of energy supply are two major challenges needing urgent action. They have common causes and common solutions. Except of that the future seems marked by permanently rising prices of energy, which we use in all areas of our own life.

Analyses based on Euro stat data show retardation of Bulgaria in basic energy-economical indicators for sustainable development. Bulgaria is the most energy-intensive country in Europe - respectively 7,46; 6,81; 6,37; 6,81; 7,41; 6,12; 2,62 и 4,7 times more energy intensive than Austria, Denmark, France, Germany, Italy, Greece, Hungary and Turkey. Except of that Bulgaria is one of the most dependent countries with regard to import of energy resources in Europe – 71, 6 %.

The proposed energy efficiency project for a factory producing sweets and baked goods aims to reduce the energy consumption of their baking process by replacing and old electric oven with a new gas fired oven. The new machine will allow the company to continue producing all of their current products.

2. BASELINE TECHNICAL CONDITIONS

The company’s main production is waffles and biscuits (i.e., baked goods). These products are currently baked in a powerful old electric tunnel oven (Table 1 and Fig. 1). The installed power of the oven is 258.4 kW of which the installed capacity of the oven module is 232.38 kW and the installed capacity of the conveyor is 26.02 kW. Due to the oven’s poor design for the type of products it bakes, it works at about 70% of its capacity otherwise it damages the final product.

The baking/manufacturing process is a continuous one with 24-hour per day operations for 340 days per year. The average annual workload of the tunnel oven is 8 160 h/yr.

The company’s staff estimates that the average productivity of the old tunnel oven is 330 kg/h., for an annual production of 2 692 800 kg/yr.

According to information, specified by the project owner, and calculations made by the auditing team, the annual electricity consumption of the tunnel oven is 1 539 678 kWh/yr. The specific electricity consumption for 1 kg of finished product is 0.572 kWh/kg.

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The primary energy conversion factor of electricity is 3.0, which leads to annual primary energy consumption of 4 619 033 kWh/yr. The CO_2 emission factor for electricity is 0.683 tCO_2/MWh. In the existing condition, the annual CO_2 emissions resulting from the tunnel oven is 1,051.6 tCO_2/yr.

Table 1. Parameters of the old tunnel oven

Manufacturer	HAAS Hecrona Keksanlagen
Type	VKB
Serial Number	900104
Type	OANT 38
Serial Number	900104
Type	OSPS
Serial Number	900481

Figure 1. HAAS Hecrona Keksanlagen

Table 2. Initial energy consumption

Sector	Electricity consumption	Primary energy consumption*	CO_2 emissions**
-	kWh/yr.	kWh/yr.	t_{CO_2}/yr.
Heater	1 327 355	3 982 064	906.6
Conveyor	212 323	636 970	145.0
Total	1 539 678	4 619 033	1051.6

* Conversion factor for electricity = 3 [2]

** Conversion factor for electricity = 0.683 tCO_2/MWh [2].

3. PLANNED MEASURES

According to the project the existing tunnel oven will be replaced with a new one natural gas fired oven, specially designed to best fit the Company’s needs. The new tunnel oven will be of hybrid type.

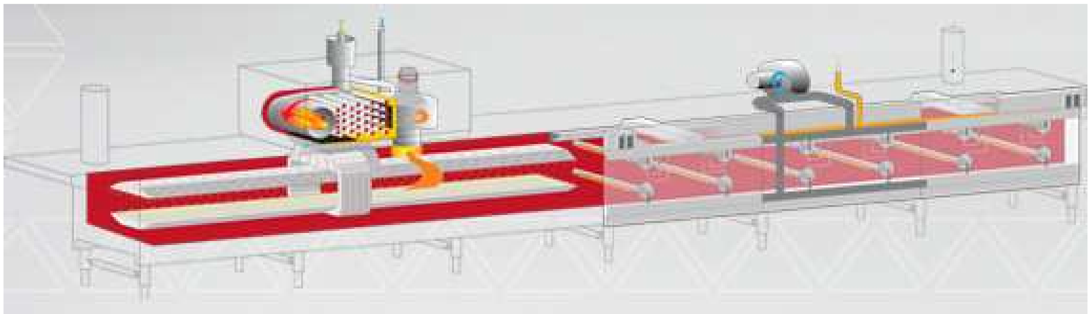

Figure 2. New hybrid oven [4]

The machine consists of two baking zones. The first zone is equipped with 19 identical natural gas burners that will supply all the heat needed for the baking process. The second zone will utilize the exhaust heat from the first zone through heat exchanger.

The productivity of the new machine is higher than the existing one and it has a capacity of about 410 kg/h of finished products. This means that for the same annual production (2 692 800 kg/yr.) the machine will work only 6 568 h/yr.

According to the technical data provided by the manufacturer, the maximum natural gas consumption, while the machine is operating at maximal capacity, is 47 nm^3/h natural gas. With an average caloricity of natural gas of 10.8 kWh/nm^3 and efficiency of the burners of 95%, and the maximum capacity of the machine is 535 kW. The machine will work at maximum load only for limited amount of time – during cold starts.

The nominal working power of the machine is about 60% of the maximum, or 321 kW. The installed capacity of the heat exchanger under normal operating conditions is 150 kW. After discussion with the manufacturer and audited company staff it was determined that the machine will need to work at full capacity for less than 15% of the year (or 985 h/yr.) and at 60% capacity for about 85% of the year (or 5 583 h/yr.).

The heat exchanger will reduce the energy consumption by 837 395 kWh/yr. by utilizing the exhaust heat from the first stage. The total energy consumed by burning natural gas is 1 481 697 kWh/yr. or total of 137 194 nm^3/yr.

The baked goods are moved through the oven by an electric conveyor, which has installed capacity of 5 kW. Its total electrical consumption for year is 32 839 kWh/yr.

The oven's specific energy consumption of natural gas is 0.861 kWh/kg, while the electricity specific consumption is 0.012 kWh/kg or in total: 0.873 kWh/kg.

The total primary energy consumption of the new oven will be 1 728 384 kWh/yr. (with primary energy factor for electricity 3.0 and primary energy factor for natural gas of 1.1).

The CO_2 emission factors are 0.683 tCO_2/MWh for electricity and 0.247 tCO_2/MWh for natural gas, which leads to annual CO_2 emissions of 388.41 t/yr.

Table 3. Final energy consumption

Sector	Energy consumption	Primary energy consumption	CO_2 emissions
-	kWh/yr.	kWh/yr.	t_{CO_2}/yr.
Heater (natural gas)	1 481 697	1 629 866	365.98
Conveyor (electricity)	32 839	98 517	22.43
Total	1 514 536	1 728 384	388.41

* Conversion factor for electricity = 3 and conversion factor for natural gas = 1.1

** Conversion factor for electricity = 0.683 tCO_2/MWh and conversion factor for natural gas = 0.247 tCO_2/MWh

Table 4. Project Benefits

Energy Savings		**Final energy**	**Primary energy*)**
Old equipment	kWh/y	1 539 678	4 619 033
New equipment	kWh/y	1 514 536	1 728 384
Savings	kWh/y	25 142	2 890 650
Savings	%	1.63%	62.6%

Table 5. Project Benefits

Emission Reduction*)		**Before**	**After**
CO_2 emission	t CO_2/a	1 051.6	388.4
Reduction			63.1%

4. ENERGY SAVINGS AND EMISSION REDUCTIONS

Table 6. Project Benefits

Indicator	**Unit**	**Value**
Initial Electricity Consumption	MWh/yr.	1 539.7
Initial Primary Energy Consumption	MWh/yr.	4 619.0
Initial Natural Gas Consumption	MWh/yr.	0
Initial CO_2 Emissions	tCO_2/yr.	1 051.6
Final Electricity Consumption	MWh/yr.	32.8
Final Natural Gas Consumption	MWh/yr.	1 481.7
Final Primary Energy Consumption	MWh/yr.	1 728.4
Final CO_2 Emissions	tCO_2/yr.	388.4
Electricity Savings	MWh/yr.	1 506.8
Natural Gas Savings	MWh/yr.	-1 481.7
Primary Energy Savings	MWh/yr.	2 890.6
CO_2 Emissions Savings	tCO_2/yr.	663.2
Primary Energy Saving Ratio	%	62.58
CO_2 Reduction Ratio	%	63.07
Industrial Sector Indicator (ISI)	%	94
Total Cash Savings	EUR/yr.	39,740

5. PROJECT PROFITABILITY (IRR, NPV, PBT)

The estimated lifetime of the entire system is expected to be 15 years (based on the typical life of such equipment). According to the information provided by analized company's management, the Project cost is EUR 375 000 (BGN 733 436.25). The financial scheme includes debt bank financing in the amount of EUR 375 000 or 100% of the Project cost. The project economic financial indicators are presented in Table 7.

Table 7. Economic and Financial Indicators

Indicator	Value
Total Cost (EUR)	375,000
Sub-Project Analysis Time (Years)	15
Estimated Annual Energy Savings (MWh/yr.)	2,890.7
Annual Savings from Electricity (MWh/yr.)	1,506,8
Total Cash Savings (EUR/yr.)	39,740
IRR (%)	6.13
NPV at 5% Discount Rate (EUR)	28,297
Coverage (%)	7.55
Payback Time (Years)	9.49

6. IMPLEMENTATION TIMETABLE

The Project's Implementation Timetable, proposed by the company's management is presented in Table 8.

Table 8. Implementation Timetable

Works	2014 September to December	2015 January
Manufacturing of the new machine	■	
Delivery and Installation of the new machine		■

The equipment, subject of the this project, will be delivered and installed as follow:

1) The machine will be manufactured in the manufacturer factory in the period September – December 2014.
2) The delivery, initial setup and testing of the machine are envisaged for the month of January, 2015.

7. CONCLUSIONS

Energy efficiency audit of a factory producing sweets and baked goods is done. It is found that these products are currently baked in an old electric tunnel oven with installed power of 258.4 kW. Due to the oven's poor design for the type of products it bakes, it works at about 70% of its capacity otherwise it damages the final product. An energy-saving measure "Replacing the existing tunnel oven with a new one natural gas fired oven specially designed to best fit the Company's needs" is proposed. The new tunnel oven will be of hybrid type with two baking zones. The second zone will utilize the exhaust heat from the first zone through heat exchanger. The obtained benefit will be: 25 142 kWh/y (or 1.63%) final energy saved, 2 890 650 kWh/y (or 62.6%) primary energy saved and 663.2 tCO_2/y (or 63.1%) reduced.

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INVESTIGATION OF THE DEVELOPMENT OF THE WIND ENERGY PROJECT

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ABSTRACT

The article presents the investigation of the development of the Wind Energy Park Irechek and demonstrates the legal actions applied when constructing renewable energy power sources. It includes the estimated energy production and the CO2 reduction, due to the use of ecological power in relation to electricity produced from conventional sources. The analysis of the wind resource is developed on the basis of 12 month wind resource data from a 50 m measurement mast, installed in the vicinity of Mogilishte village. Risk and sensitivity analysis will not be overlooked.

1. INTRODUCTION – Expected benefits of the project.

The electricity generated by this wind plant will be purchased by the National Electric Company, thus decreasing the amount of the electricity produced by thermal power plants, which use fossil fuels. Table 1.2 summarizes the revenues from the production and sales, and the operational costs resulting from the project implementation for the whole project lifetime until 2026.

The revenues from electricity sales during the Wind Energy Park Irechek operation are based on the monthly distribution of the estimated energy production for the period 2006 – 2026.

		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Electricity Sold to NEK	(MWh/yr.)	1,250	1,733	1,733	1,733	1,733	1,733	1,733	1,733	1,733	1,733	1,733	1,733	1,733	1,733	1,733	1,733	1,733	1,733	1,733	1,733	1,733
Operation Costs	(EUR/yr.)	-12,503	-17,343	-17,343	-17,343	-17,343	-17,343	-17,343	-17,343	-17,343	-17,343	-17,343	-17,343	-17,343	-17,343	-17,343	-17,343	-17,343	-17,343	-17,343	-17,343	-17,343
Tariff	EUR/MWh	61.36	61.36	61.36	61.36	61.36	61.36	61.36	61.36	61.36	61.36	61.36	61.36	61.36	61.36	61.36	61.36	61.36	61.36	61.36	61.36	61.36
Revenues	(EUR)	76,663	106,334	106,334	106,334	106,334	106,334	106,334	106,334	106,334	106,334	106,334	106,334	106,334	106,334	106,334	106,334	106,334	106,334	106,334	106,334	106,334
Power plant Operation	(EUR)	-12,503	-17,343	-17,343	-17,343	-17,343	-17,343	-17,343	-17,343	-17,343	-17,343	-17,343	-17,343	-17,343	-17,343	-17,343	-17,343	-17,343	-17,343	-17,343	-17,343	-17,343
Gross Profit	(EUR)	**64,160**	**88,992**	**88,992**	**88,992**	**88,992**	**88,992**	**88,992**	**88,992**	**88,992**	**88,992**	**88,992**	**88,992**	**88,992**	**88,992**	**88,992**	**88,992**	**88,992**	**88,992**	**88,992**	**88,992**	**88,992**

Table 1.2 Project Revenues and Production Costs

The reduction of carbon dioxide emissions was estimated based on the Operational Guidelines for Project Design Documents of Joint Implementation Projects of the Dutch Ministry of Economics as of May 2004. The emission factor values of the CO_2 emissions, for generated electricity for the period 2002-2012 are considered.

Replacement of electricity produced from conventional sources by electricity generated by the Wind Energy Park Irechek, will result in CO_2 emissions reduction of 8,628 tons for the period 2006 - 2012. Table 1.3 presents the reduction of CO_2 emissions for the period 2006 - 2012.

Emission Characteristics		2006	2007	2008	2009	2010	2011	2012	**Total**
Electricity Sold to NEK	(MWh/yr.)	1,250	1,733	1,733	1,733	1,733	1,733	1,733	**11,648**
Carbon Emission Factors for Generating Electricity	(tCO_2/MWh)	0.797	0.779	0.761	0.743	0.725	0.707	0.689	
Carbon Emission Reduction	**(tCO_2/yr.)**	**996**	**1,350**	**1,319**	**1,288**	**1,256**	**1,225**	**1,194**	**8,628**

Table 1.3 Carbon Dioxide Emissions Reduction (tons)

2. PROJECT BASELINE

The present project investigation is developed on the basis of a feasibility study of the wind energy potential in the region of village Irechek, Kavarna Municipality, Bulgaria.

A modeling of the wind flow is performed for the site of construction of Wind Energy Park Irechek. An analysis of the operation of the wind generators - Nordtank 500 41.0 and Vestas V39 chosen by the borrower is developed in the study. An analysis of the expected electricity production is also developed in compliance with the technical characteristics of the turbines, designed by the manufacturer and the distribution of the wind flow in the region.

The region of Wind Energy Park Irechek (WEP Irechek) is situated to Southwest direction from village Irechek, approximately 12 km to the North from the Black Sea coast. The terrain near the Wind Park is very flat. The slope contour near the Wind Park doesn't exceed 20 meters. The average elevation above the sea level is approximately 110 m.

The Wind Mast Mogilishte, with coordinates: N 43° 27' 18.8"; E 028° 21'47.8", is situated 4 km to the South of village Mogilishte and 2 km to the North from Kavarna town. The distance between the wind mast location and the WEP Irechek is approximately 8.5 km. The terrain between the wind mast and WEP Irechek is flat. There are no large obstacles observed between these two objects. This is an agricultural region with growing of different crops, basically wheat and maize. Vegetation such as trees and bushes does not exceed 12 m in height.

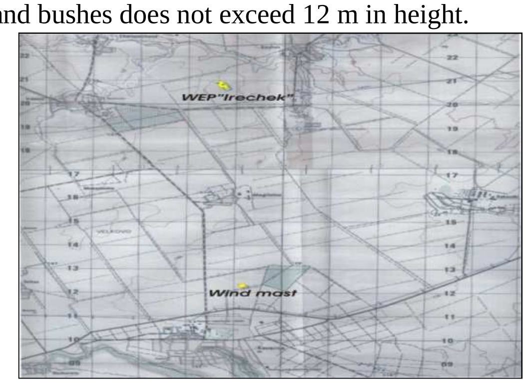

Figure 2.1 Location WEP Irechek - Wind Mast

Month	Average speed m/s
January	6.7
February	7.4
March	6.8
April	6.1
May	5.8
June	5.2
July	5.1
August	5
September	6.1
October	6.3
November	6.3
December	8.1
Average Speed/Year	***6.24***

Table 2.1 Average Monthly Wind Speed 50 meters

Monthly values of wind speed at the WEP Irechek are calculated for height of 50 m above the ground level. The maximum occurs during winter (December, January and February) with values of 8.1 m/s, 6.7 m/s and 7.4 m/s. The minimal values are observed during June, July and August with values of 5.2 m/s, 5.1 m/s and 5.0 m/s. i.e. the wind speed regime in the region of WEP Irechek at 50 m.a.g.l. repeats the regime observed in the region of the wind mast for 46.8 m.a.g.l. This result can be explained on the one hand - with the short distance between the wind mast location and the WEP Irechek location (only 8.5 km), and on the other hand - with the flatness of the terrain between the two locations. The annual mean wind speed value in the region of WEP Irechek is 6.24 m/s. (Table 2.1).

The directions of the wind flow are modelled in the developed energy analysis for the site of construction of WEP Irechek. The wind rose of WEP Irechek for 1-year period is based on measurements of the wind mast in the village of Mogilishte.

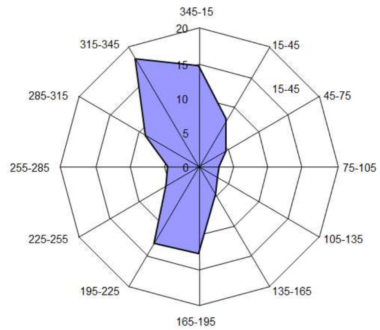

Figure 2.2 Wind Rose for the WEP Irechek for 1-year Period

Technical measures of the Wind Energy Park

The Wind Energy Park (WEP) project envisages the installation and operation of two wind generators. The infrastructure in the region is well developed and the site for the construction of WEP is close to a 20 kV electricity transmission line and a country road of the national road network.

The landed estate, on which the wind generators of Wind Energy Varna Ltd will be installed, covers an area of 1,865 sq. m. The transport access to the site will be achieved through a second-grade road of the national road network and a field road. In the prepared "Detailed Layout Plan" the estate is envisaged to have mixed functions – for agriculture and production activities, and the predominating part of it will remain an agricultural land. Two wind generators will be constructed on the planned plot of land. The area, on which the wind generators will be constructed, is differentiated as a separate estate, with appropriate geometric dimensions in compliance with the size of the wind generators. The location of the generators on the plot is planned in accordance with the technological requirements of the company-manufacturer and in accordance with the predominating wind direction. The distance between them is considered in a way, which will reduce to maximum the negative influence of the one generator over the other. The wind generators towers will be fenced, and the dimensions of each site will be 12 m to 12 m. For the execution of the construction and installation works, Wind Energy has a Construction Permission No. 123 issued on 12.08.2005 by Kavarna Municipality.

Figure 2.3 shows the location of the site for WEP construction on the land of Irecheck village, where positions 1 and 3 are the sites for installation of the chosen by the borrower wind generators Nordtank and Vestas.

Figure 2.3 Positions of the Wind Generators

Wind Energy Varna Ltd has signed a contract for delivery of wind generators type Nordtank NTK 500 41.0 and Vestas V 39.0, which have been in regular operation before their purchase.

The wind generator Nordtank has a manufacturer number NTK 96-549. Prior to the mounting of the generator on the plot for the WEP Irechek, the following repair-renovation works were performed:

- Repair and polishing of the blades. There are submitted protocols and reports on the performed renovation works;
- Replacement of the generator bearings;
- Cables replacement;
- Electric contactors replacement;

- Renovation of the anticorrosive protection of the corpus.

The basic technical parameters of wind generator Nordtank NTK 500 41.0 are the following:
Operating Data
- Rating Capacity – 500 kW
- Cut-in Wind Seed – 4.5 m/s
- Cut-out Wind Speed – 25 m/s

Tower – Rotor
- Number of Rotor Blades – 3
- Rotor Diameter – 41m
- Swept Area – 1,320 m2
- Hub Height – 50m

The generator cuts-in at 3.5 m/s, and at 15 m/s it operates at maximum capacity and at maximum power. After a wind speed of 17 m/s the capacity of the generator begins to fall down by about 10%. At speed of 25 m/s the generator stops operating automatically, since mechanical break-down is possible due to overloading. The turbine is not designed with a scheme for regulation of the angle of attack (pitch control) of the blades, which swirls the wind flow and reduces the electricity quantity produced by it.

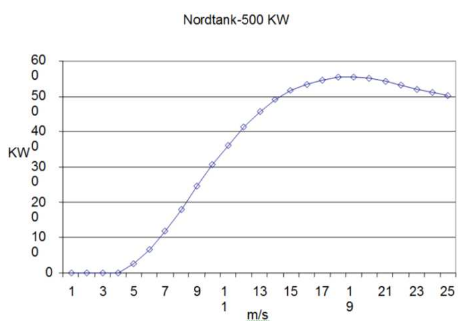

Figure 2.4 NTK 500 41.0 Power Curve

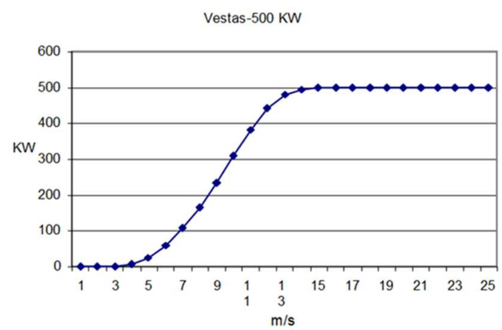

Figure 2.5 Vestas –V39 500 Power Curve

The second turbine Vestas V 39.0 has a manufacturer's serial number 9189. The borrower has no data about the operation hours of the turbine prior to its purchasing. No repair-renovation works have been performed on the main assemblies and elements of the generator, the tower and the turbine. The technical parameters of the wind turbine are the following:

Operating Data
- Rating Capacity – 500 kW
- Cut-in Wind Speed – 4 m/s
- Cut-out Wind Speed – 25 m/s

Tower - Rotor
- Number of Rotor Blades – 3
- Rotor Diameter – 39m
- Swept Area – 1,195 m^2
- Hub Heights – 40.5m

The turbine is designed with a scheme for regulation of the angle of attack of the blades (pitch control), which swirls the wind flow and reduces the electricity quantity produced by it. Figure 2.5
The borrower will construct a transformation substation on the site for connection of the turbines generators with electricity grid 20 kV. The transformation substation will transform 690 V voltage generated by the turbines to 20 kV necessary for the electricity network. Two power transformers of 630 kVA and main distribution system switchgear will be installed in the transformer substation.

For this purpose, a 0.69 kV/ 20 kV distribution systems will be constructed and it will include the following elements: a disconnector for connection to the generator and another disconnector with 20 kV network. Two circuit breakers in accordance with the requirements of the regulation for operating high voltage networks will be mounted in the switchgear. The circuit breakers secure safe work during repair and maintenance of WEP facilities. For safety and protection of the facilities and in accordance with the requirements of Varna Electric Power Distribution Company a distribution system with an electric gas circuit breaker will be mounted on the 20 kV side. According to the submitted project documentation, the breaker is manufactured by the company Schneider, with engine drive and built-in relay protection - Sepam 1000 S41. The protection performs the following functions: maximum current protection, protection of the current segment and ground current protection. For the normal operation of the protection unit it is envisaged an autonomous supply by 24 VDC for five days in case of lack of supply by the network of 20 kV. All devices within the distribution system will be sized appropriately and in compliance with the requirements for operation of high voltage networks and stations.

The 20 kV power line will be connected to the national 20 kV electricity grid of the medium voltage electricity line “Vranino” via a new electric power line branch of a total length 1,030 metres For the purpose, a medium voltage cable type AC 95 will be purchased and laid in the ground in accordance with the prepared documentation and requirements for medium voltage line implementation. According to the developed project the mechanical connection to network 20 kV will be implemented after the installation of ROM3 20/200 and surge arrester POLIM-D24 N for protection of the cables from over voltage. The nearest electricity substations, which will control the WEP operation on behalf of the National Electricity Company, are Kavarna and General Toshevo substations.

The produced electricity will be measured with electric meters on the 20 kV side close to the Wind Energy Varna Ltd property borders. The electric meter will measure in two directions – purchase and sale of active and reactive energy.

Wind Energy has coordinated all necessary technical parameters for connecting the WEP to the electricity grid with Varna Electric Power Distribution Company (VEPD), and a written statement with outgoing No.ТЕИ/624 dated 03.05.2005 has been issued by the (VEPD) Jsc. The National Electricity Company (NEC) requirements and recommendations will be included in the technical specification for drafting the engineering documentation of the distribution system.

The developed analysis in the feasibility study defines different values of the expected annual electricity production for both turbines, which are to be mounted in the WEP Irechek. For turbine Vestas 39 it is envisaged a production of 865.9 MWh which corresponds to 19,76% capacity factor of the WTG and for Nordtank 500 the expected production is 867.2 MWh. The expected annual electricity production by months for both turbines separately and the production of the whole WEP Irechek is presented in Table 2.2. The analysis shows, that the expected electricity production in January, February and December is the highest.

Month	*Vestas MWh*	*Nordtank MWh*	*Total Wind Park MWh*
January	77.50	77.60	155.10
February	85.50	85.70	171.20
March	78.60	78.70	157.30
April	70.50	70.60	141.10
May	67.15	67.25	134.40
June	60.10	60.20	120.30
July	59.00	59.00	118.00
August	57.80	57.90	115.70
September	70.50	70.60	141.10
October	72.80	72.90	145.70
November	72.85	72.95	145.80
December	93.60	93.80	187.40
Total	**865.90**	**867.20**	**1,733.1**

Table 2.2 Expected Annual Electricity Productions by Months

Risk Analysis

Several different types of risks that could threaten the viability of the project were evaluated, and the mitigation circumstances or approaches were proposed:

Wind measurement and modeling risks. The prepared energy analysis has used 12 month wind resource data from a 50m wind mast in the vicinity of Mogilishte village. The distance between the wind mast and the place of WEP Irechek construction is 8.5 km. The transducers are mounted at height of 46 m and 30 m. The distance between the place of measurement of the wind source and the place of construction of the wind equipment is a precondition for error. The measurement and modelling error were quantified in this risk scenario.

Power performance risk was noted as significant, since the wind turbines are second-hand and do not have a guaranteed power curve for the particular site. Although the turbine manufacturers and technology are well-known it is suggested to the project sponsor to verify the turbine power curve during the first several months of the operation, and to make related adjustments in the projected wind farm efficiency.

Energy production risk relates to risks associated with decreased turbine availability due to operational failure and increased operation and maintenance expenses. It is noted that the energy production risk is significantly higher for the second-hand turbine with the unknown reliability and no maintenance record. However, this risk can be mitigated by contracting an experienced maintenance company for regular and preventive maintenance and by insurances against not only natural disasters but also against mechanical and electrical breakdown including the loss of energy as well.

Price risk is associated with the regulatory risk of the establishment of the Tradable Green Certificates system and more specifically the mechanism for determination of individual quotas for conventional power producers. However, taking into account the coming EU accession, the EU requirement for minimum electricity production from renewable energy sources, and the existing higher level of wholesale prices for wind energy in EU countries, this price/regulatory risk is viewed as insignificant.

Sensitivity Analysis

In order to test the robustness of the financial results of the project, several sensitivity scenarios that have the potential to threaten the financial viability of the project were developed. The cases included decreased revenues due to wind resource assessment uncertainties, decreased revenues due the non-guaranteed power performance, decreased revenues and increased operating costs due to operational failure of the second hand equipment, and decreased revenues due to wind prices policy changes, and its combination.

4. CONCLUSIONS

In all cases modeled it was found that the project generated cash to repay the investment in 5 to 6 years of operation. Under the Worst Case scenario, which combines risks of wind resource assessment inaccuracy, low power performance and energy production and wind price decrease, the project financials are the following - 13.18 years for the payback period, and IRR of 4.85%.

The investigation of the development of the Wind Energy Park Irechek has already resulted in a build project. It has been included in the rating with the most effective Wind Parks in Bulgaria and the Kavarna Municipality is one of the most efficient regions in wind energy production in Bulgaria.

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ON CYCLE VARIABILITY OF SUPERCHARGED SPARK IGNITION ENGINE FUELLED WITH BIOETHANOL-GASOLINE BLENDS

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ABSTRACT

In the actual content of pollution the reduction of pollutant emissions from the automotives and the use of alternative fuels becomes a priority. From this point of view the bioethanol can be define as a viable alternative fuel for automotives, used as single fuel or in blends with gasoline. The paper present the preliminary results of cycle variability study for a aspirated spark ignition engine converted to turbo-supercharging and bioethanol fuelling. For three area of air-fuel ratio operating regimes, rich, stoichiometric and lean dosages, the cycle variability coefficient for gasoline and E20 are calculated. The influence of bioethanol content in blends with gasoline on cycle variability of the combustion process is reflected in the values of the cycle variability coefficients calculated for indicated mean effective pressure, maximum pressure, maximum pressure rise rate and maximum pressure angle for all domain of air-fuel ratio from rich to very lean mixtures. The cycle variability decreases at E20 use comparative to gasoline, fact which is related with the combustion process improvement.

1. INTRODUCTION

To improve spark ignition engines energetically and pollution performance research looks to alternative fuels use. From the alternative fuels used for automotive spark ignition engines, bioethanol represents a viable fuel due to its better combustion proprieties, make inexhaustible renewable resources and to diminish the consumption of the classic petroleum products [1]. Is recommend use of the bioethanol as an alternative fuel for the automotive spark ignition engines and because of actually pollutant norms which become more severe, especially for NO_x emissions and for the greenhouse gas CO_2. At the bioethanol use the NO_x emission level could be reduced by 50-60 %, [2].

Bioethanol is considered an alternative viable fuel for spark ignition engines due to its advantages [1, 3]:

- bioethanol has compatible properties with SI engine required operate conditions
- it can be manufactured from agricultural and waste products
- the distribution and storage possibilities are facilitated by the actual infrastructure for gasoline.

Several research works highlight the effects of ethanol use on the energetically performance, pollutant emissions and combustion characteristics of spark ignition engines. The best results obtained through bioethanol use in blend with gasoline, in different percentages.

Bioethanol has better combustion properties comparative with the gasoline:

- greater laminar flame speed (almost 1,36 times higher) [4]
- lowering adiabatic flame temperature (1930 ^oC, comparative to 2290 ^oC) [4]
- greater octane number (RON, 107 comparative to 95-98) [5]
- larger oxygen content at molecular level (34.7 %, comparative to 0.4 %)
- greater auto ignition temperature (420 ^oC, comparative to 257…327 ^oC) [4].

The operation of the spark ignition engine can be assured by bioethanol use with the maintaining or with the increase of engine energetically performance, without its design major

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modifications (the engine was equipped with standard equipment- intake-exhaust system, fuelling system, filters of fuel and oil etc.) [6]. In the same time, at the bioethanol use can be increased the boost pressure without combustion with knock appearance at the supercharged SI engine [7, 8, 9]. The greater laminar flame speed of the bioethanol comparative with the gasoline assures combustion duration decrease and the engine thermal efficiency increase and there are possibilities to use leaner mixtures (ethanol–air blend has a wider range of ignition ability comparing to gasoline 0.3…1.56 versus 0.4…1.4 with the possibility to provide much leaner air–fuel ratio) and the quality adjustment of the engine load [4, 9]. The use of ethanol assures an intake air efficient cooling effect due to its higher heat of vaporization, effect which at the supercharged SI engine is very important [7, 9]**.** Thus, the intake air cooling effect leads to a volumetric efficiency improvement and reduces the risk knock development. Also due to a lower in-cylinder temperature level is estimated the pollutant emissions decrease, especially NO_X. At the bioethanol use when its percentage in blend with gasoline increases, the knock resistance increases and allows the increasing of the boosting pressure, helping to improve the engine energetically performance [9]. The higher ethanol octane number increases the auto-igniting resistance of the end-gas and ethanol may be considered an efficient antiknock agent for the supercharged SI engine [9, 10, 11]. The use of bioethanol-gasoline blends leads to the increase of the in-cylinder gases maximum pressure and of the pressure rise maximum rate due to better combustion proprieties of the bioethanol, but through optimum ignition timing establishment the engine strengths can be controlled [9, 11]. The cycle variability can be characterized by coefficients of in-cylinder pressure variation. The intensity of the cycle variety phenomena is defined by the coefficient of cycle variability, as relation (1) shows. The coefficient of cycle variability is defined as a relative average deviation of maximum pressure values [5]. For *n* consecutive cycles, if is considered a normal distribution of the deviation probabilities, the squared average deviation can be calculated and the cycle variability coefficient is defined as:

$$(COV)a_i = \frac{\sqrt{\dfrac{\sum_{i=1}^{n}\left(a_i - \dfrac{\sum_{i=1}^{n} a_i}{n}\right)^2}{n-1}}}{\dfrac{\sum_{i=1}^{n} a_i}{n}} \cdot 100\% \qquad (1)$$

where *n* is the number of cycles, *a* is the parameter of which variability is study and is defined by indicated mean effective pressure IMEP, maximum pressure p_{max}, maximum pressure rise rate $(dp/d\alpha)_{max}$ and the angle where maximum pressure occurs, α_{pmax} in the cycle number "*i*".

Generally, the way of cycle variability evaluation for regimes with spark timing closer to the value of spark timing for MTB the COV of maximum pressure is suitable. The COV of maximum pressure angle, when the maximum pressure occurs, is used for characterization of the combustion cycle variability during the initial phase of combustion. The variation of the IMEP, appreciated by $(COV)_{IMEP}$, is the most suitable instrument to define the engine respond to the combustion process variability. From this point of view the limit value of $(COV)_{IMEP}$ define practically the limit of mixture leaning. This cycle coefficient can also indicate the variability of flame development during the initial phase of combustion [5, 11]. The fuel type influences the cycle variability by the value of its laminar flame velocity. For higher laminar combustion speed, of 1.36 times higher for bioethanol versus gasoline, the flame development is much quicker, comparative to gasoline. A higher combustion velocity reduces the influence of turbulence and reduces the cycle variability [5, 11]. The quality of the in-cylinder mixture influences the combustion process thru chemical reaction speed, with a maximum in the area of rich dosage. From this point of view the initial and final phases of the combustion process have minimal duration at the dosage for which the chemical reaction speeds are maximum, λ=0.9 [11] At the mixture leaning the durations of those two phases increase and the combustion duration also increases. In the area of very lean mixtures λ=1.4 the stabile running of the engine is also assured by E20 due to bioethanol wider limit of inflammability of 0.3…1.56 versus 0.4…1.4 for gasoline (defined as λ_i…. λ_s at 20 °C and 1.013 bar) [11].

2. ASPECTS OF CYCLE VARIABILITY STUDY FOR BIOETHANOL USE

A natural aspirated automotive spark ignition engine was converted to turbo-supercharging and bioethanol-gasoline blends fuelling in order to improve performance and pollution emissions. The main characteristics of the classic engine are presented in the table 1. For the operating regime of 2500 min^{-1} and full load at different values of air-fuel ratio excess defined by λ=0.9, 1.0 and 1.4, a preliminary study of cycle variability was developed. Using a AVL data acquisition system, Indimodul 621 type, a number of 150 consecutive cycles were registered for gasoline and E20 (20 $(\%)_v$ bioethanol 80 $(\%)_v$ gasoline) fuelling.

Table 1: Daewoo 1.5 DOHC 16 valve classic engine characteristics

Swept volume [dm^3]	1.498
Bore [mm]	76.5
Stroke [mm]	81.5
Conrod length [mm]	123.5
Compression ratio [-]	9.2
Supercharging pressure [bar]	1.4

Thus, were calculated the cycle variability coefficients for indicated mean effective pressure (IMEP), maximum pressure, maximum pressure rise rate and angle of maximum pressure. In order to evaluate the way that the engine running is affected by the variability of the combustion process, the cycle variability coefficient for indicated mean effective pressure is calculated and presented in the figure 1.

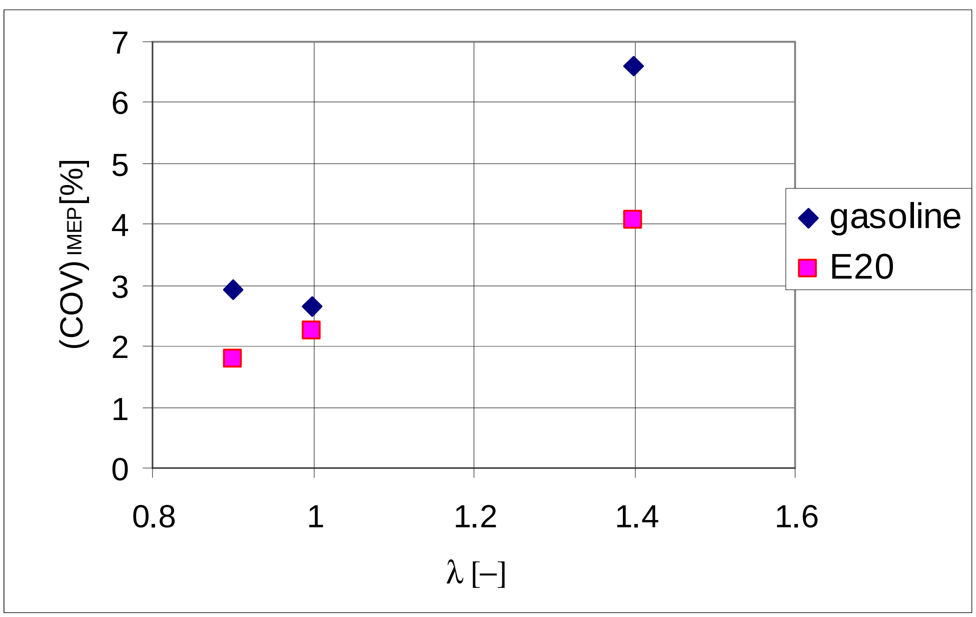

Figure 1: Coefficient of cycle variability for IMEP versus air-fuel ratio

At rich dosages, λ=0.9, the $(COV)_{IMEP}$ is 2.93% at gasoline fuelling and decreases to 1.78% for E20 fuelling. The decrease is also present in the area of stoichiometric dosage, λ=1, from 2.64% to 2.25% and in the domain of very lean mixtures regime, λ=1.4, from 6.61% to 4.07%. The decrease tendency in coefficient values shows the improvement of the combustion process at E20 fuelling for entire area of air-fuel mixtures and the possibility of stable running even in the area of very lean dosages, λ=1.4, the calculated values being under admitted value of 10%. The cycle variability coefficient for maximum pressure is related with determination of the optimum spark ignition timing value. For gasoline fuelling the $(COV)_{pmax}$ is 8.41% at λ=0.9, 8.04 at λ=1 and 15.74 at λ=1.4. The values decrease at E20 fuelling at 4.21% for λ=0.9, 4.49% for λ=1 and 12.22% for λ=1.4, as figure 2 shows. For rich and stoichiometric dosages the values of $(COV)_{pmax}$ are below 10% and the normal manoeuvrability of the automotive is assured. At very lean mixtures the values don't significantly exceed the admitted limit and a further optimization of spark ignition timing in the area of very lean mixtures can be done.

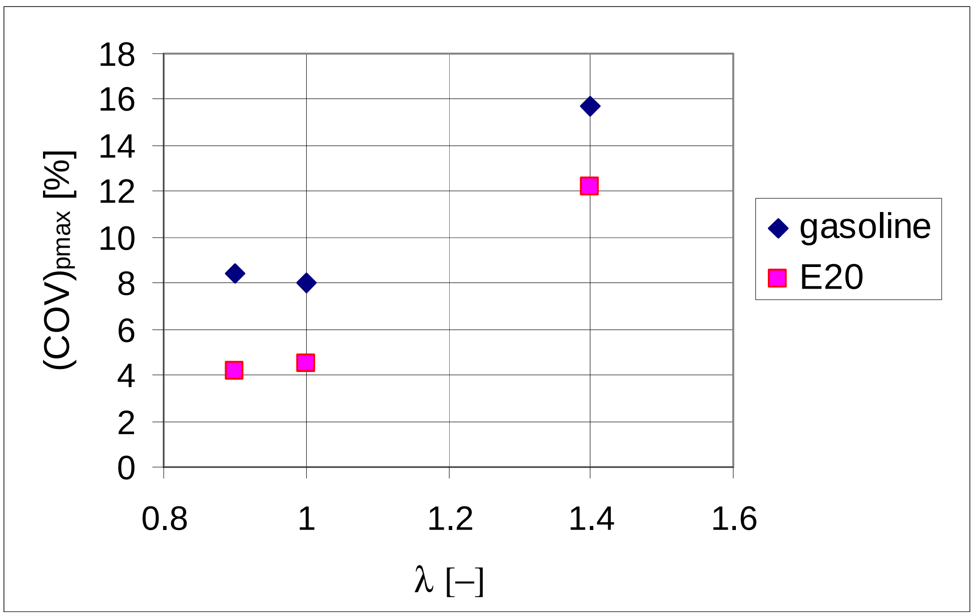

Figure 2: Coefficient of cycle variability for maximum pressure versus air-fuel ratio

The figure 3 presents the cycle variability coefficient for the maximum pressure rise rate. Initially for gasoline fuelling $(COV)_{(dp/d\alpha)max}$ is 21.729% for λ=1 and decreases to 14.93% at E20 fuelling. For rich dosages the value is 24.08% for gasoline and 41.04% for E20. At lean mixture operating appears a slightly improve in cycle variability for the maximum pressure rise rate, the value of coefficient decreasing from 51.44% to 50.01%.

For study of the cycle variability only during the initial phase of combustion, the cycle variability coefficient for the moment per cycle when the maximum of the in-cylinder pressure occurs must be calculated, $(COV)_{\alpha pmax}$. For lean mixtures, λ=1.4, at E20 use the value of $(COV)_{\alpha pmax}$ decreases from 16.102% to 14.617% with may be related to the reduction of the initial combustion phase duration. This is in correlation with the decreasing tendency of the $(COV)_{pmax}$ and $(COV)_{(dp/d\alpha)max}$ at the same regime.

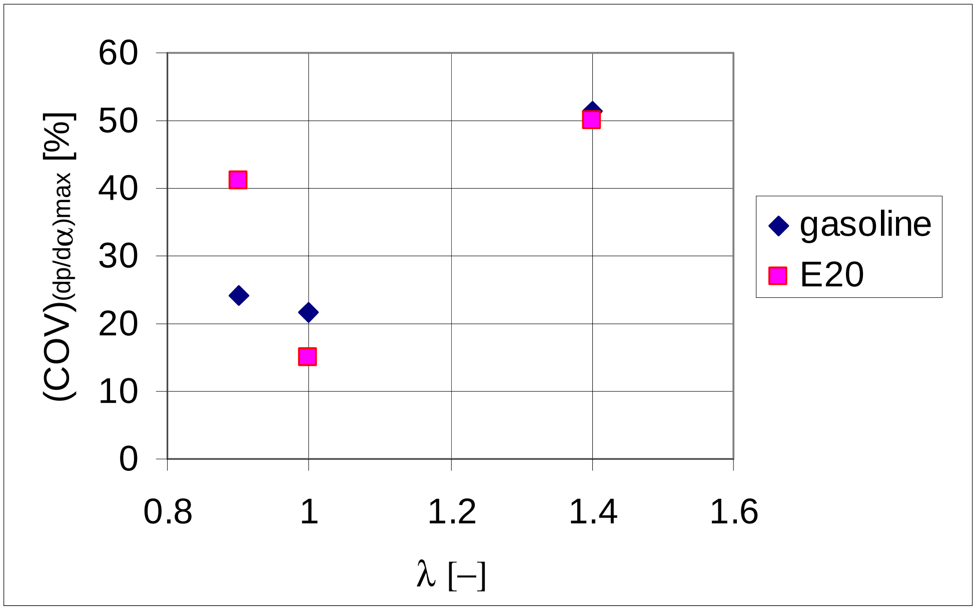

Figure 3: Coefficient of cycle variability for maximum pressure rise rate versus air-fuel ratio

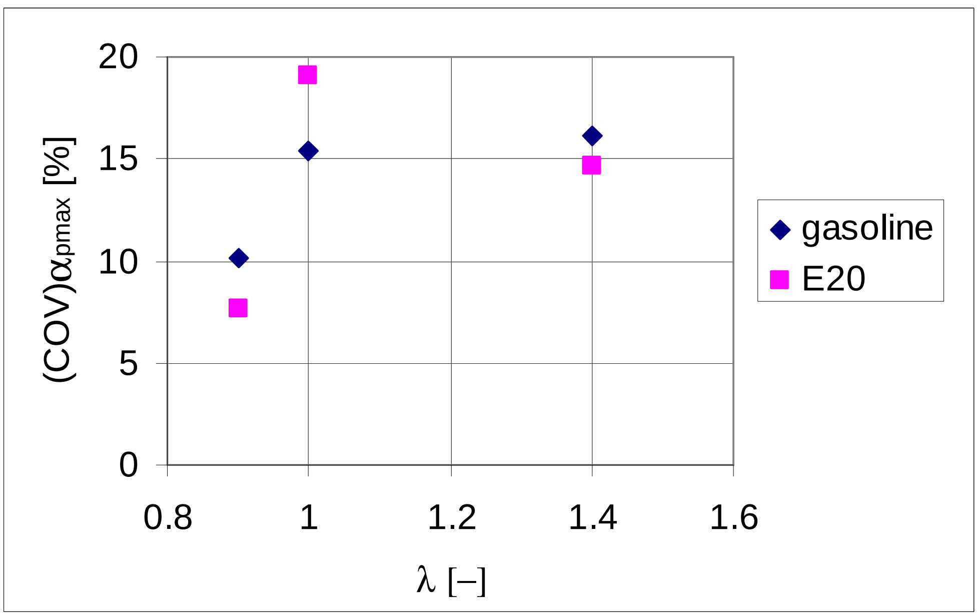

Figure 4: Coefficient of cycle variability for maximum pressure angle versus air-fuel ratio

Also, at rich dosages the $(COV)_{\alpha pmax}$ decreases at E20 from 10.17% to 7.626% comparative to gasoline may reflect the decrease of cycle variability during the initial combustion phase. For stoichiometric dosage the $(COV)_{\alpha pmax}$ rise from 15.38% at gasoline fuelling at 19.04% at E20.

3. CONCLUSIONS

The use of E20 fuel leads to a generally improvement of combustion variability, especially in the area of very lean dosage, λ=1.4, also due to bioethanol wider limit of inflammability comparative to gasoline. The cycle variability decreases in terms of IMEP for entire domain of

λ=0.9…1.4 with more significant decreases up till 2,5% in the area of very lean mixtures. This aspect shows a good respond of the engine running to cycle variability when E20 is use comparative to gasoline. $(COV)_{pmax}$ registered values with 3.5…4.2% bellow gasoline fuelling. Maximum pressure rise rate COV decrease with 1.4…6.7% in the area of λ=1.0…1.4 showing good perspective for further spark timing optimization. For rich and very lean mixture regimes, the cycle variability during the initial combustion phase, evaluated by $(COV)_{\alpha pmax}$ decrease up till 1.4…2.5%, decreases related with $(COV)_{IMEP}$ decrease for rich and lean dosages and reduction of cycle variability during the initial phase of combustion.

Aknowledgements

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CONSERVATIVE TILLAGE TECHNOLOGIES - STATE OF THE ART

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ABSTRACT

Conservative systems are based on the less intense loosening of soil, made by different methods, without furrow return and only while maintaining a given amount of crop residues on soil surface, is being considered for this reason as environmental protection strategies. In this paper is presented an analysis of the state of research on the implementation in agriculture of conservative tillage technologies and the technical-economic and environmental impacts of applying these conservative technologies. Also, there are presented the most advanced research on optimal construction of equipment for soil processing in conservation system.

1. INTRODUCTION

Soil works have been an integral part of agriculture since the beginning and served several important purposes: seedbed preparation, reducing soil compaction to increase aeration and for better development of the root system of plants, reducing the weeding, incorporation of fertilizers and amendments, crop residue management [1]. **The agricultural system** is a set of sectors, technologies, machinery and technological aggregates, in which the soil is used as the main resource for the production of agricultural crops, orchards, vineyards, vegetables, floriculture and animal husbandry. In Europe, in agriculture, depending on the technologies used, their level of intensification, specialization, the quantity and quality of biomass, the relations with the environment, etc, are practiced various systems of agriculture: conventional, sustainable, ecological (biological, organic), precision, extensive [2]. **The conventional agriculture system**, product of the over-industrialized society, with strong polluting effects, hardly controllable and unpredictable on the ecological balance, biodiversity and food quality, is the type of powerful but unsustainable farming, found in an alarming stage, due to the exhaustion of fossil fuels and multiple negative effects on society. The beneficial result of industrial agriculture is only the increase of labor productivity and increasing yields, which in the past 4-5 decades have doubled and even tripled in many countries. This is the dominant system of today's agriculture, whose change in the 21st century is imminent [3]. The term "**sustainable development**" was first used by the Prime Minister of Norway, Gro Harlem Brundtland, in 1987. As chairman of the World Commission on Environment and Development, he presented the report "Our Common Future" in which he defined the sustainable development as "the development that meets the needs of the present without compromising the ability of future generations to meet their own needs". Sustainable development implies ensuring simultaneous progress on three fronts: economic, social, environmental. In the "**environment-economic-social**" trinomial system, sustainable development emphasizes the interdependence of components and highlights the need for equality and impartiality between people raised to the rank of "universal citizen"[4]. For the term "sustainable agriculture" has not yet been developed a detailed and universally accepted definition, as agricultural practices which subsumes to this concept and aims to provide sustainable development in rural areas vary in space and time, and their effectiveness can be properly assessed, especially retrospectively [5].

Organic farming promotes the systems of sustainable production, diversified and balanced, to prevent the pollution of crops and of the environment [6]. Organic farming

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avoids the use of pesticides, herbicides, synthetic fertilizers and genetic manipulation practices. Regarding animal husbandry, it's avoided the use of prophylactic antibiotics and growth hormones and the focus is on animal welfare and on providing food with natural products [7]. Organic farming can be defined as a holistic approach of the production management system, which promotes and maintains a healthy development of agro-ecosystems, including biodiversity, biological cycles and soil biological activity. The focus is directed to the use of management practices in line with the use of external farm inputs, taking into account the regional conditions to which that systems must adapt. This is accomplished by using, where the conditions allow it, of farming methods, biological and mechanical, as opposed to using synthetic materials [8]. **Precision farming (PA)** or satellite farming or site specific crop management (SSCM) is a farming management concept based on observing, measuring and responding to inter and intra-field variability in crops. Crop variability typically has both a spatial and temporal component, which makes statistical/computational treatments quite involved. The holy grail of precision agriculture research will be the ability to define a Decision Support System (DSS) for whole farm management with the goal of optimizing returns on inputs while preserving resources. The reality today is that apparently simple concepts, such as the ability to define management zones, areas where different management practices will apply, for a single crop type on a single field over time are difficult to define [9,10]. **An agricultural system can be sustainable** if the production, the nutrients contained in crop and manure, or lost by erosion, are equal to those introduced in the form of artificial fertilizers, and created by the degradation of the rocks in the base layer. All additional inputs, such as energy, water, chemical preparations should also be durable products. Considering all of the above, it can be concluded that: precision farming is the management method that ensures the strategy of sustainable development in agriculture; precision farming associates geospatial and information technologies in order to use site-specific data, for taking decisions related to agricultural production; precision farming presents a set of technologies for sustainable agriculture [11]. **Extensive agriculture** with low-inputs – of subsistence, with less competitive production, can affect to some extent the environment, including the quality of the biomass, in particular through nutritional imbalances. Mineral fertilizers and other agrochemical substances (herbicides, insecticides, fungicides, and mineral amendments), etc., are not practically used or applied only in very small amounts (excepting the vegetable sector). Also, hybrids and performing varieties are not widespread. In Romania, this system is practiced by individual producers [12]. **Soil conservation concept** consists of a set of activities, measures and technologies that help to maintain soil fertility status without a significant decrease in yields or without high costs. This system covers a wide range of farming methods which mainly aim to preserve the plant residues on the surface of arable soil in order to reduce erosion [13]. **Soil conservative technologies** are characterized by the fact that they leave on the soil surface over 30% of plant residues of the previous crop. Crop residues protect the soil surface from water erosion by absorbing raindrops energy, thus reducing the possibility of detachment of soil particles. The layer of crop residues also reduces soil compaction by raindrops and the possibility of crust formation, thus increasing the capacity of water infiltration into the soil. By creation of small dams and obstructions along the water drainage trough, plant residues slow down its flow rate, decreases the amount of carried soil and the amount of additional particles removed by the water. Thus, by reducing the water flow rate, some soil aggregates and particles carried by the water will redeposit. During plant development, crop residues protect the soil from sun and wind, reducing water losses by evaporation and during winter they increase soil moisture by retaining snow on the soil surface [14]. **Soil conservation technologies**, which leaves a large part of crop residues on the soil surface, reduce erosion up to 95% (no-till) compared with the conventional processing systems. Crop residues, which are evenly distributed on the soil surface and in higher quantity on sloping soils where erosion is accentuated, by intercepting raindrops, absorb their energy and reduce the detachment process of soil particles (the first step in erosion), slow the water flow on the surface of sloping soils and reduce the transport of soil particles (the second step in erosion) [15].

2. METHODOLOGY

Conservative tillage technologies can be: with reduced works (minimum tillage), with works with protective layer (cover crops, catch crops), with works on ridge (ridge-tillage), with works in strips or narrow strips (strip till, zone till), without works or direct sowing (no-tillage) [16]. The European Union faces eight main soil degradation processes: soil erosion, loss of organic matter content, soil contamination, salinisation, soil compaction, loss of soil biodiversity, soil sealing, landslides and floods [17]. A spatial analysis of the distribution of susceptible subsoils in Europe, has revealed the following proportions for the 4 susceptibility classes: low 20 %, moderate 44%, high 28%, very high 9%. Thus more than a third of European subsoils are classified as having high or very high susceptibility to compaction and more than 75% moderate or high susceptibility. The patterns of high and very high susceptibility are mainly associated with areas of coarse or organic soils [18]. In Romania, most arable soils are moderately vulnerable (fig. 1) and grasslands in central regions are most vulnerable to soil compaction [19].

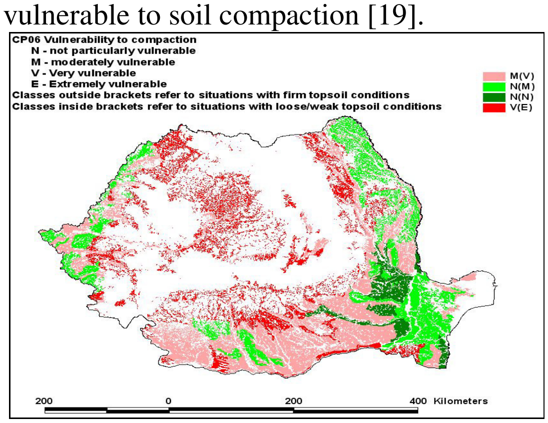

Figure 1: Vulnerability to compaction of arable soils [19]

Figure 2: Technical equipment [26]

To decrease these disadvantages, there was a tendency in agricultural practices to minimize the works of soil preparation, for planting and crop care works [20]. Systems with reduced works (minimum tillage) began to be experienced for the first time in 1950 in the USA, at Ohio University, in wet- warm climates, on flat lands, with fertile soils, rich in humus, permeable, without moisture excess, originally grown in corn monoculture of large productivity [21]. In the 1990s, a number of reduced-tillage or minimum-tillage alternatives were developed and successfully used to produce a wide range of vegetable crops in the Central and Salinas Valleys. The most common minimum-tillage operation in the Salinas Valley is shallow minimum tillage using a Sundance system (from Coolidge, Arizona), followed by a Lilliston-type implement, rollers, and bed-shapers [22].

Minimum tillage systems are now an established part of mainstream UK agriculture, accounting for an estimated 40 % of all cultivations, but as across Western Europe as a whole, it's a concept still in its infancy compared with the activities in North America, Latin America, and Australia, for example [23]. Soil Conservative technologies, leaving much of the plant residues on the soil surface, reduce erosion by a rate of 95% (no-till), as compared to conventional tillage systems [24]. Plant residues left on the soil surface or incorporated in the soil, contribute to the biological activity, which is an important source of CO_2, restores soil structure and improves its overall drainage, which allows faster infiltration of water into the soil [25]. Romania has the necessary means to introduce the technology of establishing straw cereal crops in minimal tillage system, due to the research conducted by INMA Bucharest, with technical equipment (fig. 2) which performs simultaneously tillage and straw cereals establishment, both on half-prepared and unprepared lands for sowing, leading to a substantial reduction of soil compaction, energy consumption and cost of labor [26].

After plowing, the layer of soil on the surface remains completely discovered, raindrops falling at high speed destroy soil aggregates, soil becomes compact, with much reduced permeability, and the amount of water stored in the deeper layers is reduced. These disadvantages can be removed if on the soil surface is laid a layer of organic matter composed of chopped straw or corn stalks, undecomposed manure, turf etc. During the time when the vegetation layer covers the soil, maintenance works necessary for the crops are performed using special tools that loosen the soil without burying the protective topsoil [27]. Ridge-tillage technology is preferred on soils with lower drainage. In Romania, research conducted by INMA Bucharest, using a ridge cultivator fitted with shanks to open ridges, and for the sowing of weeding plants the technical equipment fitted with a spherical horizontal disc for cutting the ridge in an area where sowing coulters incorporate the seeds, showed the efficacy of ridge sowing technology of corn [28]. Ridge sowing equipment for weeding plants (fig. 3), performs the cutting of plant residues and of soil vertically to the axis of the row to be sown by a flat vertical disk with rim, cutting of the ridge tip and its cleaning by a spherical horizontal disk, the mobilization and soil loosening in strips by a corrugated disk, sowing by the distribution equipment, seed incorporation into the soil, seed coverage and shallow soil compaction [29].

Figure 3: Ridge sowing equipment for weeding plants [30]

Figure 4: Technical equipment for soil working on narrow strips [34]

Researches conducted by Ohio State University showed that strip tillage is usually performed in the fall following soybeans or wheat to prepare the ground for corn planting. Tillage is confined to narrow strips where seeds will be planted. The loosened soil in the strip creates a ridge 3 to 4 inches high, which improves soil drainage and warming. By spring, it usually settles down to 1 to 2 inches high, and after planting the field is flat. Row middles are untilled and covered with undisturbed crop residue [31]. In Romania, INMA Bucharest has designed, developed and tested an experimental model of technical equipment for strip tillage, sowing, fertilizing and distributing granular insecticides for innovative technology of establishing weeding crops adapted to specific climatic conditions of Romania's regions [32]. The equipment (fig. 4) is designed to perform sowing of weeding plants during optimum time, depending on soil and climatic conditions, both on lands worked in "strips" since autumn and sown in spring, and on lands not prepared for sowing [33].

Direct sowing means putting seed in fallow soil, i.e relinquishing any tillage. The only "processing" is a slot created by the coulters of the sowing machine in which seeds and fertilizers are introduced. In 1974, the U.S. Department of Agriculture estimated that the amount of cropland in the United States under no-tillage culțivation was 2.23 million hectares, and that 62 million hectares or 45 percent of the total U.S. cropland will be under the no-tillage system by 2000 [35]. The implementation of a European Soils Directive is considered to be an important step towards the recognition that conservation tillage and no-tillage are both economical and ecological sustainable methods for agricultural production. It is anticipated that this development will promote the concept of Conservation Agriculture and increase adoption levels throughout Europe [36].

INMA Bucharest carried out research on direct sowing (no-tillage) of straw cereals with a new technical equipment (fig. 5), which consists of working bodies type corrugated disk, for the processing of a narrow strip of soil penetrated by disk coulters which incorporate the seeds at the set depth, in order to prevent the degradation of soil and other environmental resources, and to improve the soils degraded by conventional technologies, to reduce energy consumption, to increase the productive potential of the soil and to increase water use efficiency [37].

Figure 5: Equipment for direct sowing (no-tillage) of straw cereals [38]

3. CONCLUSIONS

- Worldwide, there is a major interest for the application of conservative technologies, that use specific technical equipment to prevent or minimize soil degradation and to restore the productive capacity of soils;
- In Romania, research is made within the conservative tillage technology with minimal tillage or direct sowing, using equipment with working bodies adapted to the soil and climatic conditions specific to the regions with light, medium and heavy soils.

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MACHINE FOR REGENERATE DEGRADED GRASSLAND IN THE CONTEXT OF THE ECOLOGICAL REQUIREMENTS

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ABSTRACT

Agricultural status of many of meadows area, and the need to optimal ensure the feed for growing effective of animals, require proper works execution of improvement, designed to correct the floristic composition and to increase the production. Given the imperative of improving living standards in the long term and under the pressure of growing demands to consumers of plant and animal products, trader S.C. MECANO FUC S.A. and research unit INMA Bucharest, with scientific concerns in the technology area for grasslands rational recovery, proposes in this paper a new machine for regenerate grasslands by soil tillage in narrow strips and direct sowing into the grassy carpet of a herbs mixture.

1. INTRODUCTION

Grasslands are lands covered with permanent grass vegetation, composed of species belonging to several plants families, especially grasses and perennial legumes, used as feed or pasture. Grasslands, occupying 40 % of the world land area, except Antarctica and Greenland, support livelihoods of approx. 1 billion people. [5]

Romania ranks 5th in Europe, after France, Britain, Spain and Germany with an area of 4.9 million ha grassland. Share grasslands in the total area of Romania is 20.4 %, and in the agricultural area is 33 %. On these areas agricultural production are reduced by approx. 10...90 %, depending on the intensity of soil erosion. [4]

Worldwide there are scientific concerns in grassland rehabilitation, in order to combat the risk of deterioration, in the context of global and regional climate change. [2]

The climate global warming will affect the agrosilvopastoral fund of Romania. The increase of air average temperature with 3°C, which is the forecast for 2070 years level, will cause deeper dryness and desertification of plains areas and hills, with major negative impact on grasslands. [3]

There are two ways of improvement, one for surface without depth mobilization of the soil, with completely keeping or a certain percentage the existing vegetation and the other radical by entirety replacing the existing vegetation. [5]

Given that there are European and national legislation concerning financial support for comply the eco-cross-compliance, SC MECANO FUC S.A. and INMA Bucharest have showed an major interest in finding an innovative solution for the regeneration of degraded grasslands and the rational exploitation of them, so that farmers can have the opportunity to get a new machine, with high performance, that meets to quality requirements imposed by the European Union market and on prices more than competitive. [6], [7], [8], [9]

2. METHODOLOGY

For grassland quality restoration technology, in terms of climate changes, is proposed a machine for regenerate grasslands, which achieve soil tillage in narrow strips and direct sowing into the grassy carpet of a herbs mixture, or even a single species, keeping wholly or in a certain percentage the existing vegetation. This machine will achieve with low cost (on the current financial possibilities of the market segment who is addressed) improvement (by overseeding) the old degraded vegetating with valuable items (leguminous fodder) so that will

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be able to use rational the existing pastoral heritage in Romania, which is part of the national wealth, with major significance by the dimension of the feed potential sources and their quality.

3. RESULTS

The machine for regenerate grasslands (Fig. 1) consists in the following main subassemblies: chassis **1**, milling section **2**, seeding section **3**, seed box , transmission for sowing **5**, milling transmission **6**, evidence box **7**, and support with tubs **8**. The machine running in a single pass:

- Seedbed preparation by performing bands in the degraded grasslands vegetation cover;
- Sowing a mixture of herbs or even one species in strips done by milling station;
- Light compaction of the soil over the seeds, for a proper contact between them and the ground, in order to get a good germination.

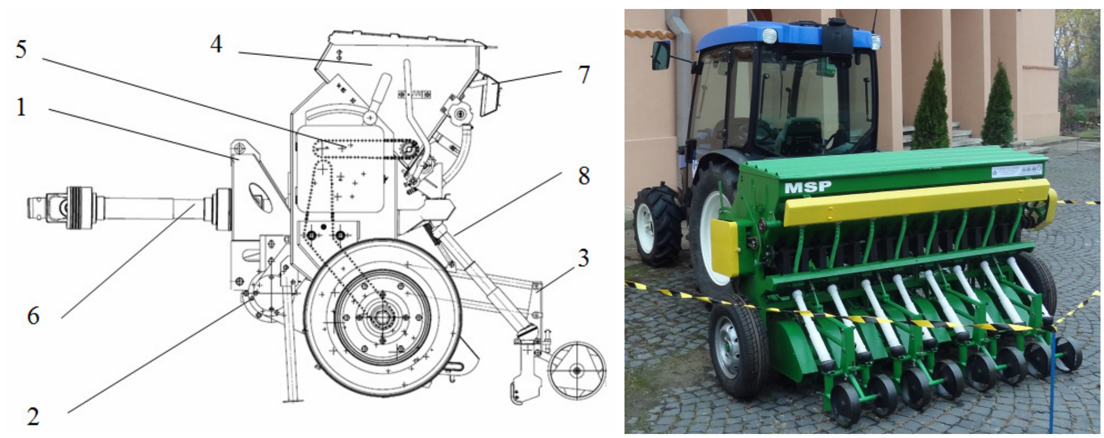

Figure 1: Machine for regenerate grasslands

The frame consists in a welded frame on which is mounted the other component subassemblies of the machine. The weld is provided in the center with a triangle, for coupling to the three-point linkage Category 2 ISO 730 of the tractor, some supports for the assembly of milling transmission bearings and the attachment of sowing sections.

On the frame sides of the welding frame are assembled the support wheels of the machine (the left wheel is provided with a sprocket z=15 for the chain transmission of the seeding system) and the parking legs.

The milling section is the assembly running the soil processing in narrow strips, by milling in order to sowing in vegetation cover of the degraded grasslands. It consists in a assembled housing in which is mounted a chain transmission (consisting in two chain wheels, 16 A Gall chain with 50 links and one chain tensioner) and two rotors, which are arranged on both sides of the section each provided with flanges on which are mounted three pairs of blades cutter left / right, in the form of "L" with short width, protected by some shields left / right.

The sowing section running incorporation seeds heavy and light flowing in the channels made by cultural coulters, in narrow bands made by milling stations, and at the same time a slight compaction of the soil over the seed, for a proper contact between these and the ground, in order to obtain a good germination. The sowing section is mounted behind the milling section and comprises two arms, one lower and one upper, which in contact with the machine chassis achieves a deformable parallelogram, two incorporation cultural coulter, two wheels for easy soil compaction (located behind the coulter) that are simultaneously wheel for sowing depth adjustment and an adjustable elastic system for pressing the section in the soil and coulters protection. Seeding depth is achieved by adjusting the position of the incorporation coulter with the compacted wheel by driving a screw.

The seeds box is mounted on the side walls of the chassis and has geometry with angles that ensure a proper flow of the seeds in any working position of the sowing sections. In order to allow the sowing of the seed mixtures with different flow properties, the box is carried out with two compartments, namely:

- A large one for running hard seeds in which are placed the spurs distributors for 0...300 kg/ha;
- An easy one for light flowing seeds in which are placed the groove distributors, with adjustable length for 0 ... 10 kg/ha.

For light flowing seeds the sowing is determined by changing the active length of groove distributors.

The sowing transmission consists in a 10A - 88 links chain, which wraps wheels Z_1=15, Z_2=11, to transmit motion from left drive and input support wheel to input shaft in an inpulse gearbox with oil bath, another 8A chain - 66 links, which wrap the wheels Z_3=Z_4=15, to transmit motion from the output shaft of the inpulse gearbox with oil to the shaft with agitators, and through the transmission gear, Z_5 and Z_6=20=18, to the distributor shaft cylinder type for hard seed flowing through the 10 B chain - 43 links, which wraps the chain wheels 15 and Z_8=Z_7 =15 to the distributors with grooved rolls for light flowing seeds. The inpulse gearbox with oil bath includes two cam-rocker mechanisms mounted in parallel, and its construction allows changing the gear ratio either manually or electro-hydraulic via an control system. To change the seed flow is acting on the control lever for the purpose of changing the position on the gradually sector.

The milling transmission is composed of a 45 HP shaft, a central bearing, an intermediate transmission with chain, a conical reducer and a hexagonal shaft that transmits the motion from the tractor in the aggregate PTO, by the four final drives with chain, to the blades rotor of the four processing sections by soil milling in narrow bands.

The box evidence is required to collect seeds during flow tests, weighing executing in a short time. To make debit evidence the box is placed on to the tubes support, just below the distributors, in which situation the seeds do not pass through tubes and coulters.

The support with tube helps, through telescopic tubes, to the set distribution of both types of seed in the grooves created by cultural coulters.

Main technical characteristics

- The necessary tractor, HP	45
- Number of sections for soil processing in narrow bands	4
- Number of sections for sowing	4
- Number of worked bands and sown rows	8
- Distance between worked and sown bands, mm	220
- Depth for tillage and sowing, cm	2...6
- Width of tillage and sowing, m	1.76
- Weight, kg	498

Operation mode

At the entrance to the plot work, lower the car up to approx. 5 cm from the ground, the power take-off shaft coupling of the tractor and the machine is still full descent, then start the submission. As the tractor forward, the knives rotor prepare the seedbed on 2...6 cm depth by making narrow strip in grassland vegetation of degraded cover. The seeds are routed through leading telescopic tubes to coulters who incorporate them into the bands performed in soil and the compaction wheel sits the processed soil over them. The soil is separated in small pieces by the active organs of the blades rotor from the milling section and is thrown towards the walls of the housing where it is cut and loosened, after which it is placed, some in worked bands and some in unprocessed lateral areas. Placing the soil in unprocessed lateral areas gives a great advantage because delay the development of the old carpet and enables to the new one to develop freely without being stifled, eliminating herbicides. At each end of the plot, before finishing the work, will be discontinue the movement of the PTO shaft and then will pick up the car from the ground.

Results of research regarding the depth sowing obtained on crop clover

The characteristics of the terrain on which the field experiments were carried out with the machine for regenerate grasslands for determining the sawing depth are shown in Table 1.

Table 1: The characteristics of the terrain on which the field experiments were carried out

No.	Characteristics	INMA experimental polygon
1	Soil type	reddish brown forest
2	Natural bumps height or anthills, cm	max. 8
3	Coverage of soil with plants,%	78
4	The average height of plants, cm	5.2
5	Plant mass, g/m^2	50
6	Soil moisture, %, in 0…10 cm layer	21.2

In order to determine the compactness of the soil, was measured in 11 sample points up to a maximum depth of 25 cm by a digital penetrometer with cone FIELDSCOUT SC 900, and the distribution of the resistance forces to the cone penetration in the soil layers, in kPa, is shown in Figure 2.

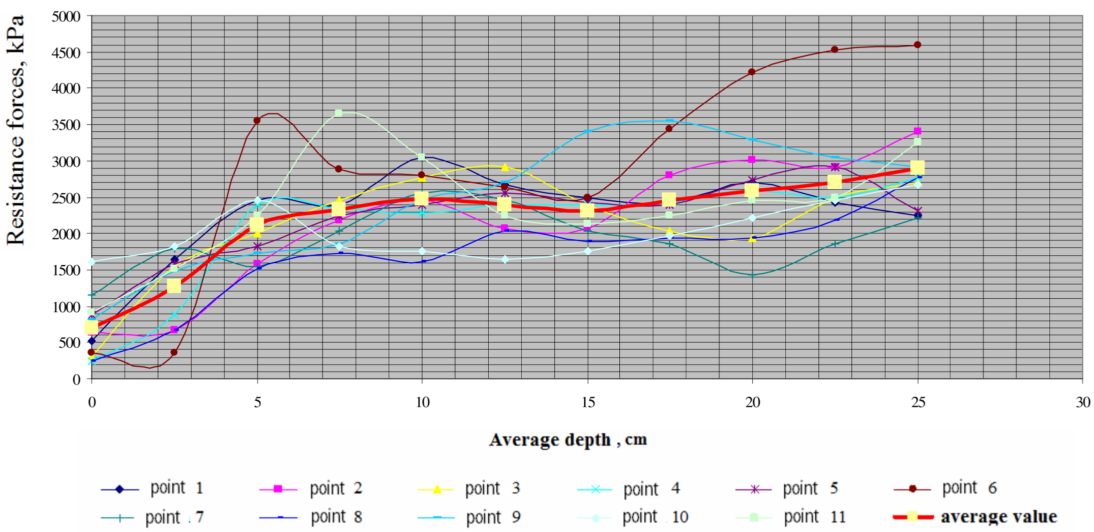

Figure 2: The distribution of the resistance forces to the cone penetration in the soil layers, measured in 11 sample points up to a maximum depth of 25 cm

Mean of the penetration resistance forces on cone penetration in the soil layers in the range 0...25 cm depth is 2204 kPa, which means that the soil is not compacted (up to 3000 kPa is in a position to be declared as compacted) .

The depth of incorporation of the seed is the distance measured from the ground level resulting from the sowing work to the horizon from which are the seeds. The measurements were carried out in three repeats in three different areas of the plot (at the ends and in the middle).

Relations calculation:

$$a_{ms} = \frac{\sum_{1}^{n} a_i}{n}, \text{ cm} \qquad (1)$$

where a_i is the depth of incorporation of the seed, measured in *i* point.

Following experimental research regarding the average depth of sowing at clover culture (degree of purity: 99.02 %, weight of 1000 seeds: 1.91 g, sowing rate: 6 kg/ha and sowing depth: 2 cm) obtained at two working speeds (2.31 km/h and 4.17 km/h) the machine for regenerate grasslands obtained following qualitative indices (Table 2):

Table 2: Mean of depth sowing obtained by the machine for regenerate grasslands

Row	Work speed 2.31 km/h		Work speed 4.17 km/h	
	Average depth a_{ms}, cm	Variation coefficient C_a, %	Average depth a_{ms}, cm	Variation coefficient C_a, %
1	2.4	7.683	2.3	7.003
2	2.1		2.0	
3	2.2		2.1	
4	2.5		2.4	
5	2.2		2.0	
6	2.1		2.1	
7	2.0		2.0	
8	2.1		2.1	

In Figure 3 are plotted the average values of sowing depth (A_m=a_{ms}/8) and variation coefficient for the two working speeds.

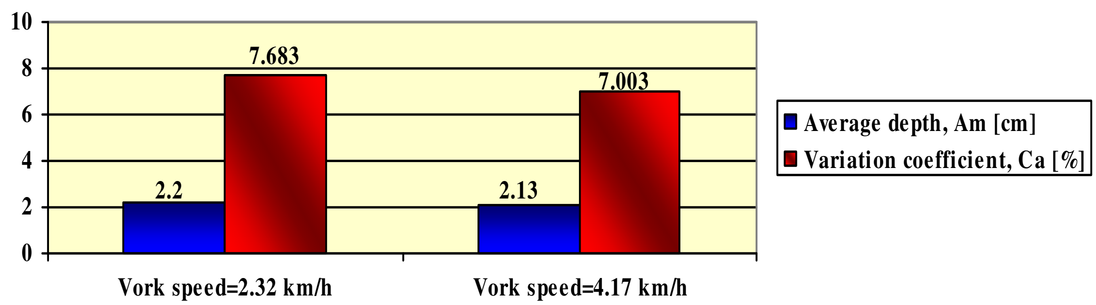

Figure 3: Graphical representation of average values of sowing depth and coefficient of variation for two working speeds

From the results shown in Table 2 it is observed that the values of the coefficient of variation by the sowing depth C_a on the working width, who at the working speed of 2.31 km/h is 7.683 %, and at the working speed of 4.17 km/h is 7.003 %, fall into agro-technical requirements specified in applicable standards (as agro-technical required $|C_a| \leq 20$ [%]).

4. CONCLUSIONS

- After experimental research, the calculations of variation coefficients and comparing them with the values from agro-technical requirements, was found that these are appropriate;

- The implementation of the machine for regenerate grasslands will get the following benefits:

- Ability to work approx. 25...55 % higher and lower the fuel consumption per hectare with approx. 38...44 %, because the work is performed on 3...5 years (even on newly established grasslands), to continuously maintain adequate floristic composition of the grasslands;

- Soil conservation by reducing compaction with approx. 10 % and improve the working conditions of farmers by eliminating previous herbicides for suppress the old vegetable cover;

- Regeneration through soil cultivation in narrow strips and directly sowing into the grassy carpet harvest is not lost in any year, more than diminishes in the first season of harvest.

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RESEARCH REGARDING GRISTS GRANULOMETRIC DISTRIBUTION AT A DIVIDE-SORTING PASSAGE WITHIN A MILLING UNIT OF 4.2 t/h

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ABSTRACT

In the specialty literature, cereal seeds are considered granular biological products whose dimensions are subject to various laws of distribution (Gauss, logistics, normal law, gamma or Euler functions). Like them, products resulting by seeds grinding using grinding equipments follows also similar distribution law.

As the number of grists and fractions sorted at plansifter compartments of the two technological phases of grinding (breakage and reduction) is very high, in the paper is presented the analysis of variation curves of grist intermediate products resulted on the sorting-divider circuit in a flour mill with a capacity of 4.2 t/h. Divide-sorter is a technological passage without a grinding machine on the technological flow of a milling unit. As samples for experiments were used grist intermediate products obtained from bakery wheat seeds from varieties grown in the South-East of Romania, of the production of years 2009 and 2011

Experimental data were analysed by nonlinear regression on the computer, using Rosin-Rammler and Gamma functions, being observed for all analysed products a very high degree of correlation ($R^2 \geq 0.946$ for most products) which entitles us to believe that the two functions can be used to estimate the size and granulometric characteristics of the other products on the technological flow.

The data presented may be of interest to specialists in the design, construction and operation of equipment on the technological flow of grain mills. Likewise, data presented in this paper can be used to choose fabrics of sifting frames within plansifter compartments that are not preceded by a grinding machine.

1. INTRODUCTION

In industrial milling units, grinding and sifting are repetitive and complementary operations, after each grinding operation is performed a sorting operation (by sifting) on fractions of grist intermediate products. Although sifting is a simple and familiar operation, many researchers agree that within her occur a number of variables (the relative velocity of the particles on the sifting surface, grist layering on fabric, machine speed, etc.) which can lead to erroneous data concerning the assessment of this process, [1,2].

Likewise, some researchers agree that tensioning of fabric threads will influence the sifting yield. Thus, fabrics that move freely (are not stretched enough) tend to tire and break through solicitations, [3]. If fabrics are not tensioned (so as to lie flat) grist layer speed is low, cleaning system is not sufficiently effective, the degree of separation is low and the risk that the particles block in fabric aperture is high, [3,4]. Sifting particles which do not sift, due to the above conditions, will lead to reduced extraction flour, [5]. In paper [6], the authors analyse the tensioning (stretching) of sifting frames fabric threads, determining that in breakage phase fabrics tension reach a value of 4.7 N/cm ± 2.0 %, and in reduction phase of 5.7 N/cm ± 0.5 %.

Grist size distribution after first breakage passage, in wheat milling units, is, generally, characterized by Rosin-Rammler distribution law as shown in the papers [7,8,9,10], in which have been tested size distribution laws of type normal, log-normal, power law, Schuhman, Gaudin-Meloy or exponential distribution law. Also, in paper [11], the authors tested several size distribution laws for grist fractions from Break 2 plansifter compartment, showing that the best law is the Gaussian distribution law, with a coefficient of correlation $R^2 \geq 0.979$ for

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all fractions. Also, was determined the density and specific surface of grist fractions obtaining values 1040 kg/m^3 for density and 7.035 m^2/kg for specific surface of grist fraction which feeds plansifter compartment, respective 1123.7 kg/m^3 and 44.5 m^2/kg for flour fraction extracted from this compartment.

2. METHODOLOGY

Samples used in experimental determination of grist size distribution were taken from the technological flow of unit S.C. Spicul S.A., Roşiorii de Vede, Teleorman, Romania. Sampling was done on two occasions, samples being obtained from bakery wheat varieties harvested in 2009 and 2011, in the South-East of Romania. In fig. 1 is shown breakage phase diagram at the mentioned milling unit, and in table 1 is shown equivalence between the mesh number and mesh size for the sifting frame inside of plansifter compartments.

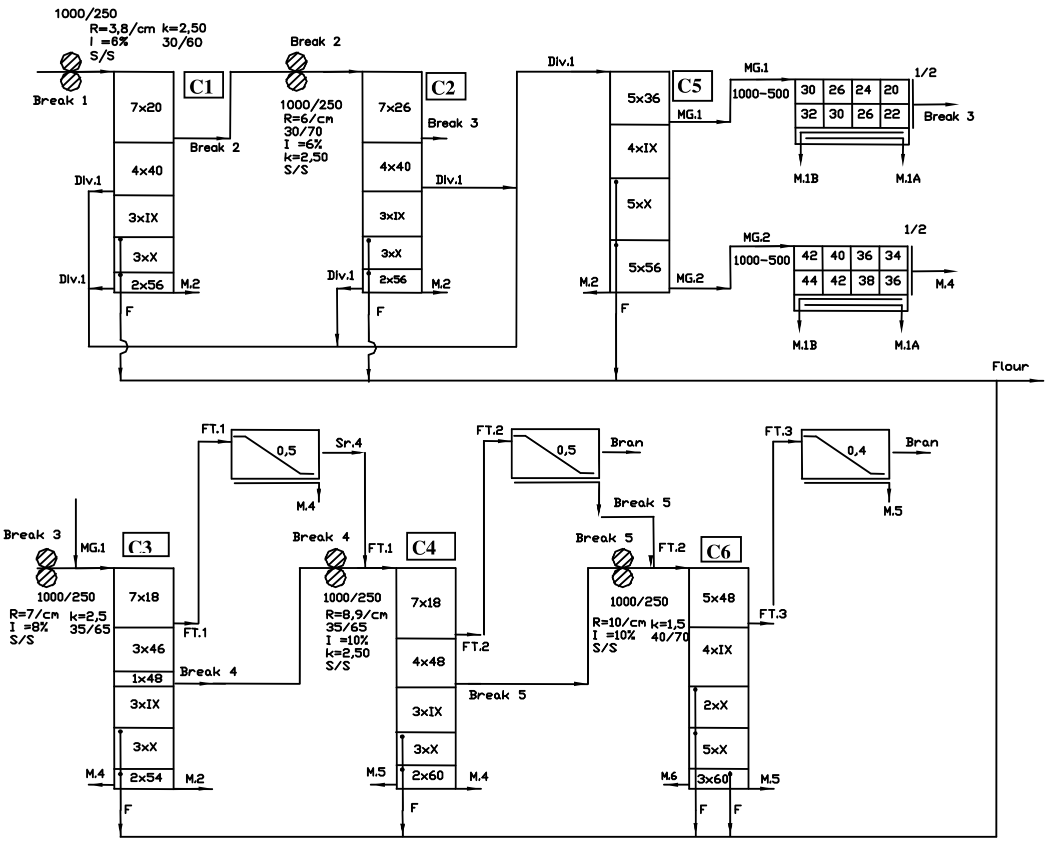

Fig. 1. Flow diagram of wheat breakage phase in a milling unit with a capacity of 4.2 t/h, [12]
C1 ÷ C6.plansifter compartments; Break 1 ÷ Break 5.break rolls; DIV1.divide - sorting; MG1, MG2.semolina machines; FT 1 ÷ FT 3.bran finishers; M1A, M1B, M 2 ÷ M 6.reduction rolls; F.flour

Table 1. Equivalence between the mesh number and mesh size

Mesh number	18	20	26	36	40	46	48	50	54	56	60	VIII	IX	X	XI
Mesh size [mm]	1.17	1.05	0.78	0.52	0.47	0.39	0.37	0.35	0.32	0.31	0.28	0.18	0.17	0.15	0.13

In paper was performed size distribution for each grist fraction sorted at plansifter compartment C5. Grist fineness, assessed by *the mean diameter* d_m of grinded particles, determined with sieve shaker, was calculated with the relationship:

$$d_m = \frac{\sum p_i \cdot d_i}{\sum p_i} \quad \text{[mm]} \tag{1}$$

where: p_i represents percentage of material on the sieve of the sieve shaker (i = 0, 1, 2,…, 5); $\Sigma p_i = 100$ – sum of the percentages of material on sieves; d_i – average particle size of each intermediate fractions, considered as an arithmetic mean of sieves size apertures surrounding the respective fraction $d_i = (l_i+l_{i+1})/2$. Classifier sieves were chosen to meet the estimated relationship $l_{i+1} = \sqrt{2} \cdot l_i$, from the topper to the lower sieve.

For *size distribution* of material fractions obtained at divide-sorting plansifter compartment C5 (represented in fig. 1) were used samples of material of 100 grams taken from the entrance, respective form the outputs of compartment. These were sifted by a sieve shaker with five overlapping sieves with different size apertures, ANALYSETTE 3 SPARTAN, trained in a vibratory motion amplitude of 2 mm, for 3 minutes. Working methodology, used in this paper, is described in detail in papers [10,11,12].

Based on the results obtained in particle size analysis for cumulative percentage of material separated through sieve apertures, were drawn, through non-linear regression analysis on computer in program Microcal Origin vers. 7.0, variation curves given by Rosin-Rammler and Gamma distribution laws for sifted fraction, T(x). Size distribution laws applied in regression analysis are based on mathematical statistics method of small particles for grinded biological materials [13,14] and have the following relations:

- Rosin-Rammler: $$T(x) = 100 \cdot \left(1 - e^{-\alpha \cdot x^{\beta}}\right) \qquad (2)$$

- Gamma $$T(x) = \alpha \cdot x^{\beta} \cdot e^{-\gamma \cdot x} \qquad (3)$$

where: *T(x)* – represents mass percentage share of the fraction with particles smaller than x (passed through the sieve with size x); *x* – apertures size sieve by which particles have passed; α, β and γ – experimental coefficients.

In table 2 are presented size distribution of grist which feeds divide-sorting compartment C5 and of fractions sorted in compartment, for grist obtained from wheat for the production of 2009, respective 2011. Data are presented together with size of used sieve apertures.

Table 2. Weight values p_i (%) of grist on sieve of classifier and weight values T_i (%) for grist products collected at input and the five outputs of divide – sorting plansifter compartment (C5), for grist obtained from the two wheat lots

Grist 2009	x	C5 Entrance		x	C5 MG1		x	C5 F		x	C5 MG2		x	C5 M2	
	(mm)	p(%)	T(%)	(mm)	p(%)	T(%)	(mm)	p(%)	T(%)	(mm)	p(%)	T(%)	(mm)	p(%)	T(%)
0	0.000	5.90	0.00	0.000	0.30	0.00	0.000	3.60	0.00	0.000	0.40	0.00	0.000	6.20	0.00
1	0.180	6.10	5.90	0.180	1.20	0.30	0.045	50.40	3.60	0.180	1.60	0.40	0.100	2.60	6.20
2	0.250	26.80	12.00	0.250	7.30	1.50	0.063	22.60	54.00	0.250	16.40	2.00	0.125	16.60	8.80
3	0.400	33.70	38.80	0.400	48.70	8.80	0.090	17.80	76.60	0.315	41.80	18.40	0.180	29.50	25.40
4	0.500	21.20	72.50	0.630	31.20	57.50	0.125	4.80	94.40	0.400	38.50	60.20	0.250	40.70	54.90
5	0.710	6.30	93.70	0.800	11.30	88.70	0.160	0.80	99.20	0.500	1.30	98.70	0.315	4.40	95.60
d_m		d_{5E}=0.44 mm		d_{5MG1} = 0.61 mm			d_{5F} = 0.07 mm			d_{5MG2} = 0.38 mm			d_{5M2} = 0.23 mm		
Grist 2011	x	C5 Entrance		x	C5 MG1		x	C5 F		x	C5 MG2		x	C5 M2	
	(mm)	p(%)	T(%)	(mm)	p(%)	T(%)	(mm)	p(%)	T(%)	(mm)	p(%)	T(%)	(mm)	p(%)	T(%)
0	0.000	14.30	0.00	0.000	1.60	0.00	0.000	4.40	0.00	0.000	1.40	0.00	0.000	6.70	0.00
1	0.180	5.60	14.30	0.180	7.30	1.60	0.040	30.30	4.40	0.180	2.10	1.40	0.100	2.90	6.70
2	0.250	16.90	19.90	0.250	9.50	8.90	0.045	21.60	34.70	0.250	15.20	3.50	0.125	16.80	9.60
3	0.400	17.90	36.80	0.400	44.10	18.40	0.063	20.40	56.30	0.315	39.40	18.70	0.180	30.50	26.40
4	0.500	26.60	54.70	0.630	30.20	62.50	0.090	17.70	76.70	0.400	37.60	58.10	0.250	39.70	56.90
5	0.710	18.70	81.30	0.800	7.30	92.70	0.125	5.60	94.40	0.500	4.30	95.70	0.315	3.40	96.60
d_m		d_{5E}=0.48 mm		d_{5MG1} = 0.56 mm			d_{5F} = 0.07 mm			d_{5MG2} = 0.38 mm			d_{5M2} = 0.22 mm		

From analysis of Table 2, of sieve aperture from sieve shaker and of material percentage remaining on each sieve it appears that grist obtained from wheat from year 2009 (experiments were carried out in 2009) reaching at divider compartment (C5) is a mixture of particles of very different sizes, mostly with values above 0.4 mm (about 60%), representing semolina categories (big – about 12% and medium – about 48%). In initial mixture there are particles with size under 0.18 mm (approximatively 6%) represented by fraction C5F. After sorting by sifting in plansifter compartment C5, the resulting fractions have average size of particles presented in table 2 from the paper, however and these in turn are mixtures of particles of varied sizes within the categories mentioned.

For grist fraction obtained from wheat harvested in 2011 which feeds C5 compartment (experiments made in 2011) can be observed that about 63% from particles have sizes over 0.4 mm, but this time are more numerous big semolina (about 21%), while 42% is medium semolina. Also, C5F fraction particles (with sizes under 0.18 mm) are in a ratio of 14.3% in fraction that feeds compartment, 2.3 times more than for grist obtained from 2009 wheat lot, leading to the conclusion that there are differences in the physical characteristics of the two batches of grain.

The first fraction extracted in the compartment C5 is a refusal mainly constituted of large and medium semolina that will feed semolina machine MG1. In the case of the grist from 2009, this fraction has a mean particle size of 0.61 mm, but in this fraction about 90% of the particles have sizes over 0.4 mm. In the case of the grist from 2011, this fraction has a mean particle size of 0.56 mm, and about 81% of the particles have sizes over 0.4 mm, therefore very similar values.

The second fraction extracted from the compartment is an undersized fraction cumulated from two frame packages (packages 2 and 3 within compartment) and represents a flour (C5F) which has an average particle size of 0.07 mm for both grists (obtained from the two lots of wheat, respective 2009 and 2011).

Third fraction resulted at plansifter compartment C5 is the refusal of the last frame package, which fall into semolina type of products, with mostly of the particles (over 80% for 2009 lot and over 81% for 2011 lot) with sizes larger than 0.31 mm. Also, fraction contains some harsh dunst product type (with sizes between 0.25 and 0.31 mm), 16.4% for grist from 2009 and 15.2% for grist from 2011. This fraction is directed to the second semolina machine (MG2) of the milling unit. The average size of fraction C5 MG2 particles, for grist obtained from wheat batch of year 2009 and for grist obtained from wheat batch of year 2011 is of 0.38 mm, value obtained using the relationship (1).

The last fraction sorted in the divider compartment (C5 M2) is a fraction composed mainly of dunst for both grists (wheat from 2009, respective 2011). This fraction re-enters in grinding process at technological passage of reduction roll M2.

Correlation degree of function Rosin-Rammler and of function Gamma with experimental data is assessed through values of coefficient R^2, presented in table 3, together with coefficients of equations (2) and (3) which depend on the type of fabric and of revolution speed of plansifter actuating mechanism. In fig. 2 are shown charts obtained by non-linear regression of granulometric data with the two distribution laws.

As can be seen from charts in fig. 2, are fractions that have a majority of particles with dimensions close to minimum value of aperture sieve from sieve shaker, but there are components that have average particle sizes close to the maximum value of aperture sieves used in particle size analysis (where most data points are located either to the left, either to the right of curve).

Regression curve shape is correlated with experimental data obtained, depending on the amount of material collected on each sieve of sieve shaker.

Tabelul 3. The values of coefficients α, β and γ from relation (2) and (3), as well for correlation coefficient R^2 for the two mathematical laws (Rosin-Rammler and Gamma), for grist obtained from wheat harvested in 2009 and for grist obtained from wheat harvested in 2011.

C5 2009	Coefficients	C5 Entrance	C5 MG1	C5 F	C5 MG2	C5 M2	C5 2011	Coefficients	C5 Entrance	C5 MG1	C5 F	C5 MG2	C5 M2
Rosin-Rammler	α	0.012	0.079	0.081	0.001	0.002	Rosin-Rammler	α	0.197	0.076	0.001	0.002	0.002
	β	-4.734	-3.894	-4.327	-6.159	-3.756		β	-1.522	-3.456	-2.718	-5.748	-3.767
	R^2	0.976	0.991	0.964	0.986	0.946		R^2	0.950	0.974	0.969	0.986	0.946
Gamma	α	2.8×10^5	5.4×10^6	1.03×10^7	5.3×10^{13}	2.9×10^3	Gamma	α	179.166	2.5×10^3	1.02×10^7	2.1×10^{12}	3.6×10^3
	β	5.902	9.689	3.849	16.288	2.670		β	1.493	3.888	3.711	14.546	2.713
	γ	8.407	11.061	28.309	31.431	1.047		γ	0.386	3.017	31.118	27.472	1.536
	R^2	0.994	0.999	0.955	0.999	0.999		R^2	0.997	0.997	0.950	0.999	0.999

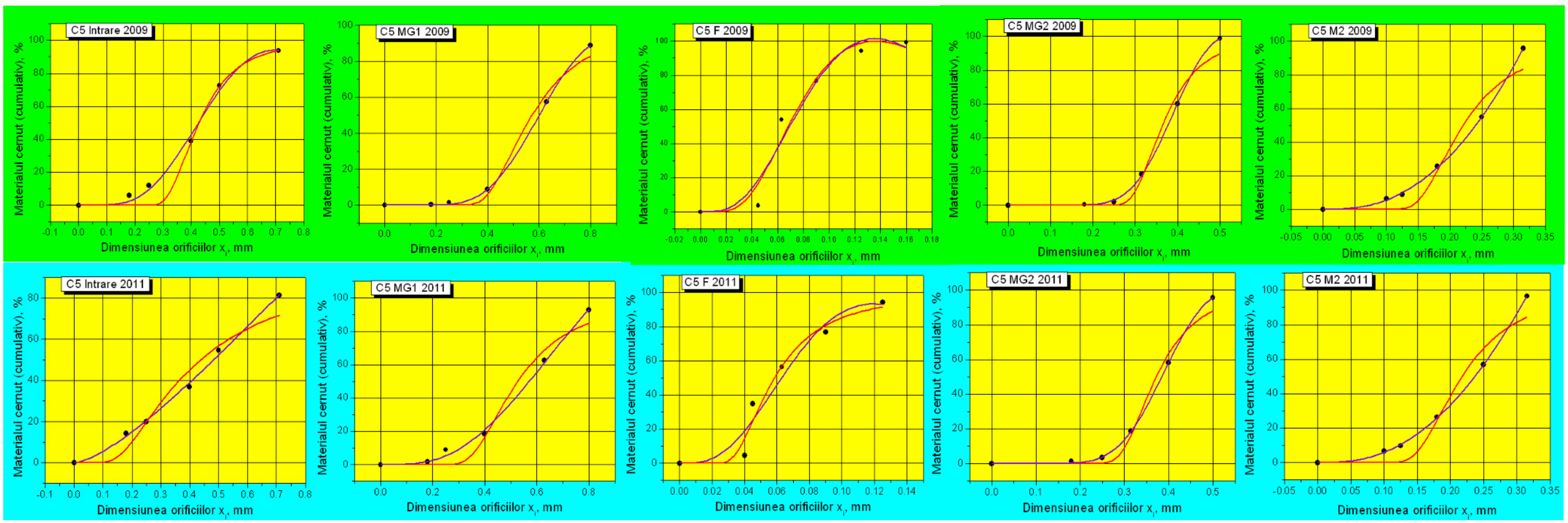

Fig. 2. Size distribution curves of grist fractions obtained from grinded wheat from production of years 2009 and 2011 in the breakage phase

Rosin-Rammler distribution curve *Gamma distribution curve*

3. CONCLUSIONS

It can be seen that, in case of divider technological passage (C5), particle size distribution can be described with good results by distribution laws represented by equation (2) and (3), but the law of type Gamma describe better the experimental results, ($R^2 \geq 0.950$). Also, β coefficient of the two equations indicates the degree of unevenness of grist fractions. It can be seen that the values of this coefficient falls in a rather narrow range of values for each distribution law, which means that the fractions analysed were pretty uniforms, as particle size.

Likewise, can also be seen (table 2) that, though for grinding were used the same wheat varieties, but cultivated in different years (2009 and 2011), pedo-climatic conditions have an pronounced character on wheat seeds endosperm content. Knowing the average size and size distribution, as well as the other physical characteristics of fractions grist particles constitutes requirements in choosing of sifting frames fabric from plansifter compartment, from input to compartment to output of each grist fraction from compartment.

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CHROMIUM REMOVAL FROM WASTEWATER USING CARBON NANOTUBES

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ABSTRACT

Heavy metals contained by wastewaters from various industrial activities tend to accumulate in the organisms causing different diseases. A representative example is chromium which has two stable oxidation states: (III) and (IV). Common chromium compounds containing chromium (III) are currently used in tanning industry. Chromium (IV) is highly toxic and it is contained by wastewater resulted from metallurgic industry. Generally conventional methods applied for heavy metals removal from wastewater have various disadvantages such as: incomplete metal removal, high amount of reagent, high energy requirements and generation of toxic sludge. Alternative technologies to conventional methods are essential for the removal of heavy metals (such as: Chromium) from industrial effluent. For these reasons, our study is focused on chromium (III) and (VI) removal from wastewater using carbon nanotubes. The effect of testing time on the removal of chromium pollutants was investigated accordingly.

1. INTRODUCTION

Between the two forms of chromium, naturally occurring chromium is usually present as Cr (III), while Cr (VI) in the environment is almost totally derived from human activities. Metallic chromium is used mainly for making steel and other alloys. Chromium compounds in either (III) or (IV) forms are generally used for dyes, pigments, chrome plating, leather and wood preservation [1,2,3,4]. In 1997, U.S. reported various information regarding environment pollution with chromium, some of them been presented in Table 1 [5,6,7].

Chromium (VI) is much more toxic than chromium (III), for both acute and chronic exposures. The human body contains around 0.03 ppm of chromium. The highest chromium amount is contained by placenta. Chromium (III) is an essential element for humans: it removes glucose from blood, has a important role in metabolism of fat, its deficit may increase diabetes symptoms, it is found in ribonucleic acid, it may improve health and cure neuropathy and encephalopathy. The studies on animals have shown that chromium (III) have a moderate toxicity from oral exposure. Chromium (IV) is known for its negative health and environmental impact, having a very high toxicity. It causes allergic and asthmatic reactions, liver damage, causes diarrhea, stomach and intestinal bleedings, cramps, kidney damage, is carcinogenic and is 1000 times toxic in comparison with chromium (III). Other effects observed for acute inhalation exposure to very high concentrations of chromium (VI) include gastrointestinal and neurological effects, whereas dermal exposure causes skin burns. After inhalation of chromium (VI) the respiratory tract is the major target organ. Ingestion of high amounts of Cr (VI) causes hemorrhage, abdominal pain and vomiting.

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Table 1: Environment pollution with chromium

Environment pollution with chromium		
AIR	WATER	SOIL
- a study referring to chromium pollution reported that in 1997 the chromium releases to the air were 706,204 pounds and represented approximately 2.2% of total environmental releases. - in some areas such as: Los Angeles, California, Houston and Texas during 1976 and 1980 period, the atmospheric chromium emissions derived from stationary fuel combustion were approximately 46-47% of the total emissions. - 1,723 metric tons of chromium annually resulted from coal and oil combustion. 0.2% from this amount of chromium was Cr (VI). - the emissions from the metal industry were between 26 to 45% of the total. - chrome-plating activities contributed to atmospheric pollution with 700 metric tons of Cr /year and consist exclusively be Cr(VI). - between the two forms of chromium, once riches the atmosphere, Cr(VI) may reacts with other types of pollutants or dust particles forming Cr(III), whereas Cr (III) does not undergo any reaction.	-in 1997 the estimated releases of chromium referring to water pollution was 111,384 pounds which represented for about 0.3% of the total environmental water pollution. -the larger sources of chromium in surface water were: electroplating, leather tanning and textile industries. The natural source of chromium from surface and underground waters is considered the leaching from rocks and topsoil. - a source of chromium pollution of the groundwater, in which the residence time might be several years is represented be the improperly disposed in landfills of the solid wastes from chromate-processing industry.	-according to the Toxics Release Inventory, in 1997 the releases of chromium to soil were 30,862,235 pounds representing approximately 94.1% of total environmental releases. - chromium waste slag containing Cr(VI) was used as fill material for many residential, industrial and recreational areas and for this reason many persons living in the vicinity of the sites were exposed to pollution through inhalation, ingestion and skin contact.

After entering the body chromium (VI) oxide suffer a dissolution process after which is formed chromium acid which has the ability to corrode the organs, causing cramps and paralysis. Generally, the lethal dose is around 1-2 g.

The inhalation of very high concentrations of chromium trioxide leads to various negative effects on humans such as: shortness of breath, coughing and wheezing. The uptake of dust containing chromium trioxide in the workplace can cause cancer.

Most countries require for drinking water a legal limit of 50 ppb chromium.

Taking into account the major concern regarding chromium toxicity and carcinogenicity and the stringent requirements for its removal from industrial wastewater is necessary to development efficient, cost-effective and innovative ways of wastewater treatment. We propose for this study the using of carbon nanotubes for removing chromium (III) and (IV) from wastewater.

As a new member of the carbon class, carbon nanotubes have already exhibited potential for various applications such as: field emitters for flat panel display, composite reinforcements, energy storage and energy conversion devices, sensors and catalysts support. These applications are sustained by some special properties such as: special mechanical, electrical, thermal and structural properties. Referring to environmental engineering field, their high chemical and thermal stabilities, as well as the, the large specific surface area make carbon nanotubes suitable adsorbents for wastewater treatment.

In this study, carbon nanotubes were used as environmentally friendly adsorbants for removing Chromium (III) and (IV) from industrial wastewater.

2. METHODOLOGY

Carbon nanotubes were used as adsorbent material. An amount of adsorbant was contacted with the wastewater containing either Cr (III) or Cr (IV). During the investigation was measured the concentration of chromium using UV/Vis Spectrophotometer Specord 200 Plus. The chromium removal efficiency was calculated using the following formula:

Efficiency (%) = Ci-Cf, t/Ci * 100

where:

Ci- intital concentration of the chromium (III) or chromium (IV);

Cf, t- final concentration of chromium (III) or chromium (IV) measured in time.

As it can be seen from Figure 1, which represents the variation of concentration of chromium from synthetic wastewater in time, the adsorbant used (carbon nanotubes) had a retention effect of chromium from wastewater.

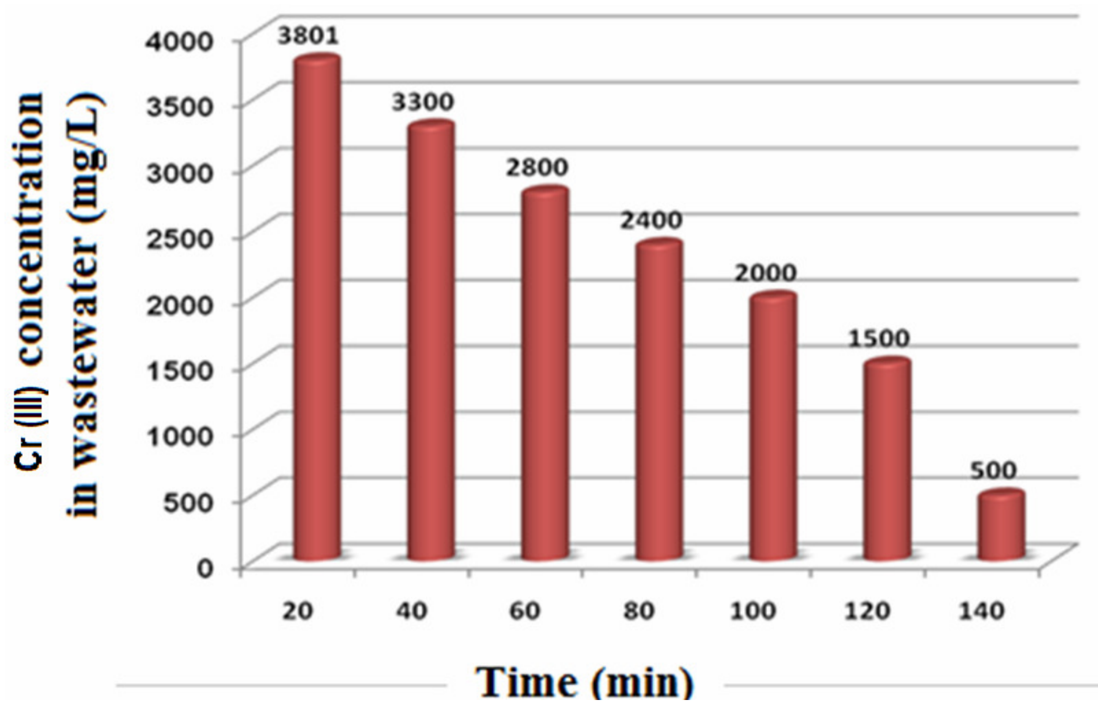

Figure 1: Variation of Cr (III) concentration from wastewater in time, as a result of the adsorbant efficiency

In addition, as contacting time between adsorbant and wastewater increases, the concentration of chromium (III) decreases. The efficiency of chromium (III) removal from wastewater was 87% (Fig.2).

The evolution of chromium (IV) concentration from wastewater under the influence of carbon nanotubes during the performance of the investigation is shown in Figure 3. It can be seen that there is an increase in the treatment efficiency of the adsorbant used as the time of conducting the experiment increased.

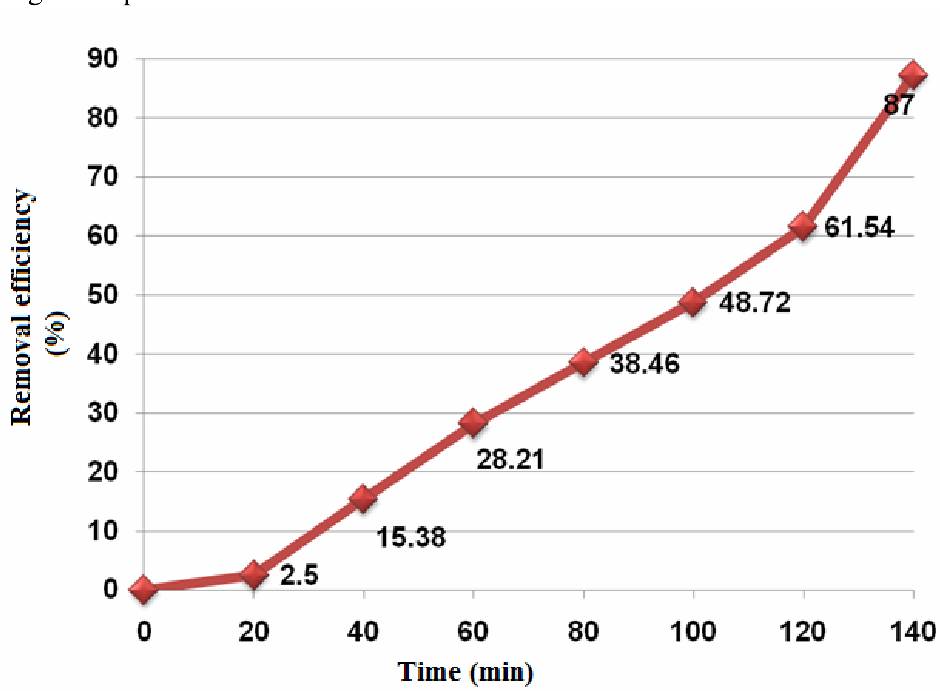

Figure 2: Variation of Cr (III) removal efficiency from wastewater in time as a result of the retention on adsorbant

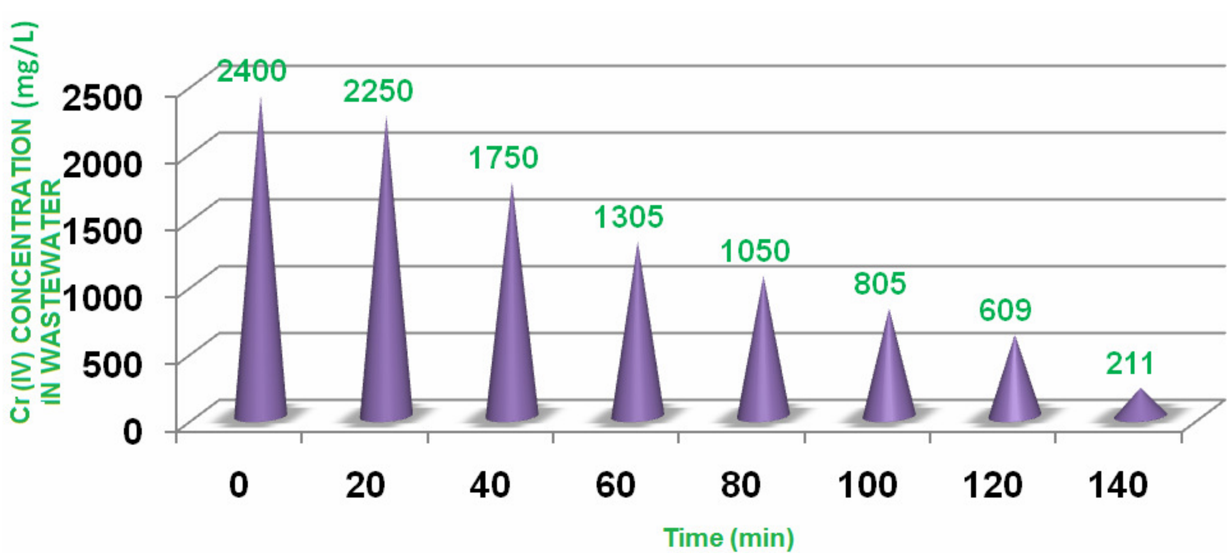

Figure 3: Variation of the concentration of chromium (IV) from synthetic wastewater in time, as a result of the carbon nanotubes efficiency

As it can be seen from the Figure 4 which represents the variation of efficiency removal of Cr (IV) during experiment investigation, the carbon nanotubes adsorbant used is efficient for the depollution of synthetic wastewater.

After 20 minutes of wastewater treatment with carbon nanotubes, the efficiency of Cr (IV) removal was 6.25% (Fig.4), whereas the Cr (IV) efficiency removal after 140 min of investigation reached at 91.21%.

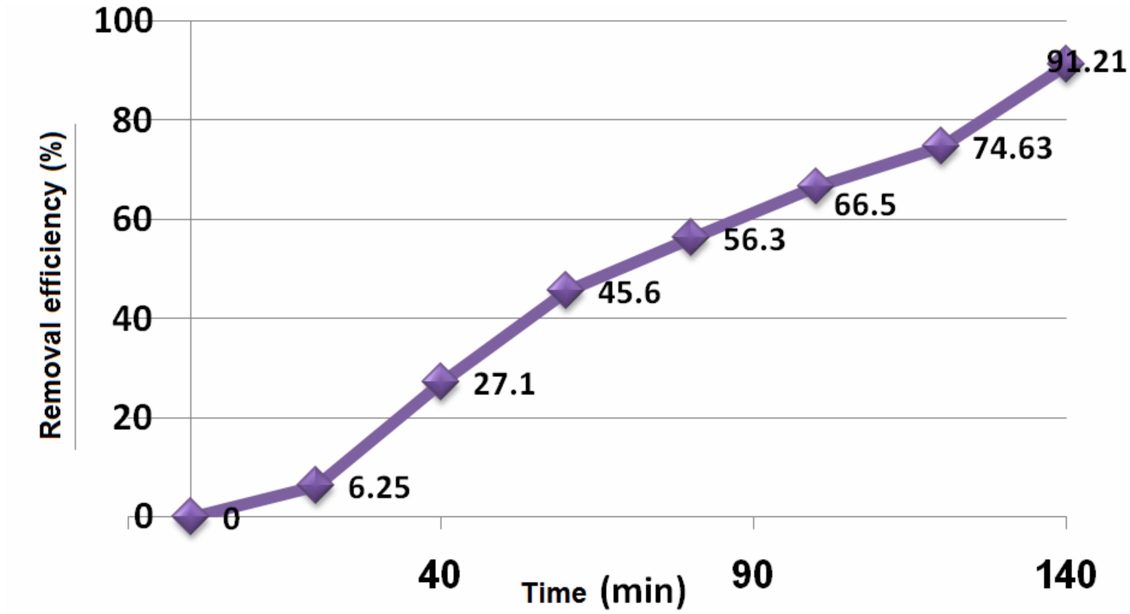

Figure 4: Variation of Cr (IV) removal efficiency from wastewater in time as a result of the retention on adsorbant

Carbon nanotubes showed a higher efficiency for Cr (IV) removal from wastewater although even for Cr (III), the efficiency was higher than 80%.

3. CONCLUSIONS

The adsorption properties of the carbon nanotubes for hexavalent and trivalent chromium have been studied and the results show that carbon nanotubes are excellent and proved to be effective adsorbants for eliminating these two harmful forms of chromium from wastewater. This study may sustain the development of a new alternative based carbon nanotubes to conventional wastewater treatment methods.

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CONSIDERATIONS ON FACTORS INFLUENCING SEEDING PRECISION OF SEEDERS FOR WEEDING PLANTS

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ABSTRACT

In the construction of precision seeders, different types of seed-metering devices are used, which differ both from a constructive point of view and also from the point of view of the principle of distribution. This paper presents the factors influencing the seeding precision of seeders for weeding plants, as well as the forces acting on the discharge of seeds in the distribution process of precision seeders.

1. INTRODUCTION

Seed-metering devices are the constructive elements that have a decisive role on the distribution of seeds, so the plants develop equally and have enough space for feeding in order to obtain maximum crop yields [6], [7].

The seeding work is an important link in the chain of activities by which man controls the life cycle of plants, phyto-technical research contributing to the increase in productivity of different varieties. Seeders should provide technical solutions so that the relations between influencing factors due to the production conditions and the expected plant performances to be maximized [4], [9].

Determining the factors influencing the precision of seeders for weeding plants is important in terms of increasing the efficiency of working organs with optimal manufacturing costs [5].

2. METHODOLOGY

In order to obtain good performance for the seeding machines, during work, the following factors that influence the accuracy of seeding should be followed: type of seed, environmental conditions, the construction of the seeding station, the degree of filling of the seed bunker, speed, flow control, adjusting the speed of the organ distributing seeds, position of seeding station, random movements of seeds and separating the seeds.

Also, the research conducted in recent years [2], [8] highlighted other factors that may influence the seeding precision, such as:

- seeds collision with the ground;
- the depression with which the seeds are kept on the openings of distribution discs;
- separation of seed distributor disc is not strictly the same point;
- different trajectories of seeds in their flight toward the channels opened by coulters;
- the sliding coefficient of gear wheel used for driving the seed distributing discs;
- kinematics of seeding stations.

3. RESULTS

In paper [1], the authors studied the trajectories followed by various types of seeds that were allowed to smash into the ground at speeds and angles of impact known, then value of rebound and roll was measured.

Factors influencing the seeding precision studied in this work were: speed and angle of impact, nature of the soil surface and the seed type. Minimum displacement occurs at low impact speeds and impact angles ranging between 75º and 85º. Displacement was lower than for loose surfaces that for pressed surfaces and for smaller seeds having irregularly shapes than for large seeds having spherical shapes.

The distribution of the seeds takes place in the following steps (Kuhnberg, 1968):

- the selection of one seed from the hopper (at this time gaps or doubles may appear);

- seed transport (sometimes errors can occur in the release of seeds and also threats of injury);
- release / projecting the seed (individual characteristics of each seed can cause different trajectories);
- the impact with the ground surface (deviation may appear is due to soil movements);
- coverage and compaction seeds (ground movements can occur due to movement);
- germination and emergence (where losses can occur).

Measurement of deviation from the required distance was determined geometrically, taking into account the apparent impact position recorded and the final position of the seed on the ground. The seed trajectory is determined by the speed, the direction of travel and the distance traversed under the influence of gravity, without regard to the resistance of air. If a seed is released from a fixed point and left to fall vertically, the vertical speed of seed at a distance *h* from the point of release is:

$$v_v^2 = 2 \cdot g \cdot h \qquad (1)$$

If at the time of release, the seed has a horizontal speed distance v_h, the seed speed on its trajectory v_t at the distance *h* from the releasing point is given by the relation:

$$v_t = \sqrt{v_v^2 + v_h^2} \qquad (2)$$

From relation (1) is obtained:

$$v_t = \sqrt{2 \cdot g \cdot h + v_h^2} \qquad (3)$$

The angle between the vector of speed and the horizontal, at a distance *h* from the releasing point is given by the relation:

$$tg\theta = \frac{v_v}{v_h} \qquad (4)$$

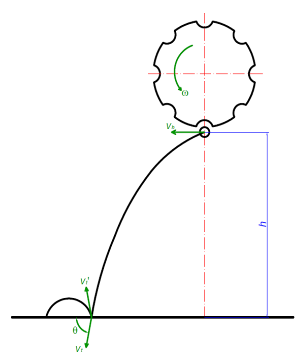

Figure 1: Seed trajectory from the distribution disc to the furrow [1]

When tested in static conditions v_h was considered peripheral speed of the distribution disc, and for the dynamic tests v_h is the algebraic sum of the moving speed of the seeding machine and the peripheral speed of the distribution disc (due to v_h, the seed describes a parabola until the point of contact with the ground). When the peripheral speed of the distribution disc is equal and opposite to the forwarding speed of travel v_h=0 and the seeds will fall vertically.

The height from which the seeds were released to the ground was 200 mm, the forwarding speed of the seeding machine was 1,000 mm / s for all experiments, and the peripheral speed of the distribution disc was 200, 400, 600, 800 to 1000 mm/s. In order to measure the angle of flight and to calculate the seed speed photographs were taken at 20 mm below the point of release, the average results being compared with theoretical values. The precision of reading angles and speeds on the trajectories from the photographs was estimated to be ± 1°, respectively ± 100 mm/s.

From the examination of the experimental trajectories, it results that for all types of seeds, they move away from the theoretical trajectories to a certain extent (with the exception of pelleted sugar beet). Based on the observed average trajectory, adjustments were made for height of the releasing point and peripheral speed of the distribution disc at a constant speed of advance of the section of 1 m / s, in order to obtain a range of angles of impact at a constant impact speed.

The soil used was sandy-clay maintained at a humidity of approximately 14%. Most of the experiments were carried out on a loose soil over which soil was sieved through a sieve with a mesh of 2.5 mm. Individual ricochets of seeds were analyzed under the hypothesis that they are normally distributed. The study shows that the relation between the average value of ricochets and the impact angle is the same for all seeds.

The impact speed and impact angle were calculated with the relations (2), (3), (4) being represented in the figure below for values of the releasing height h between 10 and 100 mm, release velocity being comprised between 0 and 2000 mm/s.

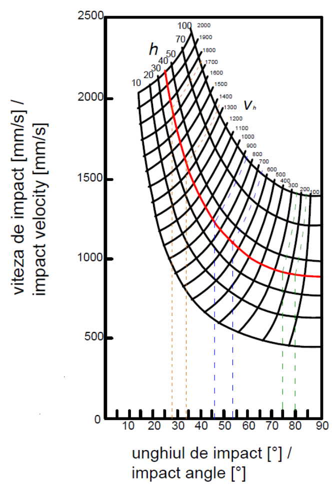

Figure 2: Impact conditions for seed released from the lowest point of the seed-metering device [1]

From figure 2 it is clear that in order to have an impact angle on the optimal range of 75° - 80°, horizontal velocity of release must be low. At a speed of advance of the seeding machine of 1000 mm/s, the peripheral speed of the distribution disc is of 140 - 330 mm/s (for typical seed-metering devices) which will lead to a horizontal speed of release of seeds v_h = 670 - 860 mm/s and the impact angle being situated between 46° - 53°. At a speed of advance of the seeding machine of 2000 mm/s, the peripheral speed of the distribution disc is of 280-660 mm/s, which will lead to a horizontal speed of release of seeds v_h = 1340 to 1720 mm/s, the angle of impact being situated between 27.5º - 33.5º.

Also it is observed that when increasing horizontal velocity of release of seeds v_h, initially the impact angle decreases rapidly and the impact velocity increases slowly. When it is about 1000 mm/s, the speed of impact starts to increase rapidly together with a small decrease of the angle of impact.

The forces acting on the evacuation of seeds in the distribution process of precision seeders influences the qualitative indexes of the seeding machine by: flow stability, respectively of the seeding norm, the seeding precision, the degree of harm done to the seeds.

Because the seed-metering devices have a decisive influence on the quality indices of the process of seeding, seeders improvement, in the course of their evolution, focused largely on perfecting the distribution equipments.

In the construction of precision seeding machines different types of seed-metering devices are used, which differ from each other both from the point of view of construction and also from the point of view of the principle of distribution. Characteristic for all these seed-metering devices is that the active elements engage a single seed.

Depending on the manner in which the active element engages the seed, seed-metering devices are grouped into: mechanical, pneumatic and combined.

Seed-metering devices with mechanical distribution of seeds, depending on the active element construction can be: discs with pockets or openings, tape with pockets or openings, band with openings, fixed and steerable teaspoons mounted on the disc. The size of the pockets openings and spoons is determined by the size of the seeds, so that these seed-metering devices generally require the use of calibrated seeds.

In the case of seed-metering devices with discs with pockets or orifices arranged horizontally, absolute speeds for releasing seeds are different depending on where the outlet is provided in the ploughshare. Thus, in points 1, 2, 3 and 4 absolute speeds for seeds leaving the alveoli or openings are:

$$v_1 = v_m + v_d \tag{5}$$

$$v_2 = \sqrt{v_m^2 + v_d^2} \tag{6}$$

$$v_3 = v_m - v_d \tag{7}$$

$$v_4 = \sqrt{v_m^2 + v_d^2} \tag{8}$$

where: v_m is the working speed of the seeder;

$v_d = \omega \cdot R_d$ peripheral speed of the disc with pockets (where ω is the angular velocity of the disc);

R_d disc radius.

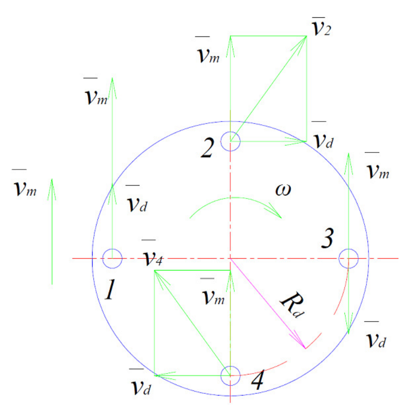

Figure 3: The speed given to the seed in different release points from the disc with openings or pockets arranged horizontally [3]

The absolute minimum speed corresponds to point 3, ensuring the uniformity of the time of seeds movement through ploughshare, due to the low number of collisions of seed with the plowshare body. Seed trajectory is a parabola vertically - disposed longitudinally directed in the direction of movement drill because $v_m > v_d$. To ensure the seed passing through the ploughshare without collision, inside the cutter should be as close to a parabola.

The active element of the seed-metering devices with pneumatic seed distribution can be disc or drum with openings. The engaging of seeds is done by creating a pressure difference at the openings, and the eviction is forced or is done under its own weight due to interruption in the area of the depression at the openings retaining seeds in the channel opened by the ploughshare.

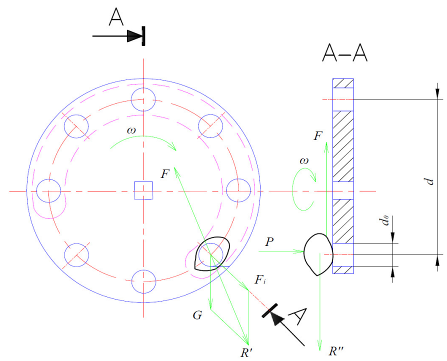

Figure 4: Forces act that act on the seeds during the spinning of the seed-metering device type vertical disc with openings with openings having a pneumatic action on seeds.
G – Seed weight; F_i – centrifugal force; R' – the resultant of forces G and F_i; P – the force of pushing the seed through the opening; F – friction between the seed and the distribution; R'' – the resultant of forces P and F; d_0 – the diameter of the seed-metering device's openings [3]

The seeds are engaged by the distribution disc, because they are pressed on the disc distribution orifices by the force P created under the action of air depression.

$$P = \frac{\pi \cdot d_0^2}{4} \cdot \Delta p \tag{9}$$

where: d_0 is the diameter of the seed-metering device's openings;
Δp is the pressure exerted on the seed.

The forces that tend to detach the seed from the disc are represented by the weight of the seed G and the centrifugal force F_i, giving the resultant R whose maximum value is reached when the seed is in the lower position.

The forces that oppose the detachment of the seed from the seed-metering device are represented by the force pressing the seeds on the openings P, because of the difference of pressure between the two sides of the disc and the friction force F between the seed and the seed metering device.

For the seed not to detach from the distributor in the least favorable situation, when it is in the lower position, the following relations have to be satisfied:

$$f \cdot P \geq G + F_i \tag{10}$$

$$P \cdot \frac{d_0}{2} \geq (G + F_i) \cdot \frac{l_{\max}}{2} \tag{11}$$

where: $l_{\max}$ is maximum seed length;
f is friction coefficient between the seed and the distributor;
d_0 is the diameter of the seed-metering device's openings.

A first condition so that the seed-metering device to work takes into consideration the minimum width of seeds $b_{\min}$ and the diameter of the orifice d_0 and is given by the relation:

$$b_{\min} > d_0 \tag{12}$$

The second condition for the seed-metering device to work is constituted by the depression created by the exhauster in the depression chamber Δ_p, pressure exerted on the seed, equal with the difference between the atmospheric pressure and the pressure in the depression chamber, whose value is given by the relation:

$$\Delta_p \geq \frac{4 \cdot G}{\pi \cdot f \cdot d_0^2} \cdot \left[1 + \frac{d}{2 \cdot g} \cdot \left(\frac{\pi \cdot n}{30} \right)^2 \right] \tag{13}$$

In order to diminish the influence on the seeding precision of the distance between the point of detachment of seed from the disc and the bottom of the channel, on the seeder for weeding plants, the seed-metering device is fitted directly on the ploughshare so that it minimizes the flight distance, or mechanical systems for seed evacuation are provided.

4. CONCLUSIONS

Seeding machines equipped with pneumatic seed-metering devices are provided with exchange disc with openings of different diameters, corresponding to the dimensions of seeds to which they are destined for. In addition, the distance between openings on the disc (number of openings) is different according to the technology of culture.

For the devices with pneumatic distribution, the distance uniformity on the surface unit is good, but the seeding precision as distance between plants on rows in negatively influenced by the manner in which the seeds get from the distribution device to the channel opened by the ploughshare (the speed and trajectory of the seed).

In order to obtain a catching force *P* of the seed on the openings, for pneumatic distribution devices and for the combined ones that make de seed dosing pneumatically, it is required that d_0 and Δ_p are as high as possible. But the diameter of the opening in limited by the minimum dimension of the seed ($b_{min}>d_0$), that is why the pressure difference Δ_p is increased by lowering the pressure in the depression chamber. If Δ_p is not high enough, the process of catching seeds on the openings and maintaining them during the rotation of the disc is not satisfactory, increasing the frequency of openings that do not take seeds, especially the ones with large dimensions and mass. In the case of a pressure difference too high, the process of catching seeds on the opening worsens by the increase of openings that take two or more seeds, a phenomenon that increases especially for seeds with small dimensions and mass.

Although diverse from a constructive point of view, devices with mechanical distribution are not very widely spread, due to their disadvantages. Thus, the seeding precision in terms of number of seeds in one pit and in the distance between plants on one row decreases with the increase of work speed and with the increase in the slope of the field being seeded.

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METHODS FOR APPLYING THE COMPOSITE MATERIALS / NANOTECHNOLOGIES TO ACTIVE PARTS OF TECHNICAL EQUIPMENTS FOR SOIL PROCESSING

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1. INTRODUCTION

The processing of metallic materials by using unconventional technologies to obtain products has emerged as an necessity objective, complementary, essential and sometimes unique, next to classical technologies.

Nonconventional processing are defined as being those processes that fulfill at least one of the following conditions:

- Are effective for the processing of some materials with special properties (eg: high hardness, or breakables etc.);
- Allows obtaining with high precision of some special surfaces like shape, dimensions, roughness (with microasperities);
- It is applied in special environments, ionized or not, at high pressure or in vacuum.

2. METHODOLOGY

The most usual processes and unconventional technologies used to cover the surfaces of working bodies wearing are:

- applying through thermo spraying of the metallic and ceramic materials:
  - thermo spraying with oxyacetylene flame;
  - thermospraying with plasma arc
- applying through pulverization of composites materials with content of fluoropolymers;
- special technologies:
  - application through distribution and local heating by laser;
  - application through electron beam;
  - application through the system HVAF-ARC (high speed air fuel-arc).

3. RESULTS

3.1. The application technology through thermospraying with oxyacetylene flame

Thermospraying - consists in spray the particles of molten material on the surface of the working body that requires loading and bringing the desired dimensions (originally or wear compensator). The difference between thermospraying and welding consists in value temperature of the chuck (working body) whose surface need to be loaded:

- to thermospraying, the particles are rapidly cooled during the impact with the surface of the chuck, or immediately after impact;
- to welding, the local temperature of the chuck is that who ensure the maintenance of the filler material at the melting point.

The oxyacetylene flame play the role of melting the metal intake, the melted particles being driven by compressed air. The flame produced by the combustion of acetylene in oxygen has different layouts for a device of metallization by spraying over a burner for welding. In the case of device for spray metallization, the oxyacetylene flame is more compact because the action of compressed air, which produce a heating effect more intensely, in particular in the reducing area that melts the metal. Complete combustion requires a quantity of 2,5 m^3 oxygen for $1m^3$ of acetylene, but in practice this amount is less. The essential quality of a oxyacetylene flame is to get as quickly at a high temperature, avoiding the cooling or quenching the flame by the flow of compressed air. The temperature produced decreases with the distance from the point of melting the filler metal.

The distance between the flame of device and the metallic piece must not be less than 100 mm, to avoid overheating of the piece and the metallic layer which could cause tension, deformations or cracks. The adjustment of the oxyacetylene flame must take account on the indicatives from description of the metallization device, on the color and size of the flame and on the appearance of metallic layer obtained on preliminary samples.

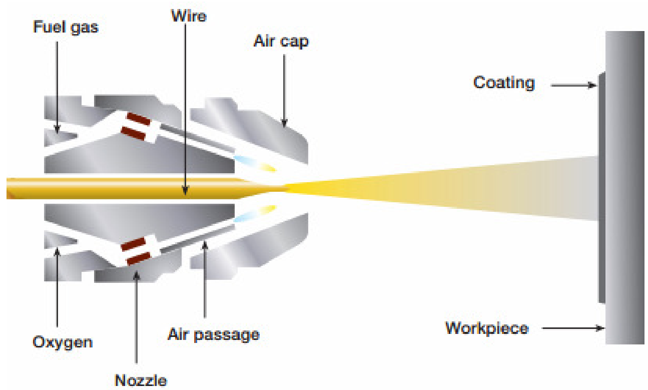

Figure 1: Schematic diagram of a metallization system (thermal spraying) with wire in the oxyacetylene flame

As an advantage we can mention:

- getting some special materials couplings in achieving the basic functions of various working bodies;
- the process is easily adaptable for various geometric shapes and working bodies architectures (the coulter, plow, moldboard, before moldboard, additional moldboard, hammers for mills, diverter, skates, knives, etc.);
- higher economic efficiency – the base material is soft and provides better resilience to stress and lower costs.

New materials used in this process:

- powders Ni – Cr – B – performs hard layers with corrosion resistance and high abrasion;
- powders METCO 15F – hardness after submission 55HRC, after remelting 60HRC layer thickness 0,4 mm;
- powders METCO 45 Ni – Al – adherent layer (0,1 – 0,15 mm) – on filing occurs an exothermic reaction resulting a self-adherent and resistant to oxidation dense layer. Does not apply in the case of remelting;
- wire SPRASTEEL 80;
- wire STEELCORED M 141 - coppered tubular wire, filled with metal powders, without slag, ally with Ni-Mo. Good values of resilience until -60°C.

3.2. Thermospraying with plasma arc

Plasma metallization process is based on spraying a material (ceramic powder, metal powder, etc) melted in the plasma jet on a support to obtain a coverage. On thermospraying with plasma jet, the material in powder form is injected into a plasma jet at a very high temperature (10.000-15.000 grade C).

The principle of application consists in passing a material (typically in powder form) through the plasma jet, generated by a primed electric arc between the electrode of tungsten and copper nozzle of plasma generator. High temperature melts the material and is trained by gas jet to the workpiece and the particles found on the surface, in a plastic state, adhere to this based on specific mechanisms.

The advantages of this process are:
- coatings resistant to abrasion, erosion and corrosion;
- obtain special materials couplings in performing the basic functions of various working bodies;
- restoring the geometry (restoration) of wrong or worn working bodies, during mechanical processing, requires low cost, high engineering performance and / or the increasing of the duration of use;
- is a fast and economic way to restore the dimensions
- in the jet, the powder is quickly heated and accelerated to high speeds
- the powder reaching the softening point is projected on the substrate and quenched forming the covering.
- New materials used:
- tungsten-cobalt carbides (up to 540° C)
- chromium-nickel-chromium Carbides (up to 850^0 C)
- ceramic oxides such as chromium and aluminum
- autofuzionante alloy (Ni-Cr-B-Si)

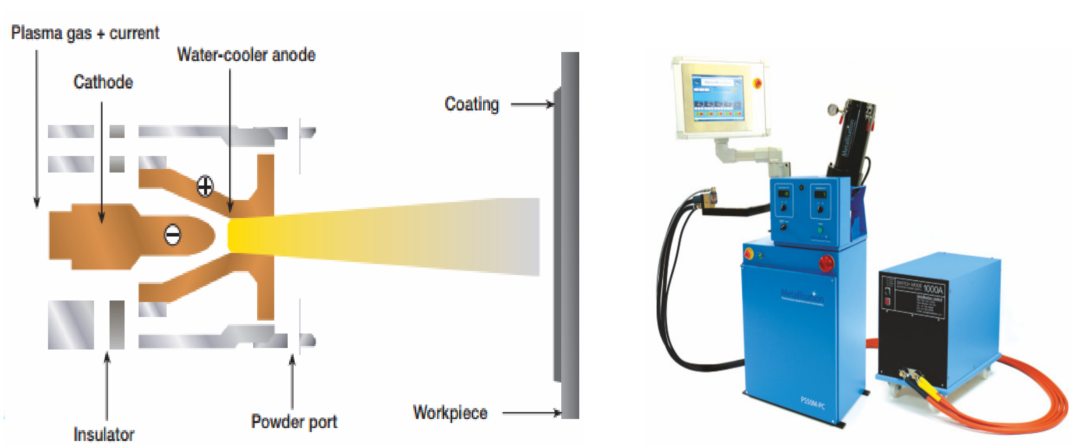

Figure 2: Schematic diagram of thermal spray with jet plasma / Plasma metallization equipment PS50M-PC

3.3. Spray application of composite materials containing fluoropolymer

The spray application (painting) involves the application of paint in the form of finely divided particles which, on piece, come together again to form a film. The difference between spray and brush consists in the appearance of the surface. Spraying ensures a uniform distribution of the particles resulting a uniform thickness. There are several methods of distributing paint: pneumatic spray, hydraulic spray and centrifugal spray, each method representing advantages and disadvantages.

The film obtained by spraying differs from that obtained by brushing only in terms of surface appearance (the brush leaves parallel traces, spray obtain a lot of very small interlocking projections). As the stretchability is better more the footprints attenuates. The perfect extent could not be distinguish at the spraying by an ordinary brush.

The preparing of surfaces for spray application involves a series of tests carried out on the surface, on the heating furnace and the check of the fluidizing air pressure. The painting activity is carried out in specially designed workshops, with temperature and humidity control, good brightness, exhaust systems, finishing booths, drying booths. As much the smoothness of paint particles is greater, the fineness of the particles is better, the size of powder particle varying between 6 and 20 mm.

The advantages of this method are:

- spraying provides a uniform film like thickness and appearance;
- it can be applied on any surface using the full range of paints directing it's thickness.
- the painting track width for ordinary sprayers is between 200 and 500 mm;
- the crossing speed is 20mm / min.;

New materials used in this process:

- email (epodur, super, ema, sodilac, 5001, 5044, 5046, 5620, 815-8) : is used for the repair and maintenance of vehicles:
- epodur (PC varnish, VP100 varnish, VSA varnish): is used for corrosion protection of car bodies operated in atmosphere with the maximum temperature of 60^{0} C.
- nitrolac (2103, 2106, 2108, 2447, 2491): is used to cover metal surfaces (it is apply by brush or spray in enclosed and ventilated spaces)
- solvents used to prepare the materials for painting (epodur, silurex, prenandez, 004-50, 006-50,005-1(11), 104(D001-1), 210, 212, 213, 214, 215, 501, 502, 506, 509, 510, 522, 523, 524, 535, 903): are used to dilute primers, paints, enamels and varnishes based on epoxy resins.

Figure 4: Spray application equipment

3.4. Application by distribution and local heating with laser (pulsed laser deposition)

Is used in the production of thin layers of materials and combinations of materials that can not be processed without great difficulty by other methods (materials no matter how complicated composition can be transferred to a substrate without changing the stoichiometry - congruent ablation). It is always a sequence of two processes: vaporization of a target material followed by depositing it on a collector located at a certain distance and placed, generally, parallel-plane with the target.

The laser beam is focused in a first step on the target surface for a sufficient amount of incident laser intensity, all elements of target are rapidly heated above their evaporation temperature. This value is defined as the *ablation limit*. The ablation rate is dependent on the fluence of the laser incident on target. The ablation mechanism involves several physical phenomenals such as collisions, electrical and thermal excitation, exfoliation and hydrodynamics. In a second step the expelled material moves to the substrate in accordance with the laws of gas dynamics and is deposited on the collector surface.

This process has many advantages:

- high quality coatings are obtained with a variety of special properties;
- ensure the control of the stoichiometry from the target, both in vacuum and in inert or reactive gases;
- can be easy obtained many-structures, and the thickness can be controlled with great precision.

In this process are using new materials, such as:

- pentacen [55], TPD şi Alq3 [56],
- policatenar material based on antracen [57].
- superconducting materials, metals, semiconductors and dielectrics, piezoelectric materials, ferroelectric, nitrides and carbides, oxide binary or tertiary compounds, polymers, biocompatible materials, etc.

3.5. Application by electron beam

Imply the coating of the surfaces by deposition of thin layers in vacuum. The electrons bombardment is superior to any other method which has the vaporization as heat source, because the high temperature zone is the vapor emissive surface and not how it usually happens when the support material vaporizes.

Advantages: arrangement of corrosion thin layers, anticorrosive protection of low alloy steel, anticorrosive and antioxidante films of nitrides and carbides from the transition metal.

New materials utilized: protection of mild steel, by the deposition of anticorrosive films of Cu, or Cu-Zn; Zn, Cd, Sn-Zn and Sn-Cd; Al-Zn; Ni, Cr and Ni and Cr alloys; antioxidant and anticorrosive films of nitrides and carbides from the transition metals.

3.6. The ARC HVOF system (high velocity air fuel-arc)

Produces dense coating and finely structured from molten metal wire, resulting in electric arc formed between the two wires, is atomized and accelerated to a substrate (piece) where is deposited and cooled rapidly forming coating.

The TSR300H gun uses an electric arc to melt the wire and a jet air-fuel (propane, propylene, LPG) supersonic, for atomization of molten metal and the resulting fine particle acceleration. The spray head includes a toroidal combustion chamber, with a ceramic catalytic insertion to stabilize the combustion, where takes place the combustion of propylene, the flue gas form a supersonic jet oxygen-free (not oxidize the molten metal) directed to the arc. The molten metal, resulting in the arc formed between the two wires, is atomized and accelerate to a substrate (piece) which is deposited and rapidly cooled forming the coating.

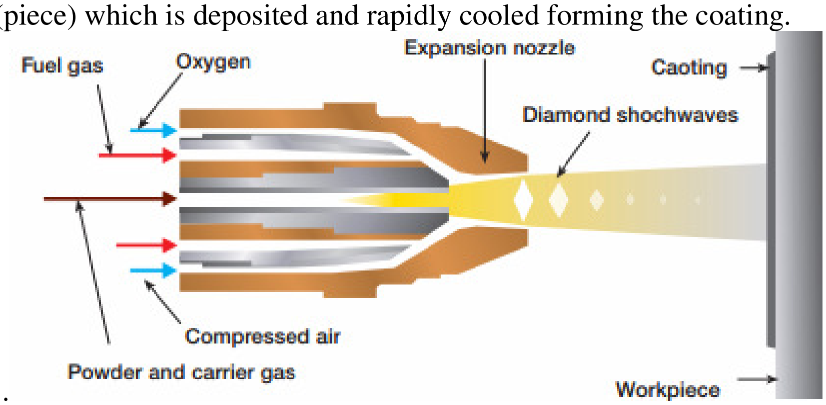

Figure 5: Thermal spraying system AC-HVAF

This process has many advantages:

- dense and finely structured coatings, due to atomization in extremely fine particles of molten wire (0.002 mm), accelerate mrtallic particles to high speeds and protect from oxidation
- the TSR300H gun model file different tubular or alloy wires, resulting very tough coatings (> 60 HRC) with high resistance to erosion and abrasion wear, replacing the hard chrome plating in many industrial applications.

New materials used:

- carbides of tungsten-cobalt (up to540 ^{0}C)
- carbides of chromium-nickel-chromium (up to850 ^{0}C)
- ceramic oxides such as chromium and aluminum
- autofuzionante alloy (Ni-Cr-B-Si)

4. CONCLUSIONS

Unconventional covering technologies of the working bodies surfaces for agriculture machinery:

- Improve tribological priorities
- Ensure thermal protection
- Increase corrosion, abrasion and impact resistance
- Increase the service life and offers a greater efficiency

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RURAL DEVELOPMENT IN SUSTAINABILITY CONDITIONS WITHIN THE EUROPEAN UNION

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ABSTRACT

This paper aims to present the importance of the rural sector in the European Union. Start from the first measures adopted over 50 years ago for the sector, focusing then on the agricultural sector and ensuring food market. It comes now that organic farming is to be achieved and the measures taken are to maintain ecological balance and environmental protection in rural areas, with particular emphasis on sustainable development of the sector and the social aspect, ie people who live here.

1. INTRODUCTION

The concept of rural development embraces the totality of the activities in the rural areas that assure the existence and evolution of the people living herein, as well as the ones to maintain and preserve the natural landscape, thus providing an ecological and economic balance in that region.

Nowadays, the durable development underlies this concept and involves the usage of the natural resources and exploitation of the rural areas under rationality conditions, while the economic development is balanced and unbiased.

The rural development of an European Union member state has to comply with the development policy adopted by this entity. And this policy includes both a rural and agrarian component, based on a competitive and ecological evolution, taking place under provisions of environment preservation and social development.

The policies on rural development in the rural area have been varied, both in time and also from one state to another, mainly in the older and newly acceded member states and it is required to have a consistency in the regional policies of this type in the community space.

Due to the financial crisis that has recently occurred, the rural development is now established on the sustainability concept, expanding its communication and information means for the non-agricultural sector and building relations among international organizations, national agencies and/or the civil society.

2. PAPER CONTAIN

In the European Union, the rural development strategies focused on agriculture at first; later on, an additional goal was to assure a healthy life, for humans and animals alike, within a clean environment that preserves the natural landscape and maintain the activities specific to the rural regions.

An important role among the rural development policies is played by the Common Agricultural Policy. In the beginning, this was a policy relying on the production and

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protection of the internal markets in the European Union from the non-European producers, until it bankrolled the rural development and the environment protection.

The Common Agricultural Policy, from 1950 until present, has targeted three objectives:

1. Productivity, involving the stimulation of the food production of high quality and under safety conditions;
2. Competitiveness, providing subsidies to the European farmers for an ecological agricultural activity;
3. Sustainability, deriving from the support of the rural community development.

The recent direction of this policy implies a better cooperation among the pillars of the Common Agricultural Policy, as well as the funds of the European Union, such as the European Regional Development Fund, European Social Fund, Cohesion Fund and European Maritime and Fisheries Fund.

The current stipulations of the Common Agricultural Policy concern a harmonious evolution of the rural areas in the European Union without having a surplus production and exclusively extensive, aiming to keep the backbones of this policy as the measures directed to the market, the direct payments and the rural development.

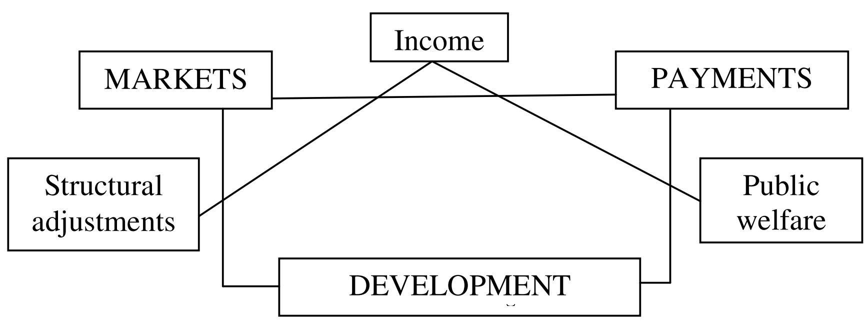

Figure 1: The pillars of the CAP and the interconnections between them

Source: Dragoi A.E., *Dezvoltarea rurala pe principiile sustenabilitatii economice si sociale*, Romanian Academy, 2013, pg.35

The measures applied within the national strategies of such development need to consider the interconnections among the posts of the Common Agricultural Policy. 'While the system of the direct payments ensures a level of minimum income for the farm workers and the intervention measures on the market regulate the prices of certain products, the measures of the rural development contribute to the increase in the wellbeing degree of the population and to the easing of the structural adjustment process of the farms and the agricultural exploitations.'

The rural space of the European Union involves the integration of the agrarian policy into its analysis, where the focus falls on its preservation, care and promotion.

While looking forward to 2020, the European Union intends to support the farmer's income by direct payment fairly distributed among these workers, regions and member states. Similarly, another goal is to protect the farm workers, as it is common fact that the agricultural sector has the highest exposure to the natural and economic risks.

To shelter the ecosystems and the agricultural sector, what is planned is to promote the initiatives in the agro-environment field, which means an efficient use of the resources, an important pillar of the rural development policy.

The rural sector is being challenged by the aging of the workforce, which is beyond 55 years of age, as the young people have relocated to the urban sector or left the country. To this purpose, it aims to promote entrepreneurship, stimulating the economic activities in the rural areas and developing new projects in that space.

Until 2013, the main role in the rural development programs was played by the agriculture and the food products. The new approach aims a sustainable development, to protect the environment and the people and, at the same time, to assure an economic growth. The accent is placed on the implementation of certain programs that will generate new employment places, leading to a durable economic growth in the European rural sector.

To have a sustainable development in the rural areas, the conclusion is that more employment places in agriculture are not sufficient, even though it is the central support of the rural economic development. This is the reason why the farm workers will be involved in non-agricultural activities, such as tourism, promotion of the trades specific to each geographical area, thus achieving strategies of multi-sectoral development.

The agricultural sector is facing a low information degree in all domains, mainly the business'. This turns into lack of adjustment to market changes, scarcity of opportunities of professional training of the workforce and its conformation to the market requirements, as well as restricted possibilities of local development.

In order to fight against such drawbacks, the Common Agricultural Policy will look more into a durable development of the rural areas that will take into account the environment needs via measures that promote the local traditions, to shorten the distance between the employment place and employees' houses and embolden the young families to settle down in the rural areas.

Similarly, it is the intention to have an ecological agriculture on as wide spaces as possible in the rural sector of the European Union, which to provide sufficient quantities of safe and high quality food for the community consumers. This has been possible by promoting innovation, research projects that led to higher productivity and smaller negative effects upon the environment.

The agriculture can bring its contribution to building and preserving a durable environment but it can equally deliver seriously negative repercussions upon the environment, leading up to destruction. This is why a middle way should be found, as a balance between the two extremes of the agriculture.

According to the Common Agricultural Policy on the rural development, each member state will be given the freedom to adopt those measures that are required in line with their needs and the received funds could be used for both agricultural and non-agricultural activities, such as:

- Assistance for the small companies;
- Support for the processing industry of the food products;
- Development of the educational sector in the rural area, so that mothers can be employed.

Hence, the emphasis of the Common Agricultural Policy falls on:

- Competitiveness of agriculture, food products and forestry;
- Protection and improvement of the natural resources and environment in the rural sector;
- Promotion of the services meant for the rural population, local tourism, and development of micro-companies and capitalization of the cultural heritage.

Even though the adjustment of the rural development policy of the European Union to the needs of the member states is endorsed, a common policy is an imperative, since certain events cannot be dealt with individually, such as pollution. To this purpose, the projects being proposed for the rural development are financed from both the European Union budget and from the member states', focusing on the experience acquired from the past.

Prior to 2007, Romania had to do with agricultural exploitations of small dimensions and low prices of the agricultural products, compared to the production costs and relatively high prices of the local products versus the imported ones; hence, the income of the farm workers were inadequate, who had a weak purchasing power and ability to invest into the development of the economic activities.

Post 2007 and the accession into the European Union, it has aligned with the Union criteria in terms of restructuring and development of the agricultural and forestry production and related industries, in order to have an economic growth in the rural sector. Similarly, the accent has been placed on maintaining and improving the environment quality in the rural areas by promoting a durable management. The life quality in that sector has increased via upgrading infrastructure and rural services, by preserving and enhancement of the cultural, architectural and historic heritage in the rural regions.

3. CONCLUSIONS

What can be ascertained is that the rural policies have shifted from a sectoral to a territorial approach, from subventions granted to declining sectors to strategic investments. It has thus become a development policy of certain new activities, focusing on the local responsibilities and aiming to decentralize the management of the policies.

Within the European Union, the concept of rural development that is sustainable from an economic and social perspective is established on the concept of durable development, i.e. responsibility towards the usage of the natural resources, for the environment protection, social cohesion and a fair and balanced economic development.

Romania has to concentrate on the local development in order to be able to achieve the policy of the community rural development, based on an ecological agriculture, environment preservation and provision of social durability.

To have a better employment percentage in the rural sector, there is a need to develop the production activities in the regional economies, by carrying out non-agricultural activities that can be performed by both agriculture workers and also by the other people in that region.

The route to be followed in terms of the rural sector is that this is a pleasant living space, which keeps its originality by means of the traditions and customs and where people can achieve economic activities (agriculture, tourism, trades) that will guarantee them the necessary daily income and also sufficient profit to boost their activities and progress themselves in their personal life.

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THE SUBSTRATE INFLUENCE ON THE ANAEROBIC DIGESTION PROCESS

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ABSTRACT

Biogas production obtained from agricultural and animal residues, municipal solid wastes, specific energy crops and sludge from wastewater in anaerobic digesters, has been studied experimentally and theoretically worldwide. The anaerobic digestion is the most used technology for treatment and energy recovery from different kinds of organic residues.

In the present paper, the influence of substrate parameter on the performance of anaerobic digestion process was studied in order to determine the optimal biogas production. The substrate used in anaerobic digestion process was made of miscanthus biomass and poultry manure in different proportions. The results obtained from the experiments on the co-digestion of these two substrates showed that the addition of 10,5% poultry manure improved the biogas production.

1. INTRODUCTION

In the last period, biogas production has undergone extensive research, resulting in numerous articles dealing with aspects regarding biogas production, the improvement of biogas production, optimization of bioreactor, optimum pH and temperature, [1 -3].

Biomass is one of the most attractive energy feedstocks which can be converted to heat, steam, electricity, hydrogen and biogas through appropriate technologies, [4].

Anaerobic digestion is a biological process in which organic matter is decomposed by an assortment of bacteria under oxygen - free conditions and produces biogas (about 50 -75% CH_4, 25 - 50% CO_2, and traces or significant quantities of undesirable contaminants, such as hydrogen sulphide, ammonia and siloxanes), [5]. The anaerobic digestion process is a widely used technology for converting organic wastes, such as: agricultural and animal residues, municipal solid wastes, specific energy crops and sludge from wastewater to biogas, [6].

The anaerobic digestion as a complex biological process is influenced by several environmental factors such as: temperature, pH, substrate composition, pressure, agitation, nutritive elements, inoculation and heavy metals, [7].

The microbial community present in the anaerobic digestion process is largely determined by the substrate composition [8]. In this context, the most recommended co-substrate for anaerobic digestion process is animal manure due to its stable pH, prevention excessive production of volatile fatty acids and ensuring a wide range of nutrients for bacterial growth, [9]. Biowaste used as a substrate for anaerobic digestion contains different organic materials from food crop residues to waste originating from industrial processing. The European Commission estimates that about one-third of the EU’s 2020 target for renewable energy in transport could be met using biogas produced from biowaste. According to European Commision, [10] the amount of of bio-waste generated is expected to rise from 87,7 Mt to 96,4 Mt (a 10% increase) within the next 10 years. Figure 1 shows the expected evolution of bio-waste generation from 2008 until 2020.

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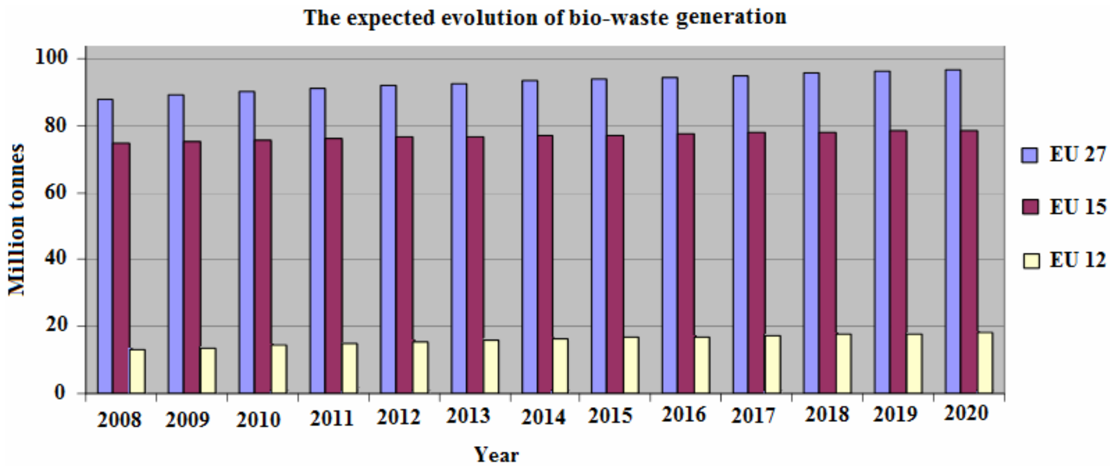

Figure 1: The expected evolution of bio-waste generation, [10]

Also, the C/N ratio of the substrate or mixture of substrates used in the process of anaerobic fermentation, greatly influences the production of biogas, [11]. For a good performance of the anaerobic fermentation process, the C/N ratio of the substrate should be in the range of 20-30, [12]. Crop residues (alfalfa, cereals straw, corn stalks) and animal manure have recently been used together to produce biogas by anaerobic digestion, this co-digestion of crop residues and animal manure increasing the rate of biogas production because of the greater balance between carbon and nitrogen, [13]. In table 1 can be observed the C/N ratio for different types of feedstock used as substrate in anaerobic digestion process.

Table 1: C/N ratio for different types of feedstock, [14]

Feedstock	C/N ratio
Poultry manure	5 - 15
Alfalfa meal	15
Corn silage	35 – 45
Cow manure	10 – 30
Grass hay	32
Horse manure	22 – 50
Pig manure	10 – 20
Sheep manure	13 – 20
Wheat straw	100 - 150

Up to now, most investigations have studied co-digestion with cow manure, having a lower potential for biogas production than pig manure, [15].

In the present paper, the influence of substrate parameter on the performance of anaerobic digestion process was studied in order to determine the optimal biogas production. The substrate used in anaerobic digestion process was made of miscanthus biomass and poultry manure in different proportions.

2. METHODOLOGY

Miscanthus plants, used during experiments, have been harvested at maturity, in 2014, from the National Institute of Research Development For Machines And Installations Designed To Agriculture And Food Industry – INMA Bucharest. Poultry manure was collected from a household near Ilfov county, during February 2015.

Feedstock preparation

Regarding the biomass processing, miscanthus grinding was done with the help of a laboratory mill Grindomix GM-200 equipped with a tray and two stainless steel knives fixed at the bottom of a rotor, thus comminuting the material by impact of particles. For the comminuting of the miscanthus plants, the revolution speed was set at 5000 rpm and the grinding time was 1 min.

Experimental set-up

The proportion miscanthus biomass – poultry manure - water is presented in Table 2.

Table 2: The proportion of substrate used in experiments

	Miscanthus (%)	Poultry manure (%)	Water (%)
Erlenmeyer flask 1	11,76	-	88,24
Erlenmeyer flask 2	9,5	3,2	87,3
Erlenmeyer flask 3	6,9	6,9	86,2
Erlenmeyer flask 4	6,1	18,2	75,7
Erlenmeyer flask 5	8,3	8,3	83,4
Erlenmeyer flask 6	10,5	10,5	79
Small bioreactor	5	5	90

Each sort of this substrate was placed in the above proportion in tightly closed Erlenmeyer flasks and in a small anaerobic bioreactor with a capacity of 500 ml (Figure 2). After that, the Erlenmeyer flasks were placed in the bacteriological thermostat for 10 days at a temperature of 35 °C. The small bioreactor was put on a stove equipped with a magnetic stirrer and the temperature was also set at 35 °C.

Figure 2: Small bioreactor and Erlenmeyer flasks in the bacteriological thermostat

The biogas production obtained from mixture of poultry manure and miscanthus biomass was measured after 10 days of digestion using a gas chromatography device. Gas chromatography is an optimal analytical instrument for the analysis of components such as

CH_4, CO_2, H_2S and siloxanes which are present in the gas.

The quantitative analysis was carried out by gas chromatography with diathermancy detector through the external standard method with correction factors. Oxygen (O_2), nitrogen (N_2) and methane (CH_4) were analyzed on a column with stationary phase molecular sieve and carbon dioxide (CO_2) on a column with stationary phase Porapak N.

In table 3 are listed the concentrations of different components which are presented in the obtained gas, as a function of the substrate used. The data obtained from the experiments in which the proportion substrate was 10,5% miscanthus, 10,5% poultry manure and 79% water, showed an improved biodegradability and biogas production compared with the other one proportions of substrate.

Table 3: The concentration of the biogas components

	CH_4 (%)	**CO_2 (%)**	**O_2 (%)**	**N_2 (%)**
Small bioreactor	<0,01	1,6	20,4	78
Erlenmeyer flask 1	<0,01	1,1	23,2	75,7
Erlenmeyer flask 2	<0,01	0,6	22,6	76,7
Erlenmeyer flask 3	<0,01	0,5	26,2	73,3
Erlenmeyer flask 4	<0,01	1,3	25,7	73
Erlenmeyer flask 5	2,9	<0,01	22,3	74,8
Erlenmeyer flask 6	5,4	1,9	22,6	70,1

In table 4 there are given the data recorded during the experiments for each parameter followed (TSS and pH) for each proportion in the time interval 24 h - 240 h. Based on the obtained data, were made graphs in Fig. 3 and 4.

Table 4: Data recorded during the experiments after 24 h-240 h of fermentation

Parameter	Time, hours	Erlenmeyer flask 1	Erlenmeyer flask 2	Erlenmeyer flask 3	Erlenmeyer flask 4	Erlenmeyer flask 5	Erlenmeyer flask 6
pH	24	4,97	5,51	5,97	5,76	5,41	5,47
	48	5,09	5,62	6,28	5,71	5,81	6,45
	192	4,93	5,35	5,77	5,6	5,7	6,61
	240	4,84	5,44	5,7	5,49	5,51	5,97
TSS	24	1,9	1,4	1,8	1,1	1,3	1,2
	48	1,5	0,7	0,8	1,3	0,8	1,8
	192	0,8	0,6	1,5	1,8	2,3	3
	240	0,5	0,1	1,5	2,2	2,6	2

The pH of liquid samples had an ascending tendency, characteristic for this type of fermentation. In the first days, the pH value increases slightly and after 48 hours the pH values begin to decrease and at the end of the incubation period values ranging from 4,9 - 6 units. In the first part of the process act hydrolytic and acidogenic microorganisms (*Streptococcus, Lactobacillus, Salmonella*) to produce organic acids and in the second part of the process act the methanogenic bacteria.

The initial TSS values are different depending on the amount of miscanthus and poultry manure used as a substrate. TSS value refers to the amount of soluble compounds released into the fermentation medium from the vegetal material, mainly substances with low mass. In time, as seen in all cases, the bacterial populations consume nutrients from the medium and the TSS values decreased significantly.

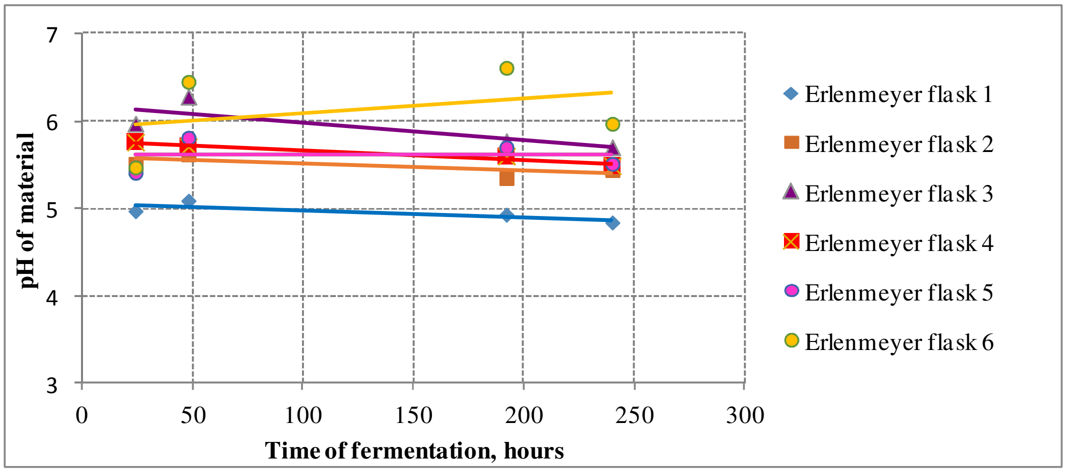

Figure 3: Variation of pH with time of fermentation, for each proportion of substrate

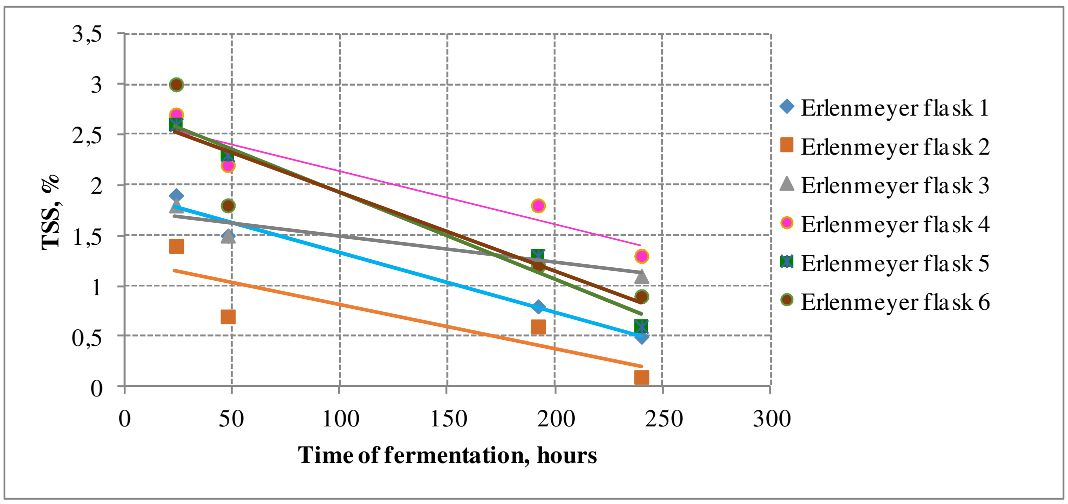

Figure 4: Variation of TSS with time of fermentation, for each proportion of substrate

3. CONCLUSIONS

Anaerobic digestion of animal manure has been demonstrated to be an attractive treatment that provides several benefits such as: fertilizer for agriculture; reduction of odors, pathogens and greenhouse gas emissions; production of a renewable fuel: the biogas. From the experiments conducted, it was found that the anaerobic digestion efficiency is highly dependent on the type of feedstock, for example, digestion of animal manure is more efficient than digestion of lignocellulosic biomass because of the complexity of lignocellulose.

The substrate used in anaerobic digestion process was made of miscanthus biomass and poultry manure in different proportions. The results obtained from the experiments on the co-digestion of these two substrates showed that the addition of 10,5% poultry manure improved the biogas production.

Aknowlegement

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THE IMPORTANCE OF THE BYPRODUCT BIOCHAR ACHIEVED IN THE PROCESS OF OBTAINING ENERGY FROM BIOMASS

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ABSTACT

The authors of this paper, who have theoretical and experimental concerns in the gasification of biomass for obtaining energy and biochar especially by the TLUD method, have been forced to also consider some related matters. Based on specialized publications there has been analyzed why biomass is a great energy resource and what are the main processing technologies. There have been also investigated the economic methods which could make the processing of biomass for energy a profitable activity. A very important method is the simultaneous achieving of energy and biochar, especially through the gasification process in TLUD. By presenting extremely important uses of biochar it is concluded that one of the basic solutions for growth as to obtaining energy from biomass is the biochar-energy co-production.

1. INTRODUCTION

One of the basic elements of mankind development is the energy resource available at a given moment. Throughout history there has been prevalently used the energy stored in coal, oil, gas and wood. While wood production is, as a rule, renewable, although in reality it is not, the production of other listed fuels is limited, and studies of recent years tell about their decrease. The modern era has abused liquid fuel consumption, obtained from petroleum, depleting resources to an alarming level, and therefore through applied research alternative renewable sources have been investigated. The main alternative energy sources that mankind began to use quite extensively can be grouped into energy from biomass, wind energy, hydropower energy, geothermal energy and solar energy.

2. BIOMASS AS AN ENERGY SOURCE

While solar energy has been deliberately or not always used, the first energy source used intentionally and with effort has been the biomass, since the prehistoric man burned for survival wood and debris is forests ever since the first steps of mankind. Biomass includes besides forest products also agricultural products and the biodegradable fraction of municipal or animal wastes, which leads us to the conclusion that it is by far the largest resource. The traditional solution for burning biomass for heating and for preparing food, used by almost half of the world population, led to massive and uncontrolled felling of forests but also to higher prices on fuels of this type. The first measure was the modernization of stoves, leading to increase of their efficiency because greenhouse gases resulted from the low-efficiency combustion of fuel produce 20-35% of carbon emissions that cause global warming and therefore climate change. Interestingly, the improved cooking stove also produces a special charcoal that due to its quality of being a fertilizer is called biochar. The upgraded stove and especially the one based on the TLUD method warms by burning gas obtained through the pyrolysis or gasification process, but produces as a secondary element the charcoal which was called biochar. The biomass used can consist of primary wastes, of secondary wastes or from

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crops specially grown for energy consumption. Thus there have spread energy maize, rape, poplars or willows plantations, which have occupied plenty of land on which one could produce food. By 2050 it is expected that about 9 billion people will live on earth (6), which means that there should be quickly found serious strategies for the economy, agriculture and social development, prevalently in the energy sector. Changes will be needed in the management of food resources development, for instance through increased use of nutrients for crop growth, in finding alternative energy sources cheap and secure, in the development of living conditions in all countries. Many have proposed to find alternative methods of obtaining energy from biomass (21) through methods that will allow producing biochar as a byproduct, which in addition to improving soil fertility also ensures sequestration of carbon from the atmosphere, thereby helping to reduce the rate of climate change.

The current trend is to use secondary wastes, i.e. residues resulting from the use of biomass for making primary products or conducting primary processes, residues which may be as origin domestic wastes, agricultural wastes, forestry wastes or even wastes resulting from wastewater treatment. A very useful solution is to use small and medium gasification systems on the TLUD method for heating of surfaces up to 200 sqm as in greenhouses (18). Due to the increasing demand for biomass for obtaining energy it can be noted that there is already a tendency for increasing its price surpassing the stage when money was paid to get rid of garbage, household wastes, forest residues, now reaching the point where money is paid by who takes them over, as for example in the case of sawdust. First-generation biofuels having as main representatives the bioethanol made from corn, wheat, beets and the biodiesel made from rapeseed, peanut, sunflower, begin to be no longer regarded as a source of energy rescue for mankind, increasingly resorting to second generation biofuels obtained from secondary wastes. It seems that increasingly more specialists have critically analyzed the costs of excessive use of renewable energy because agricultural land is lost, and the need for liquid fuel can continuouly increase, so that at a certain moment to be no longer possible to increase the amount obtained from biomass, and they have reached to some quite interesting conclusions for energy production. Of course it is not the best solution to return carbon back into nature through biofuels, but try to get energy from other sources such as the wind, water and sun. Hydroelectricity and wind are two of the biggest contributors to renewable energy providing 82%, as told by J. Lehmann who cites a material from 2011 of US EIA. It is estimated that wind has a potential of 12% from total added energy by 2035.

3. METHODS AND TECHNOLOGIES FOR PROCESSING BIOMASS

To obtain energy from biomass there is used mainly burning, pyrolysis or gasification. Throughout history solid bio mass was burned and as a result of obtaining acceptable results, sometimes even good results, research for pyrolysis and its gasification has appeared quite late, after 1990, perhaps with the exception of some tests in Germany and Japan. Pyrolysis and gasification eliminate or reduce the flow of oxygen during the progress of the process and they thermally decompose solid bio mass into liquid, gaseous and solid fractions. Energy recovery is done by immediately using the heat produced or by storing the synthesis gas (syngas) and bio oil for future use. However the use of gasification and pyrolysis of solid bio mass is only at the beginning. Japan has a centenarian tradition in production of coal from forest biomass, which has been used in energy production and agriculture (10). Pyrolysis and gasification capture the latent energy contained in solid bio mass and produce biochar.

The pyrolysis and gasification systems can be fixed or mobile, small or large. The small ones are those that are powered by 50-1000 kg of biomass per hour. The largest ones can process up to 4000 kg per hour (17).

In a document on fuels (4) the authors have studied three concepts of thermochemical conversion of biomass depending on the temperature of the process progress.
Py300. Pyrolysis at 300°, which gives much biochar that takes up to 80% of the carbon in biomass and supplies less syngas.
Py450. This type of pyrolysis is mostly used in slow pyrolysis units. The technical solution based on Py450 converts about 45% of the carbon into biochar.
Gas800. Gasification at 800° produces the largest amount of syngas, but the lowest amount of biochar (about 15% of the carbon).

The three concepts through which there is obtained liquid fuel as a main element can not compete in price nowadays with the costs of classic fuels based on petroleum. In these circumstances it is clear that for the process to become economic it is necessary for biochar to be obtained in an amount that is sufficient to balance the cost with the benefits achieved. This is possible only by stabilizing the price of biochar around at least 220 USD/t. In the same document on fuels (4) there are shown two block diagrams for the technologies of obtaining methanol and biochar from biomass, which present great interest. While in the diagram in Fig.1a technology starts with slow pyrolysis, in the diagram in Fig.1b technology starts with the gasification process. The two diagrams ensure achieving the three above presented concepts.

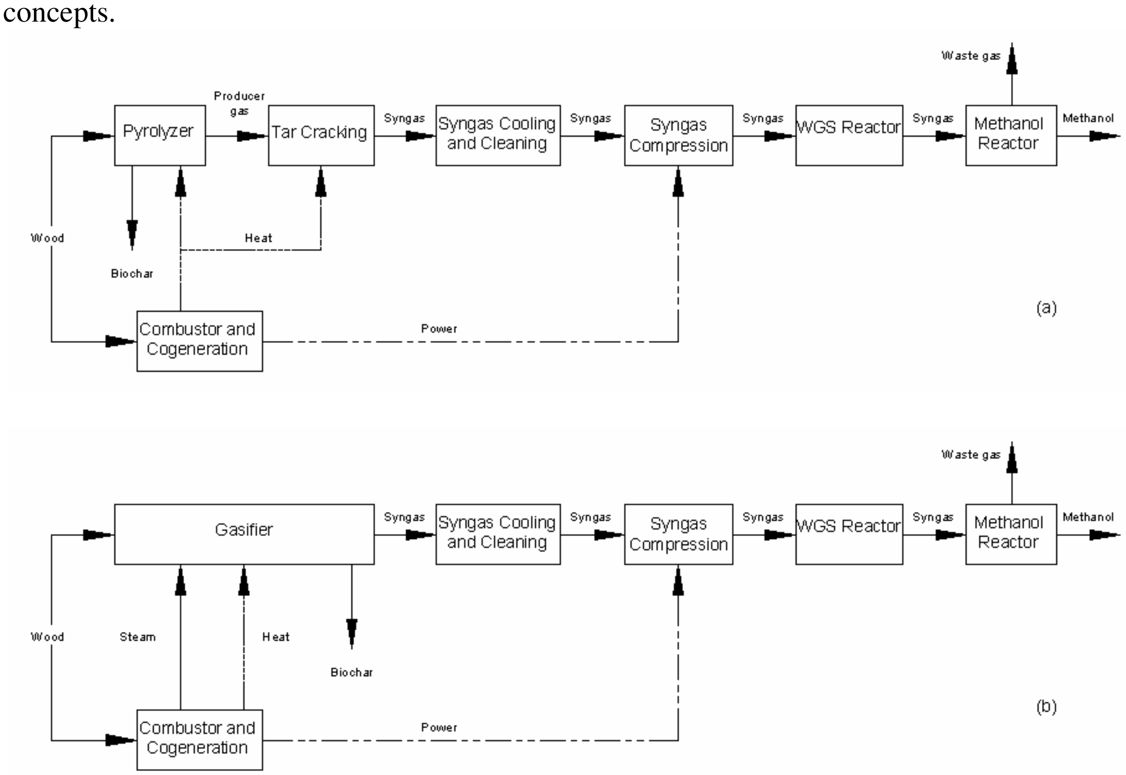

Figure 1: Schematic layout of a biomass to methanol and biochar plant

The bioenergy produced simultaneously with biochar may be in the form of thermal energy, synthesis gas like syngas or bio oil. Both syngas and bio oil can be used to produce heat for the pyrolysis to continue, and the remains - to produce heat or electricity in general. Syngas is rich in hydrogen, methane and carbon monoxide, and in addition to the production of heat or power can turn into liquid fuel or other chemicals. The bio oil can also turn into liquid fuel or industrial chemical products. In many applications there will be reached the point where the main purpose of the process becomes the production of biochar. In a guide (8) for the development and testing of the pyrolysis equipment which produces biochar there is shown a diagram (Fig. 2) for biochar production now classical presented by Roberts et al in 2009.

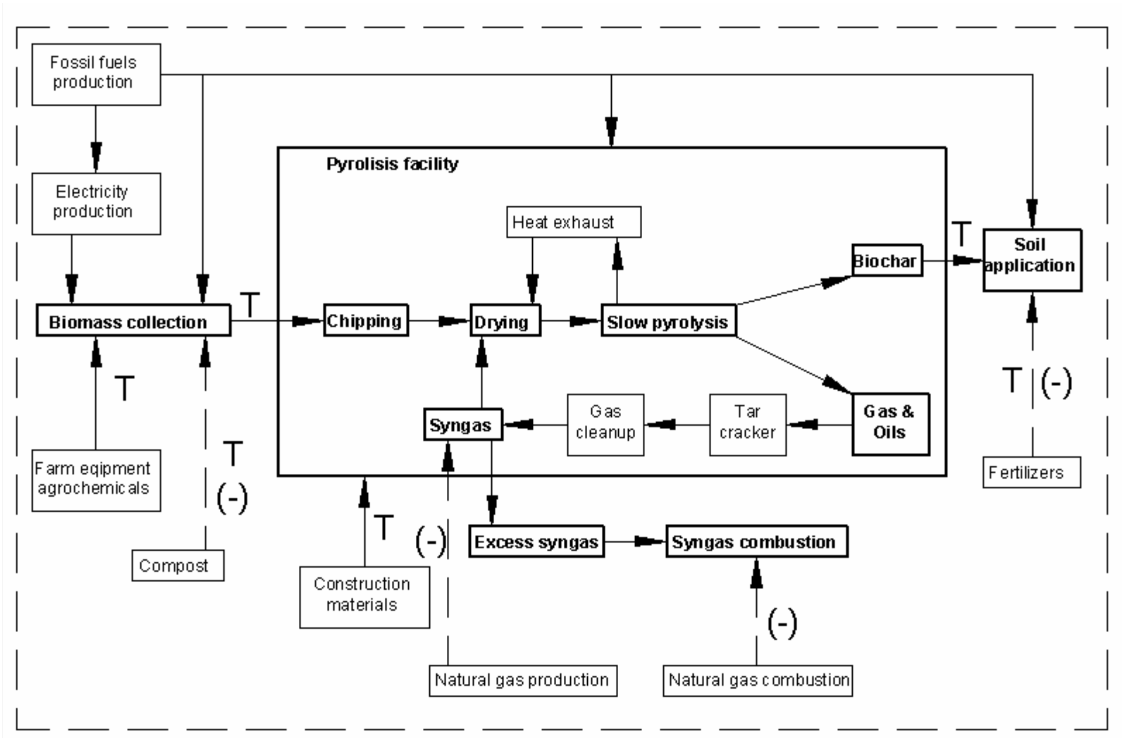

Figure 2: Process flow diagram for biochar production process (Roberts et al., 2009)

The research activities of the team which includes the authors of this paper although focused on the construction of TLUD gasifiers met the same problem of obtaining processes, technologies and equipment that would provide a positive economic component and would dispose of the large series of conditionings such as raw material, location relative to the resources or complexity. Improved performance can be achieved by using functional diagrams (19) appropriate for the type of solid raw material and functional diagram of the TLUD which should be able to optimize the proportion of gasgen and biochar.

4. THE USE OF BIOCHAR

Agricultural use of coal obtained in pyrolysis and gasification of biomass processes therefore under oxygen limiting conditions, known as biochar, is nothing new considering that there are hints about its use since pre-Columbian times in the Amazon region.

One of the major problems of agriculture is preserving soil carbon, which if done with biochar, can range from hundreds of years to thousands of years depending on the type biochar, peculiarities of climate, soil type and even theoretical and practical experience of the user.

Co-production of biochar and energy from urban, agricultural and forestry biomass can help combat global climate change by replacing fossil fuel use, carbon sequestration and reduction of emissions of nitrogen oxides and carbon dioxide, and also helps reduce soil acidity and demand for chemical fertilizers. Biochar production makes the energy producing system become a carbon-negative one (hence to take carbon dioxide from the atmosphere and store it in the soil) compared to other systems of energy production from biomass which in the best case scenario are carbon - neutral.

The use of biochar in agriculture is a technologically simple issue, but extremely difficult from the perspective of the specialist, because it is necessary to make biochar production systems for individual applications, which take into account the soil type, climate and social situation.

Depending on the soil and quality of biochar the harvest is likely to increase by 60% or decrease by 30% by applying it randomly. If we apply at the same location different types of biochar we can get different responses, from increased production by over 100% to a decrease of the same amount.

Biochar qualities are essential in carrying out the improving of soil quality in agriculture, but also in the case of influencing mitigation of climate change already discussed. Pyrolysis temperature increase from 300° to 800° decreases the amount of biochar from 67% to 26% but also increases the content in carbon from 56% to 93%, as told by Tanaka in 1963. Area of biochar increases along with the temperature of the pyrolysis through which it has been obtained, 120 m2/g at 400° and 460 m2/g at 900°, as told by Day et al. in 2005. These large variations lead to limiting the use of biochar.

Rigid application of the results obtained by specialists in other conditions, on other soils and other types of biochar can lead to unknown results. What is clear is that significant benefits can be achieved where there is performed simultaneous management of organic garbage (as fertilizer), and also of biofuel and biochar production. For sure the use of biochar will be successful where the soil needs water and nutrient retention and organic fertilizers are economically and, most important, scientifically applied. Although theoretically biochar can be obtained from any type of biomass, actually the basic raw material is the solid biomass.

Biochar takes from biomass nutrients that ensure soil fertility, but could also take toxins, if the technological process and raw material are not well controlled. Although biochar is used to improve soil quality, the amount of nutrients it contains is low, and therefore it is not a long-term source of nutrient. Biochar retains on long term nutrients existing in soil as well as those added through fertilization or obtained by decomposition of organic matter. Biochar is a good support for soil microorganisms which act against predators. As a result, many studies have done mixtures of biochar with nutrient, bacteria, fungi, etc. Thus biochar is used in making compost. Biochar is a pretty important element in the processes of recovery of land damaged by human activities (20).

The famous Japanese soil amendment Bokashi contains a large amount of biochar, being obtained by compost or fermentation, with many recipes where biochar is not missing from (16). Biochar is highly resistant to biological or physical degradation when introduced into the soil because it is not destroyed by agricultural works such as plowing, and not even by the annual burning of the vegetation remaining on agricultural land after harvesting.

Interaction between biochar, soil, microbes and plant roots is expected to occur rapidly after the introduction of biochar in soil. Recent studies (2007-2010) showed that the type and level of interaction depends on several factors, such as: composition of biochar raw material; pyrolysis process conditions; biochar particle size and the system for its infusion into the soil; soil properties and local environmental conditions.

Finally it shall be pointed out that biochar production simultaneously with energy production has several advantages that one can not overlook such as increasing soil quality and therefore agricultural production, reducing the amount of carbon in the atmosphere and mitigating the global climate change.

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MODELING THE AGRICULTURAL MOBILE TRACTOR – MOUNTED MACHINE UNIT

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ABSTRACT

This paper presents the modeling of a mobile agricultural unit for a model with four degrees of freedom. The tractor is a complex mechanical system that, while driving, transmits the vibrations from the path to the driver. With the help of the experimental data and the modeling program for the mobile unit the curve of the slip coefficient depending on the thrust will be drawn; the variation of the actual velocity of movement curves for the mobile unit depending on the thrust; the variation on the thrust depending on the thrust for fast speeds of the U-650M tractor; the variation of the hourly fuel consumption by thrust; the variation of the specific fuel consumption by thrust.

1. INTRODUCTION

Based on the tractors dynamics modeling program using a model with four degrees of freedom, a modeling program was made to study the dynamics of the mobile agricultural unit. The tractors dynamics modeling program using a model with four degrees of freedom is supplemented by data on the machine working with the U-650M tractor as a single unit. Because the machine is connected to the tractor, the dynamic distribution of weight on the tractor axles will be different than the tractor without a machine. The dynamic distribution coefficient of weight on the drive axle of the tractor is:

- in the case of a towed machine:

$$\lambda_{din} = \lambda_s + \frac{F_t[(L+c)tg\gamma + h_c]}{M_t g L} \tag{1}$$

where: F_t - thrust;

c - distance from center of the drive wheel to the coupling point of the towed machine;

γ - angle formed by the thrust with the horizontal plane;

h_c - distance for the ground to the coupling point of the towed machine.

- for semi-mounted machine:

$$\lambda_{din} = \lambda_s + \frac{R(L+c) + F_t h_c}{M_t g L} \tag{2}$$

where: F_t - thrust;

c - distance from center of the drive wheel to the coupling point of the mounted machine;

λ_s - the static weight distribution coefficient on the tractors motor axel;

R - the weight of the semi – mounted machine distributed on the tractors motor axel:

$$R = 0{,}15(M_m + M_u)g \tag{3}$$

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where: M_m - machine's mass:
M_u - load mass;
M_t - tractor's mass.

- for mounted machine:

$$\lambda_{din} = \lambda_s + \frac{(M_m + M_u)g[h_m \sin\alpha + (l_m + L)\cos\alpha]}{M_t g L} \quad (4)$$

where: h_m - distance for the ground to the mass center of the mounted machine;
l_m - distance from the driving wheel axis to the center of mass of the mounted machine.

The trust is:

$$F_t = f_r (M_m + M_u) g \cos\alpha + (M_m + M_u) g \sin\alpha \quad (5)$$

where: f_r – machine's rolling resistance coefficient;
α - the angle of the road.

2. METHODOLOGY

It was considered that the agricultural mobile unit consists of a U-650M tractor and trailer with two axles for general use RM-2 with the following features:

- trailer mass: M_n = 2100 kg;
- useful mass M_u = 5000 kg.

The coefficient of static weight distribution on the drive axle $\lambda_s = 0{,}633$, the dynamic is $\lambda_{din} = 0{,}733$ and the thrust is $F_t = 7592$ N. After running the modeling program for the agricultural mobile unit mobile the following parameters were recorded:

- real movement speed (v_i) of the agricultural mobile unit for the tractor quick gears;
- actual driving force (F_m);
- maximum driving force of adhesion conditions (F_{max});
- slip coefficient (δ);
- specific fuel consumption (c_t);
- hourly fuel consumption (C_h);
- traction power (P_t).

For each dimension we determined for each gear, the minimum, maximum and range of variation. These data are presented in Table 1 and Table 2.

Table 1

Gear	Real Speed [km/h]			Actual driving force [N]			Maximum driving force [N]		
	min	max	Δv	min	max	ΔF_m	min	max	ΔF_{max}
1	3,4964	3,4971	0,0007	11106	11015	9	12535	12592	57
2	5,009	5,011	0,002	11004	11017	13	12522	12610	58
3	7,065	7,069	0,004	11001,5	11020	18,5	12510	12620	110
4	8,327	8,336	0,009	10998	11022	84	12490	12640	150

Table 2

Gear	Real Speed [km/h]			Actual driving force [N]			Maximum driving force [N]		
	min	max	Δv	min	max	ΔF_m	min	max	ΔF_{max}
1	3,4952	3,4982	0,003	10990	11030	40	12446	12680	234
2	5,005	5,016	0,009	10982	11040	58	12385	12740	355
3	7,057	7,075	0,018	10975	11050	75	12350	12750	400
4	8,314	8,348	0,034	10960	11065	105	12228	12850	622

Figure 1 shows the variation of the actual speed of the tractor according to the theoretical speed. It is noted that the variation rate is higher when the unit is working at higher speeds. When driving on country road increases the scope for changing the actual speed of the vehicle is higher. When driving on country road the slip coefficient is $\delta = 11{,}82 - 11{,}89\%$ and the movement on agricultural land.

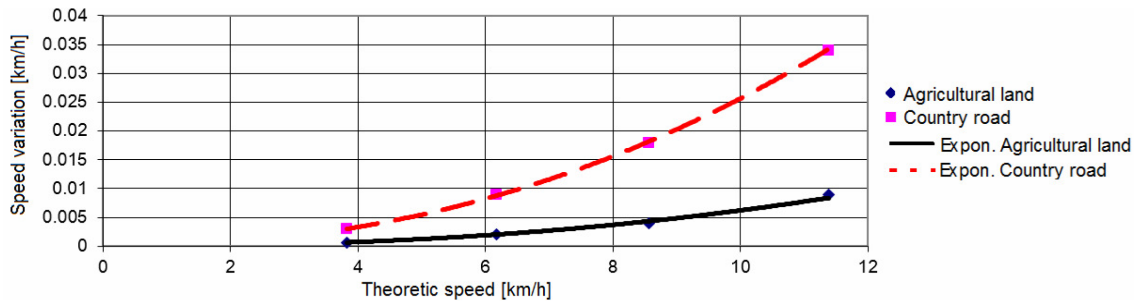

Figure 1: The range of the actual speed of the tractor – trailer unit driving on two fields.

The range of the maximum driving force, determined in terms of adhesion, of movement for the mobile unit in the different types of land are shown in Figure 2.

The range of maximum driving force increases when the units speed increases. The range is greater when driving on country road than for agricultural land.

The effective driving force must be lower than the maximum driving force to achieve the movement of the unit.

The range of effective driving force, shown in Figure 3, increases with increasing unit speed. These increases are higher when driving on country road.

The effective driving force is $F_m = 10938...11022\,\text{N}$ when moving on agricultural land, while the maximum driving force is $F_{\max} = 12490...12640\,\text{N}$. When driving on country road $F_m = 10960...11065\,\text{N}$ and maximum driving force is $F_{\max} = 12228...12850\,\text{N}$.

Traction power, hourly fuel consumption and specific fuel consumption, measured on the displacement of the U-650M tractor - RM-2 trailer unit on agricultural land is shown in Table 3, and for driving on country road is shown in Table 4.

Table 3

Gear	Traction power [kW]			Hourly fuel consumption [kg/h]			Specific fuel consumption [g/kWh]		
	min	max	ΔP	min	max	ΔC_h	min	max	Δc
1	11,465	11,471	0,006	6,296	6,298	0,002	520,67	520,98	0,32
2	16,504	16,515	0,009	7,796	7,8	0,004	441,2	441,34	0,14
3	20,613	20,635	0,022	9,456	9,463	0,007	495,283	495,333	0,05
4	28,112	28,148	0,036	11,009	11,021	0,012	414,38	414,5	0,12

Table 4

Gear	Traction power [kW]			Hourly fuel consumption [kg/h]			Specific fuel consumption [g/kWh]		
	min	max	ΔP	min	max	ΔC_h	min	max	Δc
1	11,455	11,48	0,025	6,293	6,301	0,008	520,2	521,5	1,3
2	16,487	16,53	0,043	7,789	7,806	0,017	440,96	441,55	1
3	20,58	20,67	0,09	9,444	9,475	0,031	495,20	495,43	0,23
4	28,05	28,21	0,16	10,99	11,041	0,051	414,15	414,7	0,55

The range of the traction power for the different speeds of the mobile unit on the two lands is shown in Figure 4.

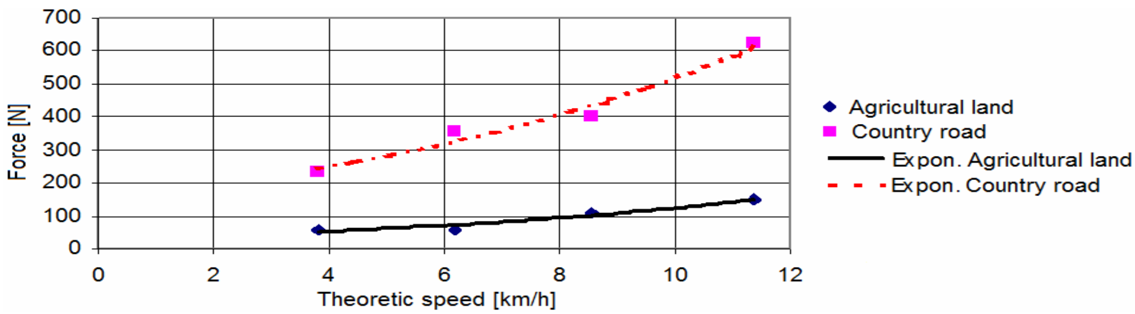

Figure 2: The range of the maximum driving force, depending on the speed of the mobile unit for the different types of land

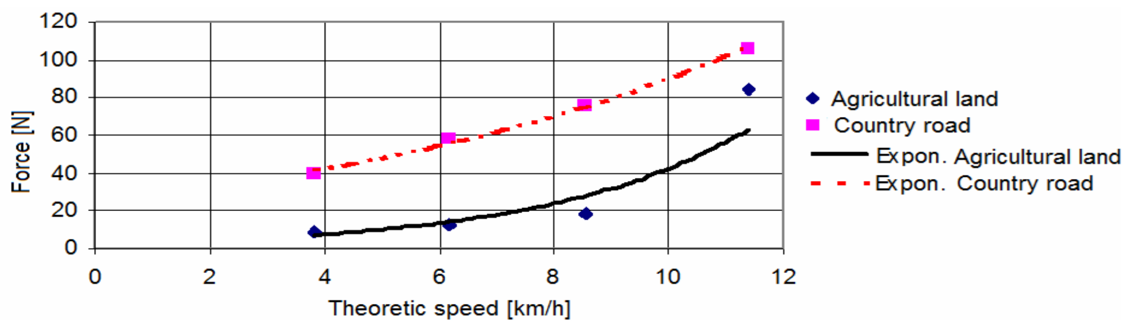

Figure 3: The range of effective driving force depending on the speed of the mobile unit for the different types of land

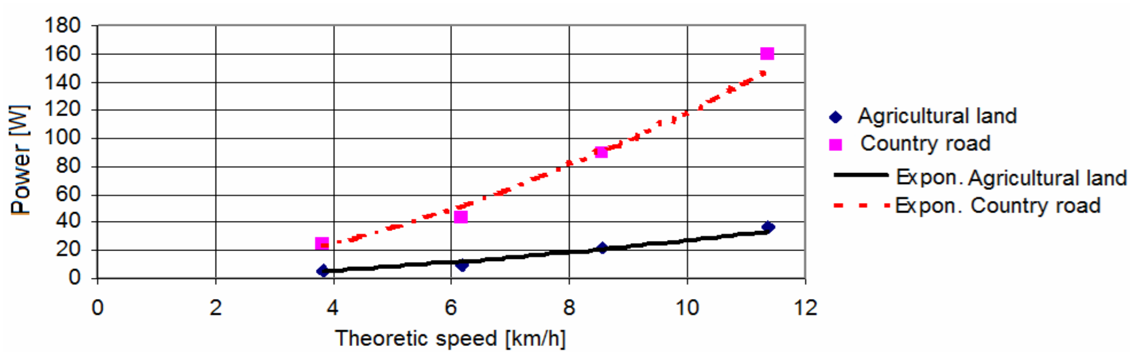

Figure 4 – The range of engine power required for driving the mobile unit on both lands

The range of the traction power is directly proportional to the speed of the unit. The range is larger and its growth is more pronounced when driving on country road.

Changes in hourly fuel consumption depending on speed of the U-650M tractor - trailer RM-2 unit on both land types is shown in Figure 5.

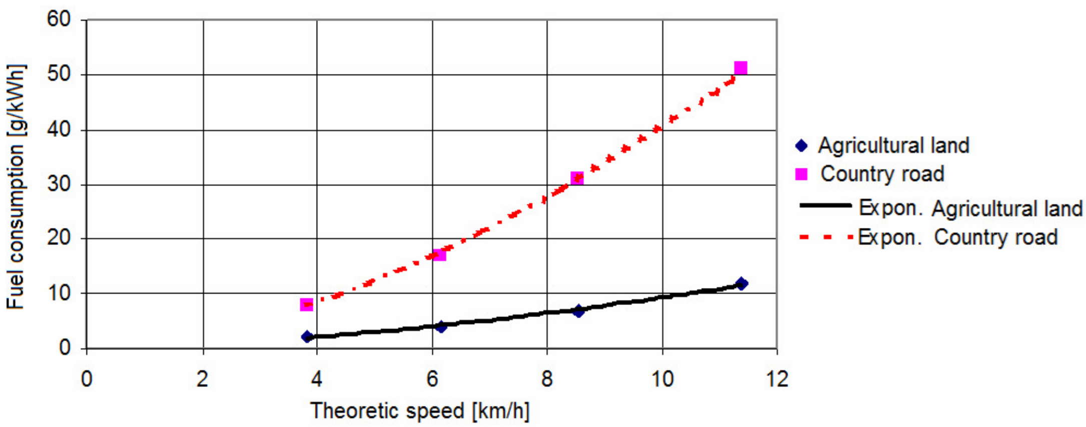

Figure 5 – Changes in hourly fuel consumption depending on speed of the U-650M tractor - trailer RM-2 unit on both fields

It can be observed in this case a range of variation of the hourly fuel consumption higher when driving the unit on country road.

The increase is more pronounced in this case than in the case of movement on agricultural land.

Changes in specific fuel consumption depending on the speed of movement of the unit in the two fields is shown in Figure 6.

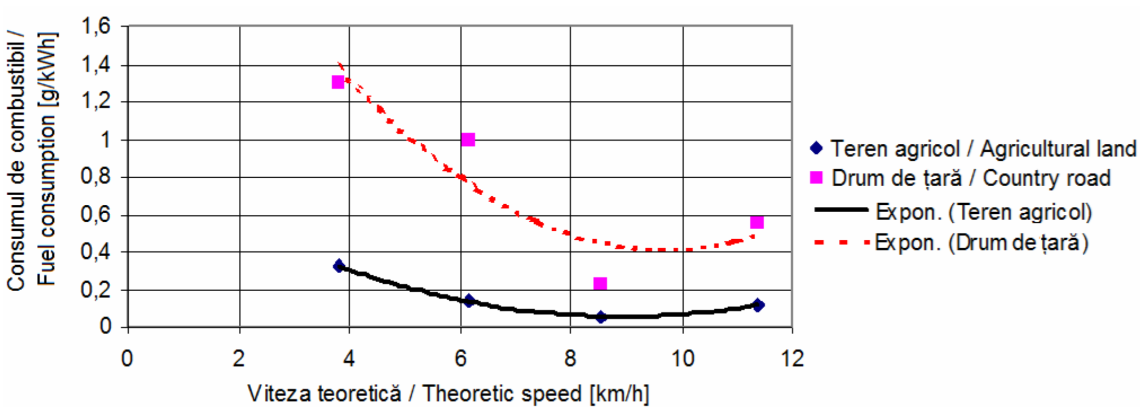

Figure 6 – Changes in specific fuel consumption depending on the speed of movement of the unit in the two fields

It is noted that the variation in fuel consumption rate has the minimum value for $v = 8{,}56$ [km/h]. Variation of specific fuel consumption is higher for driving the U-650M tractor - trailer RM-2 unit on country roads than the movement on agricultural lands.

3. CONCLUSIONS

3.1. The modeling program of the agricultural mobile unit based on four degrees of freedom model of tractor filled with working machine parameters working with the tractor and tractor real pulling feature.

3.2. Functional and dynamics parameters the unit which can be determined by modeling program are:

- oscillation amplitude of the tractor wheels and the center of mass of the tractor to move the unit on any ground;
- pitch and yaw angle of the tractor;
- tractor wheel slip coefficient;
- variation of the effective driving force and maximum wheel of the tractor;
- variation in traction;
- variation of hourly consumption and specific fuel consumption when driving on different terrains unit.

3.3. The range of actual speed of travel of the unit increases with the unit's speed, the increase being more pronounced when driving on country road than on agricultural land.

3.4. Variation of the effective driving force depending on the speed of the unit is more pronounced when driving on country roads than on agricultural lands and varies closest in the case of the tractor – mounted machine unit.

3.5. The range of tensile strength is higher for unit traveling on country roads than on agricultural lands and increases with speed.

3.6. The range of hourly fuel consumption is higher when driving the unit on country roads than agricultural land. The range is lower in the case tractor unit - towed machine.

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EFFECT OF NITROGEN SOURCES ON GROWTH AND PIGMENTATION OF *RHODOTORULA RUBRA* IN SUBMERGED CULTURE

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ABSTRACT

Carotenoids pigments are of great interest to many areas because of their wide distribution in nature and their benefits for health. *Rhodotorula rubra* produces carotenoid pigments when growing in submerged cultures containing sugars, nitrogen sources, growth factors and salts. Among the carotenoid pigments, this yeast synthesizes small quantities of torularhodin, the only pigment with antioxidant properties. The influence of carbon and nitrogen sources on composition of carotenoid mixture in culture media is significant. The *Rhodotorula rubra* strain was grown in shaken, submerged cultures on appropiate medium with different nitrogen sources: $NaNO_3$, $Ca(NO_3)_2$, $(NH_4)_2C_6H_6O_7$, $(NH_4)_2SO_4$, NH_4Cl. The daily values of absorbance, pH, total soluble solids in culture media were recorded and the carotenoid pigments were extracted in acetone, n-hexane and alkaline methanol.

1. INTRODUCTION

The color is considered an important psihosensorial characteristic in food industry, in correlation with the freshness, flavor, sweetness, or acidity of food products. The raisons of food coloring are multiple: the restoration of natural color altered in processing treatment, improvement of aspect, new attractive products, and suggesting of certain ingredients such as butter, eggs, fruits. Carotenoids are well known in food industries as colorants and pro-vitamin A sources. Current trend in fermentation biotechnology towards the development of processes for high-value products including high-value food additives such as carotenoid pigments. Commercial production of carotenoids from microorganisms competes mainly with synthetic manufacture by chemical procedures.

Carotenoid pigments are substances belonging terpenes class and are synthesized by plants and microorganisms (fungi, bacteria and algae) from Acetyl-CoA as key precursor [3]. Carotenoids are roughly classified into two groups. One is the hydrocarbon carotenes such as β-carotene, torulene, and the other is the oxygenated xanthophylls such as torularhodin and astaxanthin [6].

Carotenoids posess a protective effect explained by their provitamin A nature [2,8] and by the antioxidant activity. This pigments are known to protect against diseases like arteriosclerosis, cataracts, age related macular degeneration, multiple sclerosis and cancer. Cosmetic products containing carotenoid pigments demonstrate protective effect in preventing skin damage due to exposure to UV light. Carotenoids like β-carotene, lycopene, lutein, phytoene and phytofluene were reported to be effective in preventing various kinds of skin damage resulting from oxidation and exposure to UV light. Carotenoids are used as skin-care cosmetics and sunscreens to inhibit skin aging due to sunburn.

More than 600 different carotenoids are synthesized by plants and microorganisms [7]. For example, the red yeast genera *Phaffia*, *Rhodotorula*, and *Sporobolomyces* can produce valuable carotenoids such as β-carotene and astaxanthin [4].

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Among yeasts, *Rhodotorule rubra* often called “pink yeast” is well known for beta-carotene, torulene and torularhodin production. *Rhodotorula* genus is a non-fermenting, unicellular, asporogenous yeast found commonly in nature. Torulene and torularhodin, the two characteristic pigments of this yeast, seems to have significant importance in preventing oxidative damage and radioprotective properties. The lipo-carotenoid complex of *Rhodotorula glutinis* posess a normalizing effect on the parameters of the lipid transport system and peroxide oxidation of blood serum lipids in irradiated rats. The advantage of carotenoid biosynthesis from yeasts is the high rate of growth and production of biomass and the posibility to use the dried cells as food and cosmetic additive. In addition, the growth of *Rhodotorula* yeast can be carried out using low cost media components as nutrient sources, which included various industrial by-products.

2. MATERIAL AND METHODS

Microbial strain

The pigments biosynthesis was carried out using a strain of non-fermenting yeast, *Rhodotorula rubra* ICCF 209 grown on potato dextrose agar medium. The stock cultures were kept at 4 ^oC before using.

Culture media

The cultures were performed in 500 mL conical flasks on a orbital incubator at 150 rpm, 28^oC, for 5 days. The culture medium contains: 40 g/L glucose, 1.5 g/L yeast extract, 5 g/L NH_4NO_3, 1 g/L KH_2PO_4, 0.4 g/L $MgSO_4$ x$7H_2O$ and 0.4 g/L NaCl. NH_4NO_3 was replaced with different nitrogen sources: $NaNO_3$, $Ca(NO_3)_2$, $(NH_4)_2C_6H_6O_7$, $(NH_4)_2SO_4$, NH_4Cl in a concentration of 5 g/L.

Extraction of pigments

After cells separation by centrifugation three freeze-thaw cycles were performed. The pigments extraction method was done in accordance with the dedicated literature. First, the acetone extraction of the total pigments mixture including water soluble species [1] was performed. The second stage was represented by n-hexane extraction to separate the total carotenoids content; another extraction with alkaline methanol allowing the torularhodin (the only pigment with acid structure) component isolation. The VIS spectra were recorded for each extract using a T+90 UV-VIS spectrophotometer.

The cell growth was monitored by measuring the absorbance at 600 nm, evolution of pH and total soluble solids content.

3. RESULTS AND DISCUSSION

On potato dextrose agar medium the colonies of *Rhodotorula rubra* are coral pink, usually smooth, sometimes reticulate and rugose. Microscopic morphology shows spherical to elongate budding yeast cells or blastoconidia, 2.5-6.5 x 6.5-14.0 micrometers in size (Figure 1). In the cells of *Rhodotorula rubra*, carotenoids are generally localized in lipid droplets and confer the characteristic color of biomass.

The samples were analyzed in terms of absorbance, pH and total soluble solids and the results are presented in figure 2. As can seen, the highest values of cell number (determined as absorbance at 600 nm) were recorded in the media containing $(NH_4)_2C_6H_6O_7$, $NaNO_3$, $Ca(NO_3)_2$, NH_4Cl, NH_4NO_3 and $(NH_4)_2SO_4$.

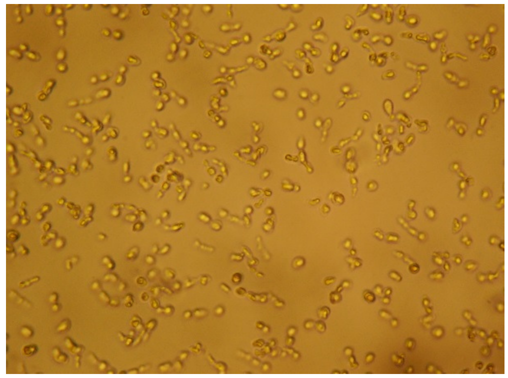


Figure 1. Microscopic aspect of *Rhodotorula rubra*

The final pH values were quite different for the six nitrogen sources. For the media containing NH_4Cl and $(NH_4)_2SO_4$ the final pH was 2 units, but for other nitrogen compounds the pH values are higher, between 4 and 5 units (Figure 3).

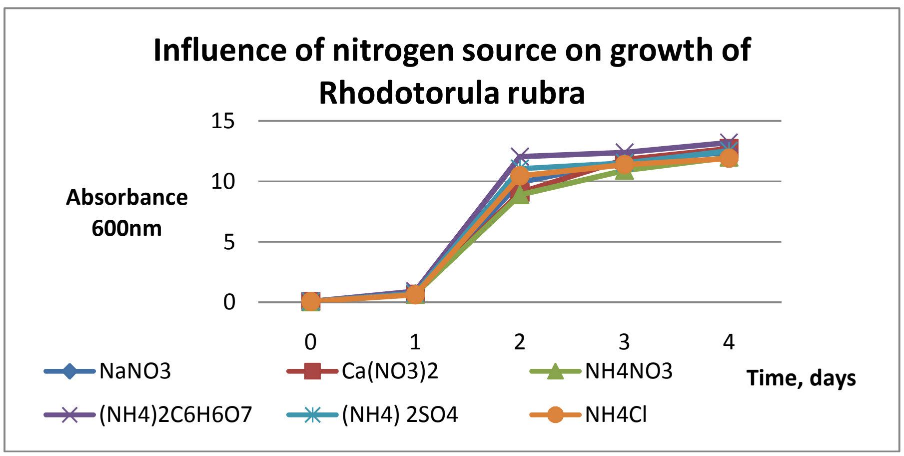


Figure 2. Absorbance values in culture media of *Rhodotorula rubra* for different nitrogen sources

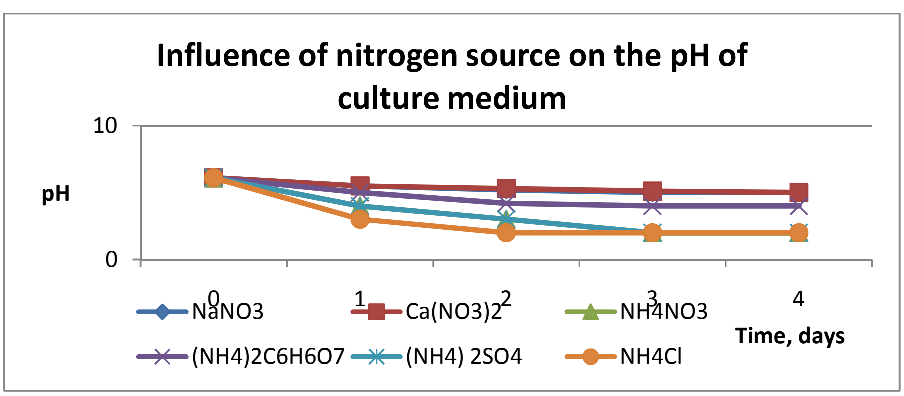


Figure 3. Influence of nitrogen source on the pH of culture medium

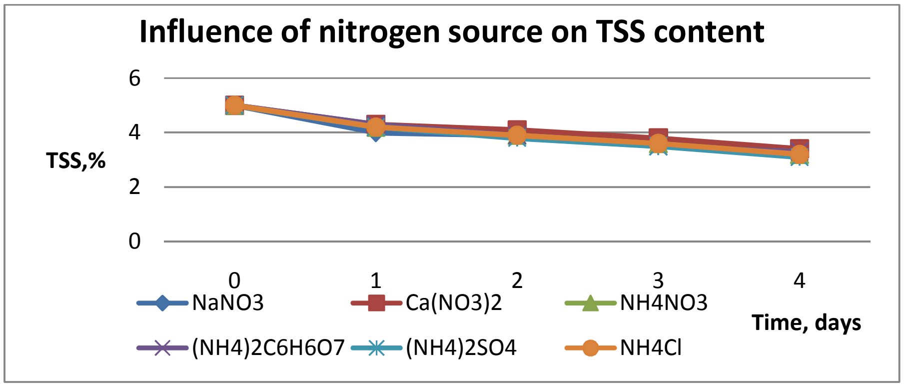


Figure 4. Influence of nitrogen source on the TSS content

The stationary phase characterized by an important production of carotenoid pigments starts after 48 h and shows a deep decrease of pH to acidic values.

The values of total soluble solids represent a good indicator of nutrient consumption and of production of yeast biomass. The initial TSS in culture medium was about 5% and the nutritive medium contains glucose, yeast extract and different nitrogen salts. The final values of TSS in culture medium were between 3.1% and 3.4% for all variants.

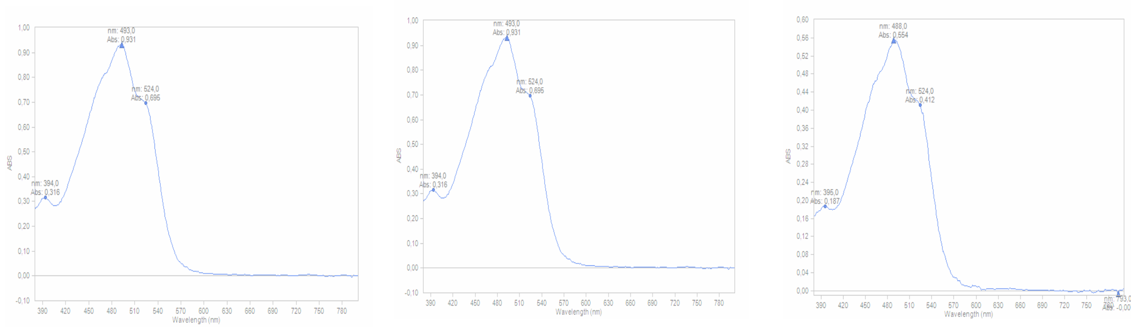
Table 2. The values of wet and dry biomass in culture media with different nitrogen sources

No.	Nitrogen source	Wet biomass, g/L	Dry matter, %	Dry biomass, g/L
1.	$NaNO_3$	37	15.39	5.66
2.	$Ca(NO_3)_2$	32	17.26	5.52
3.	NH_4NO_3	26	14.77	3.84
4.	$(NH_4)_2C_6H_6O_7$	53	14.50	7.68
5.	$(NH_4)_2SO_4$	42	12	5.04
6.	NH_4Cl	22	15.85	3.48

In table 2 the values of wet and dry biomass from *Rhodotorula rubra* demonstrate that the highest growth was observed in the case of ammonium citrate in culture medium (7.68 g/L) while the wheakest growth was determined in NH_4Cl containing medium.

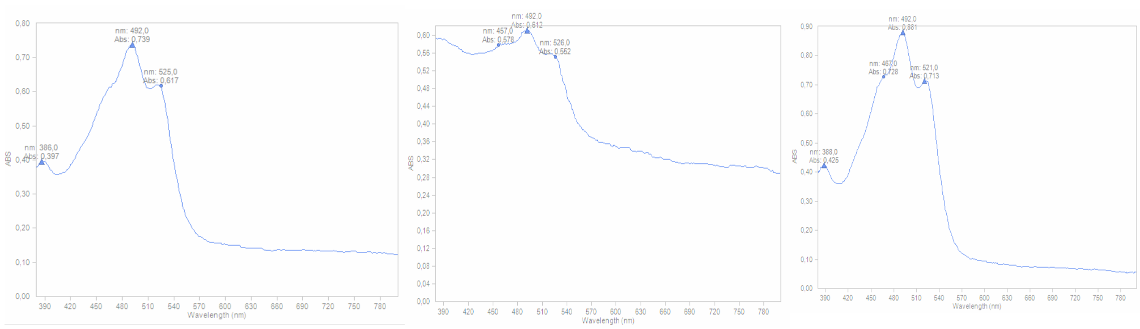
Torularhodin is one of the carotenoid pigments produced by the yeast *Rhodotorula sp*., with a terminal carboxylic group considered now-a-days as a powerful antioxidant to be included in food and drugs formulations [9]. The carotenoid pigments produced by yeasts contain a high percent of torularhodin compared with other sources. It is for this reason that the extraction method aimed at separation of non-acidic pigments and torularhodin. The antioxidant effect of torularhodin is superior to that of β-carotene, and enhanced torularhodin synthesis has been observed in *R. glutinis* treated by peroxyl radicals or irradiated [5]

The extraction of carotenoid pigments was performed in 3 stages, in acetone, n-hexane and methanol. In the method conditions, carotenoids could be extracted only from the yeast biomass grown in media containing NH_4NO_3, $(NH_4)_2SO_4$, NH_4Cl as nitrogen sources. The absorbtion VIS spectra of n-hexane and methanol carotenoids extracts were recorded and illustrated in figure 3 and 4.



a) b) c)

Figure 3. Absorbtion spectra for carotenoid pigments extracted in n-hexane from yeast biomass grown in media containing a) NH_4NO_3, b) $(NH_4)_2SO_4$, c) NH_4Cl as nitrogen sources



a) b) c)

Figure 4. Absorbtion spectra for carotenoid pigments (torularhodin) extracted in alkaline methanol from yeast biomass grown in media containing a) NH_4NO_3, b) $(NH_4)_2SO_4$, c) NH_4Cl as nitrogen sources

Absorption maxima of carotenoids mixture extracted in n-hexane were found to be in the domains of 386-395 nm, 488-493 nm and 525 nm. For the alkaline methanol the absorbtion maxima was at 457 nm, 492 nm and 521-526 nm characteristic for torularhodin, similar to those described in 1995 by Perrier.

4. CONCLUSIONS

Carotenoids play important role in animal health by inactivating harmful free radicals produced in normal cellular activity and in stress. *Rhodotorula glutinis* often called “pink yeast” is a free living, non-fermenting, unicellular yeast found commonly in nature, well known for its characteristic carotenoids torulene and torularhodin.

Culture media have a considerable influence on the yeast biomass accumulation and carotenoid pigments biosynthesis, particularly torularhodin, component with a high-level antioxidant potential. It was found that the nitrogen source represented by different salts resulted in different behaviors of yeast population. For all tested nitrogen sources the *Rhodotorula rubra* strain showed a good growth as can be seen from the absorbance and TSS values.

The stationary phase, when the carotenoid pigments formation is the most important process, starts after 48 h and it is characterized by deep decrease of pH to acidic values.

The pigments extraction was achieved in n-hexane for total carotenoid pigments and in basic methanol for torularhodin, the unique acid component. Only for biomass accumulated in media containing NH_4NO_3, $(NH_4)_2SO_4$ and NH_4Cl as nitrogen sources the carotenoid pigments can be extracted under the method conditions, probably due to the capsule formation around the cell walls. The values of wave length for characteristic pigments for *Rhodotorula* were similar to those of literature.

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THEORETICAL CONSIDERATIONS ON THE GRANULATION (PELLETIZINNG) OF BIOMASS

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ABSTRACT

Granulation is a technological operation widely used in many industries, aiming the controlled increase of the dimensions of particle formations, providing an internal structure and some mechanical characteristics required for the external surface, density, compactness, porosity, etc. Biomass, in its original form, is difficult to be successfully used as fuel because it is bulky, wet and dispersed. The densification of biomass represents the conversion technologies of plant residues into fuel. These technologies are known as pelletizing, briquetting or agglomerating, and improve the handling characteristics of products for a better transport, storage, etc.

1. INTRODUCTION

Granulation (agglomeration) is defined as the operation through which from powder materials, liquid solutions or suspensions, are obtained granules of a particular size and shape, with an imposed composition and internal structure and with certain qualities of the external surface. Bringing together powdery material of the same nature or of different natures, as a whole (grain) of a certain shape and consistency is obtained based on well established physical and / or chemical processes. The particle size of granules usually ranges between 2 and 40 mm - depending on the purpose for which they have been prepared [1].

Granulation is a technological operation widely used, aiming the controlled increase of the dimensions of particle formations, the providing of an internal structure and of some mechanical characteristics required for the external surface, density, compactness, porosity, etc.

Depending on the manner of achieving the process of agglomeration, on the characteristics and appearance of the finished product obtained, the operation carries a series of specific names: *agglomeration, briquetting, granulating, pelletizing, nodulizing, synthesizing,* etc.

In order to obtain from a powdery material granules (conglomerate) having a much larger size, between the particles of the material composing the conglomerate bridges must be made to stiffen the connection between them. Inside the granule, the particles remain joined together as a result of the action of physical attraction forces (which have a short range of action) or due to the formation of bridges, of a physical or chemical nature [2].

2. METHODOLOGY

From the point of view of the relative position of constituent particles, within a granule, between neighboring particles there may be contact points or proximity points (surfaces of the particles are close to but not in direct contact).

Between these two categories of points, between particles can occur attraction forces (fig. 1), resulting in bringing particles together in a conglomerate of a certain shape and with certain physical characteristics.

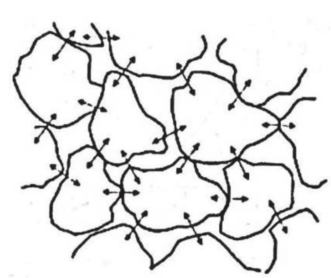

Figure 1 –Diagram showing the cohesion forces in the contact or proximity points [1]

During the granulating operation, between the fine particles of material in the grain arise the binding forces whose nature is diverse: thermal, diffusion, chemical, plastic deformation, dissolution, crystallization, etc. If the humidity content of the material is smaller than the saturation humidity (the liquids are not free-flowing), between the particles of the material bridges can be developed due to adhesion, capillary and cohesion forces. Binding forces can be due to intermolecular interaction forces (van der Waals type).

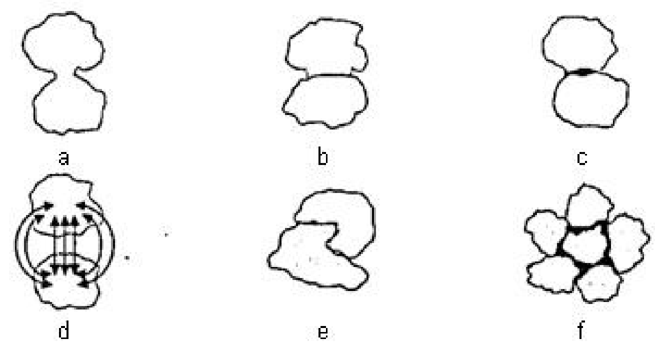

Figure 2 – Schematic representation of the mechanisms of joining two or more particles [1]

The emergence of relatively large forces that join the individual particles represents a prerequisite for the formation of stable agglomerations. Particle binding mechanisms have been divided into five categories by Rumpf H.:

- solid bridges (fig. 2 a, b), which may be formed at high temperatures at contact points of the particles as a result of the diffusion of molecules from one particle to another;
- cohesion and adhesion forces (fig. 2 c) occurring in the binding substances that do not allow a free movement of particles: high viscosity substances (glue, paste) can form bonds similar to those present in solid bridges;
- sealed forms of mechanical connections (fig. 2 e): they can appear in materials with fibrous and lamellar structures and also in the case of particles that after deformation are blocking each other;
- capillary pressure forces (fig. 2 f): these forces can form strong bonds in the liquid bridges and capillary spaces, but these links will disintegrate when the liquid evaporates and there is no other mechanism to maintain these links;
- forces of attraction (fig. 2 d) interacting between particles, as van der Waals type forces, electrostatic or electromagnetic forces, which can cause the joining of particles where the particles are sufficiently close to one another: these forces increase significantly as the size of the particles decreases.

A different classification is proposed by W. Pietsch, who divided the binding mechanisms into two groups (fig. 3). The links that appear as a result of attraction forces, based on the law of universal gravity were placed in one group, while the mechanisms that were formed as a cause of bridge formation between particles were placed in the second group.

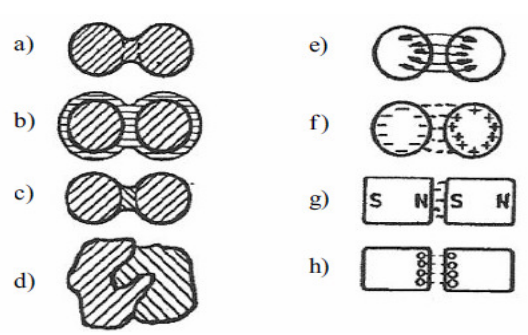

Figure 3 – Classification of the binding mechanisms according to Pietsch [1]
a) chemical reactions, synthesis, partial melting; b) adsorption layers; c) liquid bridges; d) closed bonds; e) molecular and van der Waals forces; f) electrostatic forces; g) magnetic forces; h) valence forces

Table 1 – Agglomeration methods

Method used	Process	Specific equipment
Compression	*Compacting* (granulation at high pressure)	Briquetting roller mold
		Smooth or profiled roller compactors
		Tablet press
	Extrusion (granulation at low and medium pressure)	Roller pelletizer
		Ring die
		Screw extruder
		Piston extruder
Agitation	*Mechanical agitation* (free granulation)	High speed mixers
		Slow speed mixers with drum-type (cylindrical or conical) or plate type discontinuous operation
	Pneumatic agitation (free granulation)	Discontinuous operating fluidized bed
		Continuous operating fluidized bed
Heat transfer	*Synthesizing*	Sliding grid
	Nodulizing	Rotating drum
		Rotating disc
Liquid systems	*Spray drying*	Spray dryer with of without fluidized bed
	Cooling the hot melt	Spray dryer
		Cooling tower
		Cooling drum
	Coagulation or flocculation	Rotating drum
		Filter strips

- ***Granulation by pressing***

In the case of the agglomeration by pressing, the grain structure is due to the action of external forces, and as a result of their action, the material is pressed in the interior of the press chambers. In the case of continuously operating presses, the pressed material is forced to pass through the openings of a plate (die), the final result being the cylindrical or prismatic noodles that at the exit of the die are cut to a certain length. The process for obtaining the agglomerate is dependent on the particle sizes (degree of grinding), the composition and humidity of the materials submitted to the pressing, the additives with binding effect, the size and shape of the pressure chambers. The pressed material becomes rigid, keeping the form of the agglomerate, the resulting product having a much higher density and the form of pellets, briquettes or tablets.

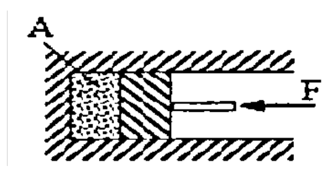

Figure 4 – Granulation by pressing [2] (A – pressing material; F – pressure force)

Characterization of the agglomeration operations

- *compaction*: high pressure agglomeration method by the means of a pair of rollers with a smooth or profiled surface, which rotate towards each other in the feeding area. The material is passed through the space between the rollers and after it is pressed increases its density.
- *briquetting*: agglomeration method under pressure of up to 300 MPa, with or without binders, for powdery or granular materials, transforming them into briquettes with characteristic geometrical shapes.
- *tableting:* high pressure agglomeration at high pressures of 50 ... 200 MPa, in individual dies placed on a rotating disc, from non wetted powdery materials obtaining tablets.
- *pelletizing*: average pressure agglomeration operation, in ring or flat dies, periodically the material being forced to pass through the holes of the die, at the exit the noodles being cut.
- e*xtrusion*: agglomeration method at low and medium pressure, wherein the material mixed with liquid binders in brought to a plastic status by a mixing operation, after which it is forced through the openings of a die.

All compaction granulation methods have as common element the pressing operation, which produces the shoving of particles of the primary material, resulting in the increase in density of the finished product (tablets, pellets, briquettes, etc.).

- **Granulation by compaction at low and medium pressure**

Granulation by compaction at low and medium pressure is carried out wet and is produced by prior wetting, by spraying the material with a fluid binder, which ensures the formation of liquid bridges between granules, the liquid being volatile and nontoxic. For the homogenization, the initial wetted material is subjected to a mixing process. The working pressure is dependent on the moisture status of the mixed material, the thickness of the orifice plate and the diameter of the orifices, the pressure being lower for a higher degree of wetting and higher for a greater length and a smaller diameter of the orifices.

- **Granulation method by pressing at low pressure**

By wetting, only the porosity of the powdery material will be modified, the size and shape of the particles are unchanged, the material having a consistency specific to the status of plasticity. The status of plasticity is crucial in successfully achieving the granulation operation at low pressure.

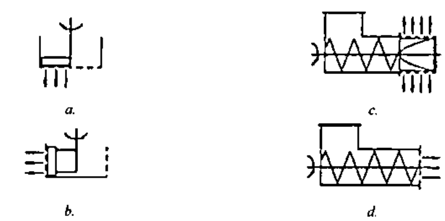

Figure 5 – Methods of achieving the agglomeration operation at low pressure [2]

The pressing chamber is of the semi-open type, the pressing body having the shape of a paddle (fig. 5 a, b) or a screw (fig. 5c, d), the pressed material is forced to pass through the calibrated orifices of a thin wall plate (is extruded). The surface of the orifice plate (sieve) may be flat (fig. 4 a, d) when the noodle flow is parallel to the direction of flow of the feed stream (axial movement) or cylindrical (fig. 5 b, c), when the noodle flow is perpendicular to the direction of the flow of the feed (radial movement).

- **Granulation method by pressing at medium pressure**

The pressing chamber is in the form of channels, the length of a channel being equal to the thickness of the walls of the die, which is imposed by its mechanical resistance. As a result of the action of the pressing body, the powdery material, which has previously been homogenized and wetted, is forced to pass through the calibrated openings, of a determined length of the die (is extruded). Characteristic for this granulation method is the following fact: in the narrow space between the working bodies, the pressed material reaches the flowing limit and slides through the holes of the die.

The agglomerated material is in the form of noodles, their section being identical in shape to that of the openings. Cutting the noodles at determined dimensions is performed by a knife, whose travel speed is correlated with the output speed of the noodles through the die, thus resulting pellets.

Technical equipments for medium pressure extrusion of materials brought to the consistency proper for the plastic status, depending on the manner of operation, are divided into two categories: with the pressing chambers operating in continuous flow and with the pressing chambers operating in discontinuous flow.

Figure 7 presents the principle schemes of the granulator with flat die and pressure rollers. The die has the shape of a circular plate with a given thickness, provided with circular openings evenly distributed on its surface. It is driven in rotation by a screw transmission from an electric motor. The material to be granulated is supplied onto the die surface forming a layer of a given thickness (Fig. 7c).

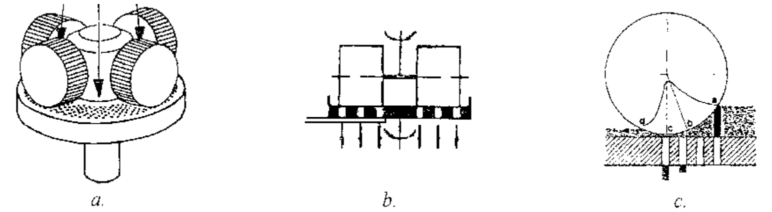

Figure 7 – Principle schemes of the granulator with flat die and pressure rollers [2]

The rollers can have a cylindrical or truncated cone shape. The surfaces of the rollers are corrugated or may be provided with different types of marks. During movement, the rollers press the material in the die openings, each channel being active only during the period when it is in the path of a pressing roller.

Pressure variation on the surface of the roller in the pressing process is presented in the polar coordinates shown in figure 7 c. In point *a,* the loose material is caught and begins to be compressed by the compaction roller. In the *ab* area occurs the compressing of the material, the pressure reaching a maximum value in point *b*. The value of pressure is dependent on the flow properties and the resistance to deformation of the material and the angle of catching. In the *bc* are, the compressed material is pushed into the channels of the die, the pressure force balancing the friction force between the material in the channels and their lateral surface. Point *c* corresponds to the minimum point of the compaction roller circumference, characterizing the end of the pressing cycle and of the movement of the material compressed in the die’s channel. In the *cd* area, the relaxation of the compressed material occurs, both on the die surface, and of the one that has been compressed into channels.

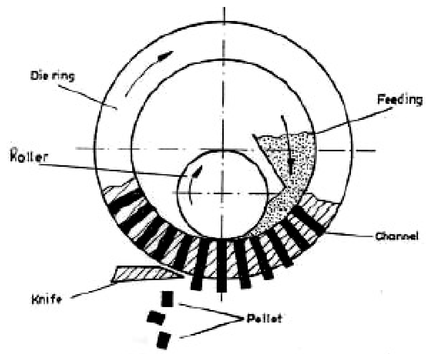

Figure 8 – Schemes for the granulator with ring die and pressing rollers [1]

- **Biomass pelletizing**

Biomass is used for energy purposes ever since the discovery of fire by mankind. Today, biomass fuel can be used for different purposes - from central heating to producing electricity and fuel for automobiles. Most often the term is used to refer to matter derived from plant, used for the production of bio fuels, but the term also includes animal or vegetable matter used to obtain fibers, chemicals or heat. Biomass is usually grown from several plants such as hemp, corn, poplar, willow, osier, reeds, miscanthus, etc.

The big challenge for the planet in the third millennium in the energy field is moving towards renewable energy production systems RES, in the terms of sustainable development of energy, which will provide the population the energy required, without major alteration to the planet's ecosystem.

Currently, biomass accounts for about 12% of the primary energy production in the world, and in developing states it occupies 40-50% of the energy supply needs. Biomass is an alternative source that, by Gominho etc. (2012) contributed with 7% of the energy produced in the world. Currently, the use of renewable combustion materials such as forestry waste for bio-fuels production increases the chances of biomass availability on the energy market.

Fresh biomass can be processed in various ways:

- *burning* - produces heat and electricity;
- *fermentation* - produces biogas;
- *pressing* or pelletizing - produces solid fuel (briquettes or pellets);
- *distillation* - produces liquid fuel (bio ethanol, biodiesel).

~ 80 kg/m³

~ 640 kg/m³

Biomass, in its original form, is difficult to be successfully used as a wide scale fuel because it is bulky, wet and dispersed. The densification of biomass represents the conversion technologies of plant residues into fuel. These technologies are known as *pelletizing*, *briquetting* or *agglomerating*, and improve the handling characteristics of products for transport, storage, etc. Pelletizing and briquetting have been applied for many years in several countries.

Pellets have a very high density. They are easier to handle than other compacted biomass products, for pellets using the same infrastructure that is used for cereals. The pellets are formed by a process of extrusion, using a piston press, whereby the biomass raw material is passed through a round or square die and cut to the desired size. The standard shape of biomass pellets is cylindrical, having a length smaller than 38 mm and a diameter of about 7 mm. Depending on the raw material used, the pellets vary in terms of energy and ash content.

Figure 9 – Types of biomass used for pelletizing [7]

Densification is critical for producing dense material, with good flow, uniform for improved handling and efficiency throughout the entire value chain. During densification, the material initially undergoes a rearrangement of particles to form a compact mass, process followed by elastic and plastic deformation. At the end of the compaction process, the densified material reaches the real density of its composing ingredients.

The technologies commonly used for the densification of biomass are pellets presses, presses for briquettes and extruders. Pelletizers are similar to the briquetting presses, but use smaller dies and smaller particles. In a pelletizer, the die restricts the particle size of the biomass, but the capacity is not restricted by the density of the material used as in the case of a screw or piston press.

Moisture content, durability, bulk density and calorific power are important quality attributes of densified biomass because they have a significant impact on storage, handling, transport and conversion characteristics.

3. CONCLUSIONS

- biomass pelletizing is promising technology for reducing transport costs and for improve the quality of the material for the production of bio-fuel;
- current pelletizing technology presents many technical challenges and requires further research and development;
- steam treatment and the addition of low cost binders could significantly improve the energy density of biomass;
- granulation of biomass is very promising, but requires further research on the optimization of binder requirements and the alteration of the surface characteristics of biomass.

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RENEWABLE ENERGY FOR DRYING GRAIN

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Summary: The development of agriculture is a political and economic goal consistently followed by all the countries of the world, one of the reasons being the strong population growth.

The products obtained on the agricultural holdings solve the food problem, the agriculture providing , first of all, food resources of Terra's population. The crops are very diversified and depend on the climatic conditios and the properties of the soil in each country. A special importance has the cultivation of the cereals which, besides the man's feed, contribute to the development of some industries and the livestock sector.

The grain production on a year cannot be capitalized immediately. In these conditions the production is subjected to the conditioning operations, the most important is to ensure humidity for storage. The energy used to obtain high quality finished products is expensive, traditional resources will be exhausted. Natural drying is possible only on small productions that characterize family farms where low yields are obtained sometimes subsistence production. On farms that have large areas specialized in grain production, natural drying is not possible. In practice, existing dryers are energy intensive. Drying processes have an important role in the thermal processing of materials, as well as to ensure the conditions for the preservation of agricultural products.

THE GRAIN PRODUCTION:

Table .1 Productions recorded in Romania in 2013

	Acreage -thousands ha-		Production -thousands tons-		Diferences(+, -) 2013 compared to 2012	
	2012	**2013**	**2012**	**2013**	**thousands ha**	**thousands tons**
Cereal grains, of which:	**5440**	**5475**	**12824**	**21016**	**+35**	**+8192**
wheat	1998	2135	5298	7428	+137	+2130
barley	424	475	986	1544	+51	+558
oatmeal	195	185	339	375	-10	+36
maize	2730	2580	5953	11373	-150	+5420
Grain legumes	**45**	**44**	**63**	**71**	**-1**	**+8**
Oil plants which :	**1261**	**1432**	**1668**	**2990**	**+171**	**+1332**
Sunflower	1067	1068	1398	2135	+1	+737

Soy	80	69	104	151	-11	+47
Colza	105	286	158	686	+181	+528

Source: Statistic National Institute

UNCONVENTIONAL ENERGY

Knowledge of the mechanisms of drying processes has allowed the design and use of new technologies which extended drying period of storage of agricultural production and contributed to reducing energy consumption and fuel. The use of non-conventional energy future can be a solution if it improves processes capture and use of renewable energy. We define everything as an energy source that allows the production of useful energy directly or by transformation. We have two types of energy sources:

-renewable energy sources;

-non-renewable energy sources which are obtained from fossils fuels.

In this work is use renewable energy , heat pump and solar energy. Renewable energy sources can be expanded as existing in the environment, which can deliver continuously or at intervals of some, and the consumer does not get exhausted.

These energy sources are all around us, we must find oriented new technologies for the use:

- Energy obtained from the sun;
- Geothermal energy (ground);
- Wind energy (wind);
- Biomass, which can be obtained combustible gas or oil for biodiesel;
- Energy of rivers by building hydroelectric power or mills;
- Tides;
- Sea and ocean waves.

These energies are independent of human activity. Why not use them? We lack of technical support, technology. As we move increasingly more attention to renewable energy.At this moment we can only say:

-they are sources of clean energy;

- they are energy sources without danger of collapse;

- can be produced at the site of use without the need for transportation (this refers to small power equipment);

-non-waste for man or nature (if we take into account comments made by specialists in the Danube Delta on this observation should be considered wind turbines)

- does not generate greenhouse gas emissions.

Energy production from renewable sources is possible due to a major advances in Physics and Chemistry on solar energy or heat pumps use with heat fluids efficient.

Renewable resources will not have a major role in the production of primary energy than when :

-Will there is a balance between technology / cost;

- when charges put on the effects of fossil fuels will be unbearable (taxes on carbon dioxide emissions). Non-renewable energy sources is related material and may not be released thean after human activity (energy is related to coal, oil, uranium, oil shale…)

Why desired during the drying processes using the renewable energies:

- because the use of solid fuels are depleting sources;
- because the use of solid fuels pollute produce greenhouse gases;
- this type of resource requires imports (coal, oil);
- have low efficiency and are becoming increasingly expensive.

In this work we are focused on the use of heat pumps and solar panels.

Fig. 1.3 Experimental equipment used in experimental research 1- solar panel; 2- heat pump; 3-water tank; 4-fan-coil

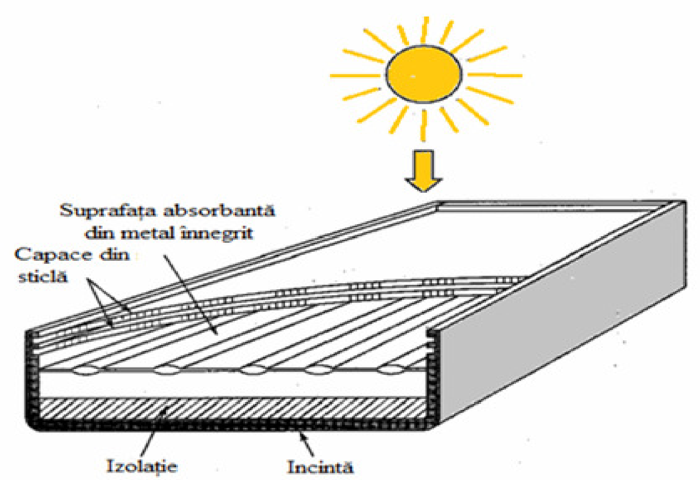

Fig 1.4 Solar panel

The system shown in FIG. 1.3. was used for drying the seeds of wheat, corn and sunflower. Determination of optimal temperature and duration of drying are the basical elements ensuring the quality of drying. The heat is received from the sun through solar panel and from atmospheric air using air-water heat pump.

- Cross section of a flat solar collector panel covered with two layers of glass;
- Heat is transferred to a fluid flowing through pipes fixed "intimate" absorbent surface

Making a solar heating does not require special technologies.

- Solar radiation is captured by a aolar collector
- This energy is transferred to a storage tank with a special fluid or distilled water.

Heat is transferred from the storage tank to the place of use which may be a fan coil for drying of cereals.

This type of equipment can be used in any place exposed to the sun. The results are outstanding for March-October

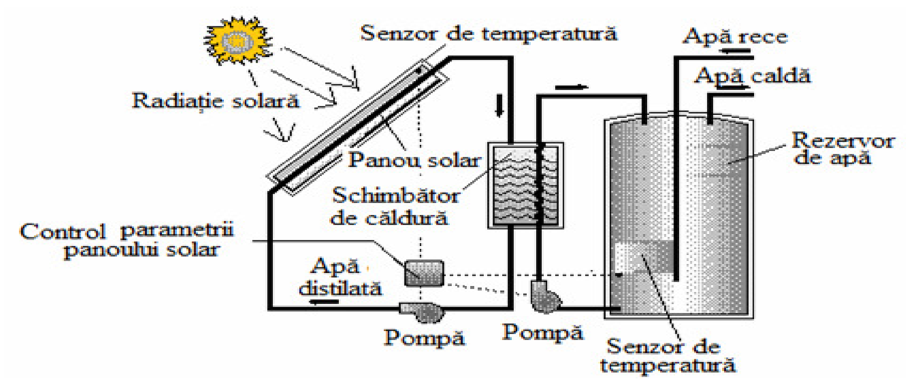

Figure 1.5 Installation of solar hot water

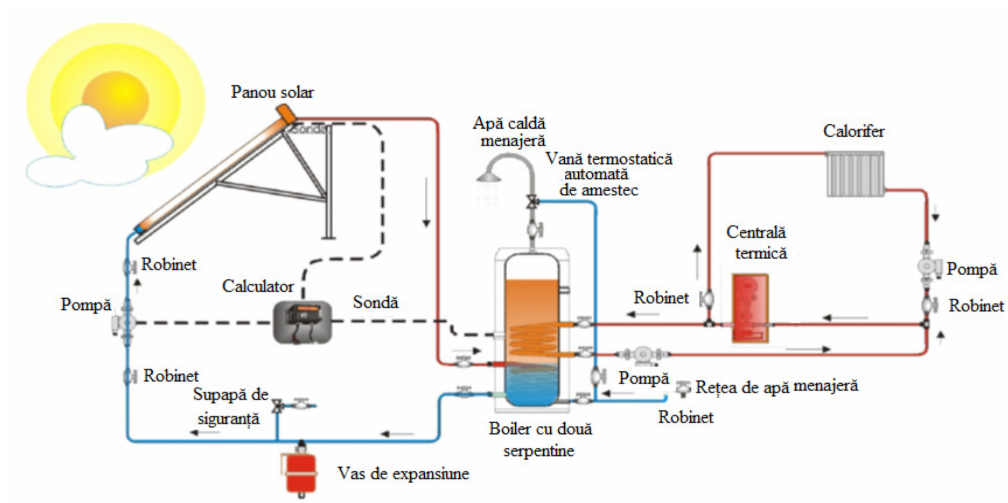

Fig.1.6. solar installation and boiler

Geothermal energy is heat various individual categories, contained in the earth's crust. The descends deeper into the earth's crust, the temperature rises and theoretical geothermal energy can be used more effectively, the only problem being represented by the depth at which this energy is available and the high salt content water content.

Geothermal energy is used on a commercial scale, starting around 1920, when it began to be used, in particular, heat geothermal waters, or that from geysers for heating, or commercial premises.

In modern systems are built wells in geothermal reservoirs and obtain a continuous flow of hot water. The water is brought to the surface by a mechanical system, and another whole it back to the pit after cooling, or discharged to surface.

Geothermal heating is used in countries such as Iceland. Despite the low temperatures recorded in this country, geothermal energy is used since the 1930s.

There are numerous examples of the use of geothermal energy for heating in the world. According to the WGC 2000 countries using geothermal energy are:
* Tunisia; * Hungary; * China; * Italy; * USA * Romania; * Japan; * Russia; * Iceland; * Bulgaria.

The advantages of using geothermal and factors influencing choice of technical solution:

- electric geothermal heating requires relatively simple installation, but can be added later computerized advanced facilities, the total climate conditioning;
- a good correlation between the place of use and low enthalpy geothermal resources;
- low enthalpy resources are common to many countries;
- economic competitiveness of geothermal energy for heating, especially in cold climates;
- the use of geothermal resources in combination with the existing fossil fuel for heating peak**.**

In our country, the only company with geothermal heating systems (greenhouses for tomato production) is Transgex Oradea. The heating system is composed of 4 tracks. The power supply used geothermal water, extracted from a deep drilling near the village of Livada Bihar. The heating system is used as a plate heat exchanger.

It may remind some other advantages to using geothermal energy:

–Low operating costs
- 300 to 400% efficiency;
- Special comfort ;
- Protect the environment;
  Not produce energy by burning fossil fuels;
  It regenerates continuously;
  Not a waste;
  Do not smoke or ash resulting;
  Safe operation;
  It does not remove carbon monoxide;
  No open flames or explosive.

Conclusions. Alternative energy sources, above, can be used successfully (a series of experiments and studies show it) for providing the necessary heat a greenhouse, residential heating, drying plants etc. Each alternative energy source has advantages and disadvantages:

Solar heating. The sun is the largest source of energy, inexhaustible and environmentally friendly. Solar heating systems cover only part of the heat requirement (10-60%), requiring additional heating systems for completion. The use of active solar heating systems still experiencing technical difficulties and economically. Passive solar heating technologies are more widespread, but it is not practical heating systems, but are only used to raise the temperature a few degrees.

Heat pumps may provide an opportunity to reduce heating costs due to their ability to efficiently convert heat from a power source with low temperature at a temperature much more useful. There are a number of possible configurations using heat pump technology and previous studies tested some of these systems.

Among the technical solutions presented our attention turned to the air source heat pumps to provide the necessary heat in a small capacity dryer. The electricity required to operate the heat pump can be obtained using photovoltaic solar panels.

To increase efficiency, the heat pump may be associated with solar panels. This system is practiced especially in cold areas, when recording very low temperatures and heat pump does not achieve the required parameters.

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THE EXPERIMENTAL STAND FOR DRYING CEREAL

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The experimental stand was designed and built in grain farm from Padea, Dolj county, where it grows wheat, corn and sunflower. The design and construction of the stand was made by the author through its own financial effort. Gauges and thermography measurements were performed in the laboratories of the Faculty of Mechanics and Chemistry of the University of Craiova. Due to the complex phenomena of heat and mass transfer, the present study theoretical and experimental approaches them both to indicate the optimal solutions and to establish relations of calculation used in the design of new equipments. The main focus in this paper was to demonstrate that it is possible to use renewable energy as a heat source: solar and heat pumps. To check the viability of using alternative sources of energy-energy heat pumps and sun energy I have designed and built an experimental stand which I used in farm specializes in the cultivation of cereals from Padea , Dolj county. We verified the mathematical relationships underlying the calculation of the seeds drying process. It was intended to maintain the temperature to values that do not compromise the ability of seeds to germinate.

The experimental stand. The first step in building the stand was choosing the type of pump to be used and the location. The first intention was that the location is in water pumping station for irrigation located on the banks of the Jiu river. We needed a water-water pump, because the heat source was the waterfrom the Jiu river. At this point it would be resolved the grain transportation problem to the location. For a ,, pilot "stand there were no particular difficulties , but for an installation with a large capacity for drying, the solution was not recommended for economic and transportation difficulties. It was accepted the idea of an air-water heat pumps with the location next to the intermediate storage cereals, fig.1

Fig.1 The location of the experimental stand

For execution experimental researches was chosen air-water heat pump type Railton RSI 12-1 Split. Being located outdoors there were no space restrictions or minimum distances from the walls of a room. To achieve the stand were considered heat pump manufacturer's recommendations, fig. 2

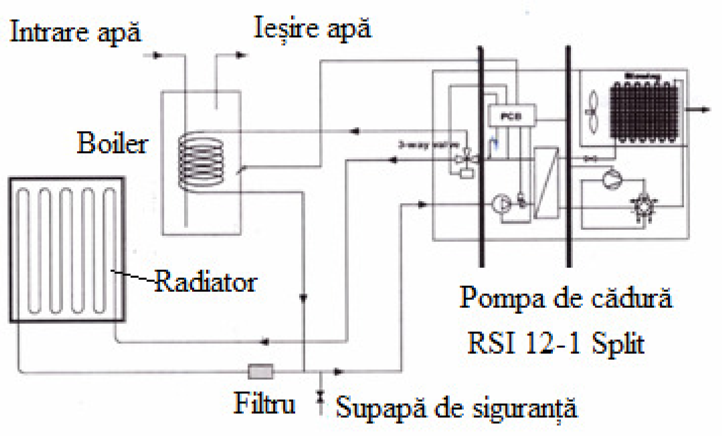

Fig. 2 Schematic diagram of the experimental stand.[1]

The heat pump uses refrigerant R410A 2.38 kg, used for thermo-physical properties (product description):

- Shape: Liquefied gas
- Color: Colorless
- Odour: Similar to ether
- pH: Neutral
- Boiling point / Boiling range: approx. -46.9 ° C at 1013 hPa
- Flash point: not applicable
- Vapor pressure: 12 750 hPa at 25 ° C
- Density: 1.079 g / cm3 at 25 ° C, (as a liquid)

The product is not flammable at ambient conditions of temperature and pressure.

Measuring and control equipment. For the fan coil chosen for this experimental stand it was by the condition imposed of the flow for drying agent. From theoretical study conducted maximum flow required for a particular type of heat pump is 900 m3 / h. The noise level is 455 dB and maximum air flow accomplished was 920 m3 / h. It had four operating speeds which allowed for the flow of the four experimental values. Hydraulic pressure drop 19 kPa - centrifugal fan - 4-speed asynchronous motor, insulation class B Power supply 230 V / 1 Ph / 50 Hz (catalog presentation).

The circulation pump used is Wilo ST20 type which is / 6-3P recommended for use in heating equipments, is a solar circulation pump with an wet rotor (made of polypropylene) with threaded connection (1), especially designed for use in solar thermal installations. The pump flaming is made of cast iron, protect by cataphoresis for external corrosion .Stainless steel shaft is mounted on bearings of carbon. Maximum pumping height: 6 m. Specifications: Voltage / frequency: 230V / 50Hz, protection class IP 44; minimum operating temperature: -10 Maximum operating temperature: 110C (120C for approx. 2 hours); 3-preselected speed . (Product catalog)

By using this type of pump it has been enable to accomplish several drying regimes.

Fig.3 Circulation of water in the heater cylinder

To ensure compliance with the preset operating modes it was use a differential thermometer,fig.4

The using of this type of differential thermometer enables the acchivement of a simple automation program Wilo ST20 / 6-3P. It has a protective function against overheating solar panels.

Fig. 4 Differential thermometer

Fig. 5 Moisture meter

Fig.6.Heater

Fig.7 Recorder JUMO LOGOSCREEN nt

- 144 x 144 mm format
- color graphic display 5.5 "TFT
- field control with knob or touch
- 3 ... 18 universal inputs measuring
- external extension interface with 24 channels
- Storage cycle 125ms to 18 analog inputs
- Measurement data storage on CompactFlash card / USB stick
- Representation of measured values in various diagrams and process images
- Representation of alarms and events
- Batch protocol up to 3 batches simultaneously
- Batch input possible through barcode reader
- Print function with respect to minimum, maximum, average
- Ethernet interfaces, PROFIBUS-DP, Modbus Master / Slave
- Webserver with integrated online and view Quadview
- 2 the selectable languages (Unicode)
- mathematics and logic function with counter / integrator
- evaluation of archived data through the PC evaluation
- device configuration via keyboard or software setup
- optional stainless steel front and sensory field

JUMO LOGOSCREEN nt represents a new generation of paperless recorders JUMO that stand out with a modular concept of measurement data collection (3 .... 18 internal inputs as possible), an innovative drive concept and with a high safety standard according to access control and security of stored data manipulation. In LOGOSCREEN nt can view data as measuring value curves or alphanumeric process images. To evaluate the archived data and the configuration software of LOGOSCREEN are not available proficient PC programs.

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RESEARCHES REGARDING THE OBTAINING PROCESS OF VEGETABLE OIL USING PRESSES

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ABSTRACT

Within this paper are presented the results obtained from the pressing sunflower seeds using a screw press having constant diameter, with circular holes for oil drainage and a single nozzle for cake outlet. From the results it was observed the dependence between the oil yield and the nozzle diameter, the variation of the oil percentage expressed along the pressing chamber and the influence of nozzle diameter on the specific energy consumed for pressing the material. The experimental results were subjected to regression analysis using Microcal Origin version 7.0 program.

1. INTRODUCTION

The raw materials for vegetable oils industry are the oilseeds which represent an important component of modern agriculture. From oilseeds it can be easily obtain highly nutritious human food and oil crops, and these products represent some of the most important commerce commodity. Vegetable oils are a major source of vitamins, calories and essential fatty acids for human consumption, obtained at a relatively low price, [2].

The process of oil extraction from oilseeds may be carried out mechanically by pressing, or chemically using solvent extraction methods, [9]. Screw pressing is used for oil recovery up to 90-95%, while solvent extraction is capable of extracting 99%. In spite of its slightly lower yield, screw pressing is the most popular oil extraction method as the process is simple, continuous, flexible and safe, [4]. Screw pressing, also called oil expression process, is the most common method for extracting vegetable oil from oilseeds in small and medium-sized plants, [8]. Nowadays, the largest amount of vegetable oil used in food industry is produced in large capacity industrial plants using solvent extraction, while the screw presses are mainly used for preliminary pressing of the seeds with a high content of oil. Screw presses are also extensively used to achieve virgin vegetable oil in developing countries and for obtaining vegetable oils used as fuel, [5].

Numerous attempts have been made to improve the efficiency of oil extraction through pressing, [10]. In general, three types of intervention have been studied: optimization of the operating parameters of the process, improvement of the geometric configuration of the press and pre-treatment of the seeds. However, many of these studies are the result of criteria based on experience and intuition of manufacturers and operators rather than on a rigorous theoretical analysis of the physical principles involved in the process, [3,12]. When discussing about screw pressing process, a number of parameters had to be taken into account for optimization of the oil production. After a thorough study on the scientific literature regarding the pressing process it can be said that the most important parameters which influence the pressing process are: screw speed [7,13], restriction size [6], hull content [15], moisture content [14], temperature [11] and pressure [1].

This study set out to evaluate the influence of nozzle diameter on oil extraction, the variation of the oil percentage expressed along the pressing chamber and the influence of nozzle diameter on the specific energy consumed for pressing the sunflower seeds using a laboratory screw press. Also, the experimental results were subjected to regression analysis using Microcal Origin version 7.0 program.

2. MATERIAL AND METHOD

For the experiments, a small capacitiy PU-50 oil press, with constant diameter and pitch of the screw, manufactured by STIMEL Timisoara, was used. The length of the oil outlet and collection zone is approximately 40 mm and for the cake discharge one central nozzle is provided, for each exhaust end. For the experiments were also used the following equipments: a digital scales (to measure weight), stop watch (to measure time) and wattmeter bridge QN 10 (to measure the power). The material used in experiments consisted of whole (undecorticated) sunflower seeds, from Procera PRO 229 variety, harvested in farms of Giurgiu County, Romania, with density of 410 kg/m^3 and moisture content of 4.9%.

The experiments were carried out in three stages, each stage using a different diameter nozzle (8, 10 and 12 mm) to the exhaust end of the press, which is equivalent to the variation of the pressure in the chamber. The amount of seed that was subjected to pressing in all the three cases was 15 kg, but the feed rate was different due to the different diameters of the nozzles. The oil outlet zone has been provided with a collector tray which has four equal compartments, as shown in Figure 1, in order to determine the extraction degree along the separation chamber.

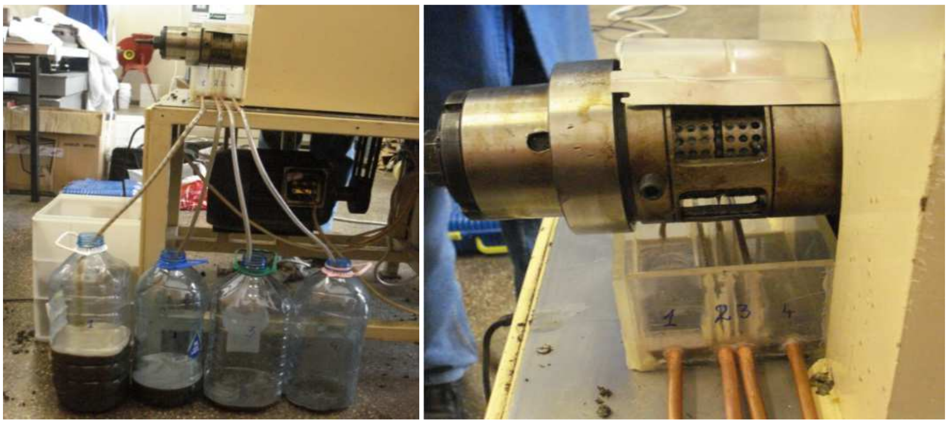

Figure 1: The collection of extracted oil in the compartmented tray

After each experiment, the expressed and collected material from the oil outlet zone, as well as the amount of cake press, was weighed. During the experiments the pressing time and the necessary power were measured. These measurements were performed with three material samples for each type of nozzle used and the inlet flow rate of the seeds (Q_S) and the specific energy consumption (E_{ms}) were determined using the following relations. The liquid material expressed was left to decant for three days, and then manually separated into two components: oil and impurities.

$$Q_S = \frac{M_S}{t_p} \quad \text{(kg/s)} \qquad \text{and} \qquad E_{ms} = \frac{P}{Q_s} \quad \text{(J/kg)} \qquad (1)$$

where: M_s represents the weight of the seeds (kg); t_p- the pressing time (s); P- the measured power (W); Q_s -the inlet flow rate of the seeds (kg/h).

3. RESULTS

Table 1 presents the values of the two fractions obtained at the decantation process, as well as the results obtained at the pressing process, while in Table 2 are presented the amounts of oil obtained in the four compartments of the collection tray. In Table 2 are also given, as percentages, the cumulatively quantities of expressed oil from the length of the separation zone. Analyzing the data from Table 2, it can be observed that in all three experimental conditions (nozzles of different diameters), the maximum percentage of oil obtained after decantation has not exceeded 20.8%, regardless of the nozzle diameter. However, the degree of expression increases dramatically with the decreasing of the nozzle diameter.

Table 1: Values of fractions obtained at pressing for the three exhaust nozzles, based on the weight of the seed sample (15 kg)

Nozzle diameter (mm)	Expressed material (oil+impurities) (kg)	Decanted oil		Impurities		Cake	
		(kg)	(%)	(kg)	(%)	(kg)	(%)
8	5.18	3.12	20.82	2.05	13.69	9.68	64.57
10	5.02	3.07	20.44	1.96	13.06	9.89	65.96
12	4.87	3.01	20.05	1.86	12.43	10.10	67.35

Table 2: Expressed oil quantities along the collection zone and the cumulatively oil percentages, for the three nozzles

	Expressed oil (kg)			Cumulatively percentage of expressed oil (%)		
Nozzle (mm) / Compartment	8	10	12	8	10	12
C1	2.79	2.82	2.84	20.82	20.44	20.05
C2	2.09	1.76	1.43	9.53	8.85	8.17
C3	0.28	0.34	0.40	1.15	1.78	2.41
C4	0.02	0.11	0.199	0.08	0.45	0.81

Given the complexity of the expression and separation oil process, for screw presses, as well as for hydraulic presses, has been attempted the mathematical expression of the degree of oil extraction on the length of the zone with holes for oil drainage. This was achieved by testing the variation of the experimental data by computer regression analysis using Microcal Origin vers. 7.0 program, with an exponential law, such as:

$$P_x = a \cdot e^{b \cdot x} \tag{2}$$

where: P_x (%) – represents the cumulatively oil percentage separated along the length x (mm) of the press separation zone; a, b – constants that depend on the working process parameters of the press and on the characteristics of the pressed material.

The analysis was carried out for each of the three sets of experimental data, meaning, for each of the three types of nozzles for cake outlet.

Analyzing the graph from Figure 2, it can be noticed that the first zone of the oil collection and separation chamber, the percentage of oil extracted is relatively low, which means that the pressure on the material is relatively low, especially if we taking into account that the screw press has constant diameter. In the second part of the collection zone, the percentage of extracted oil rapidly increases, reaching a maximum at its end, but not exceeding a value of 20.82% for any of the three cases considered.

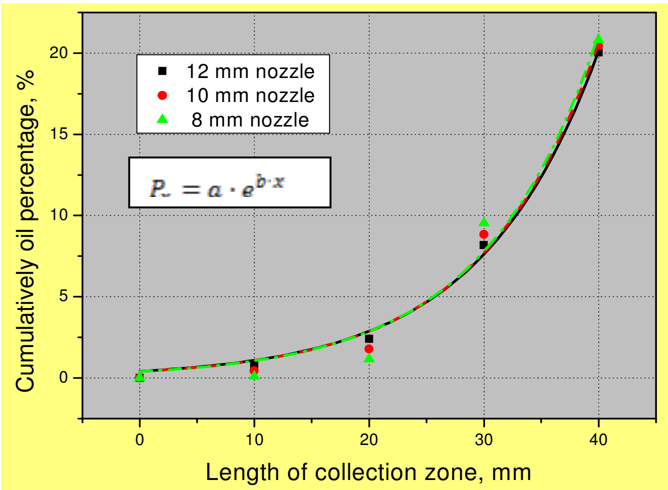

Figure 2: Variation of the cumulatively oil percentages along the collection zone, for the three nozzles, using the exponential distribution law

The coefficients values of the relationship together with the correlation coefficient values obtained by regression analysis are shown in Table 3.

Table 3: The coefficients values of the (2) regression equation and of the R^2 correlation coefficient, for the three nozzles types

Nozzle diameter (mm)	Coefficients of the (2) regression equation		
	a	b	R^2
8	0.389	0.099	0.978
10	0.398	0.099	0.990
12	0.410	0.097	0.997

After decanting the material collected through the holes of the outlet zone in the four compartments of the tray, quantities of impurities decanted were reported to the total amount of expressed material (oil + impurities discharged through the holes) and the percentages obtained are shown in Table 4, for the three used nozzles, cumulatively on the discharge zone. Based on these values, were graphically traced the variation curves (Figure 3).

Table 4: Cumulatively percentages of the decanted impurities, based on the amount of expressed material, for the three nozzles, along the collection zone

Collection zone length (mm)	Decanted impurities percentage, %		
	12 mm nozzle	10 mm nozzle	8 mm nozzle
0	0.00	0.00	0.00
10	1.58	0.86	0.17
20	4.89	3.62	2.43
30	16.50	17.52	18.49
40	38.26	38.99	39.68

As mentioned above, the amounts of impurities expressed together with the oil through the separating zone holes increases from the feeding area of the press to the cake discharge area regardless of the nozzle type, but the increase is higher for the nozzles with smaller diameter at the cake discharge. Obviously, these impurities are very small, smaller than the holes from the oil outlet zone.

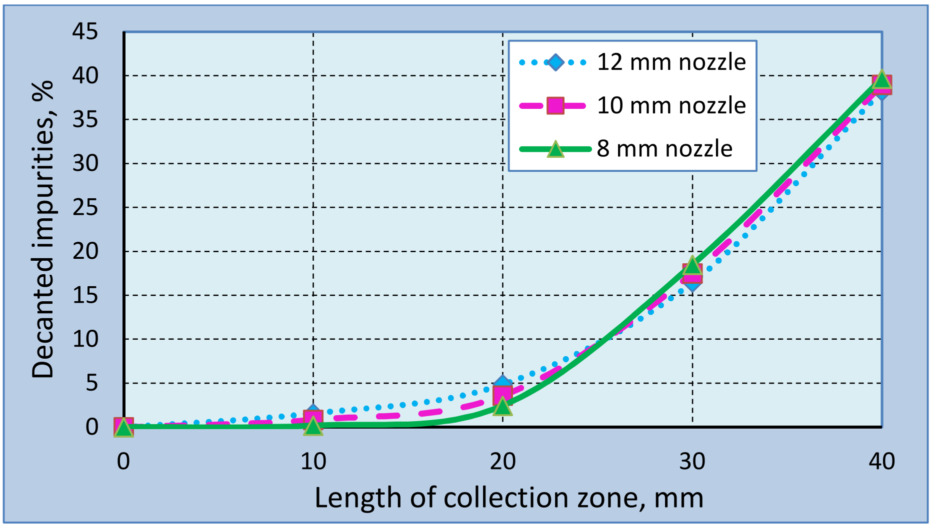

Figure 3: Variation of the decanted impurities percentage along the collecting zone, for the three nozzles

Table 5 presents the results obtained when measuring the necessary power using wattmeter bridge and calculated values for specific energy consumption, for the three nozzles used for experiments.

Table 5: The values of the necessary power and specific energy consumption from the pressing of sunflower seeds using a PU-50 screw press

Nozzle diameter, (mm)	Necessary power, (W)	Specific energy consumption, (Wh/kg)	Specific energy consumption, (kJ/kg)
12	1520	38,00	136,80
12	1480	37,00	133,20
12	1440	36,00	129,60
10	1596	42,00	151,20
10	1540	40,53	145,89
10	1490	39,21	141,16
8	1624	45,11	162,40
8	1600	44,44	160,00
8	1456	40,44	145,60

By regression analysis in Microsoft Excel on experimental data obtained (Figure 4), using the power variation law, was found that the best correlation was obtained for the second samples of pressed material (R^2 = 0.997). The values of the specific energy consumption at pressing was found between 129.60 and 162.40 kJ/kg. Also, it can be said, that the use of a nozzle for the cake outlet with smaller diameter leads to a higher consumption of specific energy for pressing the oleaginous material.

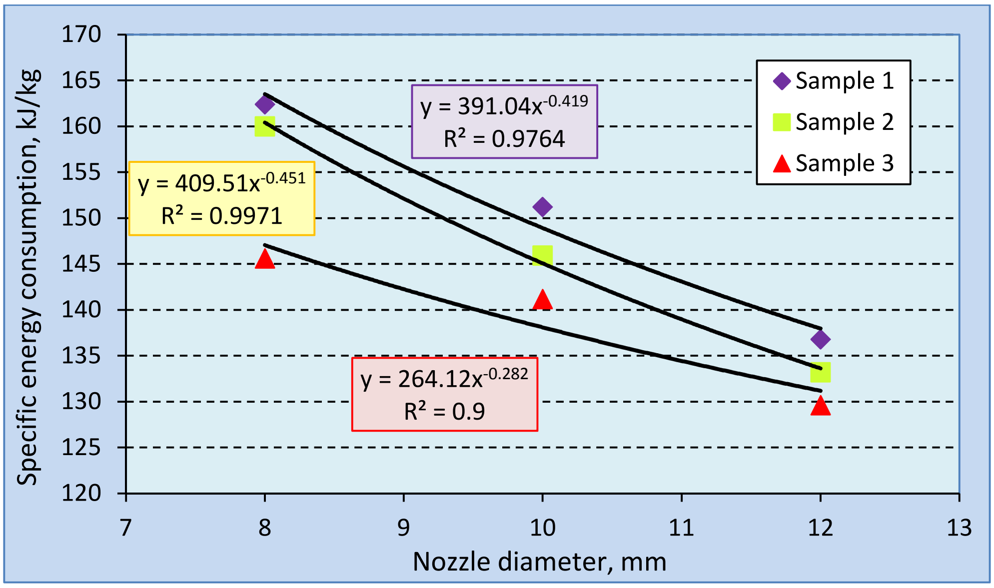

Figure 4: Variation of specific energy consumption with the nozzle diameter

4. CONCLUSIONS

As it can be seen from the experiments, the nozzle diameter has an important influence on the oil extraction yield, the specific mechanical energy and the oil content impurities during the pressing of sunflower seeds.

From the results, it can be observed that using a nozzle with smaller diameter the extraction efficiency will be higher, obtaining a higher quantity of oil and a press cake with less residual oil.

Percentage of expressed oil by pressing sunflower seeds had values between 20.05 and 20.82%, using nozzles with ϕ12 mm, respectively ϕ8 mm diameter, for cake outlet.

Figure 2, representing the oil distribution along the pressing chamber, shows that the distribution is not uniform. The percentage of expressed oil along the pressing chamber has a mainly exponential variation, regardless the nozzle diameter.

As we observed through the experiments, the diameter of nozzle directely affects the impurities/oil proportions. Figure 3 shows that using the 8mm nozzle type for the exhaust end it was obtained an oil with the highest rate of impurities.

Also, it can be said, that the use of a nozzle for the cake outlet with smaller diameter leads to a higher consumption of specific energy for pressing the oleaginous material.

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IMPROVE PLANT STAND AND CONSERVE ENERGY IN GREENHOUSE WITH LED LIGHTING SYSTEM

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ABSTRACT

Horticultural crops represent an important sector of the economy, generating approximately 25% of total crop production in our country. The vegetable food and ornamental crops in the greenhouse industry impose their own needs, significantly affect their ambient conditions in a nonlinear way. Crop lighting is an energy-intensive necessity of the greenhouse industry, particularly in seasonal photoperiod. Product supply and market demand determine wholesale prices that growers can expect to receive for their horticultural products. Apart from favorable climatic conditions for the production of vegetable farming Romania still lacks the requirements and facilities technical characteristics of the market economy. This any advantage that they can obtain farmers to reduce production costs while maintaining product quality and integrity is worth consideration. Our work presents a low-cost LEDs lighting control system, based on the Arduino hardware platform and a PID controllers, one of the most commonly used controller structures in the industry. This system was designed to be integrated in an environmental evaluation platform that will be used to manage the climate greenhouse.

1. INTRODUCTION

In the last few years, Light-emitting diodes (LEDs) represent a promising technology for the greenhouse industry that has technical advantages over traditional lighting sources, but are only recently being tested for horticultural applications. LEDs are solid-state light-emitting devices (fig. 1), and as such, are much more robust and longer lived than traditional light sources with fragile filaments, electrodes, or gas-filled, pressurized lamp enclosures (Bourget, 2008). Compared to traditional lighting systems existing in the horticultural industry, lighting, LED shows some advantages such as the possibility to control the spectral composition; ability to produce high levels of the light output for a long time, without the need for replacing them; low levels of radiation heat flux (Morrow, 2008).

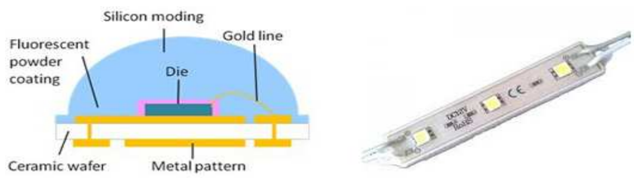

Figure 1. Solid-state light-emitting devices

Several studies and research applications involving the influence of light emitted by LEDs and light control in greenhouses have been performed by many researchers (Albright and Both (2000), Klaassen et al. (2005), Morrow (2008), Bourget (2008), Massa et al. (2008), Gómez and Mitchell (2012), Singh et al. (2014), Nelson and Bugbee (2014)). Use of new LED technology improved drastically over the previous growing conditions, with more uniform and consistent growth, better roots and stronger plants. The general findings of this research are: reduced cultivation time, higher controlled cultivation processes, an improvement in product quality and conformity, constant delivery all year round, more efficient use of space.

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Scientists at Purdue University experimented with LEDs to compare year-round crop production with supplementing light vs. traditional overhead HPS lighting vs. high intensity red and blue LEDs. The results showed that an LED lamp needs only 2.83 kWh per day to provide the correct amount of light in the wavelengths required. For the same amount of light an HPS lamp needs 6.42 kWh per day – a increasing of 56%. This shows significant savings in energy, and therefore money, which provides an advantage to the greenhouse industries to compete with production at low cost. In addition, as technology progresses LED potential benefits in terms of promoting vertical farming are great, opening door concept of urban agriculture where farmers can grow crops in multi-storey warehouses, near to where of consumption.
This works implements a PID controller with the ATmega328 microcontroller in order to control the brightness of a LED light by varying its input voltage. The PID controller compensates any differences between the input and the desired value by adjusting the duty cycle of the voltage to the LED making the lamp glow brighter or dimmer. This voltage will remain constant until the next sample is taken from the sensor light and the controller varies the voltage again based on the PID algorithm. This process is done again several times in the same way until the desired brightness is achieved.

2. METHODOLOGY

Light is a form of electromagnetic radiation that is visible to the human eye. A small fraction of the total electromagnetic spectrum that includes gamma rays, x-rays, and radio waves (fig. 2), is the radiation that we perceive as sunlight or the visible spectrum.

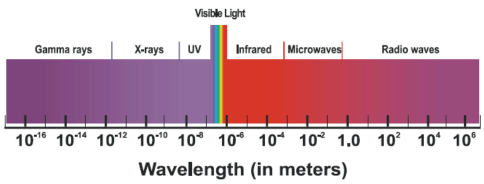

Figure 2. Electromagnetic spectrum

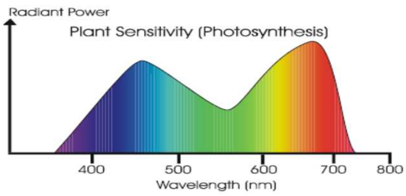

Figure 3. The emission spectrum of plant receives

Plants respond strongest to blue and red light for **photosynthesis** (fig. 3) and to red and infra-red light wavelengths for photoperiod growth responses and germination control. Within the chloroplasts of plant cells, light energy is used to convert atmospheric carbon into carbohydrates in a process called photosynthesis (fig. 4). Photosynthesis, flowering, climate response and plant shape are strongly influenced by the intensity, duration, direction, and spectral quality of light radiation that plants receive.

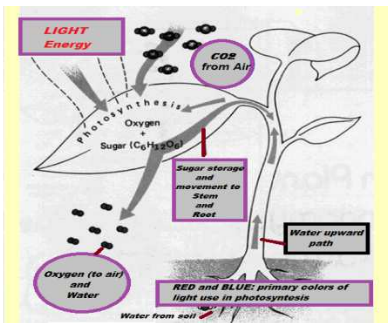

Figure 4. Plant photosyntesis

Figure 5. Greenhouse experimental stand

LEDs Lighting systems can be operated automatically using complex integrated controllers or simple time clocks. When integrated controllers are used it is possible to control the operation of supplemental light systems by a number of parameters including: ***time*** for photoperiod

control (cyclical lighting, supplemental lighting duration control); ***light*** for integrated daily light levels or instantaneous radiation set points and ***CO2 level synchronization*** (Argus, 2010)**.** Greenhouse experimental stand is schematically shown on figure 5.
The proposed control system has two main parts, hardware and software. The main component of hardware section is the **Arduino Uno**, a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), a 16 MHz ceramic resonator, a USB connection to simply connect it to a computer with a USB cable. Light sensor information is a key factor in integrated control systems, since the amount of light received influences all climate variables. ***Grove TSL2561 Sensor*** (fig. 6), a high second-generation ambient light sensor devices, contain two integrating analog-to-digital converters (ADC) that integrate currents from two photodiodes. Integration of both channels occurs simultaneously.

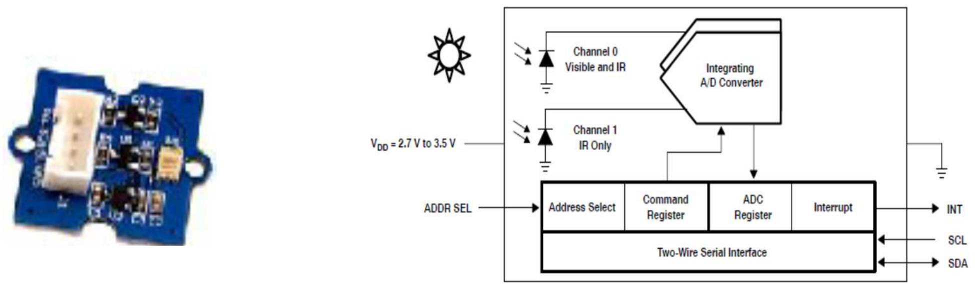

Figure 6. TSL2561 light sensor

Upon completion of the conversion cycle, the conversion result is transferred to the Channel 0 and Channel 1 data registers, respectively. The transfers are double-buffered to ensure that the integrity of the data is maintained. Typical characteristics of TSL2561 photodiode sensor are presented in fig. 7.
Regarding the software, there are two main programs developed: the Arduino Firmware, which controls its operation, and an Application Programming Interface (API), which communicates with the Arduino, controls the acquisition process, allows the access to the collected raw data and enables high-level applications to access both the device and the data.
PID controllers are probably the most commonly used controller structures in industry. It is based on mathematical modeling of the response of a loop process to be controlled, that join proportional, integral and derivative actions, thus causing the error signal is minimized by proportional action, integral action and cleared by a speed obtained with the preemptive derivative action (Astrom and Hagglund, 2004). The PID controller contains three of the most important controller structures in a single package (fig. 8). The parallel form of a PID controller can be described by a transfer function:

$$C(s) = \frac{U(s)}{E(s)} = K_p + \frac{K_i}{s} + K_d \cdot s = K_p \left(1 + \frac{1}{T_i \cdot s} + T_d \cdot s\right) \quad (1)$$

where: K_p - Proportional Gain; K_i - Integral Gain; T_i - Reset Time ($T_i = K_p/K_i$); K_d - Derivative gain and T_d - Rate time or derivative time ($T_d = K_p/K_d$).
In our work, we performed indoors brightness control with Arduino. We developed a code that runs the illumination using an algorithm of PID control provided by incredible library written by Brett Beauregard.

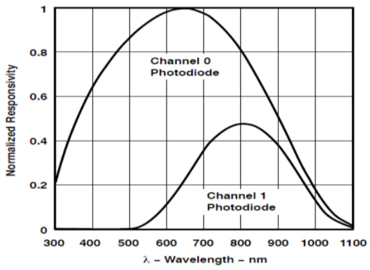

Figure 7. Spectral responsivity

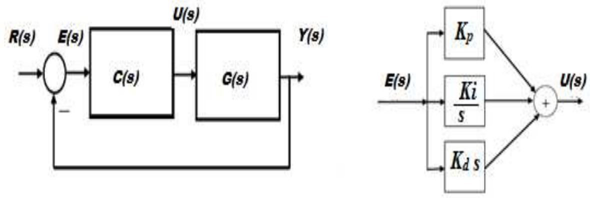

Figure 8. Parallel Form of the PID Compensator

Also, to configure control parameters such as K_p, K_i, K_d, reference value or working methods, we used a graphical user interface (GUI) programming environment built in Processing, easy to implement and very friendly Arduino environment.

3. RESULTS AND DISCUSSION

The experiments were organized in the springtime of 2015, in March-April. As vegetal material, we used Green Peppers (Capsicum annuum), which were put to grow in the laboratory greenhouse, in uncolored plastic casseroles, having the size of 38 cm in length, 26.5 cm in width and 28.5 cm in height. The substrate for growing plants flower soil type was obtained by processing FLORISOL black peat deposit Dersca-Dorohoi with the following physical-chemical parameters: organic matter in 68-70% dry weight, pH value 6.8-7.0, nitrogen (about) 410, 192 phosphorus (ppm) potassium in 1350 (ppm). Soil moisture was maintained at 40 ± 3%.

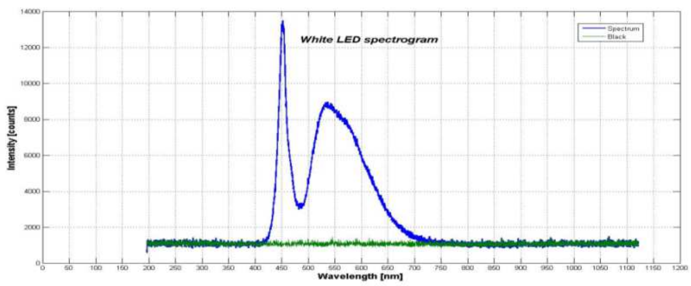

Figure 9. Emission spectra of the white light produced by LEDs

The growth of plants was followed over 10 days, period in which the cultures were either illuminated with natural light and LEDs, the light intensity setpoint was maintained at a range value of 80-100 lx. The natural light treatment consisted of placing the plants on the greenhouse bench located near a window facing west. In figure 9 there are presented the emission spectra of the light produced by white LEDs. The Light-Emitting Diodes (LEDs) of high intensity, used for the realization of lighting installations, had a 3.2 mm in diameter (superbright 5050 smd LEDs). The white LED Light Bar is a pre-packaged strip of 3 high-output LEDs powered by 60mA @ 12V, whit a service life more than 40000 hrs. The relative humidity of the air from the laboratory greenhouse varied between 60-80%, the ambient temperature was of 24±1°C and was also controlled throughout the experiment, day and night. LEDs light intensity was adjusted using a PID controler represented schematically in figure 10. The PID controller uses a feedback loop to control the PWM output of the MCU. Within this loop, the controller uses a combination of the previous output, the current error, and the previous two errors to estimate what adjustments must be made to reach or maintain the desired output. If the controller is reading a smaller luminescence than the desired value, the duty cycle of the output signal will be increased, if it is lower, it will be decreased.

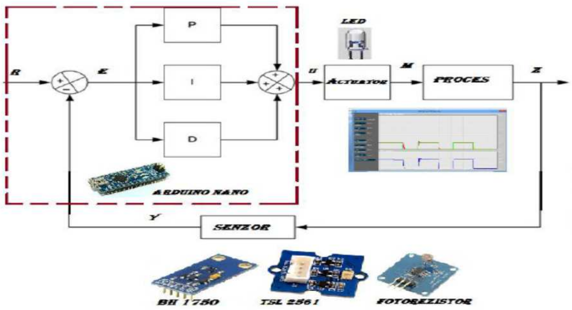

Figure 10. System block diagram

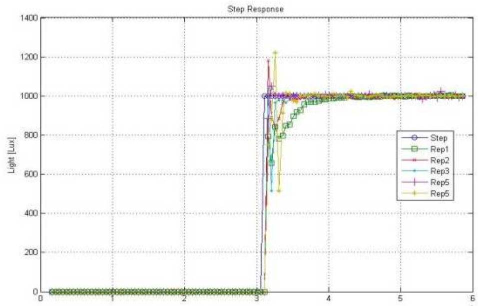

Figure 11. Step response family of the PID Light controller ***(K_p=0.2, K_i=variable, K_d=0.02)***

There are many versions of a PID controller, but in this paper we consider a controller described by:

$$u(t) = K_p\left[y_{sp}(t) - y_p(t)\right] + K_i \int_0^t \left[y_{sp}(\tau) - y_p(\tau)\right] d\tau + K_d \left(\frac{dy_{sp}(t)}{dt} - \frac{dy_p(t)}{dt}\right) \tag{2}$$

where u is the control variable, y_{sp} the setpoint and y_p is the process variable, i.e.. Tests were performed to the final system, to check and evaluate its validity. Various scenarios and possible conditions that occur in the field was tested using the systems such as manual and automatic management mode. There are several prescriptive rules used in PID tuning. An example is that proposed by Ziegler and Nichols in the 1940's and is described in their research note by Astrom and Hagglund (2004) or Grif (2006). To find the parameters of the PID controller was performed an classical experimental tuning method combined whit a own experimental algoritm.

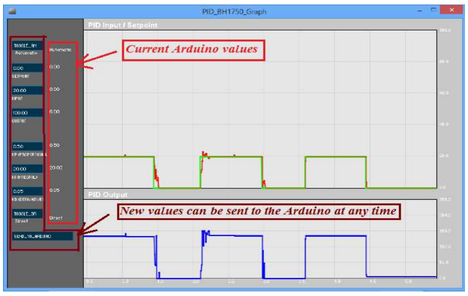

Figure 12. Processing PID system control (GUI)

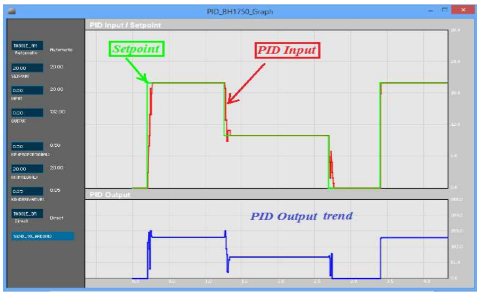

Figure 13. Control test

Value of input was carefully observed as the collected information either online mode. Keeping constant the values of K_p=0.2 and K_d=0.02 was acquired the step response family of controller for different values of the K_i (0.1 - 0.75). The increasing of the K_i will produce a decreasing of the transient response duration but will produce increasing of the overshoot. Analyzing the step response family from fig. 11 we have chosen for the integral gain the value K_i=0.2. Once the system was complete, several tests were run to observe the response of the system to a changing reference level. The figure 12 and 13 shows these control examples; tests run with the complete system at K_i values of 0.2.

Figure 14. System responds to a high setpoint value

In addition, Figure 14 demonstrates how the system responds to a high setpoint value; when the controller requests too high a value, the system will simply rail at a 70% duty cycle. The main advantage of PID controller is reflected in the resulting control signals (represented by red line in figure 14). It is clear that the PID controller has a very large robustness measures, due to small integral actions. Optimizing photosynthetic radiation level specific plant species and modeling their morphology and chemistry is great potential in the development of lighting control system. In order to understand the effect of different spectra (using LED) on the physiology of plants are necessary, however, more detailed scientific studies. Are required also technical innovations to design and build energy-efficient light sources with a specifically adapted for optimal growth range of different plant species.

4. CONCLUSIONS

Although lighting is essential for crop production in the greenhouse, is a parameter of the variable, and one of the most difficult and costly to set. At all stages of the design of a greenhouse should be considered for both its lighting and climate effects of light. Environmental control strategies must be used indoors to maximize the benefits of light on plant production time and reduce the negative consequences associated with the variability of light. Design simple and unsophisticated implementation of a stable system of automatic control microcontroller is good reason to recommend that such systems are used in applications for light control in greenhouses.

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THE INFLUENCE OF DIESEL CONCENTRATION ON SOIL MICROBIOTA

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ABSTRACT

The influence of diesel presence in soil is quite big on the local microorganisms. The present research tries to underline the influence that an organic pollutant can have on soil microbiota depending on the concentration and on the time that remains without being removed. The study was focused on diesel, a well encountered fuel that usually can be found around the extraction and distribution points of petroleum products. Two types of soils were tested, one type was taken directly from nature, and one was a soil that can be found on the market. The contamination with diesel was different, of about 1%, 5%, 10%, 15% and 20% and the monitoring was done after each week of contamination.

1. INTRODUCTION

Lack of attention to soil degradation can be seen not only in the lack of European directives or soil protection targets, but also in the scarcity of data. While, for instance, 300,000 sites across the EU have been identified as definitely or potentially contaminated, the best estimate is that there are 1.5 million contaminated areas [1].

A wide range of contaminated sites exists as historical contaminated sites. This type of contamination of soils often occurs because of their use by industry and by processes and practices, which by current environmental standards would be judged inadequate. Although much of the contamination caused by these methods occurred since the beginning of the Industrial Revolution, some examples of much older contamination are known [2,3].

That potential hazards can arise from the addition of chemical substances to soils is probably not a matter of dispute. There is, after all, a widespread knowledge that altering the chemical condition of a soil will affect plant life and that substances deposited on land can later migrate to streams and rivers, and then enter the human food chain [1, 2, 4].

Environmental pollution is considered a serious problem in Europe, and it has been regulated by several directives and regulations, with the purpose to limit the amount of pollutants that reach the environment.

Although microorganisms are the most diverse and abundant type of organisms on Earth, the progression of microbial diversification and the distribution of microbial diversity from small scales such as micrometer and millimeter scales, up to large scales such whole landscapes or even continents, has been poorly documented and is little understood [3,4]. The analysis of historical and recent advances in this scientific field shows a “step-by step” evolution in both methodologies and concepts which has occurred.

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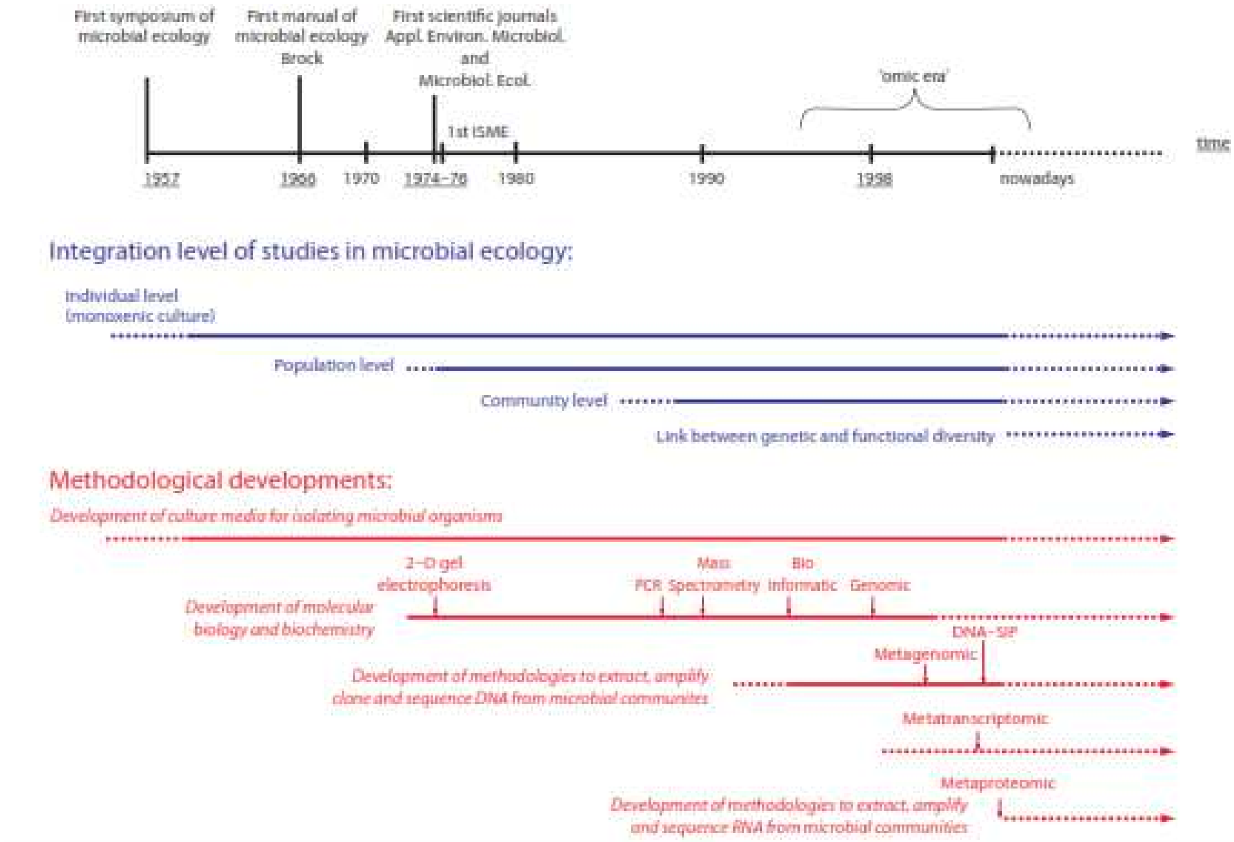


Figure 1. Historical and salutatory evolution of microbial ecology [3]

2. METHODOLOGY

The experimental research was performed in a laboratory and the idea was to see how much the diesel influences the development of microorganisms once the pollutant has entered the soil. In order to see how the microbiota is influenced, the Koch method was used. In the following this methodology of using Koch method will be described.

Koch method consists in seeding of a given volume of the cell suspension/or solidified culture medium in Petri plates and, after an incubation period, the colony count is done considering that each colony is resulting from the multiplication of a single cell. Plate cultivation method is very often used to determine the number of live microorganisms from a product and allows at the same time, a qualitative analysis by studying morphological characters of the developed colonies. Usually it is used the decimal dilutions of the analyzed product [4].

The result is expressed in CFU (colony forming units), as there may be more crowded cells that are forming a colony, and for fungi fragments of multicellular hyphae can appear. In addition, there are plenty of isolated cells that do not form colonies. The plates that are containing between 30 and 300 colonies will be chosen.

The culture medium that is contained in the Erlenmeyer flask is placed in order to melt on a water bath. After complete fluidization, will be introduced for incubation at 45 ° C.

Using a sterile pipette, three dilutions of the samples are prepared and then harvested 1 cm^3 of these dilutions, and by releasing the sterile Petri plate, will be allowed to pass only the pipette and drain the contents.

Over the suspension volume the sterile culture medium is added to 42-45° C and immediately the homogenization with the medium is done by using a horizontally rotating plate, and after it is left to solidify the medium and fix the cells. It is recommended that from the same dilution to make the seeding in two parallel plates.

Seeded media plates are placed to incubate at 37° C, in order to help the growing of microorganisms. Counting of colonies will be made after 72 hours. The plates that are chosen for counting must have the number of colonies in the range of 30-300, where possible. If colonies are dense, to facilitate the counting, the Petri plate is reversed and placed on the counter of colonies TITRIPLAQUE.

At the culture method, all operations are executed carefully avoiding any source of infection with foreign microorganisms, which would influence the outcome of the analysis.

The number of colony forming units is given by the following formula:

UFC / mL = no. colonies X dilution ratio

3. EXPERIMENTAL RESEARCH

The experimental research consisted in testing five concentrations for the pollutant. These concentrations were 1%, 5%, 10%, 15% and 20% of diesel in soil.

For the experiment it was decided to use two types of soils:

- one type of soil extracted from a natural area, a garden, identified as S1.
- one that can be obtained from commerce and it is used for flower planting and because of that contains a larger quantity of humus, identified as S2;

The Koch method was applied for all four concentrations (for each type of soils) and also for a blank sample from each type of soil.

This research will have two stages, one in which we see the influence of pollutant concentration on soil microbiota after an artificial contamination, and a second one that involves the same method but this time, will use plants that have been removing diesel contaminant from soil, and see how the microbiota is influenced also. In this paper only the results from the first part of the research will be presented.

The analysis were performed in the Microbiology Laboratory from Faculty of Biotechnical Systems Engineering of University Politehnica of Bucharest.

Each type of soil was artificially contaminate with diesel. The contaminant was procured from local fuel station. After the contamination each sample was mixed very well and left for a week to homogenize. The initial analysis were done after the sample were in contact with the contaminant for a week.

Each time the method was applied, the main steps were the followings:

- 1 mg of contaminated soil (or clean one for the blank sample), was weighted and combined with 10 ml of water;
- 1 ml of the combined sample from the step 1, was extracted and combined with other 10 ml of water;
- at the end 1 ml from the second solution was extracted and put on the Petri plate;
- the next step was to insert the environment needed to develop the microbiota, and homogenized the sample through circularly movements and left it to solidify;
- the Petri plates were introduced at 25^{0}C and after 24 hours the colony number was determined.

In figure 2, some picture during the preparation of Petri plates are presented.

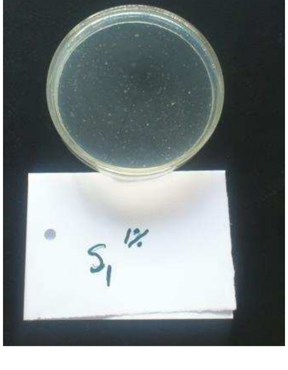
a) **b)**

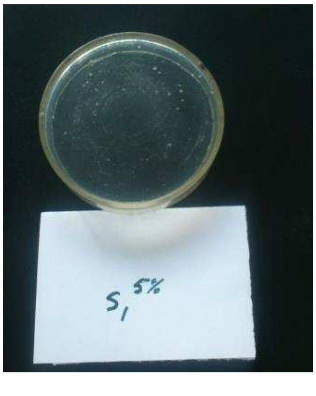
c) **d)**

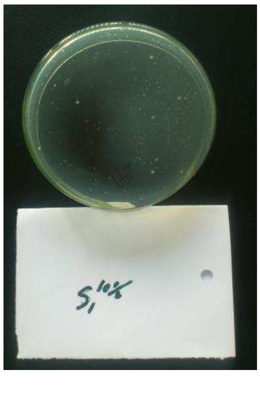
Figure 1: The sample preparation for Petri plates (a- the contaminated samplea and the blank ones, b- the weight of 1 mg for the first step of dilution, c- the dilution with 10 ml of water, d- the mixing after each dilution)

The monitoring was done for a period of 4 months after contamination, but the first analysis were performed after the first week of interaction between contaminant and soil. So, the initial values will be considered the ones measured after one week.

After each week the analysis with the Koch method was done and the number of the colonies were counted and a photo of each Petri plate was done (see figure 3 and figure 5). After the UFC was calculated for each sample, that is the colonies number was multiplied with the dilation ratio (in our case was 1000), it can be observed the influence of the pollutant concentration on the local microbiota. The variation of the results for each type of soil, is presented in figure 4 and figure 6.







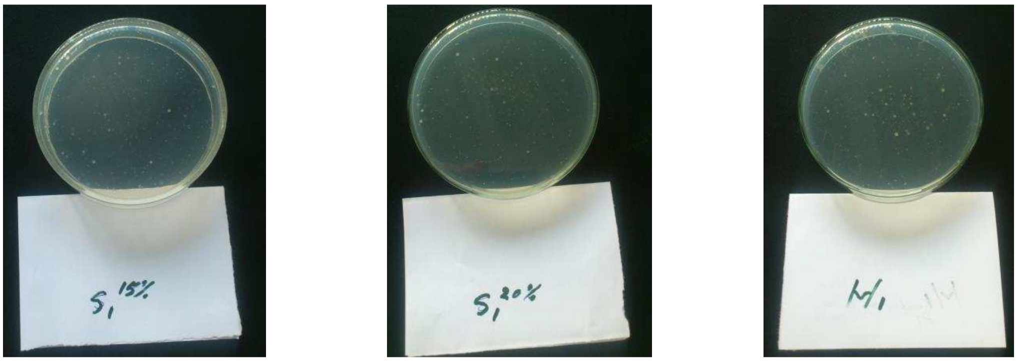


Figure 2: Petri plates after 3 weeks of contamination for soil S1 (where M1 is the blank sample for soil S1)

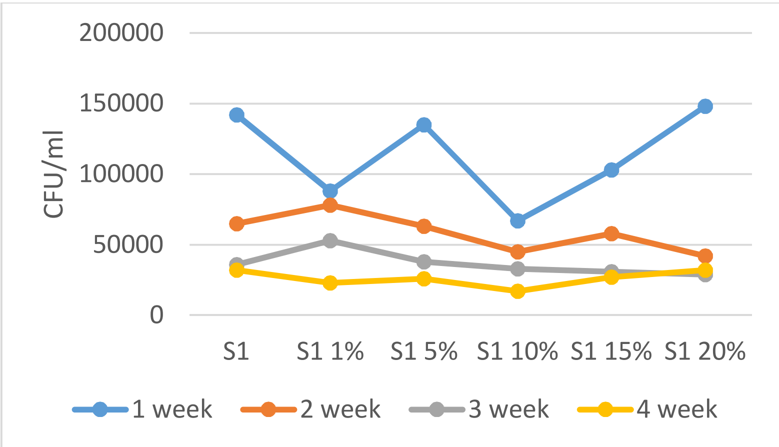


Figure 3: CFU/ml variation in time

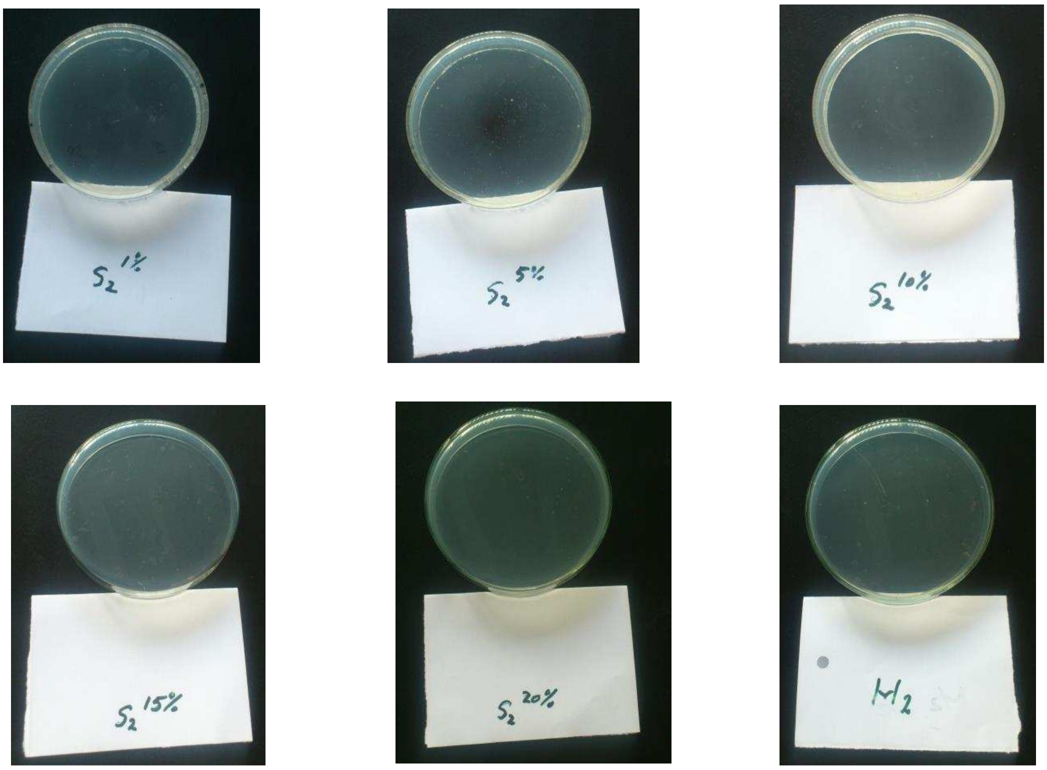


Figure 4: Petri plates after 3 weeks of contamination for soil S2 (where M2 is the blank sample for soil S2)

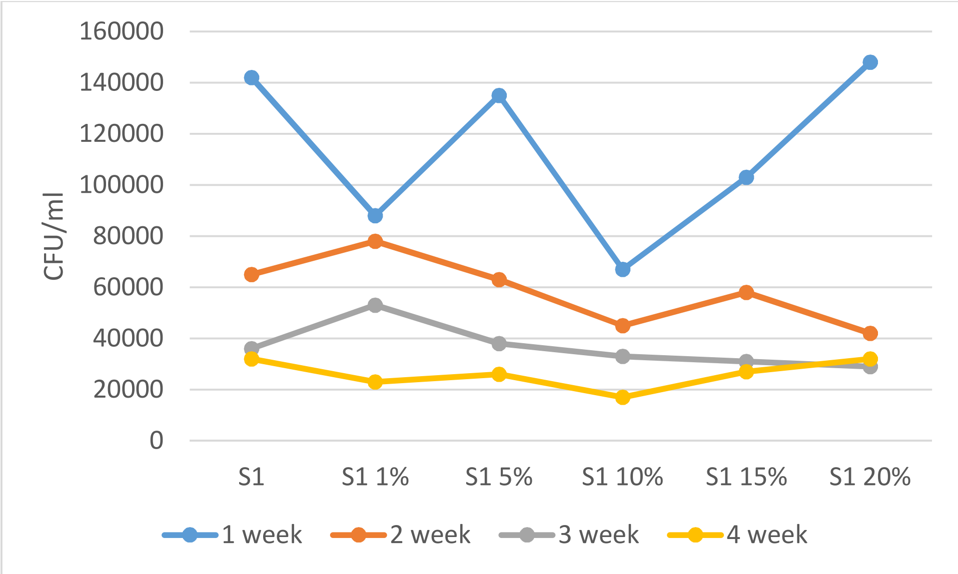


Figure 5: CFU/ml variation in time

4. CONCLUSIONS

The contamination of soil with any types of conventional or non-conventional fuel, has a negative impact on the biological activity.

From the UFC variation can be observed that as the time passes the pollutant influence on soil microbiota is quite big. The UFC/ml characteristic for each sample decreases with the time passing. The highest decrease can be observed for the pollutant concentration of 20%, which is quite normal, but also for S1 soil we have a big decrease for 5% pollutant concentration.

The values of UFC after 4 weeks of contamination for each type of pollutant concentration is quite similar, which may signify that the samples eventually will adapt to the new environment. The problem that appears is the high difference between the initial values of UFC and the ones after 1 month of contamination.

The problem could be partially resolved if the contaminated soil will be mixed with a clean soil in order to repopulate the biological environment.

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THEORETICAL CONSIDERATIONS ON THE INFLUENCE OF THE INCLINATION ANGLE OF THE KNIFE OVER THE POWER OF AN EQUIPMENT FOR CHOPPING FODDER

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ABSTRACT

Harvesting forage plants represents a very important process in preparing animal feed and their growth, having a determining role in nutrition of the population, while also constituting a strategic feedstock for the food industry.

Therefore it is necessary to accomplish the optimal harvesting conditions of fodder for ensiling, to achieve a good quality feed.

This paper proposes to approach aspects related to the influence of the knife inclination angle of chopping drum on chopping power needs.

1. INTRODUCTION

By forages (fodder) we understand all products of vegetable, animal, mineral and synthetic origin, used in animal nutrition, determined to ensure their vital functions and putting in value their productive potential. [1]

Fodder crops represents a especially important group of cultures for the national economy, through the large plant mass production of great qualitative value. [2]

Ensuring good quality fodder all year round is one of the main concerns of livestock farmers, who, in order to reduce costs, minimize losses in forage harvesting and obtaining higher nutritious qualities of material, they implement modern methods (technologies) for harvesting and conservation fodder, using combined technical equipment that performs multiple operations on a single pass. [5]

Harvesting using combines, is one of the most important methods of harvesting of fodder harvesting technologies for ensiling, which enhances their digestibility and eatable proprieties, and is, at present, the solution with the most significant advantages as, in this case, we obtain high quality fodder, ensuring complete mechanization of the harvesting process and allow execution of work in a short time with minimal losses. [4], [6]

2. METHODOLOGY

Compared with the cutting of homogeneous bodies, at the green forage chopping can also appear processes caused by the the structure and properties of the plant, which is a non-homogeneous material. In addition, the layer of material submitted for mincing consists several plants, which direction is not uniform in relation to the feeding direction. Vegetation and plant moisture status strongly influence their cutting process.

3. RESULTS

The influence of the knife angle on chopping power: depending on the elasticity of the material (fodder) the pressing process before chopping is shown schematically in figure 1 [3]; the diagram shown in figure 1a) is valid for inelastic materials (corn) and the scheme shown in figure 1b) is valid for strong resilient plants (herbs withered).

During the chopping process, the trail (path) of the blade h at the pressing point $h = 0$, when the knife touches the plant and reaches $h = h_T$ the pressing force is maximal. After completing h_T space the pressing force is maximum and the chopping force occurs.

On the h_s chopping portion is active the maximum chopping force F_{Tmax}, which then decreases rapidly when the knife and counterknife are at the same height (finally the knife traveled the trail h_0).

In the case of an less elastic forage (fig. 3a) the chopping process begins after a short pressing of the material, according to the h_T displacement, thus the plant it's pressed until the tensions inside the material becomes greater than the maximal supportable tensions.

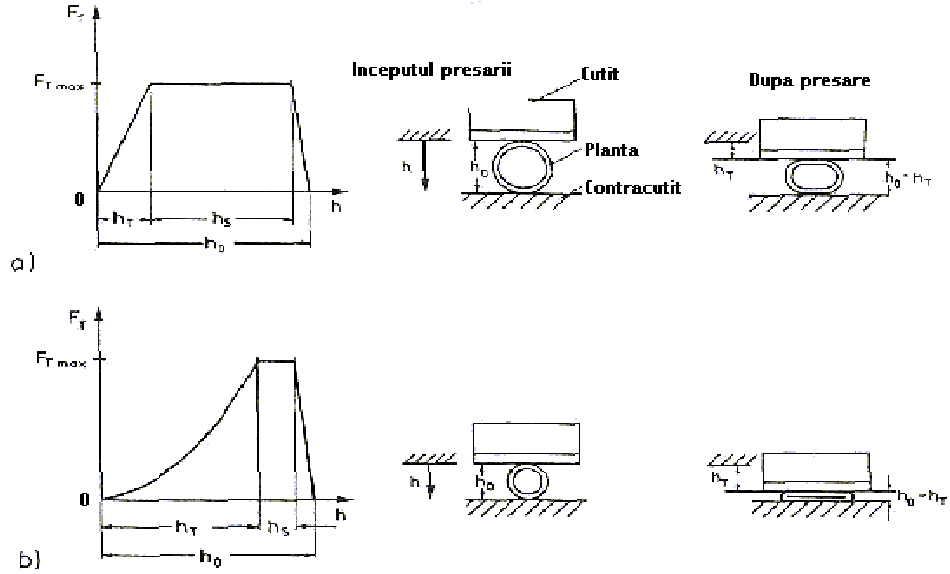

Figure 1: The pressing process of the material before chopping, depending on the elasticity a- inelastic material; b- elastic materials [3]

At the elastic forage, the maximal supportable tensions, reach until after a preliminary stage of long pressing. As a result, the space h_s is shorter and h_s/h_0 is much smaller than inelastic materials.

In the figure 2, are shown, schematic the forces that are interacting on a knife at normal cutting (fig. 2a) and at cutting with a inclined knife at angle λ (fig. 2b). At normal cutting, the knife is crossing the height h_o of the layer over the entire width b_w.

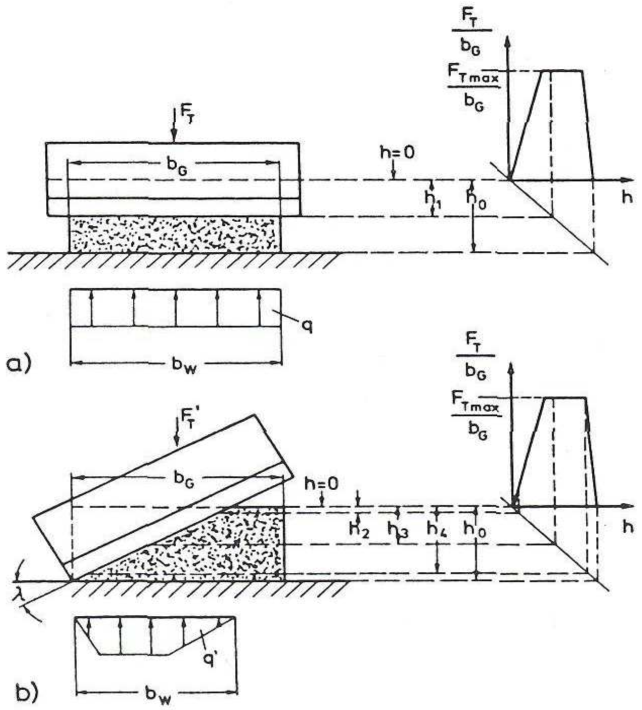

Figure 2: Forces that are interacting on a knife
a) normal cutting;
b) sliding cutting.

In the normal cutting case (fig. 2a), the chopping force F_T is uniformly distributed across the width of the material b_w, it results an uniform loading q along the length of the blade. [3]

At the cutting with a inclined knife at angle λ (fig. 2b), the cutting of the layer of the material is made with sliding, in wich case the knife load q' is not constant and it depends on the cutting space. The total chopping force F'_T at the sliding cutting results as a surface load q', composed of infinitesimally small forces.

Cutting phases (chopping) for sliding cutting are shown in (Fig. 3a, b, c, d) and the variation of the cutting force is shown in figure (3e). [3], [6]

The total area h_{tot} traveled by the knife from the first touch of the material to the finished cut is given by the relation:

$$h'_{tot} = h_Z + h_0 \tag{1}$$

where h_0 is the thickness of the material;

$h_Z = B \sin\lambda$, the space traveled by the point E of the blade until it reaches the layer, position c) (3ig. 3 a)

$$B = \frac{b_G}{\cos\lambda} \text{ the width of the blade} \tag{2}$$

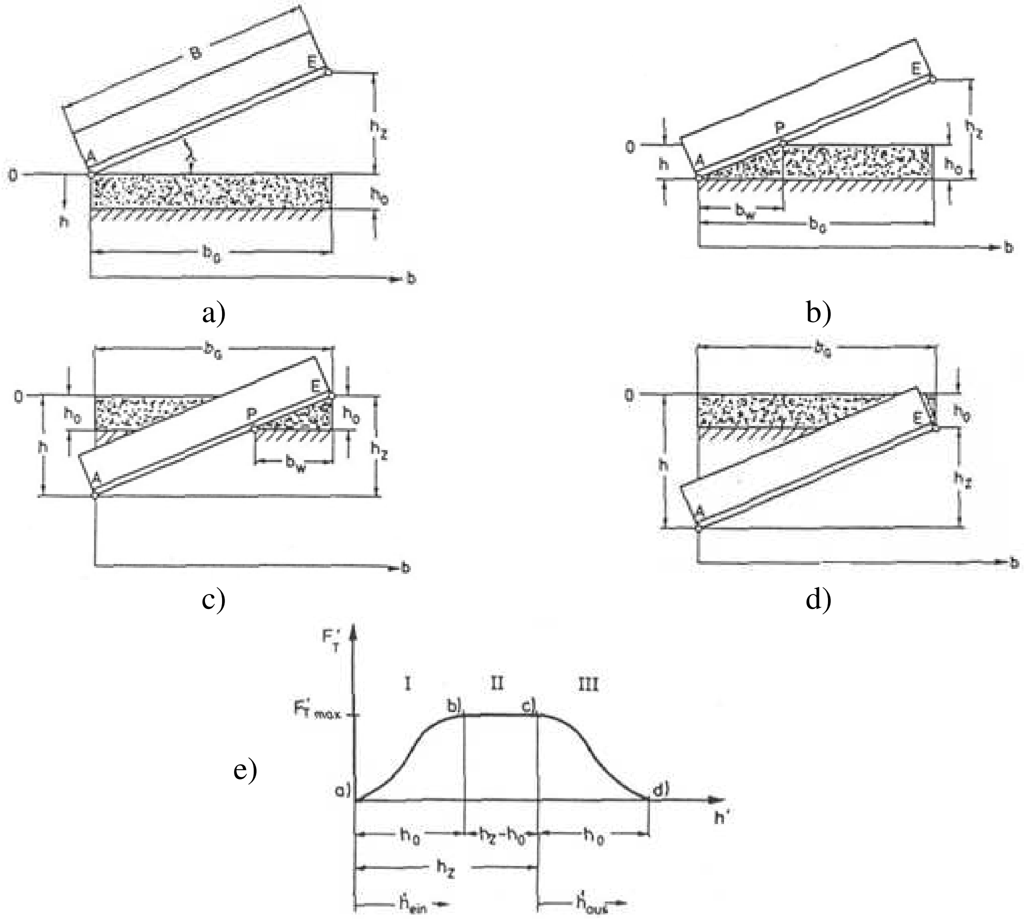

Figure 3: Cutting phases [3]:
a), b), c), d) – representation of the grinding phases; e) – the development of the chopping force F_T
A - the beginning of the shredding; E - the end of the shredding

a) at $h'=0$, it takes place the first touch of the knife and the material (the beginning of the chopping phase);
b) at $h'=h_0$, the point *A* reached the counterknife;
c) at $h'=h_Z$, the point *E* from the knife touches the material;
d) at $h'=h_Z+h_0$, the point *E* from the knife has reached the counterknife (the end of the grinding process).

As it results from figure 3e, the shredding force F'_T increases from 0 to the maximum value F'_{Tmax} and it remains constant until the end of phase I and during the phase II, thru phase III it drops to 0.

The chopping force results by summingthe singular chopping forces corresponding to the narrow cutting portion Δb, witch are arranged in small infinitesimal distances $\Delta h'$ inclined with λ angle (fig. 4).

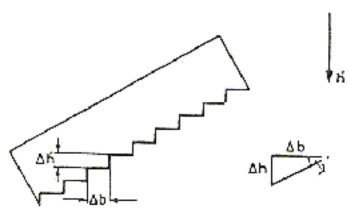

Figure 4: Representation of sliding cutting as a result of the width of singular elements Δb [3]

When F_T (h) is measured for directly cut, then it comprise a width of the flow of the material b_G:

$$\Delta F_T' = \frac{\Delta b}{b_G} \cdot F_T(h) \tag{3}$$

Because

$$\frac{\Delta h'}{\Delta b} = tg\lambda\,, \tag{4}$$

it results:

$$\Delta b = \frac{\Delta h'}{tg\lambda} \tag{5}$$

By replacing the equation (4) into the equation (5), it results

$$\Delta F_T' = \frac{1}{b_G tg\lambda} \cdot F_T(h) \cdot \Delta h' \tag{6}$$

This relationship is valid when the knife is driven over the entire width. For The chopping force shall be deemed at limit $\Delta h \to 0$ (phase I), it applies: $0 \le h_1, h_2 \le h_0$, where it results:

$$F_T' = \frac{1}{b_G \cdot tg\lambda} \cdot \int_{h_1}^{h_2} F_T(h) \cdot dh' \tag{7}$$

If $h_0 = 0$ and $h_2 = h_0$, and the all the knife blade is angaged (phase I) the folowing relation is valid: $b_G \cdot tg\lambda = h_0$, so:

$$F_T' = F_{T_{max}}' = \frac{1}{h_0} \cdot \int_0^{h_0} F_T(h) \cdot dh' \tag{8}$$

which is the mean value for F_T (fig. 4a) and is less than F_{Tmax}.

Because $h_Z > h_0$, it results that only a portion of the cutting edge is in engagement. For the case in which $h \ge h_0$ and $h \le 0$ the ratio of the knife that is in the engagement is:

$$A = \frac{h_0}{h_Z} \tag{9}$$

Equation (19) can be written:

$$F_T' = \frac{h_0}{h_Z} \cdot \frac{1}{h_0} \int_0^{h_0} F_T(h) dh' \tag{10}$$

In wich $h_Z = b_G \cdot tg\lambda$, then it results:

$$F_T' = \frac{1}{b_G \cdot tg\lambda} \cdot \int_0^{h_0} F_T(h) \cdot dh' \tag{11}$$

Determination of mechanical work used for grinding is essential to establish the required power of the shredding process:

$$W_T' = \int_0^{h_Z + h_0} F(K) \cdot dh' \tag{12}$$

Given that the the power requirement in phase II is constant, and the grinding forces in phases I and the III are considered equal to the maximum grinding force is reached the mechanical work needed, by multiplying the maximum force corresponding the engaging way:

$$W'_T = F'_{T_{II}}(h_Z - h_0) + (F'_{T_I} + F'_{T_{III}}) \cdot h_0 \tag{13}$$

Because

$$F'_{T_I} + F'_{T_{III}} = F'_{T_{\max}} = F'_{T_{II}} \tag{14}$$

the mechanical work $W_T^{'}$ will be given by the relation:

$$W'_T = F'_{T_{\max}} \cdot h_Z \tag{15}$$

or

$$W'_T = \frac{1}{B \cdot tg\lambda} \cdot \int_0^{h_0} F(h)dh' \cdot h_Z \ . \tag{16}$$

Because

$$h_Z = B \cdot tg\lambda \tag{17}$$

it obtains

$$W'_T = \int_0^{h_0} F(h) \cdot dh' \tag{18}$$

Follows that the mechanical work necessary for sliding cutting material is equal to the work at normal cutting.

4. Conclusions

Following research, it concluded that sliding cutting it applies the same assumptions as at normal cutting. In both cases it was admitted that between knife and the material there is no friction. Of course in practice it may occur different conditions that can change the ideal conditions.

If the knife is tilted at a sharp angle, it can appear the good known phenomenon of slipping of the material in front the cutting edge and limiting it to the sides of the feeding mouth, which leads to additional friction forces. Because of this mechanical work used at sliding cutting can grow compared to mechanical work used at normal cutting.

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CONTINUOUS PRETREATMENT PROCESS FOR BIOETHANOL PRODUCTION

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ABSTRACT

Pretreatment is the most important as well as expensive step involved in lignocellulosic bioethanol production. It has high influence not only on the subsequent technological steps of enzymatic hydrolysis and fermentation, but also on bioethanol separation and processing of residues. Usually involving biomass size reduction and degradation under high temperatures and pressure, it is also an energy intensive production step. These factors make it subject to numerous investigations aiming to develop an efficient, economically feasible pretreatment method.

Several physical, chemical, biological and combined methods are currently available at various investigation stages. A non-traditional and relatively new pretreatment procedure is based on the use of a simple extruder or of an extruding type bioreactor, where biomass is continuously subjected to shearing, mixing and heating, with or without chemical additives. During its passage through the extruder, biomass suffers physical and chemical changes, aiming to optimally influence the subsequent enzymatic hydrolysis step in order to obtain large glucose yields. Despite its advantages among the most advanced pretreatment methods, bibliographic survey demonstrates that European research is less competitive on this subject when compared with that of the United States and of some Asian countries like South Correa, China, Japan and Malaysia. This paper enters into details of continuous pretreatment through extrusion, presenting its mechanism, advantages, disadvantages and perspectives.

1. INTRODUCTION

Currently, oil is the dominant transport fuel in Europe (94%) and is proven to last around 40 years [1]. Europe's costs with oil imports are around €1 billion/day [2]. Even if car manufacturers are constantly concerned with improving the efficiency of internal combustion engines in terms of fuel consumption and CO_2 emissions, between 1990 and 2008 CO_2 emission level from transport increased by 24%. Recent assessments demonstrated a rise in the number of passenger cars of up to 273 million in Europe by 2050, and 2.5 billion worldwide [3].

In order to overcome these challenges, several measures were taken at EU level. The European SET Plan[1] establishes an energy technology policy aiming to accelerate the implementation of low carbon technologies, including the use of biofuels in the transport sector. One action in support of the SET Plan that promotes bioenergy across the EU, is the establishment in 2010 of the European Industrial Bioenergy Initiative (EIBI), whose purpose in the area of biofuels is to enable by 2020 the production of advanced biofuels at costs competitive with fossil ones. By definition, advanced biofuels are produced from non-food feedstocks such as energetic crops (grasses, miscanthus etc.), woody biomass, certain biological residues (cereal straw, wood industry residues, municipal waste etc.) or algae, thus being different from first generation biofuels that compete with food production.

Due to concerns over the sustainability and GHG[2] reduction benefits of some biofuels, on June 2014 the EU Energy Council reached a political agreement regarding a new amendment [4] to the Renewable Energy Directive and to the Fuel Quality Directive. Among others, the amendment sets the following: (1) conventional biofuels (1-st generation), produced from

[1] Strategic Energy Technology Plan
[2] Greenhouse gasses

sugar, starch and oil fractions of food crops, will account for maximum 7% of the final consumption of energy in transport in 2020; (2) encourages the transition, through incentives, to advanced biofuels (2-nd and 3-rd generation) produced from feedstock that do not create an additional demand for land, so they will contribute towards the 10% renewable energy in transport by 2020; (3) increase the minimum efficiency in terms of GHG saving threshold for new installations to 60% in order to improve the efficiency of biofuel production processes as well as to discourage further investments with low GHG performance.

Bioethanol is the alternative fuel for petrol engines. It has a higher octane number and heat of vaporization than gasoline and it can be used as a sole fuel in case of modified engines, or blended with gasoline. In the latter case, the oxidation of hydrocarbon is more effective due to the ethanol high content of oxygen, thus diminishing GHG emissions. As mentioned earlier, current EU policies support the production of second generation ethanol from lignocellulosic materials, mainly in order to avoid the agricultural land use for biofuels production.

2. PRETREATMENT MECHANISM AND METHODS

In order to become economically viable, existing technologies for ethanol production from lignocellulosic biomass (different species of wood, cereal straw, corn stover, sunflower stalks etc.) need further improvement in terms of cost reduction, use of natural resources such as water and land, reduced GHG emissions and enhanced energy balance. The expensive pretreatment step is required to break down the biomass structure at molecular level.

The main components of lignocellulosic biomass are cellulose, hemicellulose and lignin (table 1). Cellulose strains are made of D-glucose monomers linked together in a crystalline, strong structure, being insoluble in water or in most of the organic solvents. From place to place the crystalline chain is interrupted by amorphous regions. In order to become entirely amorphous, the required temperature and pressure are 320°C and 25MPa respectively. Cellulose is an important part of the primary plant cell wall.

Table 1: Lignocellulosic biomass structure (average values) [5]

Cellulose	35…50%
Hemicellulose	20…35%
Lignin	15…20%
Ash and other	15…20%

Hemicelluloses are located in the secondary plant cell walls. They are amorphous structures, with little strength, being formed of different types of monosugars like xylose, arabinose, rhamnose, mannose, glucose, and galactose. Different forms of acidified sugars (i.e. glucorinic and galacturonic acids) can also be found in its structure. Due to their amorphous aspect, hemicelluloses can be hydrolyzed more easily than cellulose.

Lignin – a biopolymer of aromatic alcohols with a highly disordered structure - is also part of the secondary cell walls. Its role is to confer mechanical strength to the cell wall. It is insoluble in water or alcohol. In order to make it soluble, weak alkaline solutions can be used.

Both lignin and hemicelluloses protect cellulose fibrils by forming a matrix around them. Therefore, in order to allow enzymes from the enzymatic hydrolysis step to break down cellulose and hemicellulose into sugars for fermentation, it is necessary a pretreatment step that (1) disrupts this matrix and exposes cellulose and hemicellulose to enzymes, (2) reduces the cellulose crystallinity and (3) increases the material's pores size and surface area, thus offering enzymes maximum access to carbohydrates (figure 1).

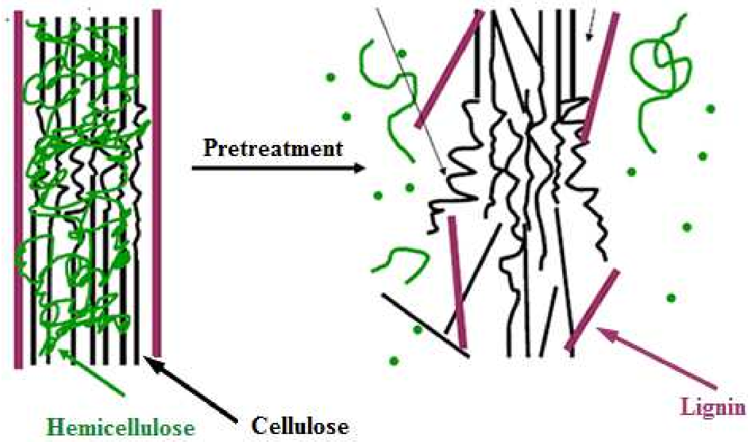

Figure 1: Pretreatment effects on cellulose, hemicellulose and lignin [6]

Moreover, other important factors should be considered when selecting and establishing the parameters for an ideal pretreatment method: minimum formation of fermentation inhibitors such as weak acids (levulinic, formic and acetic acid), furfural, hydroxymethyl furfural (HMF) and/or phenolic compounds; energy efficiency, measured in fermentable sugar yield per unit of consumed energy; efficiency against high-lignin materials; feedstock versatility; possibility for commercial scalability with low technological and environmental risks; potential for by-products. These are the reasons that make this step crucial, as it has high influence not only on the subsequent technological steps of enzymatic hydrolysis and fermentation (figure 2), but on the entire bioethanol production technology.

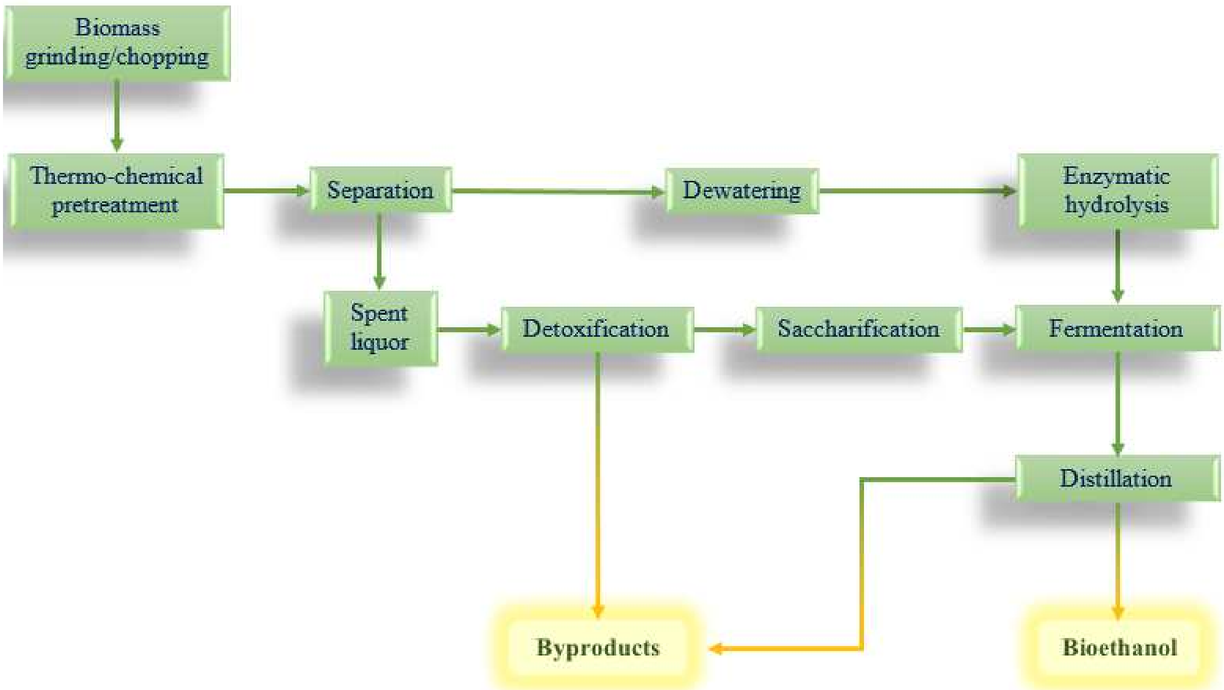

Figure 2: Example of technology for lignocellulosic ethanol production

Traditional pretreatment technologies use physical, chemical and biological principles, or a combination of them. Usually, the first step is mechanical grinding or chopping, which is needed to increase the biomass specific area, thus exposing cellulose as much as possible to enzymatic attack. However, for a sugar recovery improvement, a combined thermo-chemical stage is necessary in order to promote hydrolysis and to further disrupt the biomass structure at molecular level. Some of the most common thermal and/or chemical methods are acid pretreatment, steam explosion, ammonia fiber explosion, CO_2 explosion, liquid hot water, wet oxidation and more. Most commonly employed procedure makes use of diluted acid pretreatment. Size-reduced biomass is treated with 1-1.5% (w/w) acid (usually H_2SO_4) at 160-180°C. Hemicelluloses are hydrolyzed to monosaccharides, most of the lignin is removed, cellulose is exposed and its crystallinity is affected. Lower temperatures can be employed, but under higher acid concentration, which leads to negative effects like sugars degradation, high concentrations of inhibitors, equipment corrosion and acid recovery. Dilute acid can achieve over 90% glucose yields from enzymatic hydrolysis, and up to 90% hemicellulose yields [7], but commercial implementation requires high capital costs, neutralization of hydrolyzate before enzymatic hydrolysis and fermentation, and slow enzymatic digestion of cellulose due to binding of enzymes to lignin. Similarly, most of the above mentioned methods have important inefficiencies that currently make them inappropriate for commercial large scale applications.

3. EXTRUSION PRETREATMENT

Extrusion pretreatment is a relatively novel technique in which biomass undergoes continuous mixing, heating and shearing, thus suffering physico-chemical disintegration [5] [8] [9]. This process can be developed with or without acid or base addition, and in a very large range of temperatures.

The main component of a simple extruder is the screw (figure 3), which rotates inside a barrel. Each screw can be composed of a number of screw elements grouped in blocks, with different constructive characteristics (pitch, length and helix angle), each of them with a specific role within the process: (a) forward or reverse blocks, specifically designed to convey bulk material, without significant shearing or mixing effect; reverse screws transport the material backwards in order to intensify the mixing and shearing effects [10]; (b) kneading blocks for mixing and shearing the material, but with a low transport effect; they can have forward, neutral or reverse orientations, in order to enhance the shear effect and to achieve good pulverization; (c) compression blocks; (d) combing blocks for granulation, if needed [11].

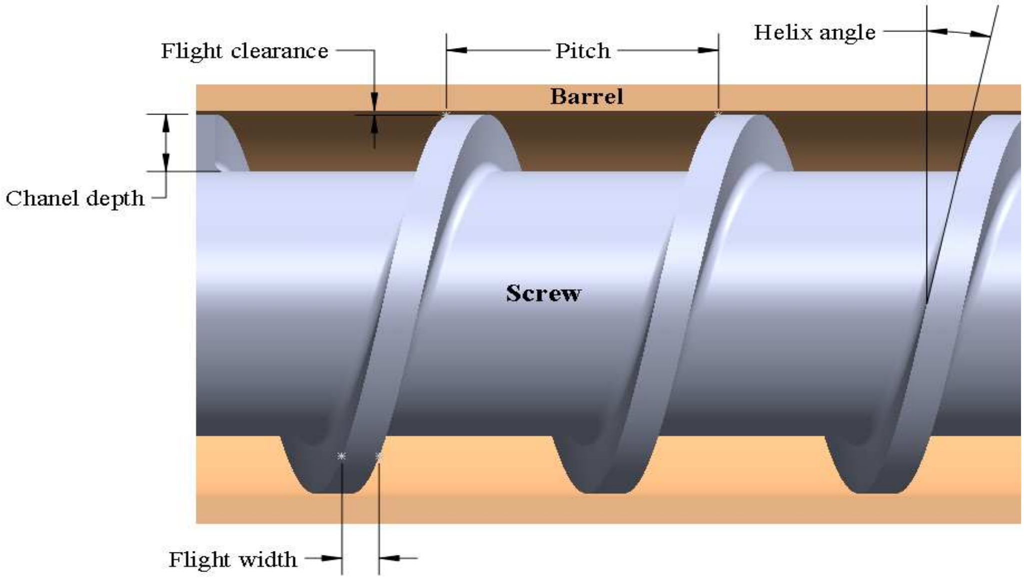

Figure 3: The main constructive parameters of an extruder

A very important parameter in screw design is the screw channel depth. Its largest value is in the feed zone and it gradually decreases along the compression zone, allowing more work to be applied to the biomass. Channel depth is used in the definition of the compression ratio, which is reported to be the ratio between the depth in the feed zone and the depth in the discharge (metering) zone. This parameter directly influences shear development and material flow inside the barrel [12].

The large number of possibilities to configure the screw using various block types in any number and order, gives the extruder high flexibility in achieving various pretreatment parameters like biomass residence time, compression ratio, mixing and shearing intensity, extrudate properties and energy consumption. Moreover, when twin-screw extruders are used in place of single-screw ones, the screws can be set to co-rotate or counter-rotate, as well as to intermesh or not, thus adding more possibilities for process set-up.

Barrel temperature is one of the main functional parameters that can be established during pretreatment. It facilitates the degree of feed melting/softening, indirectly affecting the residence time and flow pattern. Screw speed directly influences the residence time and the rate of shear development. The same role has moisture content due to its relationship with the friction coefficient between the material and the surfaces of screw and barrel. The following example presents a twin-screw reactor configuration used for the rape straw pretreatment, with screw elements (30 rpm) presented in order, from the feed zone to the discharge area [13]:

1) Conveying zone screw elements: conveying elements, used to transport the feed (solid biomass) to the kneading area;
2) Reaction zone elements (barrel temperature: 165°C): (a) Feed point for liquid catalyst (H_2SO_4, 3.0% w/v), just before the kneading elements; (b) Forward kneading elements, to mix the catalyst with solid biomass; (c) Forward conveying screws, with shorter pitch lengths, for longer reaction time between the catalyst and biomass; (d) Reverse kneading block, which alternates with the previous forward kneading block in order to increase the residence time; this configuration also leads to a better biomass pulverization; (e) Aiming to improve residence time and shear development, the following blocks are added: forward conveying block, forward kneading block, reverse kneading block, forward conveying screws with shorter pitch length; (f) Forward kneading screws at the end of the reaction zone, to increase the pulverization degree;
3) Compression zone elements (temperature: 100°C): (a) Forward conveying screws (short pitch length); (b) Very short pitch length screws for better material compression.

This configuration and pretreatment parameters resulted in 78.7% glucose yield from the subsequent enzymatic hydrolysis, but better results were reported for other feedstock types and on different pretreatment conditions. The conversion rate from cellulose to glucose was found to be around 92% for wheat straw pretreated with an extrusion type mixer, at 98°C, 35 rpm and with NaOH as catalyst. Moreover, about 43% pentosans were recovered and 72% lignin was removed [14]. A process using single-screw extruder was described for pretreatment of switchgrass at 118 rpm screw speed, 180 °C barrel temperature and 0.02 g/g biomass NaOH. In these conditions, the glucose yield was 90.5%, xylose – 81.5%, and combined sugar yield – 88% [15]. Basic physical pretreatment without any catalyst led to 75% glucose and 49% xylose recovery, when a single-screw extruder was used at a speed of 75 rpm and 125°C barrel temperature [16]. In another study soybean hulls were subjected to simple physical extrusion (screw speed – 350 rpm; temperature - 80°C; moisture content – 40%), leading to 95% glucose recovery [17].

3. CONCLUSIONS

When compared to other pretreatment techniques, extrusion has a number of key attributes. High shear and mixing, rapid heat transfer, short residence time, moderate temperature, flexibility in terms of process modification, no formation of fermentation inhibitors, no subsequent washing and conditioning of material and – very important for industrial application – possibility for continuous operation and easy scale up, are the main factors that recommends it for large-scale implementation. Due to the fact that basic physical extrusion works without liquid fraction, there is no need for effluent disposal and no solid loss, which is reflected in lower operating costs [18]. These advantages make extrusion to meet many of the key characteristics set out for an optimal pretreatment method [19].

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MACHINE FOR REGENERATE DEGRADED GRASSLAND IN THE CONTEXT OF THE ECOLOGICAL REQUIREMENTS

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ABSTRACT

Agricultural status of many of meadows area, and the need to optimal ensure the feed for growing effective of animals, require proper works execution of improvement, designed to correct the floristic composition and to increase the production. Given the imperative of improving living standards in the long term and under the pressure of growing demands to consumers of plant and animal products, trader S.C. MECANO FUC S.A. and research unit INMA Bucharest, with scientific concerns in the technology area for grasslands rational recovery, proposes in this paper a new machine for regenerate grasslands by soil tillage in narrow strips and direct sowing into the grassy carpet of a herbs mixture.

1. INTRODUCTION

Grasslands are lands covered with permanent grass vegetation, composed of species belonging to several plants families, especially grasses and perennial legumes, used as feed or pasture. Grasslands, occupying 40 % of the world land area, except Antarctica and Greenland, support livelihoods of approx. 1 billion people. [5]

Romania ranks 5th in Europe, after France, Britain, Spain and Germany with an area of 4.9 million ha grassland. Share grasslands in the total area of Romania is 20.4 %, and in the agricultural area is 33 %. On these areas agricultural production are reduced by approx. 10...90 %, depending on the intensity of soil erosion. [4]

Worldwide there are scientific concerns in grassland rehabilitation, in order to combat the risk of deterioration, in the context of global and regional climate change. [2]

The climate global warming will affect the agrosilvopastoral fund of Romania. The increase of air average temperature with 3°C, which is the forecast for 2070 years level, will cause deeper dryness and desertification of plains areas and hills, with major negative impact on grasslands. [3]

There are two ways of improvement, one for surface without depth mobilization of the soil, with completely keeping or a certain percentage the existing vegetation and the other radical by entirety replacing the existing vegetation. [5]

Given that there are European and national legislation concerning financial support for comply the eco-cross-compliance, SC MECANO FUC S.A. and INMA Bucharest have showed an major interest in finding an innovative solution for the regeneration of degraded grasslands and the rational exploitation of them, so that farmers can have the opportunity to get a new machine, with high performance, that meets to quality requirements imposed by the European Union market and on prices more than competitive. [6], [7], [8], [9]

2. METHODOLOGY

For grassland quality restoration technology, in terms of climate changes, is proposed a machine for regenerate grasslands, which achieve soil tillage in narrow strips and direct sowing into the grassy carpet of a herbs mixture, or even a single species, keeping wholly or in a certain percentage the existing vegetation. This machine will achieve with low cost (on the current financial possibilities of the market segment who is addressed) improvement (by overseeding) the old degraded vegetating with valuable items (leguminous fodder) so that will be able to use rational the existing pastoral heritage in Romania, which is part of the national wealth, with major significance by the dimension of the feed potential sources and their quality.

3. RESULTS

The machine for regenerate grasslands (Fig. 1) consists in the following main subassemblies: chassis **1**, milling section **2**, seeding section **3**, seed box , transmission for sowing **5**, milling transmission **6**, evidence box **7**, and support with tubs **8**. The machine running in a single pass:
- Seedbed preparation by performing bands in the degraded grasslands vegetation cover;
- Sowing a mixture of herbs or even one species in strips done by milling station;
- Light compaction of the soil over the seeds, for a proper contact between them and the ground, in order to get a good germination.

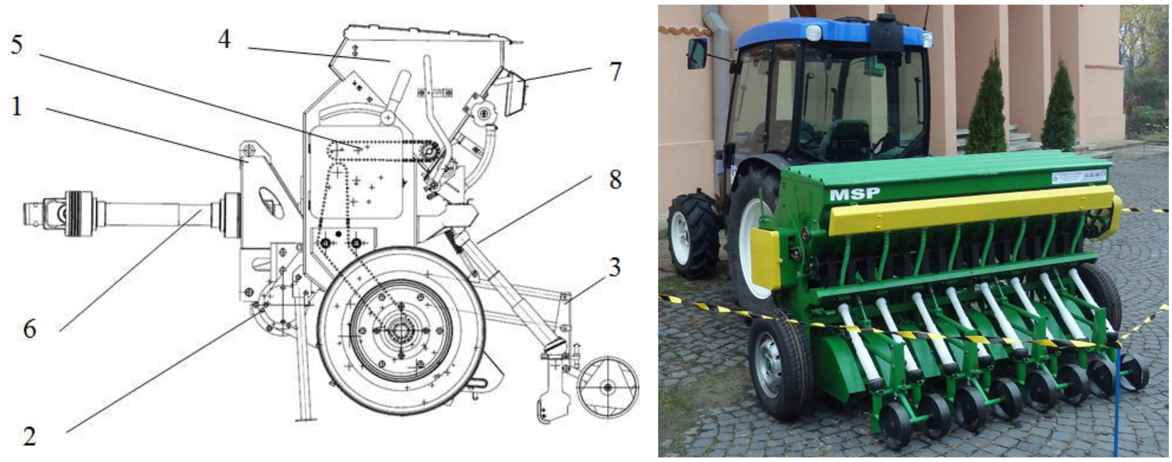

Figure 1: Machine for regenerate grasslands

The frame consists in a welded frame on which is mounted the other component subassemblies of the machine. The weld is provided in the center with a triangle, for coupling to the three-point linkage Category 2 ISO 730 of the tractor, some supports for the assembly of milling transmission bearings and the attachment of sowing sections.

On the frame sides of the welding frame are assembled the support wheels of the machine (the left wheel is provided with a sprocket z=15 for the chain transmission of the seeding system) and the parking legs.

The milling section is the assembly running the soil processing in narrow strips, by milling in order to sowing in vegetation cover of the degraded grasslands. It consists in a assembled housing in which is mounted a chain transmission (consisting in two chain wheels, 16 A Gall chain with 50 links and one chain tensioner) and two rotors, which are arranged on both sides of the section each provided with flanges on which are mounted three pairs of blades cutter left / right, in the form of "L" with short width, protected by some shields left / right.

The sowing section running incorporation seeds heavy and light flowing in the channels made by cultural coulters, in narrow bands made by milling stations, and at the same time a slight compaction of the soil over the seed, for a proper contact between these and the ground, in order to obtain a good germination. The sowing section is mounted behind the milling section and comprises two arms, one lower and one upper, which in contact with the machine chassis achieves a deformable parallelogram, two incorporation cultural coulter, two wheels for easy soil compaction (located behind the coulter) that are simultaneously wheel for sowing depth adjustment and an adjustable elastic system for pressing the section in the soil and coulters protection. Seeding depth is achieved by adjusting the position of the incorporation coulter with the compacted wheel by driving a screw.

The seeds box is mounted on the side walls of the chassis and has geometry with angles that ensure a proper flow of the seeds in any working position of the sowing sections. In order to allow the sowing of the seed mixtures with different flow properties, the box is carried out with two compartments, namely:

- A large one for running hard seeds in which are placed the spurs distributors for 0...300 kg/ha;
- An easy one for light flowing seeds in which are placed the groove distributors, with adjustable length for 0 ... 10 kg/ha.

For light flowing seeds the sowing is determined by changing the active length of groove distributors.

The sowing transmission consists in a 10A - 88 links chain, which wraps wheels Z_1=15, Z_2=11, to transmit motion from left drive and input support wheel to input shaft in an inpulse gearbox with oil bath, another 8A chain - 66 links, which wrap the wheels Z_3=Z_4=15, to transmit motion from the output shaft of the inpulse gearbox with oil to the shaft with agitators, and through the transmission gear, Z_5 and Z_6=20=18, to the distributor shaft cylinder type for hard seed flowing through the 10 B chain - 43 links, which wraps the chain wheels 15 and Z_8=Z_7 =15 to the distributors with grooved rolls for light flowing seeds. The inpulse gearbox with oil bath includes two cam-rocker mechanisms mounted in parallel, and its construction allows changing the gear ratio either manually or electro-hydraulic via an control system. To change the seed flow is acting on the control lever for the purpose of changing the position on the gradually sector.

The milling transmission is composed of a 45 HP shaft, a central bearing, an intermediate transmission with chain, a conical reducer and a hexagonal shaft that transmits the motion from the tractor in the aggregate PTO, by the four final drives with chain, to the blades rotor of the four processing sections by soil milling in narrow bands.

The box evidence is required to collect seeds during flow tests, weighing executing in a short time. To make debit evidence the box is placed on to the tubes support, just below the distributors, in which situation the seeds do not pass through tubes and coulters.

The support with tube helps, through telescopic tubes, to the set distribution of both types of seed in the grooves created by cultural coulters.

Main technical characteristics

- The necessary tractor, HP	45
- Number of sections for soil processing in narrow bands	4
- Number of sections for sowing	4
- Number of worked bands and sown rows	8
- Distance between worked and sown bands, mm	220
- Depth for tillage and sowing, cm	2...6
- Width of tillage and sowing, m	1.76
- Weight, kg	498

Operation mode

At the entrance to the plot work, lower the car up to approx. 5 cm from the ground, the power take-off shaft coupling of the tractor and the machine is still full descent, then start the submission. As the tractor forward, the knives rotor prepare the seedbed on 2...6 cm depth by making narrow strip in grassland vegetation of degraded cover. The seeds are routed through leading telescopic tubes to coulters who incorporate them into the bands performed in soil and the compaction wheel sits the processed soil over them. The soil is separated in small pieces by the active organs of the blades rotor from the milling section and is thrown towards the walls of the housing where it is cut and loosened, after which it is placed, some in worked bands and some in unprocessed lateral areas. Placing the soil in unprocessed lateral areas gives a great advantage because delay the development of the old carpet and enables to the new one to develop freely without being stifled, eliminating herbicides. At each end of the plot, before finishing the work, will be discontinue the movement of the PTO shaft and then will pick up the car from the ground.

Results of research regarding the depth sowing obtained on crop clover

The characteristics of the terrain on which the field experiments were carried out with the machine for regenerate grasslands for determining the sawing depth are shown in Table 1.

Table 1: The characteristics of the terrain on which the field experiments were carried out

No.	Characteristics	INMA experimental polygon
1	Soil type	reddish brown forest
2	Natural bumps height or anthills, cm	max. 8
3	Coverage of soil with plants,%	78
4	The average height of plants, cm	5.2
5	Plant mass, g/m^2	50
6	Soil moisture, %, in 0…10 cm layer	21.2

In order to determine the compactness of the soil, was measured in 11 sample points up to a maximum depth of 25 cm by a digital penetrometer with cone FIELDSCOUT SC 900, and the distribution of the resistance forces to the cone penetration in the soil layers, in kPa, is shown in Figure 2.

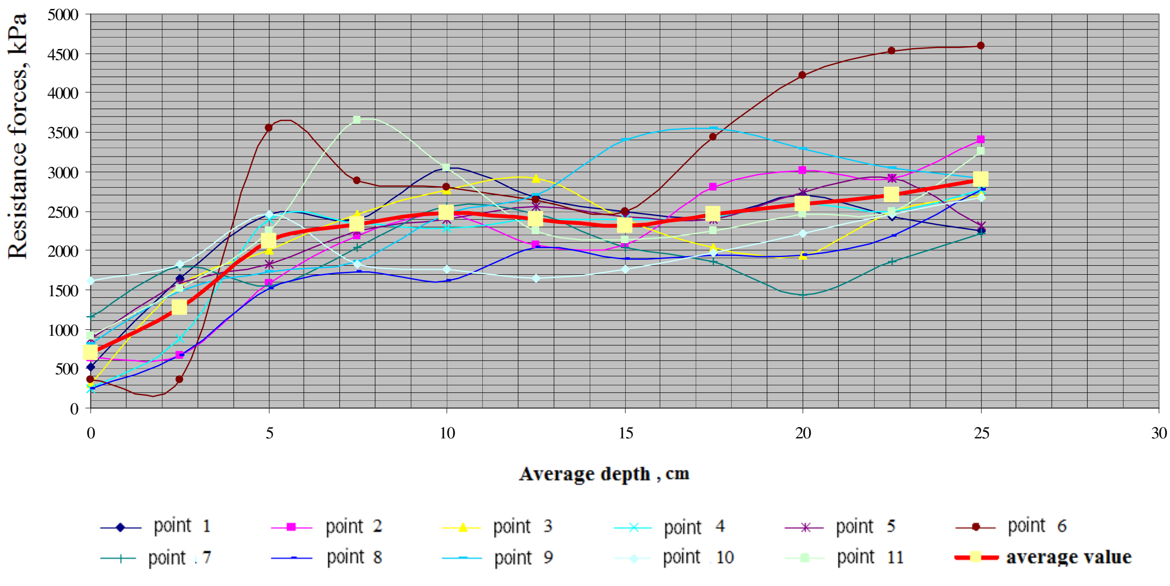

Figure 2: The distribution of the resistance forces to the cone penetration in the soil layers, measured in 11 sample points up to a maximum depth of 25 cm

Mean of the penetration resistance forces on cone penetration in the soil layers in the range 0...25 cm depth is 2204 kPa, which means that the soil is not compacted (up to 3000 kPa is in a position to be declared as compacted) .

The depth of incorporation of the seed is the distance measured from the ground level resulting from the sowing work to the horizon from which are the seeds. The measurements were carried out in three repeats in three different areas of the plot (at the ends and in the middle).

Relations calculation:

$$a_{ms} = \frac{\sum_{1}^{n} a_i}{n}, \text{ cm} \qquad (1)$$

where a_i is the depth of incorporation of the seed, measured in *i* point.

Following experimental research regarding the average depth of sowing at clover culture (degree of purity: 99.02 %, weight of 1000 seeds: 1.91 g, sowing rate: 6 kg/ha and sowing depth: 2 cm) obtained at two working speeds (2.31 km/h and 4.17 km/h) the machine for regenerate grasslands obtained following qualitative indices (Table 2):

Table 2: Mean of depth sowing obtained by the machine for regenerate grasslands

Row	Work speed 2.31 km/h		Work speed 4.17 km/h	
	Average depth a_{ms}, cm	Variation coefficient C_a, %	Average depth a_{ms}, cm	Variation coefficient C_a, %
1	2.4	7.683	2.3	7.003
2	2.1		2.0	
3	2.2		2.1	
4	2.5		2.4	
5	2.2		2.0	
6	2.1		2.1	
7	2.0		2.0	
8	2.1		2.1	

In Figure 3 are plotted the average values of sowing depth ($A_m=a_{ms}/8$) and variation coefficient for the two working speeds.

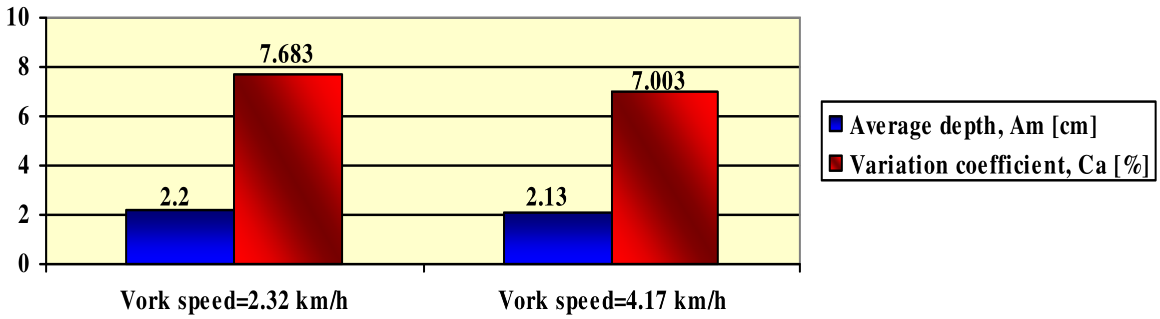

Figure 3: Graphical representation of average values of sowing depth and coefficient of variation for two working speeds

From the results shown in Table 2 it is observed that the values of the coefficient of variation by the sowing depth C_a on the working width, who at the working speed of 2.31 km/h is 7.683 %, and at the working speed of 4.17 km/h is 7.003 %, fall into agro-technical requirements specified in applicable standards (as agro-technical required $| C_a | \leq 20$ [%]).

4. CONCLUSIONS

- After experimental research, the calculations of variation coefficients and comparing them with the values from agro-technical requirements, was found that these are appropriate;
- The implementation of the machine for regenerate grasslands will get the following benefits:
  - Ability to work approx. 25...55 % higher and lower the fuel consumption per hectare with approx. 38...44 %, because the work is performed on 3...5 years (even on newly established grasslands), to continuously maintain adequate floristic composition of the grasslands;
  - Soil conservation by reducing compaction with approx. 10 % and improve the working conditions of farmers by eliminating previous herbicides for suppress the old vegetable cover;
  - Regeneration through soil cultivation in narrow strips and directly sowing into the grassy carpet harvest is not lost in any year, more than diminishes in the first season of harvest.

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INNOVATIVE TECHNOLOGY FOR ESTABLISHMENT OF ONION CULTURE IN SUSTAINABLE SYSTEM

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ABSTRACT

The economic importance of onion culture, wich is the most used vegetable, result from the fact that they allow intensive use of the land. Onion culture provides a better use of land, due to the possibilities of making, on large-scale, the inheritance, especially in the open field culture by direct sowing. For this purpose, for growing onion directly in the field can be used working mechanization technologies in classical or innovative system. At present, for onion crop establishment by classic technology, are uses five agricultural equipment (deep plowing, leveling tillage, combiner for seedbed preparation, modeler for irrigation ditches opening and shaping layers and small seeds drill), leading to higher fuel consumption. The present paper propose an innovative technologies for onion crop establishment, in sustainable system, by using a single new technical equipment, which performs in a single pass all five operations, performed individually in the conventional technology.

1. INTRODUCTION

One of the most common vegetables, especially in the south and southeast of our country, onion is a biennial or triennial, containing minerals (sodium, potassium, iron, sulfur, iodine, silica, phosphate), antibiotics principles, carbohydrates, lipids, sucrose, organic acids, sterols, vitamins (C vitamin, B group vitamins, E vitamin), volatile oil, saponin. [3]

In order to protect the soil, U.E. countries tend to maintain or even reduce the onion area, and to increase the average production per hectare by adopting in the mechanization itineraries modern technologies for soil preparation and creating good conditions for sowing, germination and emergence. [1]

By practicing innovative technologies, which involves the introduction of the minimum work system for the establishment of culture, onion become one of the most profitable vegetable species, from economic point of view. [2]

Current technology in Romania for growing onion directly in the field (Fig. 1) is performed with a range of agricultural equipments for processing soil (deep plowing, plowing leveling, seedbed preparation, irrigation ditches opening and shaping soil layers) and sowing, which are large consumers of fuel. [5], [6], [7], [8], [9]

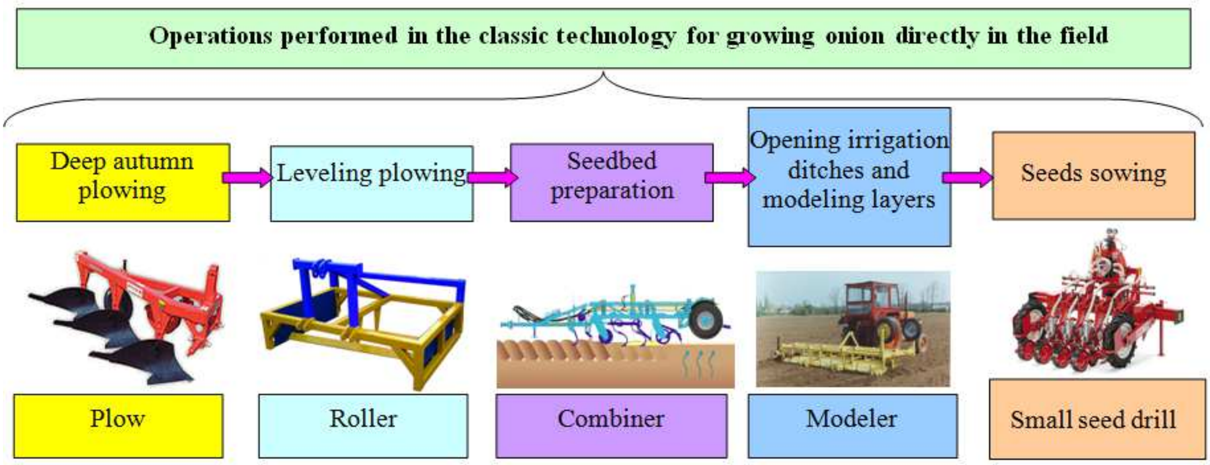

Figure 1: Technical equipments used by classic technology for growing onion directly in the field

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2. METHODOLOGY

In order to reduce the energy consumption, INMA Bucharest proposes a new approach of the technology for establishing onion culture, using a single technical equipment, which performs in a single pass all five operations, performed individually in classic technology, so is successfully promoted the sustainable agriculture. [4]

Thus, was performed an **innovative technology for mechanization the establishment of the onion crop, by planting on land shaped** (Fig. 2) who involves applying a minimal tillage system, by using a new technical equipment, which performs in a single pass all the five operations performed individually in classical technology. The immediate effects of application the innovative technology are: growth and development of the onion root system, reduce excess moisture on the surface, while reducing energy consumption.

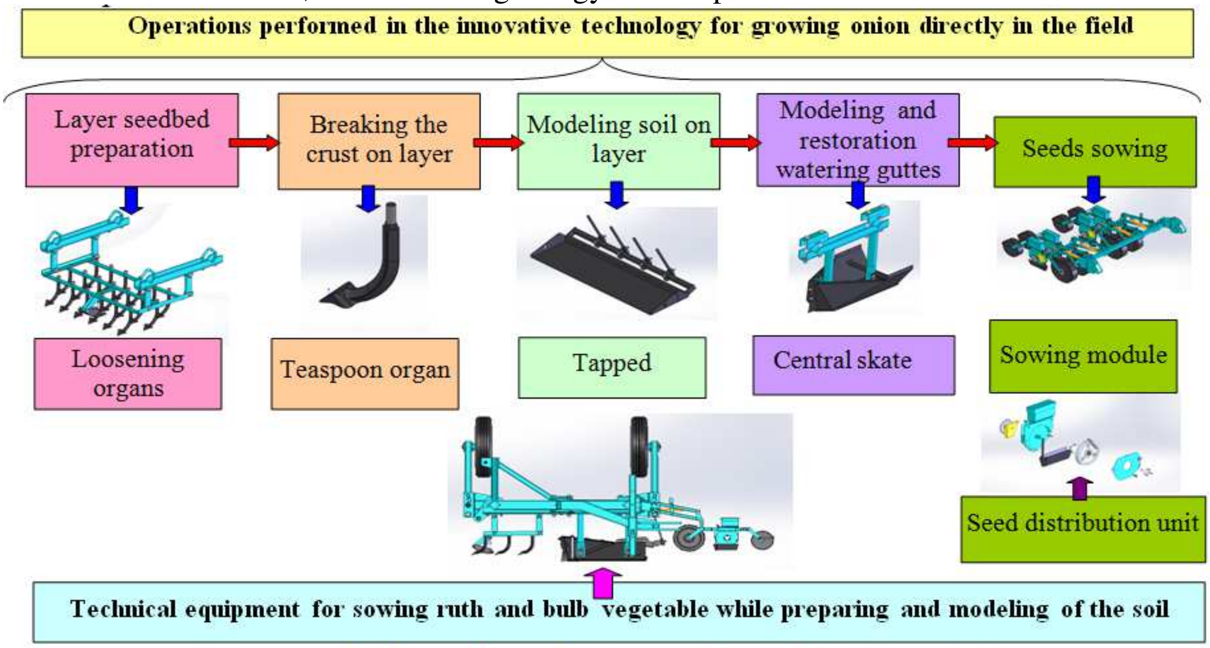


Figure 2: Innovative technology for mechanization the establishment of the onion crop, by direct sowing on shaped land

3. RESULTS

The technical equipment for sowing ruth and bulb vegetable while preparing and modeling of the soil (Fig. 3), proposed in innovative technology, is intended to soil additional loosening work and / or cracke the layer crust, modeling the layers and sowing the onion seeds in a single pass, on plowed field or stubble.

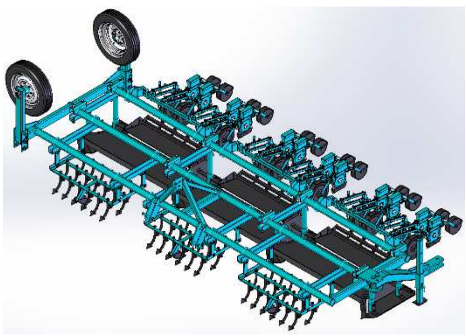


Figure 3: Technical equipment for sowing ruth and bulb vegetable while preparing and modeling of the soil

In order to minimize the soil degradation, the technical equipment can run concurrently:

- Seedbed preparation on layer at a depth of 2 ... 6 cm;
- Breaking the layer crust with passive organs teaspoon type;
- Modeling soil on layer;
- Modeling / restoration of watering gutters;
- Sowing the onion seeds.

The technical equipment is worn type in working and hauled in transport and consists in the following main assemblies:

- One equipment for loose and modeled soil on layer which comprises (Fig. 4):
    - One frame ;
    - Raising bodies;
    - Modeling organs consist in central skate, side skate and tapped;
    - Transport hitch;
    - Transport wheels.

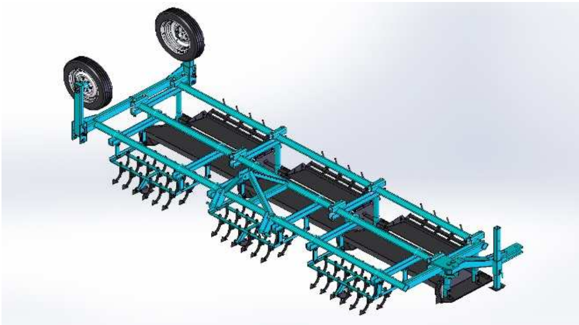


Figure 4: Loose and modeled soil on layer equipment

- Three sowing module that each are composed (Fig. 5):
    - One sections support tube;
    - Two sections support frame;
    - Four sowing sections for very small seeds.

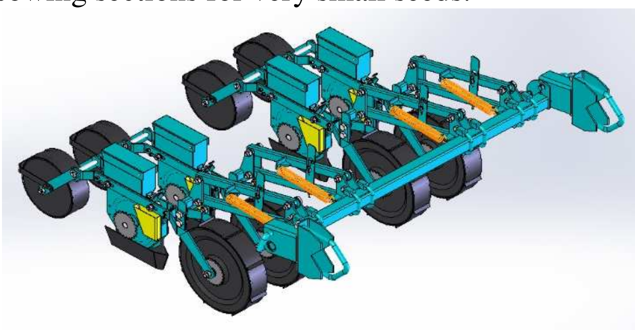


Figure 5: Seeding how

The main design features of the technical equipment are for sowing ruth and bulb vegetable, while preparing and modeling of the soil are:

- Working depth:	
- For loosening, mm	20 ... 60
- The channel depth, mm	150 ... 180
- For sowing, mm	0...20
- Width, m	4.5
- Distance between gullies, mm	1500
- Distance between sowing sections, mm	200 ... 280
- Weight, kg	1272

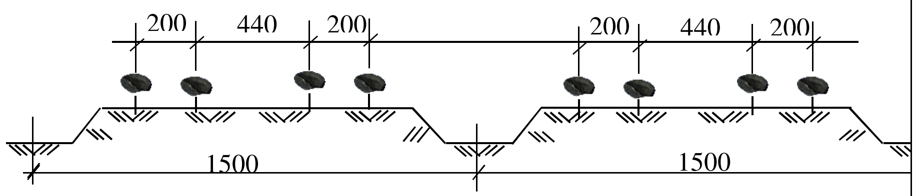
Working process

As the tractor forward, the raising bodies penetrate the soil to a regulated work depth (due to the angle of penetration), and the forming organs formats and shapes the soil from the layer and from the irrigation channels, making three layers and 2 + 2 ½ irrigation ditches. On the formed layer the sowing sections distributed the onion seeds in the schedules imposed. At each end of the plot, the work is resumed provided that the technical equipment is placed on the last ditch partially restored. It is recommended that in the transport position the technical equipment is transported on own wheels into towed position.

Planting patterns

In order to obtain high yields and good quality, at the onion crop establishment, the technical equipment ensures a specific sowing scheme of that crop. This scheme is designed to ensure optimum conditions for growth and fruiting plant. Onion seeds are very small and are directly sown in the field in early spring.

Table 1: The scheme of onion sowing on shaped field

Culture	The sowing scheme
Onion - Turn plants distance: 30…35 mm - Seeds quantity : 5 kg/ha	

4. CONCLUSIONS

Benefits of implementing the innovative technology in operation are:

- Elimination of soil compaction at plants level, as a result of reducing the number of passes;

- Removing the water excess from precipitation and prevention of water stagnation at the roots level;

- Insurence the access between plants lanes and facilitate harvesting activities;

- Improving the environmental quality through minimal tillage, which reduces the pollution sources.

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PRELIMINARY RESEARCHES REGARDING MISCANTHUS STALKS GRINDING WITH CENTRIFUGAL IMPACT MILL

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ABSTRACT

Nowadays the modern society has a very important component that is represented by renewable energy. Due to a high potential to deliver fuel and energy comparable with fossil fuels, biomass is considered the best alternative regarding renewable energy. This paper presents some experimental results regarding miscanthus grinding using a plant debris chopper TRV-0. Experimental determinations were done using different dimensions of the material subjected to grinding. The exploitation parameters obtained experimentally are also presented in the paper.

1. INTRODUCTION

The main source of energy in the world is represented nowadays by fossil fuels as gas, coal, etc. Various studies regarding the quantities of these resources and its usage by consumers showed a critical situation which we should consider, that in approximately 40-50 years these resources will considerable diminish, some will even drain. Regarding the lowering of constant degradation on the environment, more and more countries have analyzed the possibility to replace fossil fuels with renewable energy sources that don't have the same negative impact on the environment. One energy source identified is biomass, which presents specific characteristics [5]. In order to use biomass it is necessary that the material to pass through various mechanical processes. One of these is cutting and grinding process that can be done in the moment of harvesting or afterwards. Cutting process is the main process done by the cutting equipment with a very high energy consumption. The main factors that contribute to better understanding this process refer to knife sliding movement in connection to the material subjected to cutting process, the knife cutting edge pressure for cutting tge vegetal material. In our paper we present the grinding process of miscanthus stalks in order to obtain a specific degree of granulation.

2. METHODOLOGY

In order to present complex data regarding the grinding process of miscanthus stalks, a serious of experiments were done using from the National Institute of Research Development For Machines And Installations Designed To Agriculture And Food Industry – INMA a plant debris chopper TRV-0 for vegetal waste. The equipment is presented in figure 1.

The supply of raw material was performed through the supplying funnel by means of the inclined belt conveyor, the grinding process taking place through shredding and impact between the hammers mounted on the rotating disc and the counter hammers on the frontal cover. The evacuated material had between 1- 3 mm (depending on the used sieve).

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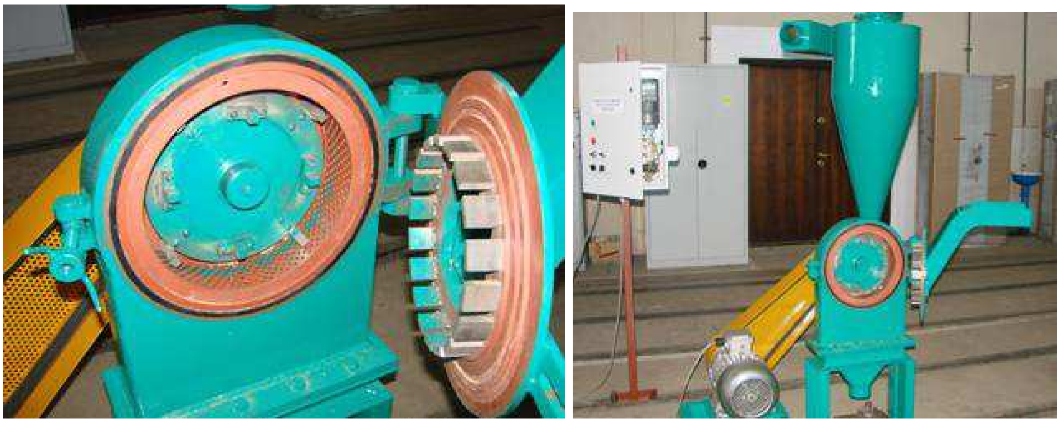

Figure 1: Centrifugal impact mill TRV - 0

All the experiments done respected the methodology and the standards specific for this kind of machines.

The technical data of the mill are presented in table 1.

Table 1: Technical characteristics of TRV-0 [4]

Nr.crt	Characteristics	UM	Values
1	Electric motor power	kW	7.5
2	Continuously adjustable electric motor speed	rpm	296 - 1490
3	Continuous tuning grinder torque	rpm	572 - 2880
4	Grinding capacity	m^3/h	200
5	Interchangeable grinder sieve with different orifices	mm	Φ3, φ4, φ6
6	Overall dimensions: • Length • Width • Height	mm	 1500 900 1200
7	Mass	kg	245

Miscanthus stalks used during experimenting process were harvested in 2011 and were cut with a guillotine presented in fig. 2.

Figure 2: Guillotine used in order to cut the miscanthus stalks at the desired dimensions

The miscanthus stalks used for grinding had the following values:

- miscanthus stalks with dimensions under 7 cm – 31%;
- miscanthus stalks with dimensions between 7 and 10 cm – 46 %;
- miscanthus stalks with dimensions between 10 and 15 cm – 22 %;
- miscanthus stalks with dimensions above 15 cm – 1%;

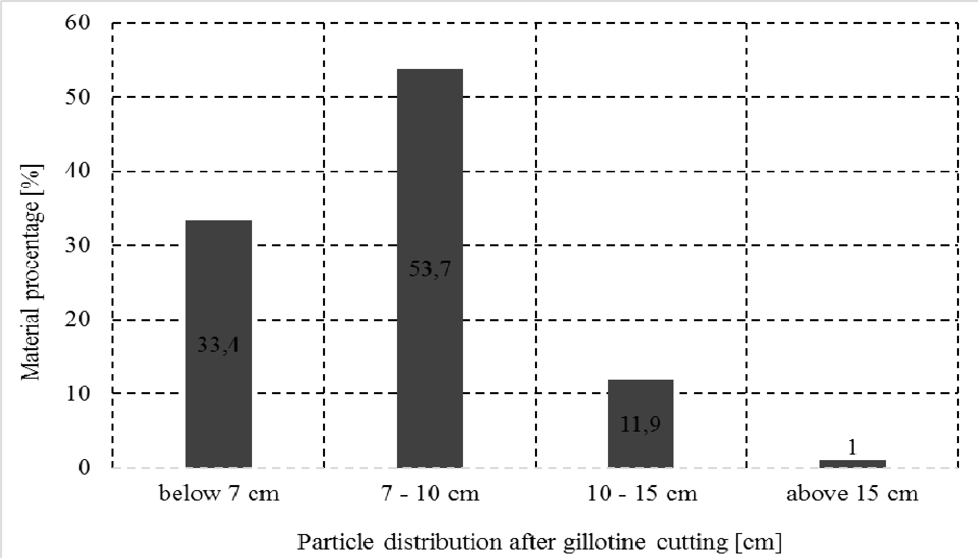

Figure 3: Particle distribution after gillotine cutting

The grinded material was collected inside a recipient of medium dimensions and the weighted. The mass of the grinded plants was 5 kg. The exploitation parameters experimentally obtained are presented in table 2 and also the granulometric distributions on sieves of the particles after the experimental tests are presented in figure 4.

Table 2: The exploitation parameters obtained experimentally [4]

Nr.crt	Characteristics	UM	Values
1	The material quantity used for tests	kg	5
2	Duration of tests	s	100
3	Working capacity	kg/h	180
4	Electric motor power consumption	kW	4,5
5	Energy consumption (during tests)	kWh	0,125
6	Specific energy consumption	kWh/t	90
7	Grinded material distribution on sieves with orifices dimensions of 2, 3, 4 and 5 mm: • under 2 mm; • between 2 – 3 mm; • between 3 – 4 mm; • between 4 – 5 mm; • above 5 mm;	%	47,2 10,4 20,7 14,5 7,2

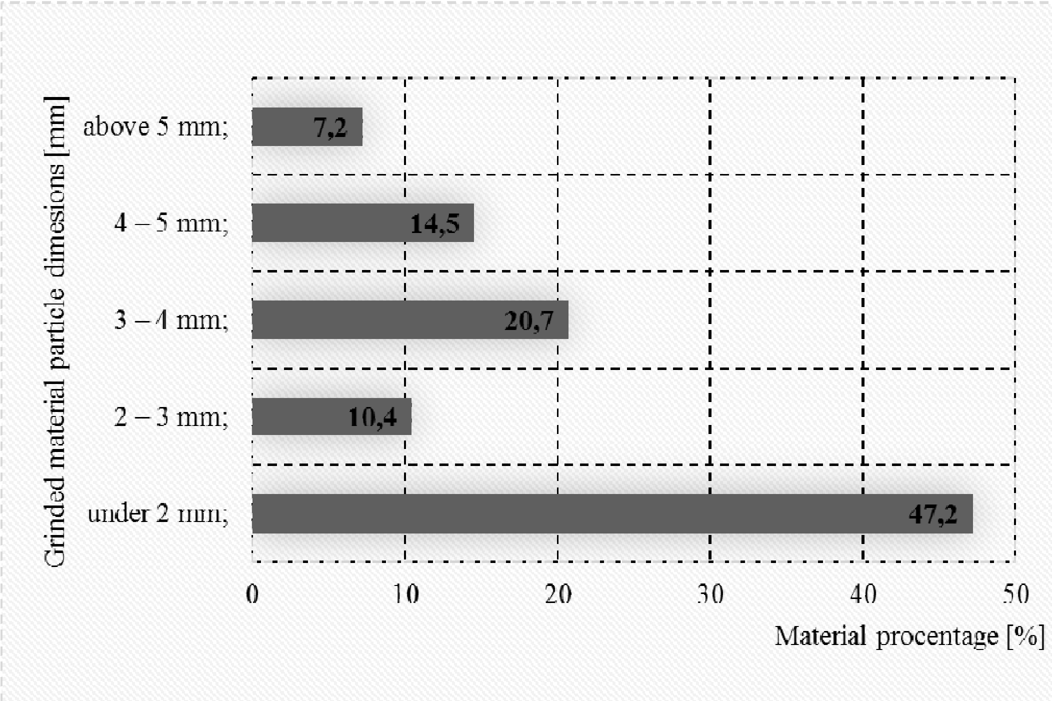

Figure 4: Granulometric distributions on sieves of the particles after the experimental tests

3. CONCLUSIONS

It could be concluded that the grinding process of this equipment it is efficient because of the degree of grinded material in very small particles. Taking into consideration other experimental tests done by INMA with this machine [1, 2], the degree of grinded material was similar, recording a higher degree of grinded material for particles under 2 mm and a lower degree of grinded material for particles above 5 mm.

Also, it is necessary to mention that the degree of grinded material depends on the dimensions of sieves orifices. Smaller the orifices of sieve higher the degree of grinded material and the specific energy consumption.

Acknowledgement

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EXPERIMENTAL RESEARCH ON THE QUALITY OF THE MECHANIZED HARVESTING PROCESS OF CHAMOMILE INFLORESCENCES

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ABSTRACT

Medicinal plants are carriers of active principles that express their therapeutic value. Growing these plants provides increased amounts of drug, required for direct valorization or by processing in product industries: pharmaceuticals, cosmetics and perfumery, food industry, etc. Mechanized harvesting, applied to these cultures, represents a guarantee for obtaining profitable productions.

This paper is a continuation of experimental research conducted at INMA, related to the mechanized harvesting of chamomile inflorescences with different sizes of the active organ. Thus, it presents the evaluation of the mechanized harvesting process by assessing the degree of harvesting, using multivariate regression functions, which were obtained by processing the experimental data.

The results are an important prerequisite for the revival of chamomile cultivation in Romania, as well as for manufacturing efficient specialized equipment, adequate for the local conditions and for a sustainable development.

1. INTRODUCTION

Chamomile (*Matricaria recutita L.*), known since ancient times for its therapeutic qualities, is one of the most cultivated medicinal plants (approx. 20,000 ha worldwide). Its production on a large scale can only be achieved through the mechanization of harvesting, using devices equipped with different types of collectors [3, 5]. From a constructive point of view, they may be of drum or carrier type, but the active organs for harvesting chamomile inflorescences are, in almost all cases, of the comb type [2, 5], the work process being a process of shaving (scraping). Processes of this kind include the following phases:
- combs penetration in the layer of stems, their movement along the stems and respectively
- combs exit the layer of stems. [5, 6]

Chamomile harvesting equipment used in the experiments was a trailed machine, equipped with a conveyor-type collector. This is a conveyor with belt and rakes, represented by combs and their supports.

Within INMA were executed and tested several types of scraper combs, with straight teeth and curved teeth respectively, for both types, the gap between the teeth having the most agreed form of a rounded "U" [1]. The collector of the chamomile harvesting machine was fitted in turns with these dimensions for the active organs, determining the work qualitative indices, afterward choosing a representative option for each dimension (V1 for straight teeth, respectively T2 for curved teeth). [6]

Harvesting chamomile inflorescences is a key point in the production chain, because it has a major impact on the quantity and quality of plant material obtained [2]. The degree of harvest is the first of the qualitative indices with the help of which the work done by the specialized machine is evaluated.

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2. METHODOLOGY

In experimental research are often met situations where the dependent variable y is a function, simultaneously, for several independent variables. Therefore, appears the need to determine an analytical expression of the form: $y = f(x_i, a_0, a_i, a_{ii}, a_{ij})$ (1)
which will express the function y dependence of the independent variables x_i and of the constants a_0, a_i, a_{ii}, a_{ij}. Solving the problem is complex, requiring the following steps:

- Creating an appropriate program of organizing the experiences;
- Determining the values of constants;
- Testing the significance of variables;
- Testing the suitability of the function's shape.

The structure of experimental research programs used to determine the function y is given by the following elements:

- Number n_* of experiences performed for different values of the independent variables, necessary to determine the coefficients;
- The number n_o of experiments performed for identical values of the independent variables, necessary to determine the experimental error;
- The levels of independent variables;
- The content of experiences. [7].

In order to determine the coefficients of the multivariable functions expressing the degree of harvest, were chosen independent variables that influence this dependent variable and their range of variation. Thus they are:

- Working speed: v_l = 0.5 - 1.22 km / h;
- Harvesting height H = 0.3 - 0.45 m;
- The peripheral speed of the combs: v_p = 0.52 - 1.08 m / s;

For each independent variable was chosen an inferior and a superior level. The structure of experimental research programs used to determine the function y is given by:

The number n_* = 14 experiments performed for different values of the independent variables, necessary to determine the coefficients;

Number n_o = 4 experiments performed identical values of independent variables, necessary to determine the experimental error;

Total number of experiments $n = n_* + n_0$ = 14. (2)

The main characteristics of the experimental program, defined in relation to the requirements to determine appropriate functions for research processes are:

Compatibility defined in relation to the achievement of a unique solution of coefficients. The experimental program is compatible when the system of linear equations obtained is compatible, so the primary determinant of the system is nonzero. This condition is achieved if the number of different experiences n_* is at least equal to the number of coefficients and if the number of levels of a variable is at least two.

Orthogonality defined in relation with the achievement of uncorrelated estimates of coefficients. Two variables x_k and x_e are uncorrelated, thus the program is orthogonal if the condition $n\sum_{i=1}^{n} x_{ik}x_{ie} = \sum_{i=1}^{n} x_{ik} \sum_{i=1}^{n} x_{ie}$ is fulfilled. (3)

Verisimilitude defined in relation to achieving conclusive values of the indicators for testing the significance of coefficients and the adequacy of shape of the function. [7]

The experimental testing program for determining multivariable functions for the calculation of the degree of harvest for V1si T2 versions of combs is shown in Table 1.

The regression function of a y_1 polynomial form with three independent variables v_l, H, v_p, expressing the degree of harvest for V1 is of the form:

$$y_1 = a_1 + a_2 v_l + a_3 H + a_4 v_p + a_5 v_l^2 + a_6 H^2 + a_7 v_p^2 + a_8 v_l H + a_9 v_l v_p + a_{10} H v_p \quad (4)$$

Table 1 Experimental program for the degree of harvest for V1 and T2

No.	v_l [km h^{-1}]	H [m]	v_p [m s^{-1}]	Degree of harvest V1 [%]	Degree of harvest T2 [%]
1	0.5	0.30	0.52	64.6	76.8
2	1.22	0.30	0.52	59.6	65.8
3	0.5	0.45	0.52	46.8	48.4
4	1.22	0.45	0.52	41.8	44.1
5	0.5	0.30	1.08	65.8	86.4
6	1.22	0.30	1.08	57.6	74.2
7	0.5	0.45	1.08	47.2	50.1
8	1.22	0.45	1.08	41.8	41.8
9	0.5	0.30	0.76	66.2	83.2
10	1.22	0.30	0.76	59.8	77.2
11	0.76	0.45	0.76	44.6	44.6
12	0.76	0.30	0.76	64.6	76.9
13	0.76	0.30	1.08	65.2	81.2
14	0.76	0.30	0.52	64.0	78.4
15	0.76	0.30	0.76	64.6	76.9
16	0.76	0.30	0.76	60.0	80
17	0.76	0.30	0.76	68.0	72
18	0.76	0.30	0.76	62.0	75

Using a calculus program, developed in Turbo Pascal programming language, were calculated regression the regression coefficients for the polynomial function, which expresses the degree of harvest for the V1 version of combs, by the method of least squares. Testing the significance of coefficients and adequacy of function are studied with Fisher's test. [7, 8].

The regression coefficients and the coefficients for testing the significance of the coefficients of the polynomial function corresponding to V1 are:

$a_1 =$ 2.892936 $\rightarrow F_1 =$ 5100.327728 > F=8.25 it results: *a_1 is significant;*
$a_2 =$ 0.00000 $\rightarrow F_2 =$ 2.326922 < F=8.25 it results: *a_2 is not significant;*
$a_3 =$ 431.089156 $\rightarrow F_3 =$ 69.515473 > F=8.25, it results: *a_3 is significant;*
$a_4 =$ 0.00000 $\rightarrow F_4 =$ 0.003607 < F=8.25 it results: *a_4 is not significant;*
$a_5 =$ -5.294853 $\rightarrow F_5 =$ 31.634284 > F=8.25 it results: *a_5 is significant;*
$a_6 =$ -756.879041 $\rightarrow F_6 =$ 371.811290 > F=8.25 it results: *a_6 is significant;*
$a_7 =$ 0.00000 $\rightarrow F_7 =$ 26.247041 < F=8.25 it results: *a_7 is not significant;*
$a_8 =$ 0.00000 $\rightarrow F_8 =$ 86.530867 < F=8.25 it results: *a_8 is not significant;*
$a_9 =$ 0.00000 $\rightarrow F_9 =$ 62.36612 < F=8.25 it results: *a_9 is not significant;*
$a_{10} =$ 0.00000 $\rightarrow F_{10} =$ 329.457316 < F=8.25 it results: *a_{10} is not significant;*

The recalculated regression coefficients are:
a_1 = 1.27033, a_2 = 0.00000, a_3 =446.101, a_4 = 0.00000, a_5 = -5.29485,a_6 = -756.87904, a_7 = 0.00000, a_8 = 0.00000, a_5 = 0.00000, a_{10} = 0.00000.

The coefficient for testing the adequacy of the form of the function is F=0.077 < F_{tab} = 9.4, thus it results that the form of the function is adequate [8]. The polynomial function which allows the calculation of the degree of harvest for V1 version of combs is:

$$y_1 = 1.27033 + 446.101 \cdot H - 5.29485 \cdot v_l^2 - 756.87904 \cdot H^2 \quad (5)$$

The regression function of polytropic form y_2 with three independent variables v_l, H, v_p, expressing the degree of harvest for V1 is of the form: $y_2 = a_1 \cdot v_l^{a_2} \cdot H^{a_3} \cdot v_p^{a_4}$ (6)

Using a calculus program, developed in Turbo Pascal programming language, was calculated the regression coefficients for polytropic function for the V1 version, following the methodology set out above. [7, 8]. Thus the regression coefficients and coefficients of testing the significance of the coefficients for the polytropic function corresponding to V1 are:

a_1 = 21.534569105→F_1 = 97029.799793 > F=8.25 it results that *a_1 is significant;*
a_2 = - 0.124448674→F_2 = 10.5475655 > F=8.25 it results that *a_2 is significant;*
a_3 = - 0.867457129→F_3 = 105.888038120 > F=8.25 it results that *a_3 is significant;*
a_4 = 0.003523061→F_4 = 0.005675254 < F=8.25 it results that *a_4 is not significant;*
the recalculated coefficients are: a_1 = 21.5345691, a_2 = - 0.1244487, a_3 = - 0.8674571, a_4 = 0
The coefficient for testing the adequacy of the form of the function is F=0.123 < F_{tab} = 9.4, thus it results that the form of the function is adequate [8].

The polytropic function that allows the calculation of the degree of harvest for the V1 version of combs is: $y_2 = 21.5345691 \cdot v_l^{-0.1244487} \cdot H^{-0.8674571} \cdot v_p^0$ (7)

In Figure 1 are represented for the V1 version of the combs, the experimental values of the degree of harvesting inflorescences, compared to the theoretical ones, calculated using the regression function of polynomial and polytropic form previously obtained, for each experiment.

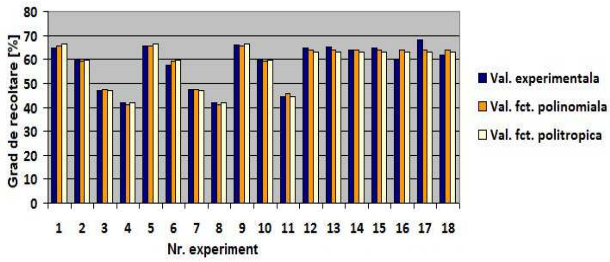

Fig.1 Degree of harvesting inflorescences for the VI version of combs

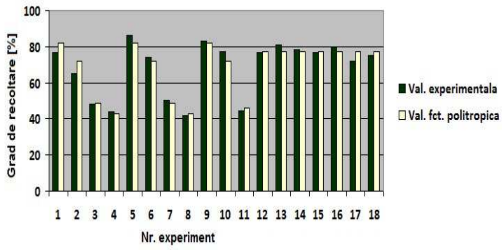

Fig.2 Degree of harvesting inflorescences for the T2 version of combs

Were calculated the regression coefficients for the polynomial function, which expresses the degree of harvest for the T2 version of combs, using the same methods as for V1 [7, 8].

The regression coefficients and the coefficients of testing the significance of the coefficients for polynomial function corresponding to T2 are:

a_1 = 210.204744 → F_1 = 5204.160411 > F=8.25 it results: *a_1 is significant;*
a_2 = -45.563698 → F_2 = 6872.130350 < F=8.25 it results: *a_2 is significant;*
a_3 = -608.771281 → F_3 = 219.033653 > F=8.25, it results: *a_3 is significant;*
a_4 = 0.00000 → F_4 = 2.589725 < F=8.25 it results: *a_4 is not significant;*
a_5 = 14.136215 → F_5 = 105.216738 > F=8.25 it results: *a_5 is significant;*
a_6 = 582.614323 → F_6 = 358.338183 > F=8.25 it results: *a_6 is significant;*
a_7 = -8.101490 → F_7 = 36.432630 > F=8.25 it results: *a_7 is significant;*
a_8 = 0.00000 → F_8 = 2.641562 < F=8.25 it results: *a_8 is not significant;*
a_9 = 0.00000 → F_9 = 0.644383 < F=8.25 it results: *a_9 is not significant;*
a_{10} = -86.746014 → F_{10} = 8.834197 > F=8.25 it results: *a_{10} is significant;*

The recalculated regression coefficients are:
a_1 = 22.97838, a_2 = 220.13518, a_3 =-577.04272, a_4 = 0.00000, a_5 = 14.13621,a_6 = 582.61432, a_7 = -8.10149, a_8 = 0.00000, a_5 = 0.00000, a_{10} = -86.74601.

The coefficient for testing the adequacy of the form of the function is F=742.299 > F_{tab} = 9.4, thus it results that the form of the function is adequate [8].

As for the V1 version, were calculated the regression coefficients and coefficients of testing the significance of the coefficients for the polytropic function of the T2 version:

a_1 = 16.139197876→F_1 = 153377.504300 > F=8.25 it results: *a_1 is significant;*
a_2 = - 0.149386085→F_2 = 22.710735275 > F=8.25 it results: *a_2 is significant;*
a_3 = - 1.282270012→F_3 = 345.739538330 > F=8.25 it results: *a_3 is significant;*
a_4 = 0.072695156→F_4 = 3.610730936 < F=8.25 it results: *a_4 is not significant.*
The recalculated coefficients: a_1 = 16.139198, a_2 = - 0.149386, a_3 = - 1.282270, a_4 = 0

The coefficient for testing the adequacy of the form of the function is F=1.279 < F_{tab} = 9.4, thus it results that the form of the function is adequate [8]. The polytropic function that allows the calculation of the degree of harvest for the T2 version of combs is: $y_3 = 16.139198 \cdot v_l^{-0.149386} \cdot H^{-1.282270} \cdot v_p^0$ (12)

In Figure 2 are represented for the T2 version of combs, the experimental values of the degree of harvesting inflorescences, compared to the theoretical ones, calculated using regression polytropic function previously obtained, for each experiment.

Using the data in Table 2, for a constant harvest height of H=0.300 m can be determined the variation in the degree of harvest for V1 and T2 versions of combs depending on the operating speed (v_l=x_1) and the peripheral speed of combs (v_p=x_2), using a function of the form: $f(x_1, x_2) = a_0 + a_1 x_1 + a_2 x_2 + a_3 x_1^2 + a_4 x_1 x_2 + a_5 x_2^2$ (13)

Tabel 2 Harvest degree for the V1 and T2 versions, at a harvest height of H=0.300

Operating speed v_l [km h^{-1}]	Peripheral speed of combs v_p [m s^{-1}]	Degree of harvesting inflorescences V1 [%]	Degree of harvesting inflorescences T2 [%]
0.5	0.52	64.6	76.8
0.5	0.76	66.2	83.2
0.5	1.08	65.8	86.4
0.76	0.52	64	78.4
0.76	0.76	64.6	76.9
0.76	1.08	65.2	81.2
1.04	0.52	61.2	71.2
1.04	0.76	58.6	73.2
1.04	1.08	59.9	68.4
1.22	0.52	59.6	65.8
1.22	0.76	59.8	77.2
1.22	1.08	57.6	74.2

Using Mathcad were determined the constants of the function corresponding to each version, then represented graphically the variation of the degree of harvest [4]. From figures 3 and 4 can be determined the value of the degree of harvesting chamomile inflorescences for any operating speed and for any peripheral speed of combs, corresponding to a constant harvesting height, H = 0.300m.

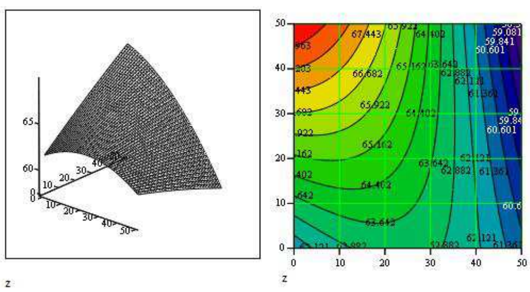

Fig.3 - Variation of the degree of harvest (z) for V1 depending on v_l *and* v_p at H = 0.300m

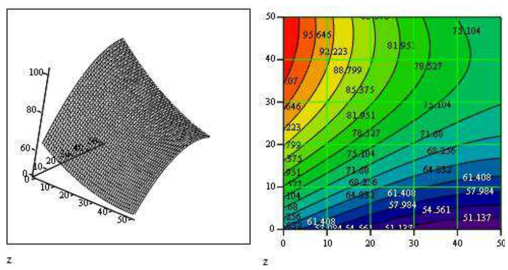

Fig.4 - Variation of the degree of harvest (z) for T2 depending on v_l *and* v_p at H = 0.300m

For each option considered for the active organs was represented graphically the variation of the degree of harvest for each peripheral speed of combs v_{p1}=0.52 ms^{-1}, v_{p2}=0.76 ms^{-1}, v_{p3}=1.08 ms^{-1}), depending on the operating speed (figures 5 and 6)

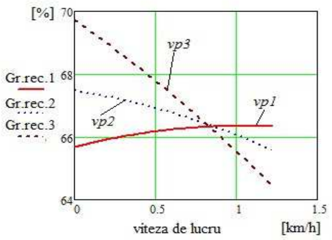

Fig.5 - Variation of the degree of harvest for V1 depending on v_l at H = 0.300m

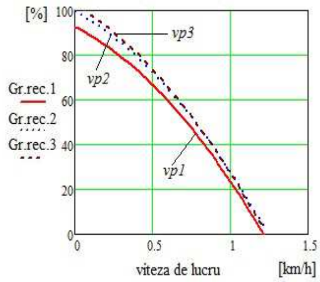

Fig.6 - Variation of the degree of harvest for T2 depending on v_l at H = 0.300m

3. CONCLUSIONS

The analysis of preliminary results of processing experimental data on the degree of harvesting chamomile inflorescences highlights the following aspects:

- for the V1 version of combs, the degree of harvest can be expressed both through a polytropic function and by a polynomial one;
- for the T2 version of combs, degree of harvest can be expressed only through a polytropic function;
- for both versions of combs, the expressions of the analytic functions of several variables are independent of the peripheral speed of combs;
- at a harvest height H = 0.300m (constant), for the V1 version is found that for an operating speed v_l=0.81 Km h^{-1}, regardless of the peripheral speed of the combs, the degree of harvest has the same value, in the conditions that it increases for the minimum speed of combs (v_p=0.52m s^{-1}) and decreases for their maximum speed (v_p=1.08 m s^{-1});
- in the same conditions (H = 0.300 m), for the T2 version, the degree of harvest decrease depending on the operating speed for any value of the peripheral speed of the combs, therefore the productivity is disadvantaged in this case;

The theoretical results obtained from this analysis constitute an important prerequisite for optimizing the degree of harvest, in order to make efficient specialized equipment designed for harvesting chamomile inflorescences, as well as an argument in favor of relaunching the cultivation of this species in Romania, in the context of sustainable agricultural development.

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CONTRIBUTIONS REGARDING THE TESTING OF KNEADING CHARACTERISTICS ON WHEAT FLOUR DOUGH

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ABSTRACT

This study deals with the possibility of correlating the measurements made on a Brabender farinograph in laboratory and those made on a mixer used in a bread making factory, to which it was connected a device for measurement which is made from an amperometric clamp and a data acquisition system made from an acquisition data plate (type Supco USB 6000), connected to a computer. The experimental research is based on the analysis of two types of flour FA-650, from two different mills.

1. INTRODUCTION

Nowadays, in the Romanian bread factories, the technology is expanding and it requires a stricter control of the entire bread making process. In Romania, the analysis of chemical, physical and rheological properties of flour are done in the laboratories and mills in which the flour is grinded.

The process of dough mixing is different from an usual mixing one because of its components properties, especially flour and water, which are the dough's main components, [1]. The dough mixing process is the first step and a very important phase in bread making industry, [6].

Dough is formed through the coalescence of hydrated flour particles and their relative movement under the action of the mixer's work mechanisms, resulting in the end, a compact and homogeny mass [2, 7].

Even if the farinograph's curves have similar profile, these present differences because of the flour's characteristics, the added water, the type of mixer, time of kneading, the quantity and the quality of added ingredients for the improvement of dough and final product. The rheological behaviour of dough during kneading, is fluctuating, [3, 4, 5, 10].

An aspect of great importance it represents the quantity of added water in the kneading process, in correlation with the water absorption capacity of the analysed flours and which is basically influenced by the type of mixing (intensive or normal) and by the shape of the kneading arms, more precisely by the energy introduced per time unit in the dough [J/kg], but also by the quality of the proteins found in flour [5, 9].

The image of the kneading process must be as clear as possible, because it can show the optimum dough development (if it is a good gas retainer, it has elasticity or it's behavior in other phases of the bread making process is optimum), which will decide the quality of the final product, [8, 2, 4].

The present article draws to attention the fact that the bread making process can be can be done with a higher accuracy, if the used mixer offers the possibility to determine the quantity of water which must be added to the flour for each individual charge.

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2. MATERIALS AND METHODS

The experimental determinations for evaluating the quality of the flour in the kneading process, were made using a Brabender farinograph, version E (figure 1a). The farinograph has a capacity of 300 g of flour and the water temperature in the recirculation system was held up to 30+1 ºC.

There were also made experimental determinations on a mixer type Tecnopast BSE 300, at which was connected a device called 'Loggit' (figure 1b), used for measuring the electricity consumed by the engine of the mixer.

In order to make a correct comparison between the two measurement devices, it is necessary to establish an equivalence between the obtained results with the benchmark mixer and the ones obtained with the data acquisition device in real time, called 'Loggit'. In order to establish the right correction that must be done to the in-house device, several combined measurements have been done, to which the benchmark mixer has been connected to and the data acquisition device as well during the establishment of values.

The working principle of this method consists in connecting the measuring and data acquisition device to the mixer, where it measures the consumed electricity by the engine during the kneading, a consumption that is growing/descending depending on the opposition force of the dough at the kneading arm, more so on the torque at the mixer's working arm.

For the experimental research, were used two types of wheat flour, both F-650, but with different physico- chemical and rheological features, as it is shown in table 1.

Table 1: Physico- chemical and rheological features of different types of flour from wheat in the context of experimental research

Flour type	Moisture content, (%)	Wet gluten (%)	Ash content, (%) s.u.	Protein content, (%) s.u.	Gluten deformation (mm)	Acidity, (º)	Gluten deformation index	Falling number, (sec)	Gluten index
FA – 650 (F1)	13,7	0,65	11	26,8	4	1,8	2	350	84
FA – 650 (F2)	14,1	0,65	11,2	27,5	5	2,5	1,5	290	82
Flour type	P, [mm]	G	L, [mm]	W $[10^{-4}\cdot J]$	P/L	Water absorption [%]	Farinograph quality number	Stability [min]	Development [min]
FA – 650 (F1)	118	18.4	57	257	2.1	60.4	35	6	3
FA – 650 (F2)	99	18.5	68	233	1.5	57.5	40	4	4

The same type of flour (FA-650 F1) used on Brabender farinograph, was used for the tests made on an industrial mixer, type Tecnopast BSE 300, with spiral blade, planetary motion and mobile vat, with a capacity of 300 l, in order to determine the variation of the resistant torque on the spiral blade. The water temperature was 30-31 ºC, in correlation with the temperature of the water used in the tests on Brabender farinograph. The mixing time in both sets of tests, was of 20 minutes.

Before starting the kneading process, an amperometric clamp was connected to the power supply of the engine which trains the kneading arm. The amperometric clamp was also connected to a data acquisition device (Supco type), which downloads real time information on a computer. The registered signals were filtered based on the electrical current variation, and the variation curves for the dough consistency during kneading, were drawn.

In order to filter the obtained data, functions like max, min, average, count and others in the Excell program were used. The next step was to correlate the measuring unit between the one used for Brabender farinograph (Nm), and the one on the results obtained by the consumption at the kneading arm.

At first, the mixer was left working without load (out-current), in order to establish the energy losses of the mixer, which were decreased from the final calculation of the torque (Nm) consumed by the spiral blade, in relation with the opposing force of the dough.

Considering the general relation for calculating the necessary driving power on the working arm, it can be written:

$$P_m = M_m \frac{\pi . n}{30} \qquad (1),$$

where: M_m is the resisting torque at the kneading arm, maximum, respectively medium and Pm is the corresponding power, [11].

For finding the power consumed by the mixer's engine, the following relation was used:

$$P_m = \sqrt{3} * U\, I \cos \varphi \qquad (2),$$

where: U is force of the current, I is the intensity of the current and which is the value measured by the amperometric clamp and cos φ is the power factor.

In order to establish the consumed power by the kneading process, without the energy losses, the next relation was used:

$$P_{mf} = P_m - P_{mg} \qquad (3),$$

where: P_{mf} is the consumed power only for the kneading process, P_m is the total power consumed by the mixer's engine and P_{mg} is the consumed power of the engine, on out-current.

Knowing the consumed power for the kneading process and the angular speed described by the kneading arm, it is possible to calculate the medium torque:

$$M = \frac{Pm}{\omega m} \qquad (4),$$

where: M is the medium torque of opposition by the dough at the kneading arm, P_m is the power consumed by the engine only for the kneading process and ω_m is the angular speed of the arm when kneading.

a. b.

Figure 1: a. Brabender farinograph; b. Portable device used for measuring the consumed current when kneading dough

3. RESULTS AND DISCUSSIONS

The experimental research was structured in four stages:

- In the first stage of research, the experimental data was processed, resulting in drawing the variation curves of the resistant torque on the kneading arm, as it can be observed in figure 2:

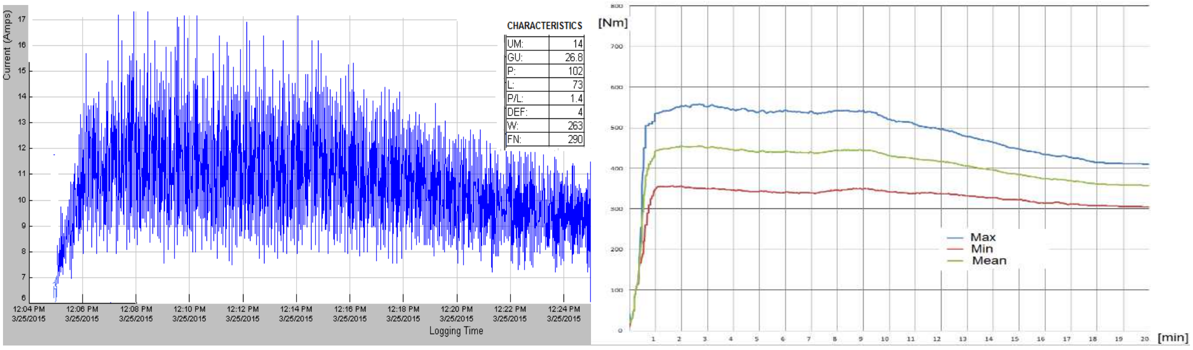

Figure 2: Data registered by Loggit device before and after processing it

- The second part of research focuses on the comparative analysis of the results obtained by the two devices that were used for the same charge of dough, kneaded by the Brabender farinograph. It was drawn the resulting farinogram with the Brabender device and simultaneously with it, was drawn the variation curve of the electrical current consumed in the kneading process, with the Loggit device, as it can be seen in figure 3.

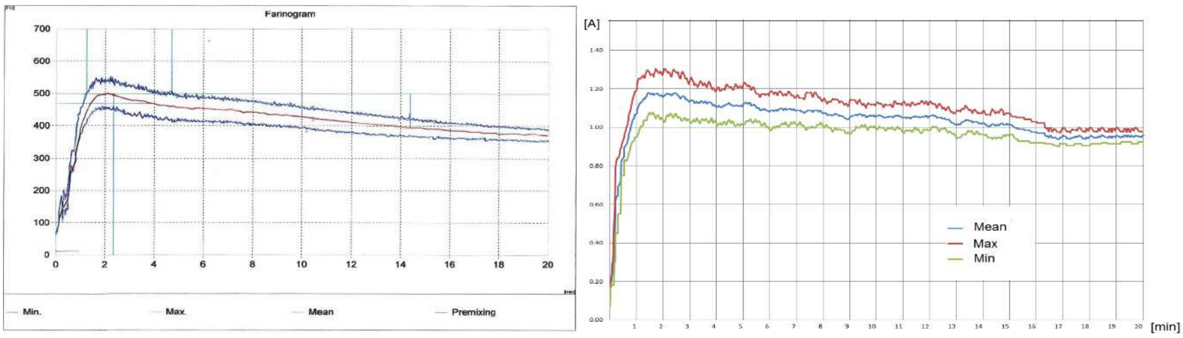

Figure 3: Flour type F1 -650, analyzed with the Brabender farinograph and the variation curves of dough consistency from FA-650 (F1) flour, drawing based on data registered by the Loggit device

- The third part of the experimental research focuses on establishing a correlation between the optimum value of dough consistency, of 500 UB (5 N·m), value indicated by the farinograph and the value indicated by the Loggit device. In order to obtain this result, there were tests made in parallel, on the Tecnopast BSE 300 mixer and on the Brabender farinograph.

For one test was used F1-650 flour type, with 58% added water in reference with the flour and one test with 60% added water, value corrected by the farinograph after the test with 58% added water. The variation curves of the torque on the kneading arm for FA-650 (F1) flour with 58% and 60% added water can be observed in figure 5.

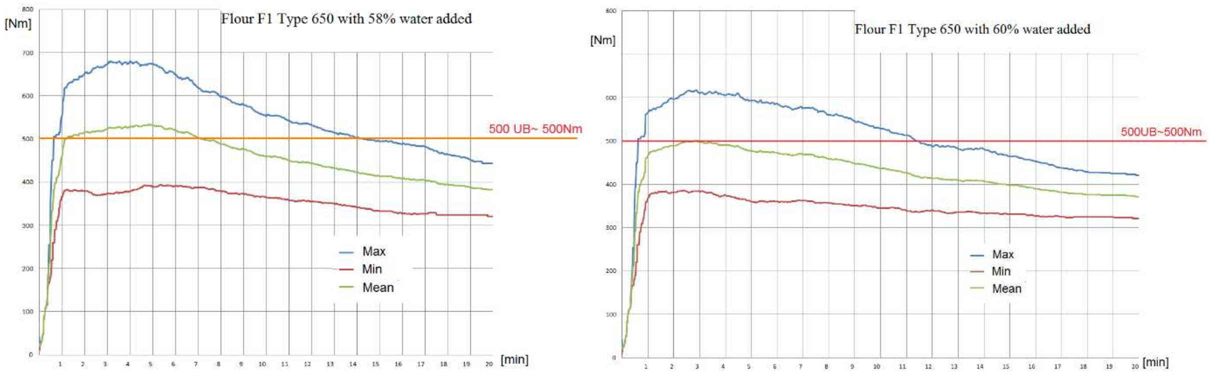

Figure 5: The variation curves of the torque on the kneading arm for FA-650 (F1) flour with 58% and 60% added water

After analyzing the farinographic parameters and taking as standard the correction indicated by the Brabender farinograph (60% added water for FA 650 F1 flour), the medium torque on the kneading arm reaches a maximum around 500 Nm (similarly to the standard value established by the farinograph, of 500UB at 60% added water for the same flour). As a result, the two values, 500UB and 500Nm can be correlated. The value of 500Nm applies only to this type of mixer.

- The forth part of the research focuses on the comparative analysis of the results obtained on tests made on the mixer Tecnopast BSE 300 for two different types of flour FA 650 (F1, F2), in similar conditions of: added water, temperatures for environment, flour and water, kneading time. The variation curves obtained for the two studied flour types FA 650 (F1, F2), in the same conditions of added water (58%), can be observed in figure 6.

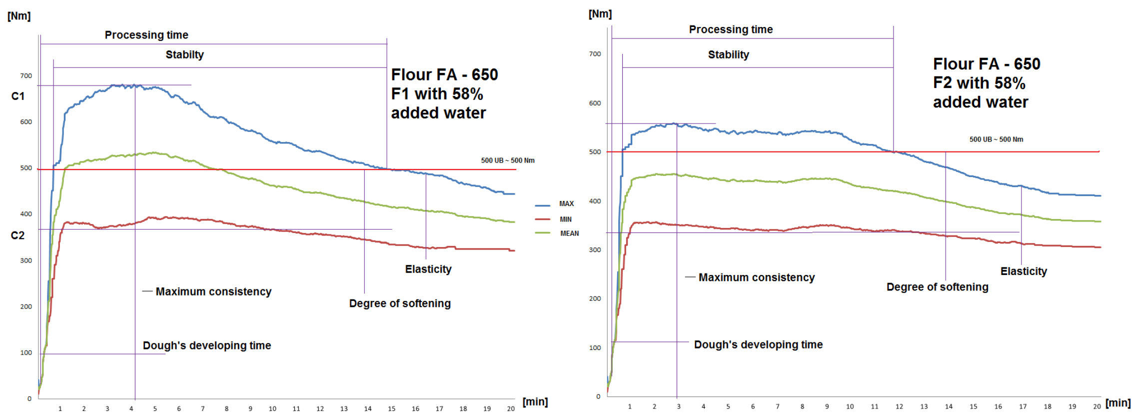

Figure 6: The variation curves obtained for the two studied flour types FA 650 (F1, F2), in the same conditions of added water (58%)

Table 2: Rheological values based on the variation curves presented in figure 6

Flour type	Processing time [min]	Stability [min]	Elasticity [N·m]	Degree of softening [N·m]	Maximum consistency [N·m]	Dough's developing time[min]
F1	15	14,2	150	120	685	4,5
F2	11,2	11,5	90	140	560	2,9

4. CONCLUSIONS:

The documentary study and the experimental results presented in this paper have lead to the following conclusions:

It is imperative to estimate the final moment of the kneading process, so as to obtain a dough with the best possible characteristics, for the ulterior processing (dividing and modeling), as well for the final proofing and baking. The image registered in real time by the Loggit device can help the operators to obtain charges of dough with the same consistency, stopping the kneading process when the optimum value shown on the monitor is reached.

The Loggit device can measure with high accuracy any modification in the kneading process, a conclusion drawn after comparing the kneading diagrams obtained by the two measuring devices used simultaneously on the same process.

The diagrams obtained on an industrial mixer are different from the ones obtained on the Brabender farinograph, but these diagrams have a repeatability character, so diagrams can be drawn for each type of mixer.

For the Tecnopast BSE 300 mixer, it has been established an equivalence between the measured value on the Brabender farinograph, of 500 UB (5 N·m) and the value of 500 N·m measured with the device proposed by the author.

The amount of added water in the kneading process modifies the position of the variation curve on the torque, as well as the specific curve.

The Loggit device can offer a clear image over the kneading process, a fact that highly contributes to its utility, for the technological engineers that work in bread making factories (making it possible to work easier with any kind of flour), as well for the operators, who can follow in real time the development of the dough and its optimum consistency.

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INFLUENCE OF THE FLOW ANGLE FUNCTION BY WORKING PRESSURE

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ABSTRACT

The spraying angle of the jet is the cone's angle formed between the tangents to the jet's contour. concurrent in the nozzle's orifice. The spraying angle. as also the jet penetration. illustrates the liquid's distribution on the surface to spray. This angle depends in a great measure of the nozzle type and its orifice size. The pressure of the liquid has a significant effect on the size of the spraying angle.

Within the paper is presented the evolution of the angle of the nozzle's jet for sprayers machines according to the working pressure and nozzle angle.

1. INTRODUCTION

Agriculture's productivity is influenced by the level of applied work technologies. phyto-sanitary protection occupying a very important place within these technologies. Actual studies and researches regarding methods and equipment for application of phyto-sanitary treatments are framed within the new tendencies for practicing a sustainable agriculture. being a known fact that the phyto-sanitary protection represents one of the main sources of reduction of environment pollution with chemicals [1].

An important aspect of continuum increasing politics of product quality promoted by each manufacturer is represented by both maintaining plants protection machines conformity as also increasing of premises of manufacturing in conditions of repeatability of those products [1. 2].

The purpose of a spraying work is to deposit uniformly a maximum quantity of phyto-sanitary products in the right place (target), respectively on the sprayed surface.

The machines working in the field apply treatment plant is a complex process requiring the start of each work preparatory phase that controls the proper functioning of the machine and make adjustments specific job to perform.

For the spraying machine in field crops, which generally has as main component parts: tank, stirrer, pump, valves, distributor, spraying ramp, one of the most important part is represented by the nozzles, which influence directly the quality of the spraying process.

2. METODOLOGY

For the tests we used a nozzle test bench equipped with pressure gauge, two-port nozzle holders with 5 jets, leakage free system and pump.

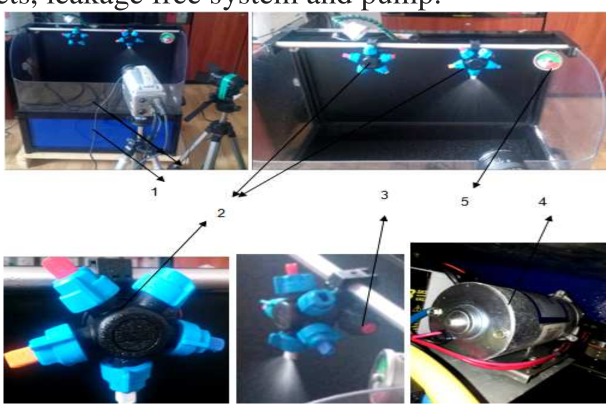

Figure 1: Stand for testing nozzles

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1 - nozzle test bench; 2 - support port-nozzle; 3 - leakage free system; 4 - pump; 5 - gauge

For tests we used a high speed movie camera Phantom V10.0.630 V series, which can record up to 2500 frames per second with the related software.

Figure 2: Camera Phantom V 10.0

3. RESULTS

Experiment description and primary recording in measurements sheets.

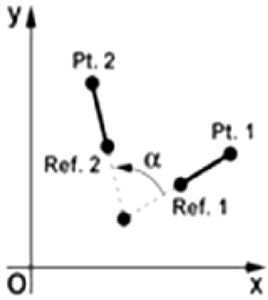


Figure 3: Representation of jet angle through 4 points [4]

Once the angle to be measured is defined by 4 points, we open the imaging panel. After selecting the points, we open a reporting file to store the measurements performed [3]. We repeat the measurements for all the proposed nozzles for experiments.

Figure 4: Nozzle types used in experiments

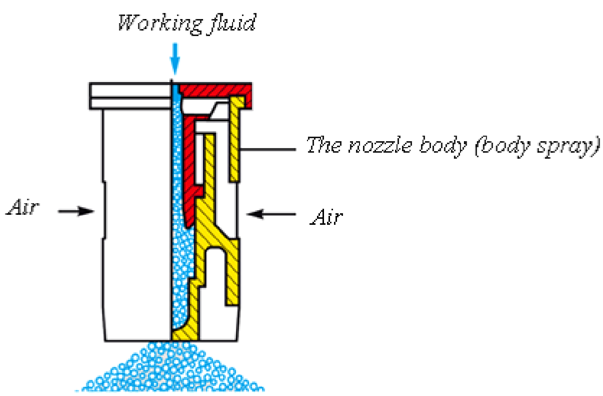


Figure 5: Section through the nozzle [3]

Figure 6: The pressures that were set up for each type of nozzle

Tabel 1: Experimental measurements for nozzle L 0.1

Pressure (bar)	Angle (°)							
	Repetition 1	Repetition 2	Repetition 3	Repetition 4	Repetition 5	Mean value	Standard deviation	The coefficient of variation c_v [%]
1	83.51	81.61	83.87	83.90	86.11	83.8	1.59931235	1.908
2	102.25	103.14	101.99	104.60	101.24	102.644	1.28706255	1.254
3	113.34	108.51	106.80	108.69	110.40	109.548	2.47337219	2.257
4	113.26	112.83	112.98	110.92	113.18	112.634	0.97287204	0.863
5	118.85	116.30	117.48	121.98	117.60	118.442	2.17407912	1.835

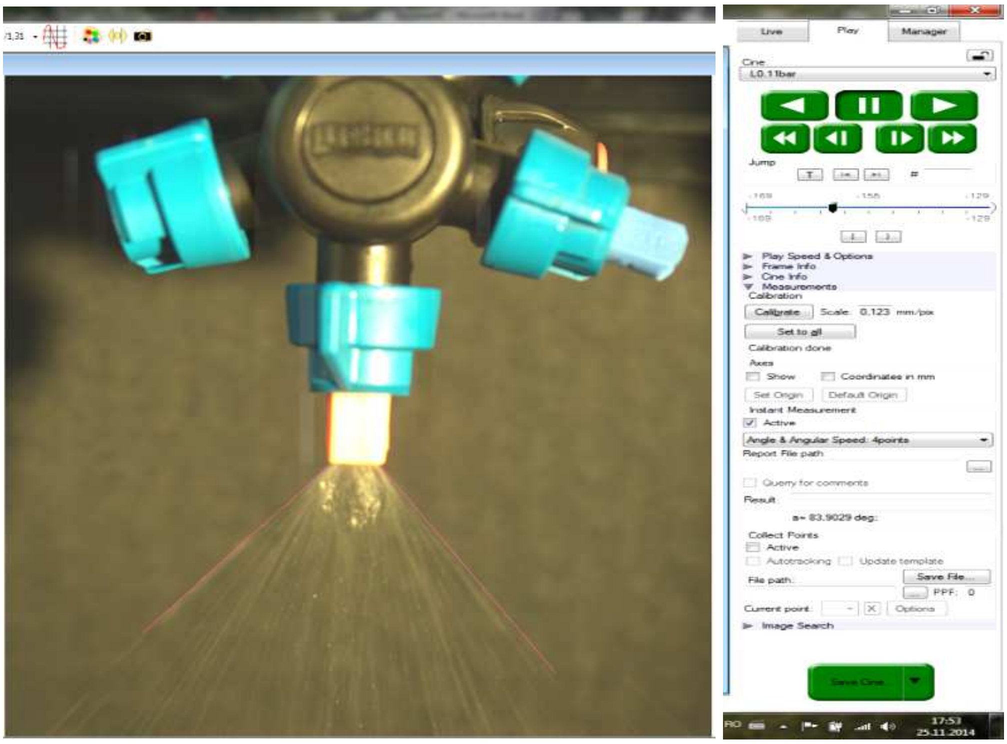
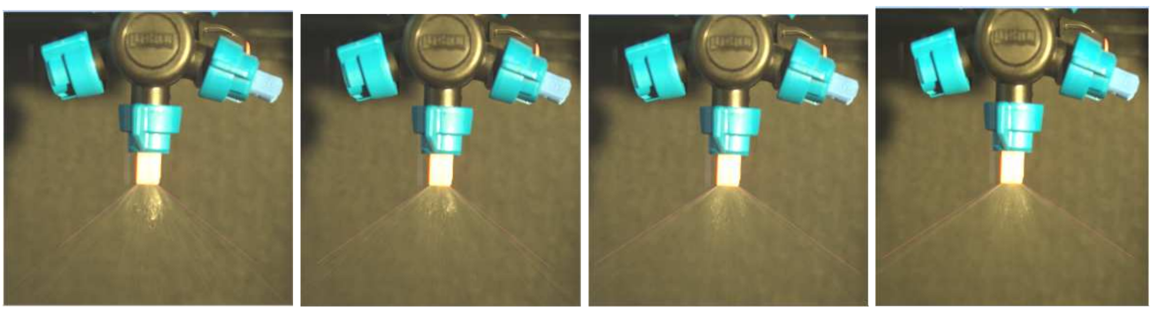


Figure 7: The angle of the spray jet for nozzle L 0.1 to 1 bar pressure

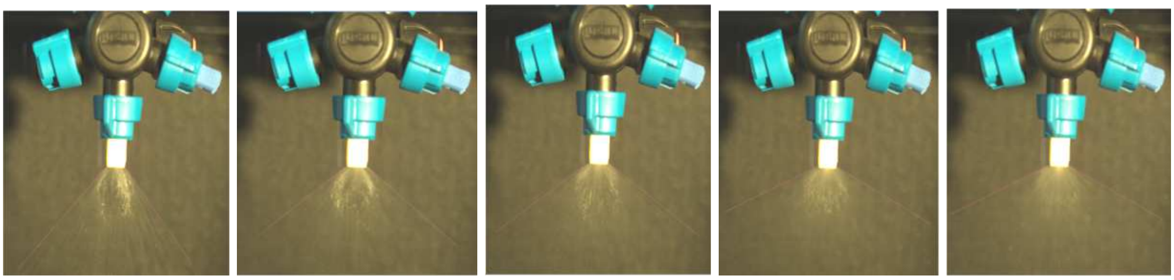


a) b) c) d)

Figure 8: The angle of the spray jet for nozzle L 0.1 to pressures: a) 2bar; b) 3 bar; c) 4 bar; d) 5 bar

Tabel 2: Experimental measurements for nozzle L 0.2

Pressure (bar)	Angle (°)							
	Repetition 1	Repetition 2	Repetition 3	Repetition 4	Repetition 5	Mean value	Standard deviation	The coefficient of variation c_v [%]
1	82.03	84.32	85.84	87.62	85.44	85.05	2.06363757	2.426
2	104.65	108.61	106.74	108.67	105.01	106.736	1.90936639	1.789
3	113.42	117.46	115.49	116.53	116.08	115.796	1.51057274	1.304
4	130.93	128.38	125.18	128.67	126.70	127.972	2.16890986	1.694
5	128.95	133.45	131.60	127.07	127.71	129.756	2.69705024	2.079

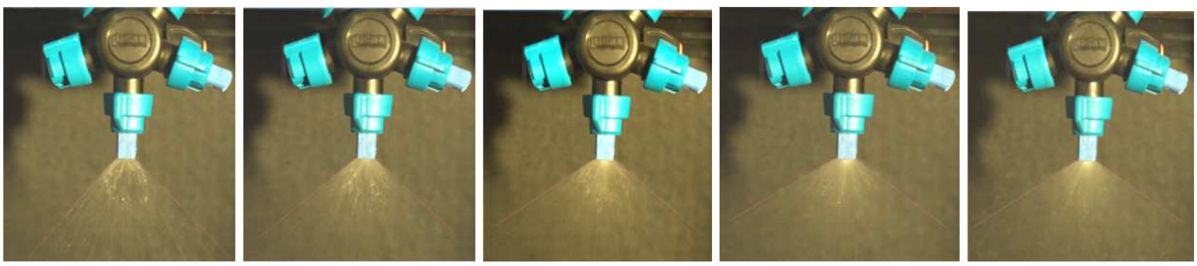


a) b) c) d) e)

Figure 9: The angle of the spray jet for nozzle L 0.2 to pressures: a) 2bar; b) 3 bar; c) 4 bar; d) 5 bar

Tabel 3: Experimental measurements for nozzle L 0.3

Pressure (bar)	Angle (°)							
	Repetition 1	Repetition 2	Repetition 3	Repetition 4	Repetition 5	Mean value	Standard deviation	The coefficient of variation c_v [%]
1	87.48	89.30	84.93	88.39	87.73	87.566	1.63313502	1.865
2	104.99	94.82	101.06	99.71	100.29	100.174	3.63568838	3.628
3	112.53	111.92	111.04	109.11	108.13	110.546	1.86864389	1.689
4	118.46	114.75	111.92	113.00	113.77	114.38	2.50556381	2.191
5	128.95	133.45	131.60	127.07	127.71	129.756	2.69705024	1.968



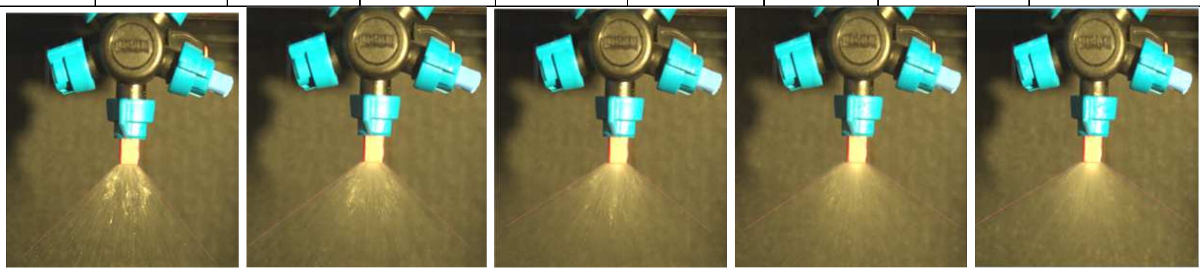
a) b) c) d) e)

Figure 10: The angle of the spray jet for nozzle L 0.3 to pressures: a) 2bar; b) 3 bar; c) 4 bar; d) 5 bar

Tabel 4: Experimental measurements for nozzle L 0.4

Pressure (bar)	Angle (°)							
	Repetition 1	Repetition 2	Repetition 3	Repetition 4	Repetition 5	Mean value	Standard deviation	The coefficient of variation c_v [%]
1	89.47	89.57	92.57	90.80	90.75	90.632	1.25260528	1.381
2	102.84	101.00	103.19	102.02	102.97	102.404	0.9009606	0.879
3	113.68	111.90	113.51	114.30	111.16	112.91	1.31981059	1.168
4	117.42	117.32	120.17	117.72	115.63	117.652	1.62768855	1.383

5	128.95	133.45	131.60	127.07	127.71	129.756	2.69705024	1.760

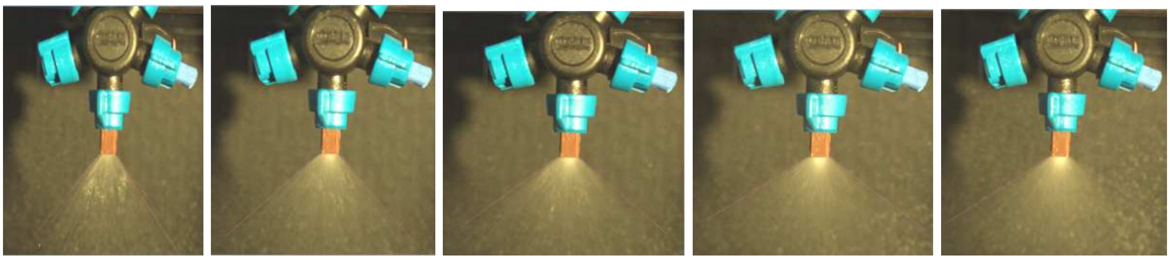


a) b) c) d) e)

Figure 11: The angle of the spray jet for nozzle L 0.4 to pressures: a) 2bar; b) 3 bar; c) 4 bar;

Tabel 5: Experimental measurements for nozzle L 0.5

Pressure (bar)	Angle (°)							
	Repetition 1	Repetition 2	Repetition 3	Repetition 4	Repetition 5	Mean value	Standard deviation	The coefficient of variation c_v [%]
1	85.20	82.61	85.79	84.27	83.55	84.284	1.26967712	1.506
2	96.46	94.96	95.36	94.25	93.13	94.832	1.24308889	1.311
3	107.69	104.00	103.73	107.55	105.08	105.61	1.90377257	1.802
4	114.30	112.37	115.05	112.78	114.22	113.744	1.12455769	0.989
5	117.48	117.21	116.09	118.57	120.52	117.974	1.67440437	1.419

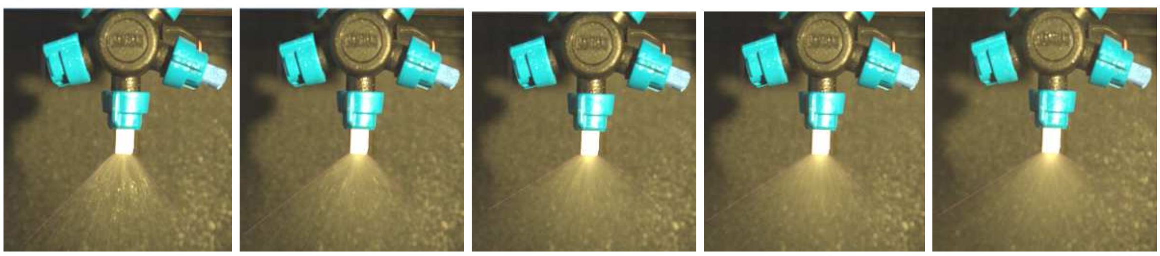


a) b) c) d) e)

Figure 12: The angle of the spray jet for nozzle L 0.5 to pressures: a) 2bar; b) 3 bar; c) 4 bar; d) 5 bar

Tabel 6: Experimental measurements for nozzle L 0.6

Pressure (bar)	Angle (°)							
	Repetition 1	Repetition 2	Repetition 3	Repetition 4	Repetition 5	Mean value	Standard deviation	The coefficient of variation c_v [%]
1	88.33	86.47	87.93	91.50	89.04	88.654	1.84714103	2.083
2	97.40	100.07	98.35	101.62	98.91	99.27	1.63059805	1.643
3	112.82	107.90	106.32	111.57	102.89	108.3	4.01471668	3.707
4	111.90	115.90	116.97	113.20	115.37	114.668	2.06921966	1.804
5	120.08	121.01	122.56	122.83	125.34	122.364	2.01010696	1.643



a) b) c) d) e)

Figure 13: The angle of the spray jet for nozzle L 0.6 to pressures: a) 2bar; b) 3 bar; c) 4 bar; d) 5 bar

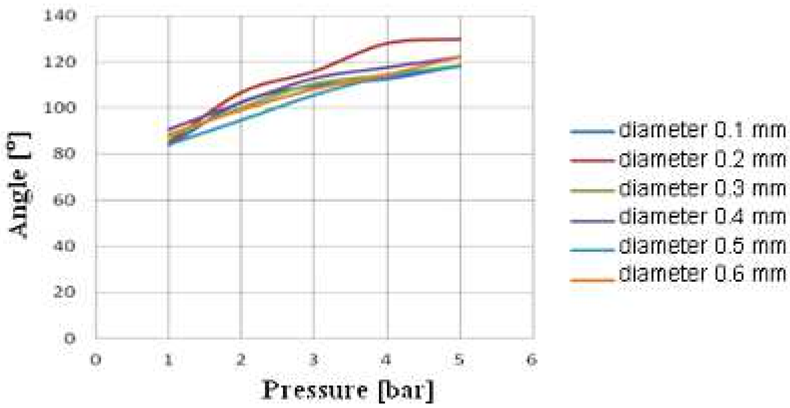


Figure 14: The variation of the angle of flow and pressure according to the different diameters of the nozzle

Next we present the mathematical models which characterize the evolution of the nozzle jet angle – y. in function of the working pressure - x. for each nozzle type. These models were obtained through interpolation of the experimental curves presented in figure 14.

Nozzle L0.1: $y = 20.799\ln(x) + 85.499$
Nozzle L0.2: $y = 28.571\ln(x) + 85.705$
Nozzle L0.3: $y = 19.53\ln(x) + 87.526$
Nozzle L0.4: $y = 19.953\ln(x) + 90.066$
Nozzle L0.5: $y = 21.552\ln(x) + 82.653$
Nozzle L0.6: $y = 20.488\ln(x) + 87.034$

We observe that the steep of the curves is similar defining a tendency of increasing nozzle jet angle function of the working pressure, no matter what type of nozzle diameter we have. Also we observe models correlation by comparing the values of natural logarithm function arguments and of free terms in the models values which are very similar for all the models.

4. CONCLUSIONS

Assuring of maximum efficiency for treatments with phyto-sanitary substances in field crops is possible through manufacturing of spraying machines equipped with spraying systems with superior parameters in the working process.

Repartition deviations at tests performed on stand are inherent even for a new nozzle but those have to fit within the limits, which should not affect the fragmentation repartition on the boom's working width where nozzles repartitions are overlapping and the deviation of the overlapping values should not overpass ±5%.

From processing of obtained experimental data there were calculated coefficients of a logarithmic model which models the spraying jet angle in function of the working pressure for each nozzle diameter.

Analysing data representing evolution of the spraying jet angle (measured and estimated) in function of the input data we observe a really good correlation between them.

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ANALYSIS OF INFLUENCE FACTORS OVER THE TRACTION RESISTANCES OF THE PLOWS

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ABSTRACT

In this paper there is presented an analysis of influence factors over the traction resistances of the agricultural plows. The traction resistance force of the plows is depending on several factors, such as: soil characteristics, constructive particularities and operational modes.

1. INTRODUCTION

Most of the researchers in the field consider that scale of the specific traction resistance of the plow is mainly dependent on: the physical properties of the soil, the type of previous crops, the amount of crop residues remaining in / on the soil and the weed spreading degree.

Structure and humidity of the soil directly influences the adherence, cohesion and the friction coefficient between the soil and working equipment.

2. METHODOLOGY

Traction resistances of the plows are mostly influenced by the following factors: working depth, constructive shape of the working equipment, quality and the material type of which is made the surface of the moldboard, the position of the plow-bottom related to the furrow's surface and the coupling (aggregation) mode of the plow on to the tractor.

Working depth represents one of the most important influence factor over the resistance forces that act over active equipment. From the figure below, Figure 1, it can be observed that the working depth has a linear influence over the traction resistance. This hypothesis is taking into consideration that the soil resistance, when deformation and overthrow of the furrow occurs, is increasing linearly with working depth. Recent researches have proven that this hypothesis is not totally confirmed into practice. Consistence of the superficial layers differs from the consistence of the depth layers. Radicular weight of the superficial layer as well as its compaction when wheels of the agricultural machinery are passing are arguments that do not sustain soil's homogeneity.

Measurements made on different soil types (light and medium) at depth values varying between 0,1m and 0,3m, as shown in Figure 1, have revealed a nonlinear variation of the specific traction resistance depending on the depth value [1]. In each one of the three given cases (light, medium and hard soil) it can be observed an obvious minimum of the specific traction resistance for certain values of the working depth.

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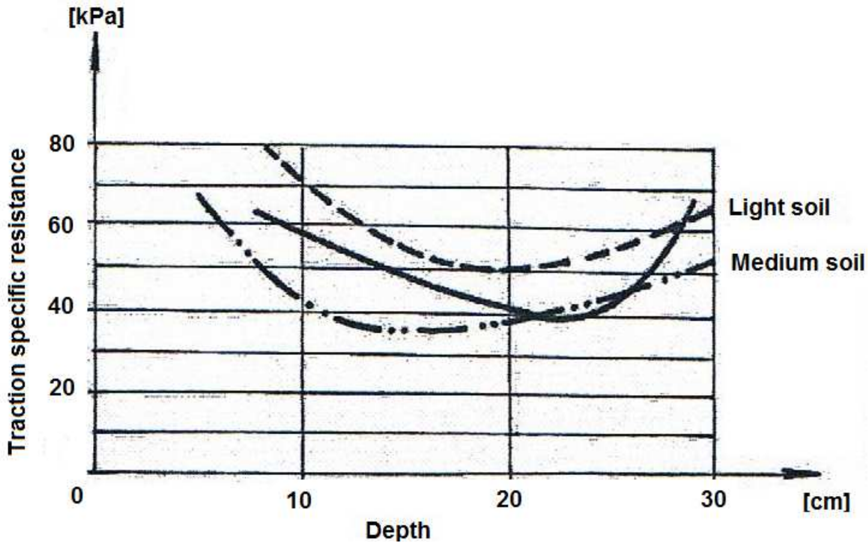

Figure 1: Variation of the specific resistance depending on the working depth, on different soil types

The constructive form of working equipment has been and still is a research issue for most of the researchers and manufacturers of plows because it has a decisive influence over the specific resistance of the active working equipment. In Figure 2, there are shown variation curves of the longitudinal force, F_x, (traction resistance force), F_y – lateral force and F_z – vertical force that act on the plow-bottom on different soil types, obtained at experimental tests in field conditions, on different soil types, with different plow-bottom types from the mass production series (S-shaped, L-shaped, W-shaped, according to German standards DIN11119 .....11125) [5].

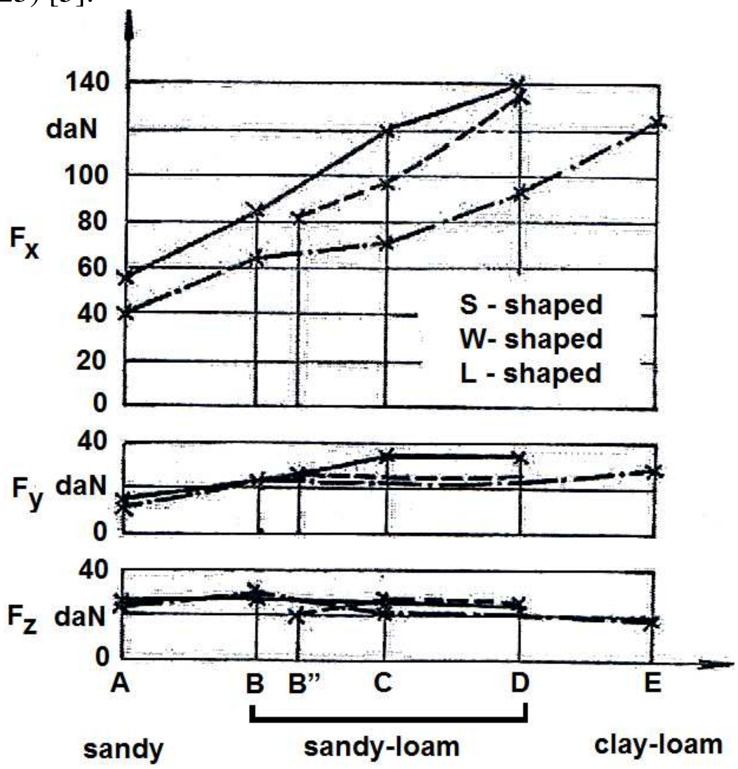

Figure 2: Variation of forces that act on the plow-bottom: F_x longitudinal (traction) force, F_y lateral force, F_z vertical force for different plow-bottom shapes (S, L, W) and soil types (light, medium, hard)

From the data given in Figure 2, it can be observed that the longitudinal force (traction) is three times larger on hard soil types (argillaceous) in respect to the light soil types (sandy). The lateral forces increase less, while the vertical forces have a decreasing tendency; the values of these forces are given for different types of plow-bottom (S, L, W), having relatively similar values.

In some technical papers, there are given the results of comparative researches, as shown in Figure 3, made over different types of plow-bottom with cultural moldboard (A, B and C), four with universal moldboard (D, E, F and G), six with half-helicoidally moldboard (H, I, J, K, L, M and N) and two with helicoidally moldboard (P and R) on different soil types.

On dry loess, the semi-helicoidally moldboards tested better, while on wet loess the universal moldboards proved to be more suitable. On dry clay-loam soil type, the universal moldboards are much more likely to be used, while on the wet clay-loam soil type the semi-helicoidally moldboards.

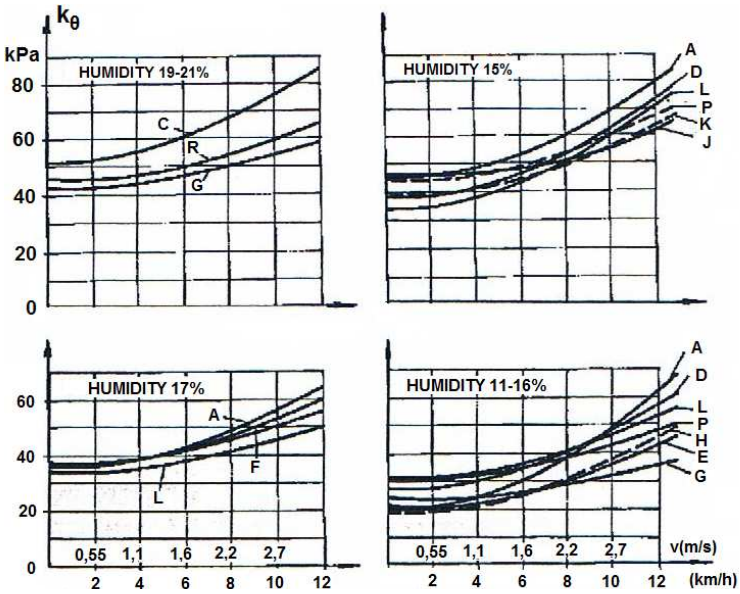

Figure 3 – Variation of traction resistance for different types of moldboards

The quality and the type of material used for manufacturing a moldboard is an important element regarding the variation of specific resistance when plowing. In some technical papers there were studied the behavior of metallic surfaces at various degrees of finishing, as well as those covered with resins or plastic materials, their variation of specific resistance at traction being presented in Figure 4.

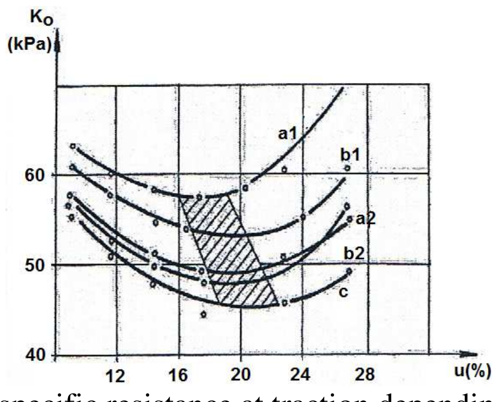

Figure 4 – Variation of specific resistance at traction depending on surface quality and humidity for active surfaces made of: steel, a1; a2, epoxide resins, b1; b2, Teflon, c

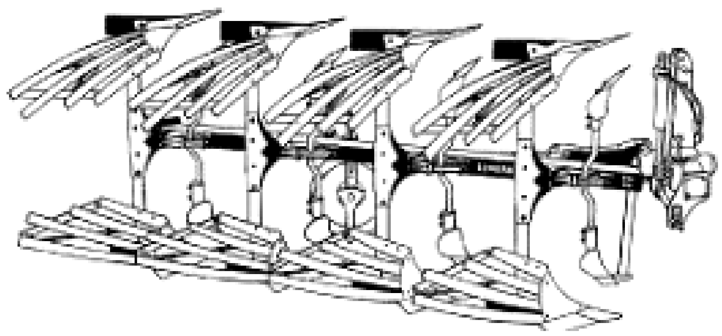

Figure 5 – Plow with lamellar moldboards

Using the sheet metal strips solution for moldboard's manufacturing it will result in an increase of pressure put on the soil, but it will decrease the friction coefficient and the adhesion forces (Figure 6).

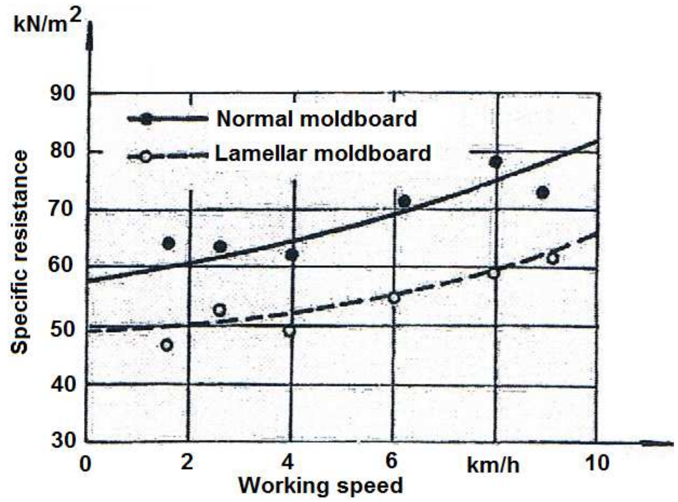

Figure 6 – Variation of traction resistance with working speed on plows equipped with normal plow-bottom and lamellar plow-bottom, on wet clay-loam soil (u_r = 19%), working depth 26 cm

Using lamellar moldboards, there were observed decreases in the values of the traction resistance forces about 8…13%, compared with classic moldboards. Some of the experiments conducted on plowing wet soil [3] shown that plows equipped with lamellar moldboards have lower traction resistances in respect with plows equipped with normal moldboards. Although in all moldboards types the specific traction resistances increase with working speed, this tendency is lower when using lamellar moldboards.

The position of plow-bottom in respect with the surface of the furrow's end influences the values of the traction specific resistance of the plow. The agro-technical requirements impose that plow-bottom must work furrows with identical section and furrow's end must be leveled. Nowadays construction of the plows and the usage of adjusting elements make possible to meet these requirements. Mounting defectively or deformation of the barsa can lead to a plow that will encounter great deviations from the normal values of traction resistances for the type of plow-bottom used. There was established that an incorrectly adjusted plow will have a traction specific resistances that will surpass with 30...40% than the normal ones. In Figure 7, there is shown the traction variation resistance for different positions of the plow-bottom [4].

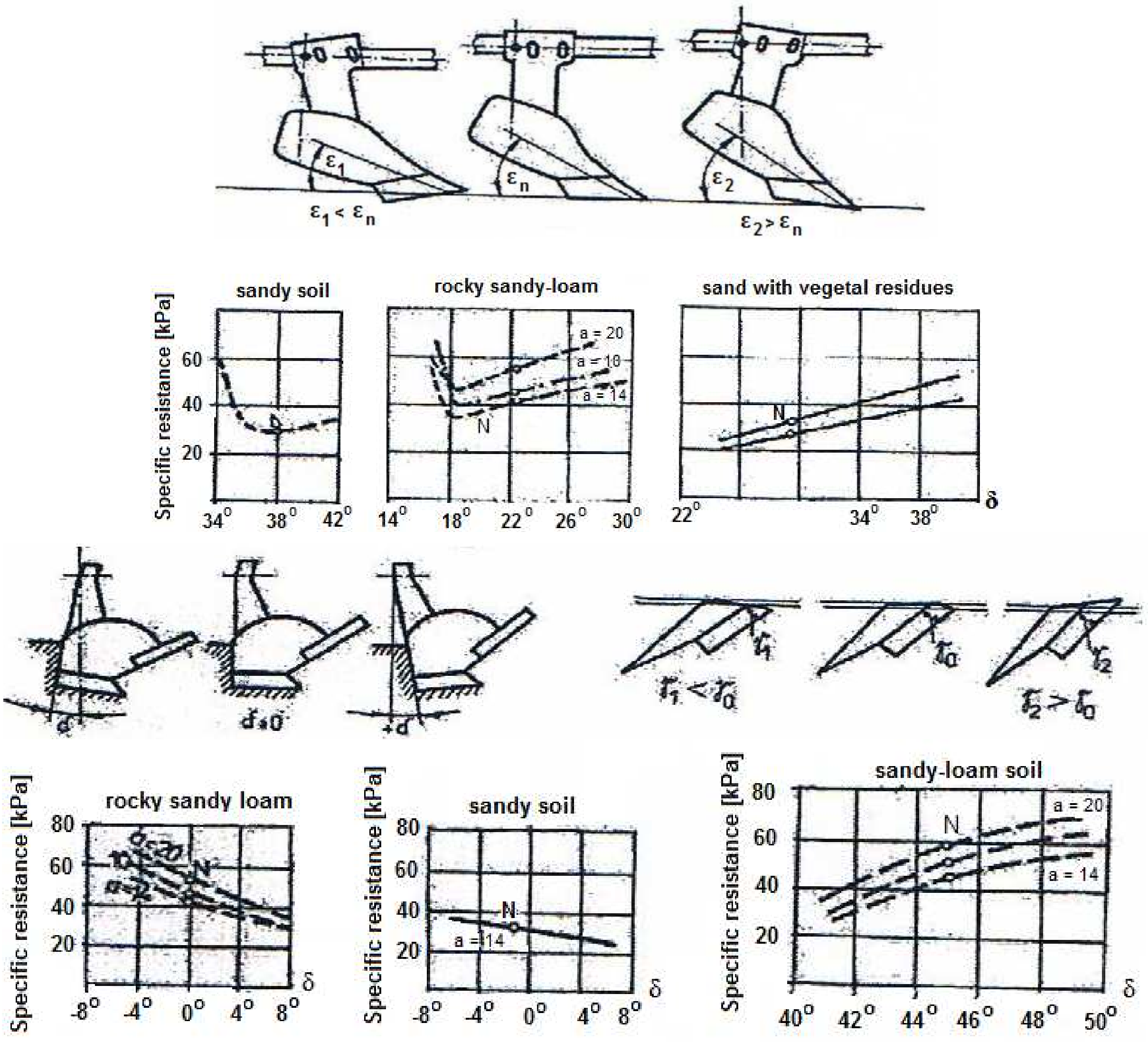

Figure 7 – Variation of specific traction resistance depending on the position of the plow-bottom

The position of the plow-bottom is considered to be incorrect in the following situations:

- it leans on the furrow's end only with the top or the bottom part of the edge of the coulter (the attack angle differs from the initial adjustment);
- it is rotated against the advancing direction (the attack angles are modified, but the coulter's edge is horizontal);
- it is transversally tilted, in this case the furrow's end it is no longer plane (this situation can be encountered when the plow's frame is not positioned horizontally)

There can be observed that a negative tilting of the plow (towards the furrow) is unfavorable from an energetic point of the view, leading to a higher specific resistance than in the opposite situation. Due to a deeper cut of furrow's end, the friction forces, displacement and overturning forces will increase.

The coupling (aggregation) mode of the plow onto the tractor has a decisive influence over the traction resistance and over the energetic consumption. Correct and stable movement of the plowing equipment is obtained when the working resultant resistance forces passes through the instantaneous rotation center. In Figure 8 it is shown the variation of the F_{xy} component of the resultant resistance forces when plowing and the friction force with the furrow's wall F_s. When the traction force direction is modified horizontally with 17° to left or to right, related to the tractor's axis of symmetry.

This variation will produce a change in the value of traction force with about 2000N, respectively 5000N, while the friction force will be modified in 0…16.000N interval. Therefore, when the tractor leaves the furrow it will produce an increase of working resistance forces due to the increase of friction forces between the plow and furrow's wall.

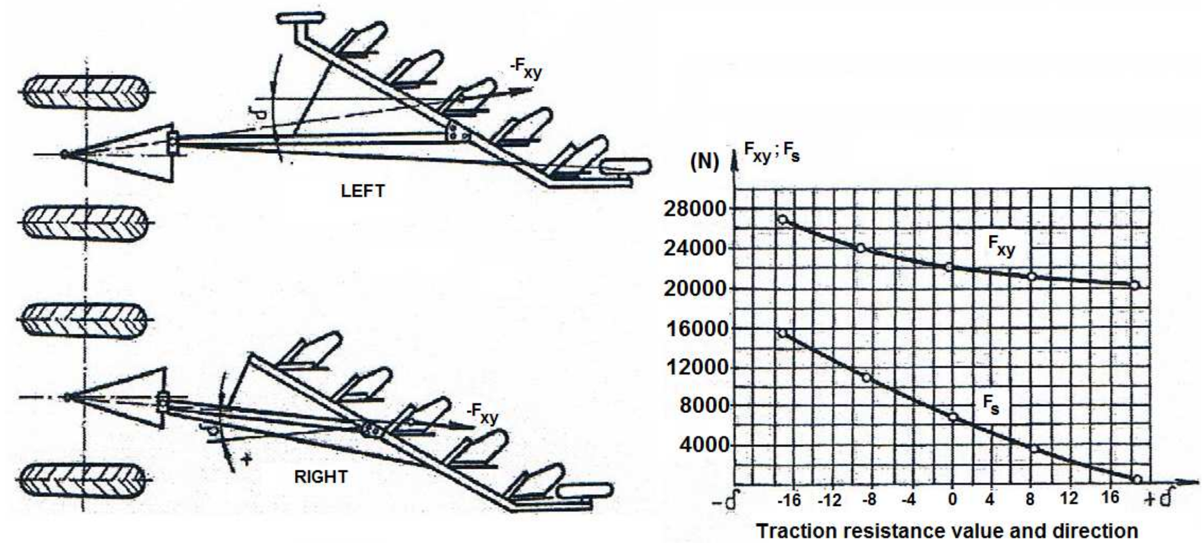

Figure 8 – Variation of the horizontal component of the resistance force, R_{xy}, when plowing and of the friction force with the furrow's wall

Taking into consideration all the above, the mathematical relation for calculating the traction resistance force of the plow, F_x, is given by:

$$F_x = a \cdot b \cdot \left(a_0 + a_1 \cdot \tau + a_2 \cdot v^2\right) \quad (1)$$

Using the relation given above (1), there can be made predictions over the specific resistance of the plow, k_0, on different soil types at different working speeds.

In some studies, it is given a simplified version of the mathematical relation for calculating the traction resistance force of the plow, given by:

$$F_x = a \cdot b \cdot k_0 \cdot \sqrt{v} \quad (2)$$

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CONSIDERATIONS ON WORKING PROCESS EQUIPMENT FOR SPREADING FERTILIZER BY CENTRIFUGATION

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ABSTRACT

In order to obtain increasing yields per hectare in agriculture developed in the US and the European Union, the plants are helped to develop through administration of granular fertilizer doses to supplement their needs for strong growth. The paper presents some considerations on the working process of the administing machine for fertilizer granulation, characteristics and peculiarities that these fertilizers have on the work process.

1. INTRODUCTION

One of the directions of development of agriculture in the European Union is to promote sustainable agriculture, based on the achievement of competitive products, but in perfect harmony with the environment through the development and implementation of environmentally friendly technologies, with direct reference to this article in technologies for spreadin granulated chemical fertilizers.

The evolution of technologies for the application of fertilizers, along with research on age and quality fertilizers fertilizer is given, it is placed on the quality of processes executed research to improve the quality of equipment and processes executed by them.

2. MATERIALS AND METHODS

Equipment to administer fertilizers are of two types: with pneumatic drives and mechanical drives, which are the most used. The study of work process knowledge of these devices is important because it will allow an appropriate adjustment that will lead to achieving the desired distribution rules. The distribution uniformity work and granular fertilizers is influenced by the peculiarities and characteristics.

3. RESULTS

• Machine working process administered by centrifugation

Distribution devices fitted to machinery and equipment for fertilizer spreaders can be classified by mode of operation in devices with mechanical or pneumatic action

Distribution devices with centrifugal action are frequently used and made with the distributors of the oscillating tube type (Fig. 1) or disk vane (Fig. 3) (one disc or double disc). These devices provide a working width greater than the width of the machine design [1].

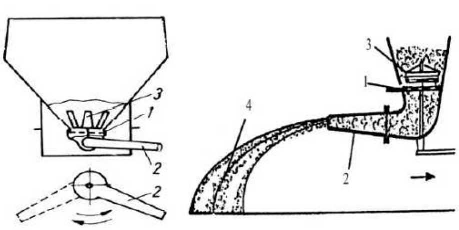

Figure 1: Scheme of the machine with the distribution apparatus oscillating tube [1]: 1 dispenser; 2-oscillating tube; 3- agitator; 4- overlapping areas of surface scattering of fertilizer

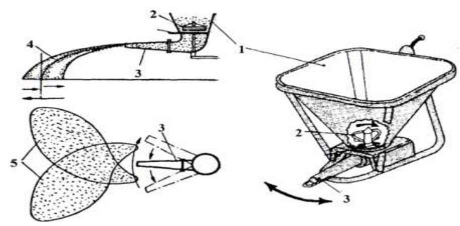

Figure 2:Construction and working process of the scattering unit with oscillating tube of solid fertilizers [4, 5]: 1 - box of fertilizer; 2 - agitator; 3 - Oscillating conical tube; 4.5 - areas of scattering material

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Distribution device with oscillating tube (fig. 1) comprises a box located in the dispenser of the machine, on which is mounted various tapered tubes, depending on mode of the fertilizer spreading. During work receives pendulum oscillating tube through an eccentric mechanism, a sector of a circle, running 350-550 runs / min. The length of the circle may change the default width of the machine [3]. From the supply box, fertilizers pass through the dispenser, where occurs the dosing of the fertilizers, are then deposited in the tube under the pendulum action of centrifugal force and are scattered on the ground surface [4, 5].

This type of apparatus equipped with various conical tubes can spread fertilizers also in strips (fruit trees and vines) [5].

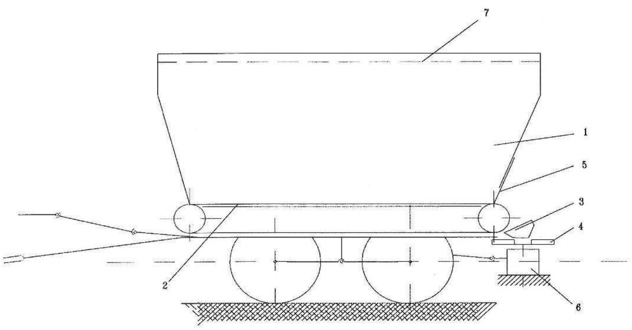

Figure 3: Scheme of a towed machine for spreading fertilizer through centrifugal action with conveyor belt [1, 3]
1 - box of fertilizer; 2 - transporter; 3 deflector; 4 - spreading disc; 5- regulation valve; 6-drive group; 7-sieve

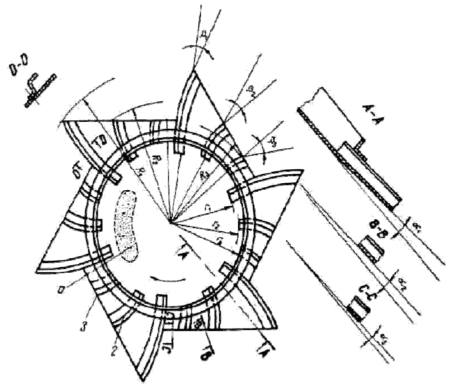

Figure 4: Spreading disc rosette-shaped [5]

The centrifugal aparatus for distribution, disc with paddle type with a single disc is represented by a horizontal disc which is fixed straight paddles or curved (Fig. 4). During work, the distributor disc is rotating with speed of 500-800 rev / min. Fertilizers or amendments in adjusted dose quantity, are reaching the distributor disc by means of a conveyor or by gravity, from which particles of fertilizer are taken up by paddles and by the centrifugal forces are scattered on the ground surface [5].

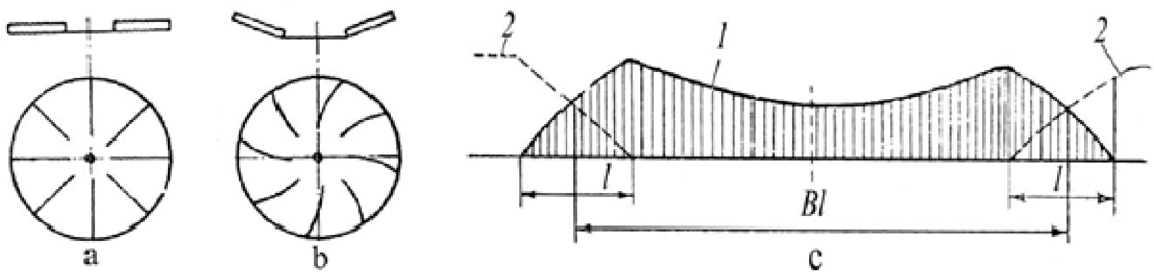

Figure 4: Disc type centrifugal distributors with paddles (single disc) [5]:
a) with straight blades; b) the curved vanes; c) scheme fertilizer distribution uniformity
Bl - working width of the machine; l - the width of the overlapping two passes of the machine; 1 first pass of the machine; 2 - subsequent passes of the machine

The distribution of granular mineral fertilizer on the soil surface is conducted by a disc paddle, arranged horizontally, which rotates at a constant speed.

Constructively, these machines use one or two disk distribution apparatus type paddles and discs may have a tapered or flat shape (Fig. 4 a and b). The discs paddles can be straight (arranged radially or at an angle to the radial direction) and curved, having the same length or different lengths (in the case of discs in the form of rosette, Fig. 5) [4].

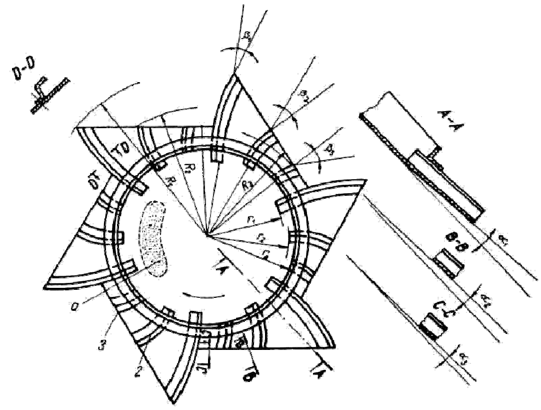

Figure 5: Spreading disc rosette-shaped [5]

The uniformity of distribution of fertilizers and depends on a number of factors: speed distributor; diameter and shape of the disc; tilting blades; how and where the suplly of the disc; parallel to the ground surface of the disc; distance from the soil surface; wind speed; particle size of the fertilizer [5].

Due to the different blade lengths different positions relative to each other, through the mouth of the hooper, they are loaded with different amounts of material to administer them at different distances, making different working widths. The curves obtained are overlapping coaxial administration, thus achieving uniformity of distribution across the width of the working layer of the fertilizer is administered in the central portion of approximately constant thickness (Fig. 6).

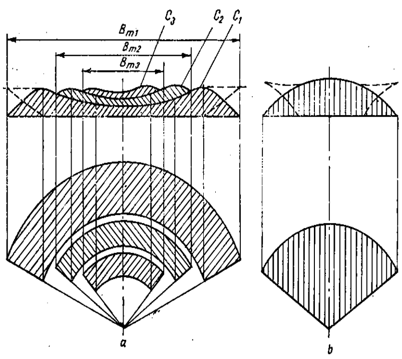

Figure 6: Scheme uniformity curves [5]
a - wheel disc type; b - flat disc type

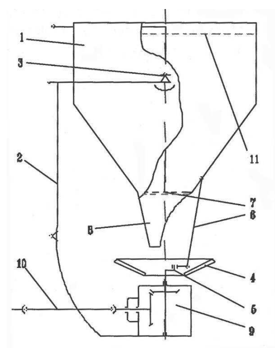

Figure 7: Scheme of the administereding worn equipment for chemical fertilizer through a centrifuge disc [1, 4]
1-bunker; 2-frame; 3-bearings; 4-dispensing apparatus; 5-crank mechanism; 6-rods; 7-dispenser with slots; Hopper 8

The distribution device type centrifugal disc, double disc with paddles (Fig. 9) performs the work in the same way as a one disk device, but provides a greater working width by about 30-40% and a satisfactory uniformity distribution to disk paddle of the same length.

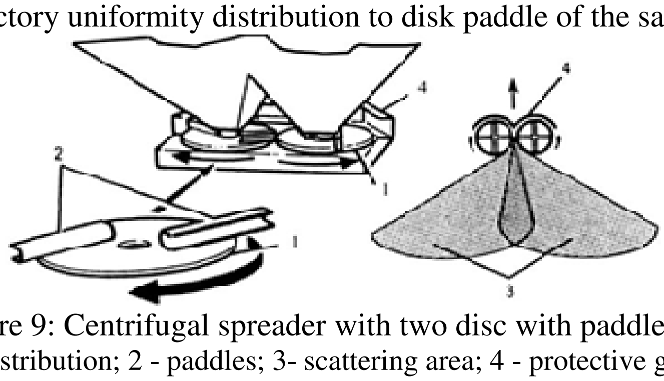

Figure 9: Centrifugal spreader with two disc with paddles [5]
1 - Disc distribution; 2 - paddles; 3- scattering area; 4 - protective guard discs

Machines equipped with centrifugal action distribution devices have high operational safety, simple and lightweight, have larger work capacity.

These machines are particularly suitable when applied to the surface of the granulated fertilizer and soil amendments [1, 3, 4, 5].

4. CONCLUSIONS

In agriculture using a wide variety of fertilizers in terms of shape, size, mineral composition etc. Within the concept of "precision farming" is a necessity management in controlled chemical fertilizers to avoid excess which is certainly harmful. However, by avoiding unnecessary administration of the additional amount is eliminated financial losses and increase in the cost of agricultural products. In addition to knowledge of the design of the existing equipment of particular importance is the capacity improvement specialists who experience new products, to determine the properties of the materials used, operating parameters of the equipment, working conditions, taking into account the requirements prescribed in relation to agricultural technology agricultural work performed.

In machines construction manufactured worldwide control process is done automatically by control systems, which enable the working parameters (speed, fertilizer level in the hopper, flow of fertilizer) and metering area worked (based on forward speed and working width).

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STUDY ON BIOCHEMICAL CHARACTERIZATION OF PLANT EXTRACTS IN ORDER TO VALORIZE THEM

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ABSTRACT:

Many species of medicinal plants are common in our country's flora and can represent affordable and available alternatives, without adverse effects on human health. In recent years there has been a reorientation towards the field of plant drugs by searching and identifying biologically active compounds from investigating plant species. In the production of medicinal and aromatic plants, the quality of phytotherapeutic products is given by the content and amount of bioactive substances from the plant. The therapeutic efficiency of bioactive substances existing in medicinal plants depends on both the quality of plant material and the quality of processing the medical plants from which different mixes will be obtained.

This paper presents a study on the biochemical analysis of plant extracts obtained from fragments of nettle and wormwood in order to subsequently valorize them as remedies in traditional medicine. The content of plant extracts obtained from medicinal plants, mainly essential oil, is rich in biologically active compounds with antioxidant, anti-inflammatory, antiseptic, antimicrobial power.

1. INTRODUCTION

Medicinal herbs are sourced, processed and extracted in different countries and continents and the extracts are used extensively by the herbal medicine industry. Preparation of herbal extracts from authentic and homogeneous starting materials is the first step in generating extract references.

By applying modern processing operations can be harnessed in a superior way several types of medicinal plants. Quality and efficacy of herbalmedicines are directly linked to the quality of the medicinal herb raw materials.Three critical steps at the very beginning of the manufacturing process are [6]:

1) cultivation/collection of authentic whole plants or plant parts that are considered to be efficacious based on traditional/clinical data,
2) sorting, drying and powdering of the required material (referred to as ‘herbal material’),
3) non-targeted or targeted, solvent(s) based extractions of the herbal materials to enrich or to include ‘active’ or ‘marker’ compounds (referred to as ‘herbal extracts’).

Any compromise in quality in each of these steps will permeate the sequential links in the manufacturing process.

Medicinal plants are often found in wild flora and not only, and so it was desired to highlight their use after processing as phytotherapeutic quality products, so as to meet the requirements of the Romanian Pharmacopoeia [18].

Medicinal plants contain bioactive substances (phyto-complex), secondary substances, inert substances (ballast) and substances that compose the skeletal structure of plant material.[15]

Nettle (*Urtica dioica*)) is a species herbaceous, perennial, high of 20-50 (70) cm, with aerial stems erect or ascending, of the genus Urtica, family Urticaceae, spread from the hilly area up to the alpine level. Harvesting is done before or during the flowering, from April to September [2].

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Figure 1. – Nettle [2]

Nettle (*Urtica dioica*) - figure 1 - contains important active substances: iridoids (lamiozide), saponins, tannins (12-14%), essential oil, flavonosids, mucilage, polyphenol-carboxylic acids (rosmarinic acid in particular); biogenic amines: histamine, methyl amine and tyramine; C and K vitamins, carotenoids, mineral salt, especially potassium. [3]

The wormwood (*Artemisia absinthium*) is a perennial herbaceous plant, 60 - 120 cm cm high of Asteraceae family; spread from the lowlands up to the hilly one. Harvesting is done in the June-July months [2].

Figure 2- Wormwood [2]

Wormwood - figure 2 - Asteraceae family contains: <u>bitter substances</u> - <u>temisine</u>, 0.2-1.5% <u>volatile oil</u> consists of about 3-12% formed by thujone and tuiol, azulene, flavones, organic acids (palmitic, linoleic, oleic, lauric, stearic, nicotinic, arachidic), vitamin C, 8% mineral elements with calcium, potassium, phosphorus, sodium, iron, manganese, magnesium, zinc, copper elements. [2] The main center of excretion of this active substance complex are foliar secretory hairs. [3]

Wormwood is used to obtain wormwood wine to adjust wines, as a preservative or is part of plant mixtures for bitter starter or vermouth type beverages. [15]

Five new dimeric guaianolides and seven known dimeric guaianolides were isolated from the aerial parts of *Artemisia absinthium*, [17]; the potential of *Artemisia vulgaris* leaves as a source of antioxidant phenolic compounds [10, 11]; hepato protective activity of the aqueous extract of *Artemisia absinthium L.* was demonstrated in the one study [1]; in the study [5] was determinated major components of the *Artemisia* populations and thei antioxidant, phytotoxic and antiparasitic effects.

The antioxidant potential of *Urtica dioica* are studies in [8]; current status of the bio-active properties of essential oils and their medicinal potentials are covered in that review [14, 16], anti-inflammatory activity and phenolic content of *Urtica sp*. extract it was studied in the paper [4]; a method for quantification of 45 plant phenolics (including benzoic acids, cinnamic acids, flavonoid aglycones, C- and O-glycosides, coumarins, and lignans) in *Urtica dioica* extracts was developed in the paper [13], based on reversed phase HPLC separation of extract components, followed by tandem mass spectrometric detection. In Kisii region, southwest Kenya. *Urtica dioica* is amongst the herbs used as phytomedicine for the treatment of diabetes, malaria and pneumonia [9].

Studies on the chemical composition of extracts obtained from nettle and wormwood were also made in our country. Phyto-chemical studies on *Artemisia* species widespread in the spontaneous flora of Romania are few, in paper [7] the results indicate the presence of caffeic and chlorogenic acid, ferulic acid was present before hydrolysis; in the case of flavonoids, rutoside, hyperoside, fiseti and isoquercitrin were present. Quercetin and Kaempferol is present as the free aglycon, Patuletin was as glycoside.

Urtica dioica (nettle) is one of the most popular and cosmopolitan plants (present in Europe, Africa, Asia, America), whose dietary and therapeutic benefits have been known since ancient times. The therapeutic activity of nettle extracts is related to the presence of phenolic compounds (mainly cafeoil-malic acid, chlorogenic acid, ferulic acid, rutin, isoquercitrin and astragalin) and their antioxidant activity. Another compound with certain antioxidant activity is the ascorbic acid. Plants maturation leads to changes of their chemical composition. Therefore, in order to evaluate the optimal moment of plant harvesting, dynamics of accumulation of polyphenols and ascorbic acid were undertaken, in the paper [12]. The results show that young nettle leaves have the highest content of polyphenols and ascorbic acid.

In this study, were measured the absorbers at different wavelengths for different alcoholic extracts obtained from different sized fragments of nettle and wormwood in order to valorize them as remedies in traditional medicine.

2. METHODOLOGY

Medicinal plants analyzed were nettle and wormwood. They were identified and harvested from the spontaneous flora by the existing biological and morphological characteristics existing in the specialty literature [2].

The herba of plants was dried and then cut in bulk with the TIMATI herb grinder for medicinal plants, adjusted to the size of 4 mm. 100 g each of the mixture of fragments resulting from the chipping were weighed and then were sived through the sieve classifier at the amplitude of 50 mm for 5 minutes. On each sieve was found a quantity of plant material that represented all fragments with sizes smaller than those of the openings of the upper sieve and bigger than the sieve through which it passes, , as seen in Figure 3.

For nettle was used the following line of sieves, in an increasing order of the size of meshes (in mm): collector - 3.35 - 5.0 - 8.0 - 10.0 mm.

For wormwood was used the following line of sieves, in an increasing order of the size of meshes (in mm): collector - 2.36 - 3.55 - 5.0 - 6.3 mm.

Nettle fragments

Wormwood fragments

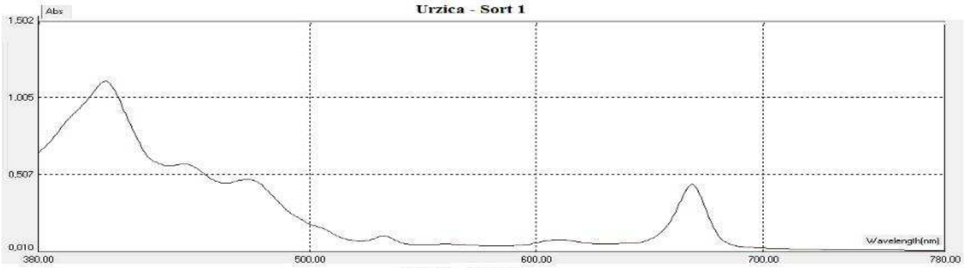
Figure 3 – Separating the plant fragmentson sieves

For each sort (fraction) resulted extractions were obtained by cold maceration for 40 minutes. About 5 g of each kind was weighed, was added in vials and they were initially wetted with 20 ml of petroleum ether, afterwards were added an additional 20 ml. Then the vials were homogenized with the sample and were left to macerate for an hour. After maceration, the samples were filtered through filter paper and then dried in an oven at 30^{o} C for 24 hours. After drying, the samples were weighed and the differences between the initial masses of samples and the masses of samples after extraction determined the masses extracted from every sort (fraction) for each medicinal plant studied.

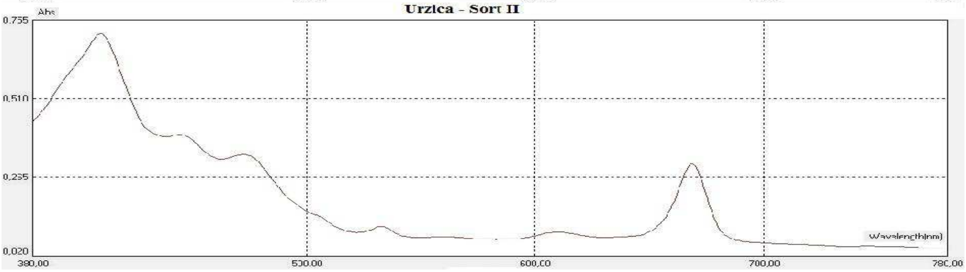
3. RESULTS

For extracts obtained from each sort of medicinal plant species studied were quantitatively measured the absorption spectra taken with UV-VIS spectrophotometer.

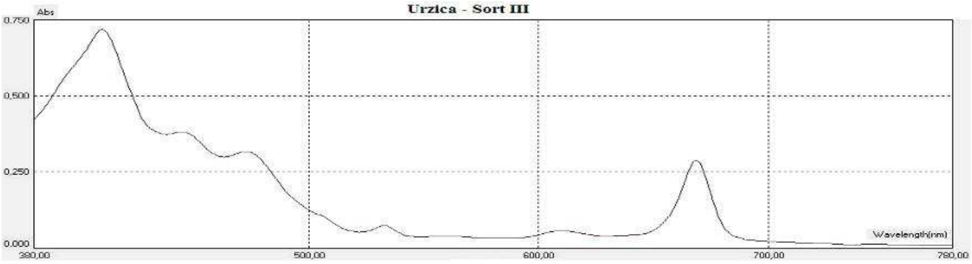
UV-VIS spectra for nettle fragments are shown in Figure 4. The absorption range is between 380-780 nm.



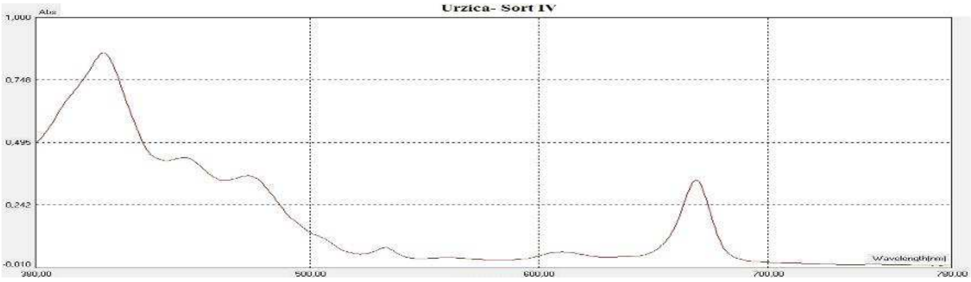
Wavelength (nm)	*Abs*
669.00	0.417
609.00	0.053
533.00	0.075
473.00	0.441
445.00	0.539
410.00	1.079



Wavelength (nm)	*Abs*
669.00	0.307
609.00	0.093
533.00	0.111
472.00	0.336
410.00	0.714



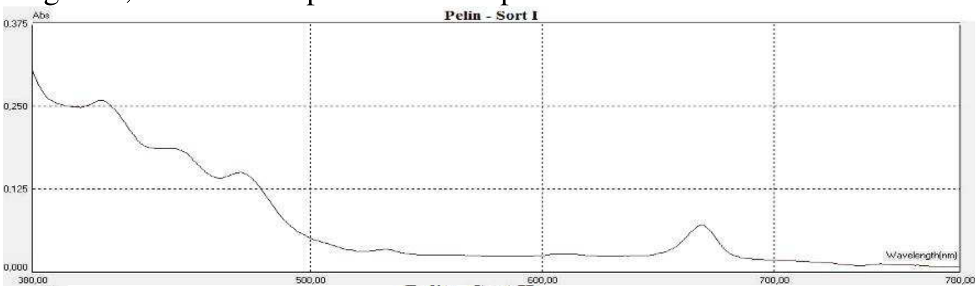
Wavelength (nm)	*Abs*
669.00	0.288
609.00	0.056
533.00	0.073
473.00	0.317
445.00	0.382
410.00	0.720



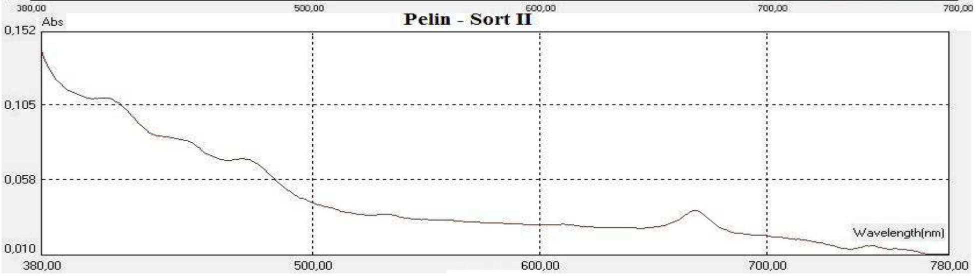
Wavelength (nm)	*Abs*
669.00	0.345
609.00	0.054
533.00	0.072
473.00	0.361
445.00	0.434
410.00	0.858

Figure 4 – Spectrograms for nettle sorts

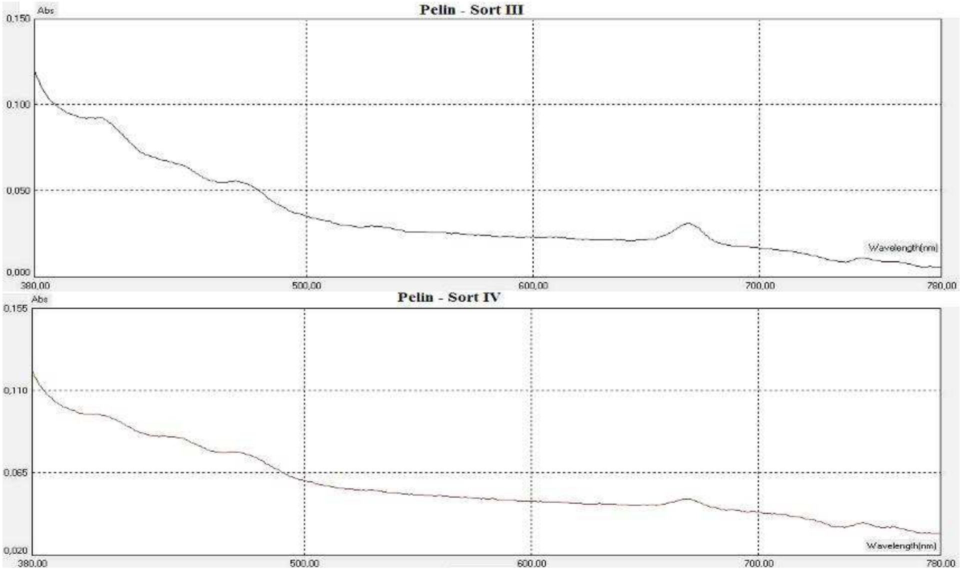
Also, UV-VIS spectra for wormwood fragments extract have been made, shown in Figure 5, for the same period of absorption.



Wavelength (nm)	*Abs*
669.00	0.071
532.00	0.034
470.00	0.150
410.00	0.259



Wavelength (nm)	*Abs*
746.00	0.016
669.00	0.038



Wavelength (nm)	*Abs*
746.00	0.011
668.00	0.031

Wavelength (nm)	*Abs*
746.00	0.038
668.00	0.051

Figure 5 – Spectrograms for wormwood sorts

4. CONCLUSIONS

This paper presents, through the spectrograms obtained, the data on qualitative and quantitative analysis of alcoholic extracts from fragments of medicinal plants selected. Qualitative analysis is identified by absorption specter from which structural information on the basis of absorption peaks encountered can be deduced. Quantitative analysis is identified from the amplitude of absorption and depends on the concentration of the main substance in the solution, the substance with antioxidant, antimicrobial, anti-inflammatory, character etc.

From the analysis of spectra obtained for each sort of medicinal nettle fragments result the following conclusions:

1. The maximum content in bioactive compounds is higher in the extract obtained from sort I (absorption of 1.079) and sort IV (absorption 0.858) for the same wavelength of 410 nm.

2. For sorts II and III also at a wavelength of 410 nm, the absorption has very similar values, 0.720 for sort III and 0.714 for sort II.

3. The extract obtained from sort I with fragment sizes between 0.1 - 3.35 mm is the most concentrated in bioactive compounds, followed by sort IV with fragment sizes between 8.01 - 10.0 mm, and sort III (5. 01 - 8.0 mm) and sort II (3.36 - 5.0 mm).

From the analysis of spectra obtained for each sort of medicinal wormwood fragments result the following conclusions:

1. The maximum content in bioactive compounds is higher in the extract obtained from sort I (absorption of 0.259) for a wavelength of 410 nm.

2. Sorts II, III and IV have very little absorbents between 0.011 - 0.038 for a wavelength of 746 nm, and between 0.031 - 0.051 for a wavelength of 668 nm.

3. The extract obtained from sort I with fragment sizes between 0.1 - 2.36 mm is the most concentrated in bioactive compounds, followed by sort IV (5.01 - 6.3 mm), then sort II (2.37 - 3.55 mm) and sort III (3.56 to 5.0 mm).

It is found that for both extracts obtained from sort I both for nettle as well as for wormwood, with the smallest fragment sizes, are the richest in compounds, for the same wavelength of 410 nm.

Therefore, recommendations can be made for chopping the medicinal plants studied but also for choosing the mesh sizes to obtain a maximum percentage of plant fragments that are of interest for making extracts rich in biologically active compounds that can be exploited later in traditional medicine. Essential oils and phenols obtained from nettle and wormwood are widely used mainly for their neuroprotective, antifungal, antimicrobial, insecticidal, acaricidal, anthelmintic, antimalarial, hepatoprotective and antidepressant properties.

The plants analyzed are a significant source of antioxidants (polyphenols and sugars). The total of polyphenols could be a specific parameter for the nutritional values of plants. Further investigations are proposed to assess the relative composition of individual compounds in nettle and wormwood.

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MONITORING WIND DIRECTION AND INTENSITY OF BUCHAREST IN 2012

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ABSTRACT

This paper presents the main theoretical and practical aspects related to wind direction and intensity. It represented graphic the wind direction wind rose in 2012 in the city of Bucharest, Romania, and wind intensity is calculated based on wind speed and direction recorded by the weather station in 2012. Based on wind speed values recorded by the weather station every day in 2012, we performed statistical analysis and chose the mean, minimum, maximum wind speed depending on the seasons we calculated wind intensity is directly proportional to wind speed. Based on wind direction values, we calculated and plotted wind rose for every season from 2012.

Key words: wind direction, wind intensity, wind rose

1. INTRODUCTION

Wind is the most influential factor in weather, causing the movement of clouds and gaseous pollutant dispersion, the dispersion of solids in air, warm air moving cold spots and even the occurrence of tornadoes.

The main reason is the difference in atmospheric pressure wind formation between two regions. Air. Hot being easier rises producing a minimum pressure will be taken place by air masses from the cold until it is equal to the pressure difference between the two regions. [1]. Wind speed has been investigated by other authors in their works. [2]

Winds rose graphically represents the frequency of the eight wind directions intercardinale cardinal in a point or in a certain area of the territory.

To formation rose frequency winds have equaled the number of all cases of wind and quiet time during a period. The amount obtained was taken as 100%, and the number of instances of each cart and wind quiet time is calculated as a percentage, after which the diagram is constructed. For this the center lines are drawn eight means eight karts (S, N, NE, NV, E, VS, SE).

Direction predominant the wind is expressed in degrees of rose winds (North = 0°, East = 90°, Suth = 180°; West = 270°).

Wind direction are: permanent winds same direction (strong winds, winds west), periodic which changes direction at equal intervals of time (monsoon) winds occurring irregular the unequal time intervals and directions.

In their paper, and other authors have studied the statistical analysis of wind in different regions [2, 3, 4].

2. METHODOLOGY

To monitor wind speed and direction to use the weather station Biotechnical Faculty of Engineering Bucharest Romania. [5,8].

Wind speed and direction sensor (TDV-N) shall be in accordance with international specifications WMO (World Meteorological Organization) Wind direction is measured in the range: 0 at 360^0.

Wind direction near the surface usually is assessed in relation to the cardinal points and is given by the direction from which it blows (the cardinal point from which the wind blows).

Intensity and wind strength is expressed as air pressure wind shifted on objects in its way. It is expressed in m/s, or km/h (1 m/s = 3.6 km/h and 1 km = 0,278 m/s) can be determined by different types of anemometers or anemograph. Pressure exercised on a surface of 1 m^2 [5]:

$$P = a \cdot v^2 \quad (1)$$

where: P - wind pressure expressed in kg/m^2; v - wind speed in m/s; a - constant air density equal to 0.065.

Wind speed and direction is determined with anemometers and wind vanes equipped with special tail surface and mounted anemometer height to the standard measurements taken 10 meters from the ground. The fluid velocity dispersion models falling atmospheric emission height (stack machine), so it is necessary dependency relationship between the two speeds, which can be deduced from the variation of wind speed with height [6].

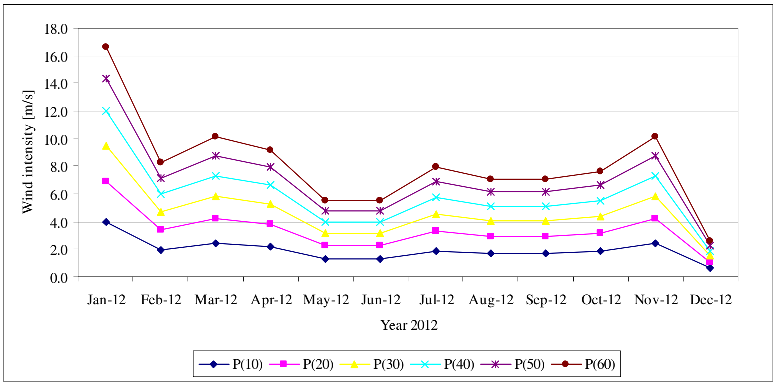

Figure 1 Maximum wind at different heights for 2012

In Figure 1 we present the variation of the wind intensity calculated according to the wind speed measured by the weather station for 2012.

Table 1 Wind direction Winter 2012 Table 2 Wind direction in March, April, May 2012

Wind direction	maximum	average	%	Wind direction	maximum	average	%
N	3.1	0.9	8.37	N	4.2	2.1	5.28
NNE	3.6	2.1	4.47	NNE	3.1	1.7	1.12
NE	4.6	1.9	7.73	NE	1.7	1.1	2.79
ENE	6.9	3.1	15.21	ENE	2.6	2.4	6.43
E	5.8	3.6	12.64	E	4.1	1.7	5.05
ESE	4.1	0.7	3.54	ESE	2.5	1.1	8.05
SE	2.9	0.9	3.32	SE	2.4	1.1	7.32
SSE	3.6	1.2	3.02	SSE	3.1	0.6	5.1
S	4.2	1.2	3.93	S	3.3	0.1	4.22
SSV	3.2	0.3	4.21	SSV	2.1	1.8	2.79
SV	3.1	1.4	7.54	SV	2.9	2.1	3.72
VSV	3.2	1.9	8.87	VSV	4.8	1.7	11.3
V	2.3	1.5	1.78	V	2.5	1.2	6.13
VNV	3.5	2.4	5.93	VNV	4.3	1.1	8.43
NV	2.9	1.4	3.79	NV	4.2	1.2	13.6
NNV	2.8	1.4	5.65	NNV	5.8	1.4	8.67

Table 3 Wind direction months: June, July, August 2012

Table 3 Wind direction month September, October, November

Wind direction	maximum	average	%	Wind direction	maximum	average	%
N	3.1	1.3	9.62	N	3.1	0.9	8.37
NNE	1.5	0.7	6.32	NNE	3.6	2.1	4.47
NE	3.2	0.2	1.34	NE	4.6	1.9	7.73
ENE	5.1	3.1	18.45	ENE	6.9	3.1	15.21
E	4.9	2.1	21.56	E	5.8	3.6	12.64
ESE	4.8	3.1	4.74	ESE	4.1	0.7	3.54
SE	3.9	2.9	3.73	SE	2.9	0.9	3.32
SSE	3.1	0.9	3.1	SSE	3.6	1.2	3.02
S	4.1	0.2	2.3	S	4.2	1.2	3.93
SSV	2.1	0.1	1.76	SSV	3.2	0.3	4.21
SV	1.3	0.1	3.84	SV	3.1	1.4	7.54
VSV	3.1	1.6	2.98	VSV	3.2	1.9	8.87
V	3.9	1.6	2.74	V	2.3	1.5	1.78
VNV	4.1	2.9	2.77	VNV	3.5	2.4	5.93
NV	6.1	1.2	3.87	NV	2.9	1.4	3.79
NNV	3.9	1.4	10.88	NNV	2.8	1.4	5.65

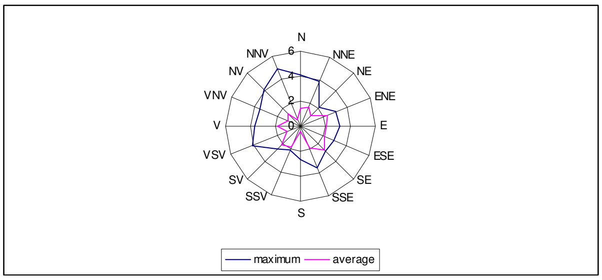

Figure 2 Wind Rose at 10 m, Winter 2012

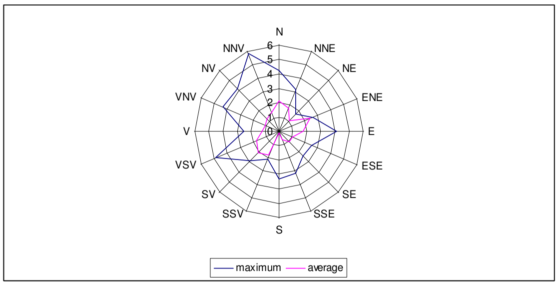

Figure 3 Wind Rose at 10 m, spring 2012

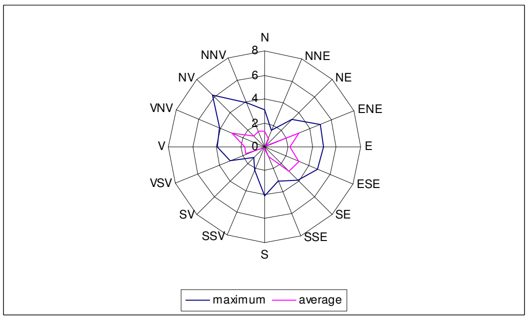

Figure 4 Wind Rose at 10 m, summer 2012

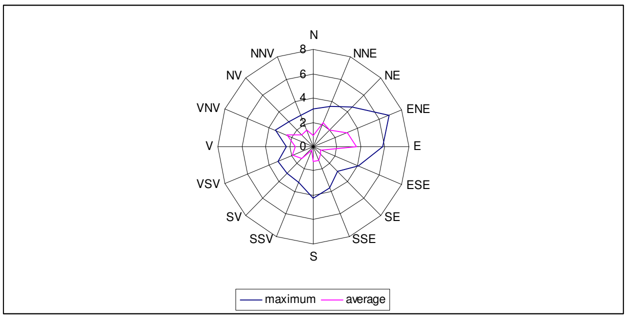

Figure 5 Wind Rose at 10 m, autumn 2012

From figure 2 and Table 1 it is observed that in the winter season 2012 is predominantly wind knocked and maximum intensity comes from the ENE to the value of 6.9 m/s.
From figure 3 and table 2 it is observed that the NE wind is predominant and maximum intensity comes from the N-NW to the value of 5.8 m / s
From figure 4, Table 3 it is observed that maximum wind intensity was 6.1 NV.
From figure 5 and Table 4 it is observed that the wind blows predominantly from NW and maximum intensity comes from the E-NE with the value of 6.9 [m / s].

3. CONCLUSIONS

Bucharest City fall transition moderate continental climate characteristic of the SE part of the Pannonian Plain, with some Mediterranean influences.

Its general features are marked by diversity and irregularity of atmospheric processes. Movement of air masses from the west persists both in the cold and in the warm seasons and is characterized by mild winters, often with liquid precipitation. Frequently, even during winter, arriving from the Atlantic humid air masses, bringing significant rain and snow rarely cold waves. Polar circulation is determined by cyclones in the North Atlantic Ocean and is characterized by decreases in temperature, cloudiness and precipitation in the form of sharp showers, winter snowfalls accompanied by intensification of the wind. Influence is strongly felt cyclones and warm air masses from the Mediterranean, which generates thaw winter and summer periods require stifling heat.

Tropical circulation causes mild winters with large amounts of rainfall and the summer a while unstable with rain showers and thunderstorms.

By monitoring wind speed and direction in the city of Bucharest, characterized by a temperate climate zone in which measurements occurred, is a protected area of influence of strong winds. Hence, although there is a potential wind farm is still considered a useful exploitation of other renewable energies. Strong winds can have serious implications in social life, by darkening the various activities that take place outdoors and the occurrence of significant damage in various branches of the national economy. In agriculture, the impact of high speed wind is marked both by mechanical action on plants and soil, and by enhancing crop transpiration process, thus contributing to increased aridity in areas with poor rainfall. The worst consequences of winds are felt in construction activity through the production of numerous accidents, and the partial or total damage to buildings or other special construction such as bridges, towers, cooling towers television kilns.

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WASTEWATER TREATMENT IN MACROPHYTES LAGOONS

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ABSTRACT

In this paper there are presented macrophytes lagoons which are extensive plants used to treat wastewater in natural conditions. After presenting the functional roles that the macrophytes lagoons could have in the extensive systems, classification and their characteristics, is done their comparative analysis in relation to other similar extensive plants. Also, there are presented the main types of macrophytes lagoons developed and operated in different parts of the world, highlighting their features and benefits, with examples for each construction type individually.

1. INTRODUCTION

Macrophytes lagoons are extensive plants for wastewater treatment in which are reproduced the wetlands ecosystems providing free surfaces (mirrors) of water, looking for the use of environmental benefits of these natural ecosystems in reducing the loading with organic matter BOD and suspended solids SS and in the elimination from wastewater of some categories of undesirable pollutants such as nutrients and heavy metals.

Although compared with microphytes lagoons they have a less efficient removal of organic load in wastewater and a more difficult operation, microphytes lagoons show a greater biodiversity and thus providing a much wider availability to removal of specific categories of pollutants from wastewater. Because of this, the role that the macrophytes lagoons have is the refining of the treatment process, constituting in technological objects for advanced treatment, placed in the final part of treatment plants. Thus, most frequently macrophytes lagoons are contained in the structure of extensive systems of wastewater treatment with natural or aerated lagoons, but there are cases where intensive systems of wastewater treatment refine its effluent before discharge in macrophytes lagoons. However are meeting situations where macrophytes lagoons are used as biological sewage treatment plant to eliminate specific pollutants.

Macrophytes lagoons used for wastewater treatment systems can be natural (marshes, ponds, puddles) or may be artificial (buildings that replicate specific marsh flora).

Macrophytes lagoons are rarely used in wastewater treatment systems in Europe but are quite commonly used in United States of America, [1] and researches on the use of macrophytes in wastewater treatment were carried out in several other countries, such as Asia, North America, Europe, Australia, etc.

2. OPERATING PRINCIPLES, CONSTRUCTION AND PERFORMANCE OF MACROPHYTES LAGOONS

In the last period, the use of aquatic treatment systems, especially floating macrophytes, is recognized as an alternative method of wastewater treatment, [2].

The scientific basis governing this process is the symbiotic association between aquatic macrophytes and microorganisms. The latter degrades the organic matter present in the water into simple nutrients that are absorbed by macrophytes and thus, macrophytes create favorable conditions for microbial activity, [3].

Aquatic plants are suitable for wastewater treatment because they have tremendous capacity of absorbing nutrients and other substances from the water and hence bring the pollution load down. Aquatic macrophytes grows in water or in wet areas. Some are rooted in the sediments, while others float on the water's surface and are not rooted to any substrate.

Aquatic macrophytes are grouped into three general categories, [4]:

- submersed aquatic plants
- emersed aquatic plants
- floating and floating-leaved aquatic plants.

In this type of ponds, are grown two types of macrophyte: soft and rigid. In the category of the soft one, are found plants that have their roots in the water layer, floating in it like: duckweed, water hyacinths, horsetail, water primrose, etc. In the category of rigid macrophytes, there are found reed, rushes - the most common water-loving plants that are rooted in the soil. The strains surface immersed in water is covered with microorganisms in the form of biofilm, which assimilates efficiently degrade organic pollutants and mineral.

All kinds of aquatic macrophytes listed above develop in wastewater previously purified and therefore, this type of ponds shows, usually the final stage of treatment.

Macrophytes lagoons reproduce natural wetlands that behave like a water basins with free surface, trying to realize the processes of natural ecosystems to improve the efficiency of wastewater treatment both BOD removal, as well as the nutrients (N and P) and metals. They can be used as a final purification stage by following natural ponds, aerated facultative or artificial ones.

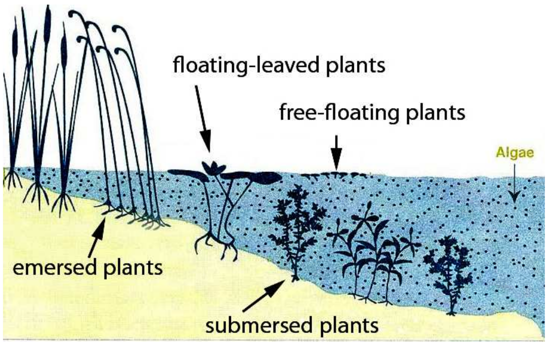

Figure 1: Categories of aquatic macrophytes, [4]

3. REPRESENTATIVE EXEMPLES OF USING MACROPHYTES LAGOONS IN WASTEWATER TREATMENT

Worldwide are made intense efforts to improving water quality through extensive methods, in conditions as close to natural ones. Applying the extensive methods of wastewater treatment has important advantages, namely: very high efficiency to remove the organic loads and the nutrients from water that is subjected of treatmnent providing high quality effluent, that can be discharge without danger to natural watercourses, in most cases they don’t need an external input of energy for carrying out wastewater treatment processes, making it very economical in use and last but not least have a very natural aspect, not like an industrial plant, fit perfectly into the natural landscape, without affecting this one at all.

From this point of view the application of some phytotechnologies of macrophytes use for wastewater treatment, in natural ponds or artificial constructs were used as alternative to classical extensive systems of natural microphytes lagoons (also called *stabilization ponds*) have been studied and successfully applied in different parts of the world.

Thus, were performed studies of wastewater treatment in macrophytes lagoons, in Asia, and it was found that existing nitrogen and phosphorus in the wastewater, of inorganic nature or decomposed by microorganisms from the organic load of water has been absorbed and incorporated by macrophyte.

The studies were mainly focused on macrophyte species, water hyacinth, and a floating plant specific to warm areas, which tend to proliferate strongly if offered favorable conditions (see Figure 2).

Figure 2: Water hyacinths, [5]

It is to be mentioned that the water hyacinth together with organic matter and aerobic microorganisms fixed or coagulated on their roots can be a very valuable feed for aquaculture of fish or farm animals.

Thus, in Figure 3 is presented an example of lagoon with water hyacinth, that services the extensive system of wastewater treatment of poultry from China [6], to which in addition the water hyacinth are taken and used as fodder for poultry feeding, especially ducks. The use of water hyacinth as fodder must be made under strict control because these plants have a strong tendency to absorb and incorporate heavy metals from water.

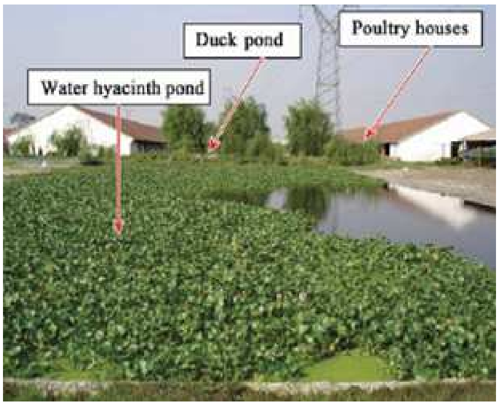

Figure 3: Macrophytes lagoon from extensive system of a wastewater treatment of a poultry from China, [6]

In Auberge le Balouchon locality from Quebec, Canada (see Figure 4) was built the largest extensive system of wastewater treatment with lagoons, whose working process is based on an innovative technology which includes both natural stabilization ponds and a macrophytes natural lagoon which is the largest of its kind in Quebec.

Figure 4: Macrophytes lagoon from extensive system of a wastewater treatment from Auberge le Balouchon, Canada, [7]

The extensive system of wastewater treatment from Auberge le Balouchon, Canada, provides an exceptional purification and evaporates up to 56% of wastewater annually.

In Europe, in Vidårdse Lansby, Andebu, Norway was developed an extensive system combined with lagoons for sewage wastewater treatment which comprises a natural lagoon with macrophytes where the predominant species is the duckweed (see Figure 5), species that proliferate in the harsh climatic conditions specific to the European continent.

Figure 5: Macrophytes lagoon of combined extensive lagoon system from Vidårdse Lansby, Andebu, Norvegia, [8]

In figure 6, is presented the principle scheme of a mixed wastewater treatment plant, having intensive technological objects for preliminary treatment and several artificial lagoons with macrophytes from duckweed species placed in series (extensive technological objects) for biological treatment.

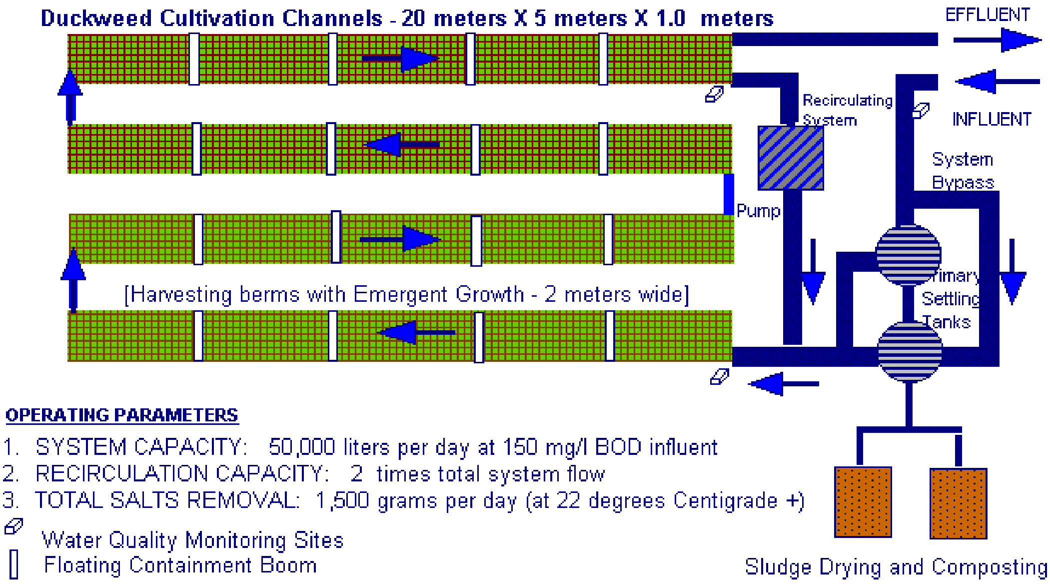

Figure 6: Principle scheme of a mixed wastewater treatment plant with artificial macrophytes lagoons, [9]

In figure 7, is presented the principle scheme of an extensive system of industrial wastewater treatment derived from milk industrialization unit which consists of aerobic and anaerobic ponds to eliminate biological nutrients and a series of artificial marshes (macrophytes lagoons) for refining the treatment process.

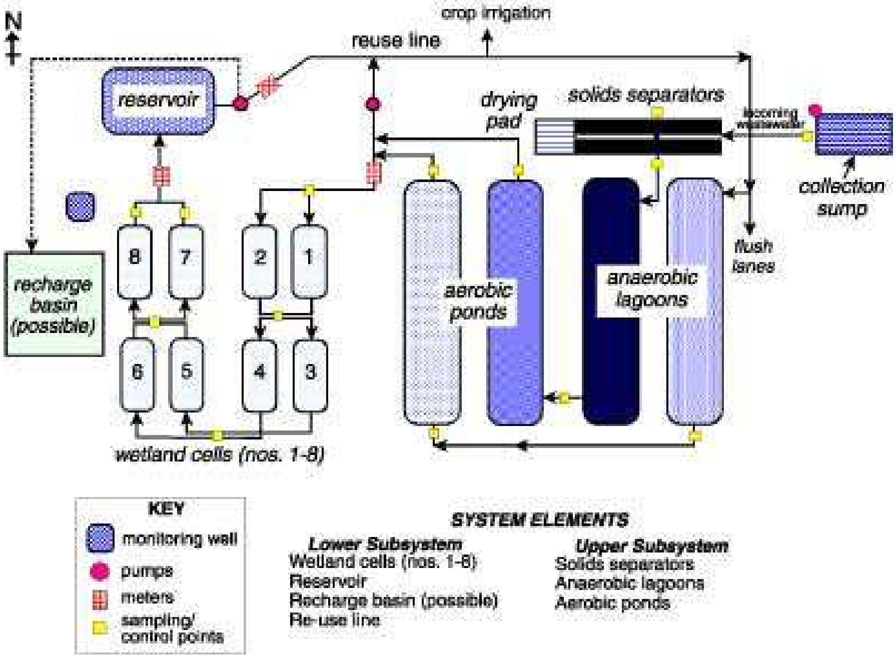

Figure 7: Principle scheme of an extensive system of industrial wastewater treatment derived from milk industrialization unit with artificial macrophytes lagoons, [10]

A more particularly system of wastewater treatment through macrophytes, which is increasingly used, is the use of floating pontoons planted with macrophytes in a nutrient medium. The principle scheme of such a biological system, generically called floating treatment wetlands is shown in Figure 8, and various examples of such systems are shown in Figure 9.

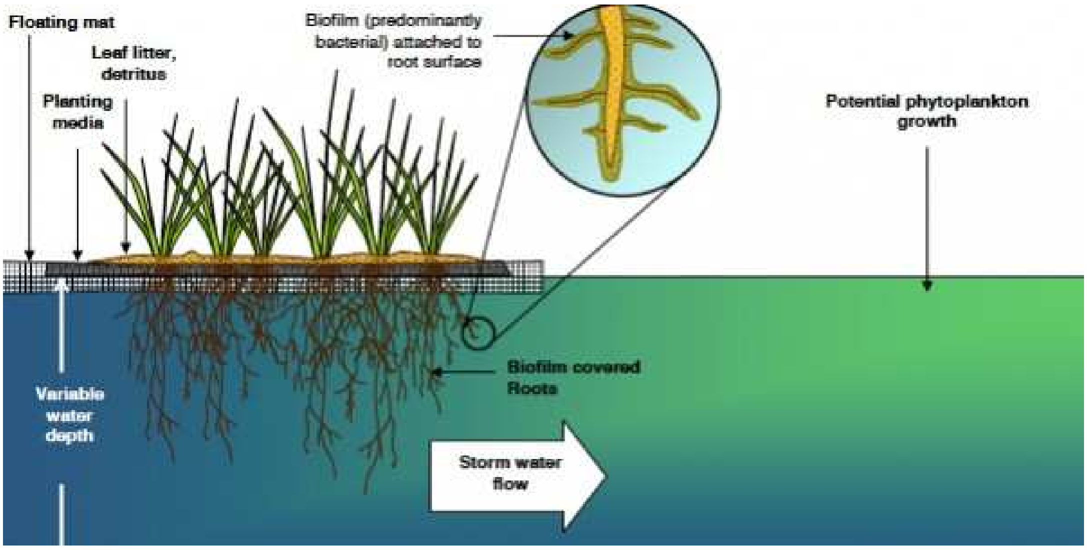

Figure 8: Principle scheme of a floating treatment wetlands, [11]

Such treatment systems with different configurations and populated with certain species of macrophytes have been successfully developed first in Australia and New Zealand where they were used to remove certain pollutants from wastewater treated, after which these systems have been implemented in other parts of the world.

Figure 9: Different examples of constructed floating wetland, [12]

4. CONCLUSIONS

Macrophytes lagoons are extensive plants of wastewater treatment which generally serve to refine the effluent resulted from wastewater treatment plants, extensive or intensive, extracting the nutrients from the wastewater, suspended solids and certain specific pollutants depending on the used macrophytes species, such as various types of metals.

Currently this type of extensive plants is increasingly found in the structure of wastewater treatment plants but also industrial, generally those extensive.

The main types of natural lagoons developed in different parts of the world are natural macrophytes lagoons, constructed macrophytes lagoons and constructed floating wetland.

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VOLUMETRIC PUMP FOR INFUSION OF LIQUID FERTILIZERS INTO THE IRRIGATION WATER

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ABSTRACT

This paper presents research concerns to achieve a volumetric pump for infusion of liquid fertilizers into the irrigation water. Precise dosing of the fertilizer is carried out with volumetric pumps, which also create proportionality between the injected flow and the flow in the facility. The devices shall be serially connected to the irrigation facility- full flow or paralleled- by-pass, and the pressure loss along the supply circuit of the facility is recommended to be as small as possible. INOE 2000-IHP owns a patent application A/00828-14.09.2010 which proposes the development of an automatic pump for infusion of fertilizers into the pressurized pipelines of the installations for crop irrigation. The pump has the advantage of automatic drive by hydraulic actuation made using a hydraulically controlled directional control valve by two check valves that sense the end of the membrane stroke.

Worldwide fertigation has reached a major scale because it allows the development of new agricultural technologies in giant greenhouses located on nutrient-poor soils but with favorable conditions in regard to the other necessities of plants, heat, light etc., which makes them very cost-effective. Plants are grown in greenhouses on artificial soils, and nutrients are supplied along with the irrigation water. Such giant greenhouses have appeared in desert areas in countries such as Spain, Israel, France, USA etc.

There are known companies such as NETAFIM, AMIAD, PLASTRO GVAT, NAANDAN, DOROT, TAVLIT - Israel, DOSATRON - France, TMB - USA., which produce a wide range of devices and equipment for administering liquid fertilizers. Fertilizing solution is achieved out of water and the water-soluble chemical fertilizer, and dissolving or diluting the fertilizer is made in various proportions.

The injection equipment inserts the *primary solution* (with concentration C_m) into the irrigation water present in the irrigation system to create the fertilizing solution, and this nutrient solution is called the final solution or *fertilizing solution* (with concentration C_s). The concentration of the primary solution C_m is calculated with the ratio:

$$C_m = \frac{M}{V} \quad [g/l]$$, where:

M - the amount of solid fertilizers dissolved in a given volume, in (g);
V- the volume of water in which the fertilizers were dissolved, in (l).
A dilution takes place at the point of injection, depending on the flow rate (Q) of the irrigation system and *injection flow rate* (q) of the primary solution injection equipment.

In order to achieve a uniform distribution of fertilizer and water, it is necessary that the dispensing devices existing on irrigation equipment and injection pumps work with high coefficients of uniformity, at clearly defined working pressures, and the flow rate injected by the pump be constant along carrying out the process of fertigation.

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The equipment for injecting substances into the irrigation water is usually represented either by Venturi static devices or piston or membrane, single or double effect volumetric pumps.

Precise dosing of the fertilizer is carried out with volumetric pumps, which also create proportionality between the injected flow and the flow in the facility. The devices shall be serially connected to the irrigation facility - full flow or paralleled- by-pass, and the pressure loss along the supply circuit of the facility is recommended to be as small as possible.

The most effective fertigation devices are those with pump with hydraulic motor, differential piston or membrane, using as a drive fluid energy of the water existing in the supply pipeline of irrigation facility; injected dose is constant and volumetric ratio (efficiency) - high.

Operation of injectors of fluid chemical fertilizers Venturi type is based on the Venturi effect, shown in Fig. 1, according to which, at the flow of a fluid under pressure through a given section, with sudden narrowing and progressive loosening, there occurs the phenomenon of suction. VENTURI injectors made within the limits 3/4″-2″, require operating pressures higher than 4.5 bar, the ratio of primary solution flow rate and fertilizing solution flow rate being 1/5 - 1/50 for the model 3/4″ and 1/5- 1/100 for the model 2″. Fertilizing solution flow rates achieved, depending on the model size (3/4″-2″), range between 193-2640 l/h.

Figure 1. The operating principle of VENTURI type injector

Concerns for the development of dosing pumps have led to the models PD-1 and PD-2 developed at ICITID Băneasa Giurgiu, protected by the patent Ro no. 102887.

This dosing pump (Figures 2, 3 and 4) consists of a directional control valve (A) driving the water circuit toward the pump body (B), an actuation mechanism of the directional control valve (C) and a control and adjustment device (D), both for the water circuit and the chemical fertilizer circuit.

The directional control valve (A) consists of a body 1, where there is pressed the bushing 2 (made of antifriction material), through which slides the sliding valve 3. In the body there are cut 5 threaded holes, this being a 5-ways and two working positions directional control valve (5/2 directional control valve), which is continued with 5 radial holes into the bushing. Into those 5 threaded holes there are mounted the hose connections, 8. By movement of the sliding valve within the pressed bushing into the body there are established between the five internal toroidal chambers the circuits required for pump operation.

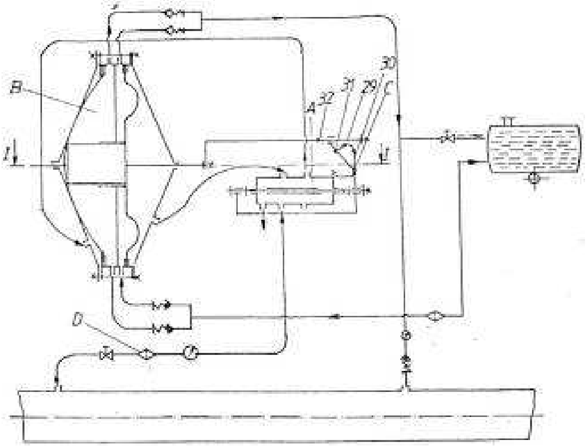

Figure 2. Schematic diagram of the PD-1 dosing pump

The directional control valve has two side covers 4, fastened with screws 5, covers in which there are placed two buttons 7, having the role of limiting the stroke of the sliding valve. The connection between the fittings of the hydraulic directional control valve and the fittings of the drive chambers of the dosing pump is provided through hoses.

The buttons 7 are driven by the buffers 9, fixed to the external frame 10 with nuts 11.

The directional control valve is fixed to the chassis 12 using the cradle 13.

The pump (B) consists of a central body 14, provided with suction connections f, g, respectively discharge connections h, i of liquid chemical fertilizers, and two side covers 15, fixed to the central body, provided with the connections j, k, for water supply - discharge to/from the drive chambers (which are connected to the consumers d, e of the directional control valve).

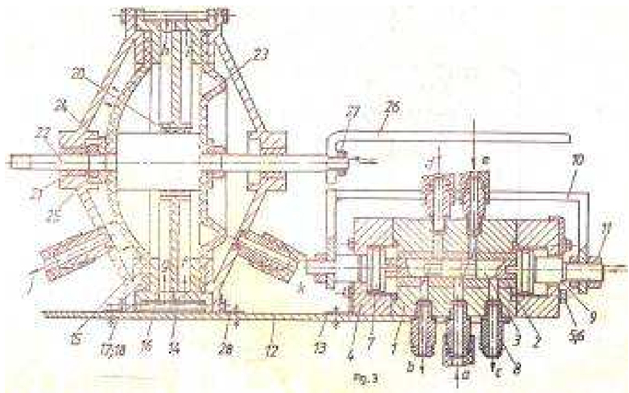

Figure 3. Longitudinal section through the PD-1 dosing pump

The main body and the covers are fitted with bearings, consisting of the bushings 20 and ″O″ ring seals 21. Inside the body there slides the rod 22, to which there are fixed two membranes 23, using disks 24 and nuts 25.

To the end of the rod there is fixed the lever 26, connecting to the actuation mechanism of the directional control valve (C). The pump body is fixed to the chassis using the soles 28.

The actuation mechanism of the directional control valve is made up of a spring 29, which sets the connection between the drive lever 30 and the receiver lever 31. The drive lever is integral with the buffers 9 of the directional control valve, and the receiver lever has one free end, which oscillates between the limiters 32.

The control and adjustment device (D) consists of the filter 33, tap valve 34 for adjusting the flow rate of the driving agent (the irrigation water), the gauge 35 and the check valves 36. The connection between the supply pipeline of the irrigation facility 37 and the hydraulic directional control valve, between the inlet - fertilizer injection chambers and the container 38, respectively irrigation pipeline, between the motor pump and the directional control valve is achieved using hoses.

The dosing pump works on the principle of variable volume chambers (two chambers for the drive fluid and two chambers for fertilizer).

INOE 2000-IHP owns a patent application A/00828-14.09.2010 which proposes the development of an automatic pump for infusion of fertilizers into the pressurized pipelines of the installations for crop irrigation. The pump has the advantage of automatic drive by hydraulic actuation made using a hydraulically controlled directional control valve by two check valves that sense the end of membrane stroke.

The pump, according to Figure 4, sucks the fertilizing fluids from the basin <Bf> through a filter <F> and a battery of valves <Ss>, and injects them through the non-return valve <Sf> into the irrigation pipeline <P>. The pump is double membrane, these forming the drive chambers <Csa, Cda> and the injection chambers <Csf, Cdf>. The pump consists of a mobile subset of two membranes attached to a shaft, and two drive rods <TA>. Two covers clamp the two membranes, so as to form four chambers, two outwards <Csa> and <Cda>, and two inwards <Csf> and <Cdf>.

In the covers there are mounted two check valves controlled by the rods <TA>. Between the devices in the body there are made internal connections, between A/B of the directional control valve and <Csa>/<Cda> inside the pump body. Internal connections are also between the valves S1/S2 and the drive chambers of the directional control valve Ccs/Ccd and nozzles D1/D2.

The nozzles are connected to the irrigation water through the pipe P. For control there is used a directional control valve which is supplied with pressurized water from the irrigation pipe <P> and distributes it alternatively in the two membrane chambers <Csa> and <Cda>. In this way the chambers <Csf> and <Cdf> increase or decrease their volume sucking or discharging fluids through the valves <Ss> in the basin <Bf>. Active surface of the chambers <Csf> and <Cdf> is smaller than the one of the drive chambers <Csa> and <Cda>; thus at the output in the non-return valve <Sf> there is obtained a higher pressure than that in the pipeline, allowing the injection of liquid fertilizer into the irrigation water.

The directional control valve, according to Figure 5, is a symmetrical construction consisting of two valves and two pistons mounted on a shaft. The valves <Se> shut the consumers A and B towards the basin in the front on a rubber seat, the other openings being on axial cylindrical surfaces. The distributor is composed of a central shaft on which there are mounted two valves <Se> and two control pistons.

The valves seal in the front on a rubber seat, and in the retracted position sealing is made on the cylindrical surface of the valve when in contact with the body of the directional control valve. Under the action of water, due to the difference between the surfaces the pressure is acting on, there is obtained a force that opposes switching the directional control valve.

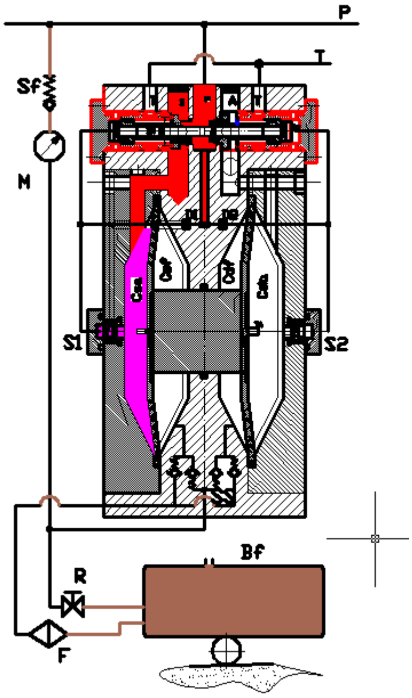

Figure 4. The membrane pump with directional control valve driven by check valve opening at stroke end

D>d; AD>Ad; so FD>Fd

where D, d - diameters of sections the water pressure is acting upon; A_D, A_d - areas of the two sections; F_D and F_d - forces acting on the valve assembly $F = A_p$. When switching, by pressure drop, there occurs unbalancing of forces.

$F_D < F_d + F_{ccd}$,

where F_{ccd} is the force caused by pressure on the control piston end which is no longer balanced.

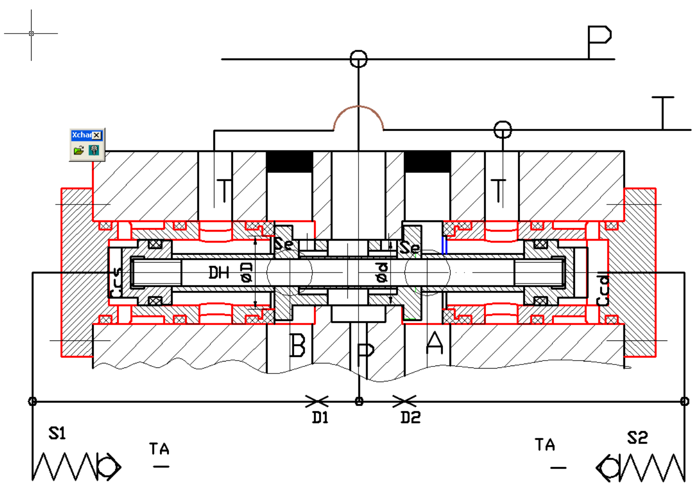

Figure 5. Hydraulically controlled directional control valve

Under the action of pressure, the movable system of the directional control valve gets unbalanced since the closing surface on the seat <D> is greater than the closing surface sliding valve type <d>. Thus there occurs a force that maintains in position the sliding valve of the directional control valve until it gets unbalanced as a consequence of pressure drop in the drive chamber caused by opening the valves done by the actuating rods <TA>.

Operation

When the membrane assembly reaches one stroke end the rod TA opens the check valve S1/S2, resulting in lowering the pressure on the pipeline and therefore the pressure in the drive chambers Ccs or Ccd, unbalancing the valve assembly of the directional control valve, which switches to symmetrical position, changing the connection from P to other pump chamber, and T (the atmosphere) is connected to the chamber where there was pressure. As a result, the direction of travel of the membranes reverses.

The technical solution described, eliminating the disadvantages of the existing systems, consists of control of the directional control valve by sensing the performing of the membrane assemblies' stroke by means of a check valve which opens under the action of a rod <TA>; pressure drop on a circuit which connects with the left or right drive chamber of the directional control valve lead to switching the directional control valve. The control pressure is conveyed to the ends of the pistons of the sliding valve and to the check valves on the closing direction through two nozzles, <D1> and <D2>, from the circuit <P>. The nozzles allow separation of the two control circuits and balancing the sliding valve after its actuation.

The solution has the advantage of developing a compact device automatically operated by hydraulic pressure generated by opening the valves by the rods <TA> over the last millimeters of the membrane stroke, achieving high efficiency and safe operation.

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SOME PROBLEMS OF WATER INDICATORS IN TROUT FARM

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ABSTRACT

To be profitable, aquaculture requires good management on environmental quality control and food. From environment factors water is very important. In trout farm, physical and chemical water indicators are very important for fish development. Monitoring of some of these indicators is done in this paper (temperature, dissolved O_2, BOD_5, pH, fixed residue TDS, total nitrogen N_T, total phosphorus P_T and chemical consumption of oxygen CCO).

1. INTRODUCTION

Food and water are the most important parameters in relation to fish farming, environmental impact and production costs. To estimate the environmental performance of fisheries farm is crucial to draw up a quantification of operational parameters of water (temperature, dissolved oxygen, pH,fixed residue TDS, total nitrogen N_T, total phosphorus P_T, BOD_5 , chemical consumption of oxygen CCO) and location of the system (components, flow volume and dimensions).

Trout is a cold water fish and we can find in water with temperatures range 12°C - 16°C summer and 1°C - 3°C winter. Trout loves very much clear water with dissolved oxygen in range 9-12 mg / l, but a short time a turbid water is supported. Water takes oxygen from the air and breaks it down. Trout have a high oxygen demand and thus setting high standards for the content of oxygen in the water is necessary. Cold water secures more oxygen, which frees heating. The fish, however, needs more oxygen at temperatures up because its metabolic processes are more active and intense, and it becomes more agile. Both factors work against each other. High oxygen consumption opposes low capacity water lock, which can lead to sudden oxygen deficiency. In open waters, fast flowing and normal temperature conditions as we find them in the mountains, the oxygen supply is normal due to constant airflow water and normally, the degree of saturation is achieved.

In the pond, through the injection of air or oxygen, or by rolling up the water, saturation level is reached, and thus, in addition to the fact that increase number of fish, it is ensured their need for oxygen, if the influx is closed soon.

The good water for fish development has values of pH from neutral 7 to alkaline pH value 8. A pH less than 6 or value above 8.5 is not suitable for trout, as it weakens the body and exposed it to disease. Values of pH are lower in winter than in summer, due to the lack of organic matter in the water in the cold season. In general, the waters of Romania have a pH between 7.0 and 8.0, with the exception of the lakes from Fagaras , Retezat and Rodna, whose value falls between 7 and 6. Waters coming from swamps or bogs are acid , the contaminated based pollutants may be highly alkaline or highly acidic. Origin of water also plays an important role. Using only rivers sources take advantage of rich oxygen and high temperatures in winter and lower in summer.

Spring waters are also used, for the advantage that they have a constant temperature, close to the optimum incubation of trout eggs and they are clear. It should be noted that the specific conditions of our country, record spring water temperatures below 5 ° C, it is not appropriate to be used as a power source for trout rainbow shaped the production, which records temperatures in the hot months, over 23 ° C. Sudden changes of temperature are very harmful to fish .In case of trout, young fish don' t resist when the water temperature changes abruptly with 3-4 ° C, and adult fish don't accept sudden variations of the temperature in range(7° C - 10 ° C) The water temperature influences time of reproduction. For the majority of salmon fish family, this taking place, when the water temperature reaches 6° C to 8 ° C. Temperature influences the internal combustion for trout body. Higher temperature ensure the increase of metabolism, need for oxygen increases, while the O2 content of the water decreases with temperature.
Repeated disturbance by flooding water and land sides and by chemical and organic pollution, endanger fish populations. Juvenile gills can be affected by small substances floating on the water. A very strong culture of algae destroys any aquatic animal power systems and it is avoided ponds a stream that runs near settlements or large industrial areas. Highly polluted water can cause burning of the oxygen and decrease the oxygen content of the water, essential to life of trout. Therefore, we must establish certain standards designed to supply water for trout ponds.

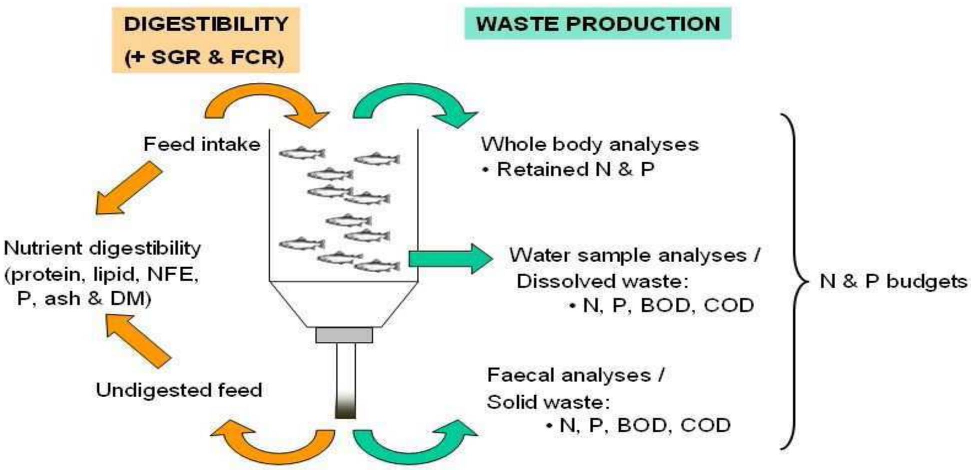

Figure 1. Trout Farm Model[2]

In Trout farm model we can see importance of water samples analyses.

2. METHODOLOGY

The amount of water plays an important role in raising trout. Modern farms operate with plenty of water, but less space. The transit flow is strong and the number of fish is higher. In any case, it can be noted that, as a rule, each liter of water influx per second is for 50 to 75 kg trout. Temperature and degree of saturation of the water plays a decisive role here. There are considered 12 samples taken from water, Month of May (Table1)and Month of June(Table2). Working points are different, so the surface pools 30 cm depth and 4.5 m depth or 50cm above the lake bottom. Monitoring of some of water indicators is done in this paper (pH, dissolved O_2, BOD_5, fixed residue TDS, total nitrogen N_T, total phosphorus P_T and chemical consumption of oxygen CCO). The results for unstable weather, with periods of rain and overcast and sunny periods with air temperature 17-24^o C are shown in Table 1.Sampling points are: S_1input pools;S_2 output pools; S_3 upstream output pools; S_4 downstream output pools; S_5 downstream trout farm (30cm depth); S_6 downstream trout farm (4,5mdepth); S_7 trout farm side (30cm depth); S_8 trout farm side

(4.5m depth); S_9 trout breeding cages (30cm depth) ; S_{10} trout breeding cages (4.5mdepth); S_{11} upstream trout farm (30cmdepth); S12 upstream trout farm (4.5m depth)[1].
The results for unstable weather, with periods of rain and overcast and sunny periods with air temperature 20-28^o C are presented in Table 2. Sampling points are : $S`_1$input pools;$S`_2$ output pools;$S`_3$ downstream trout farm (30cm depth);$S`_4$ downstream trout farm (4.5m depth); $S`_5$ downstream trout farm (50cm above the lake bottom);$S`_6$ trout farm side (30cm depth);$S`_7$ trout farm side (4.5m depth);$S`_8$ trout farm side (50cm above the lake bottom);$S`_9$ trout breeding cages (30cm depth); $S`_{10}$ trout breeding cages (4.5mdepth);$S`_{11}$ trout breeding cages(50cm above the lake bottom);$S`_{12}$ upstream trout farm (30cm depth)[1].

Table1 Indicators for water in trout farm - air temperature 17-24^o C [1]

S_i	Temp. ^{o}C	pH	Diss. O_2 mg/l	N_T mg N/l	P_T mg N/l	TDS 105^{o}C mg/l	BOD_5 mgO_2/l	CCO-Cr mgO_2/l	CCO-Mn mgO_2/l
1	11	6.64	11.36	0.07	0.009	44.75	1.80	3.58	2.96
2	11.5	6.58	10.08	0.09	0.016	48.24	1.95	3.95	3.2
3	11	7.24	11.12	0.052	0.006	98.24	2.06	4.28	3.6
4	11.5	6.75	11.4	0.06	0.015	48.6	1.52	3.05	2.5
5	11.5	7.42	11.3	0.026	0.009	58.71	1.50	3.12	2.5
6	10	7.96	11.1	0.027	0.008	56.6	1.28	2.69	2.07
7	11.5	7.62	11.12	0.039	0.006	51.62	1.26	2.48	1.99
8	10	7.23	10.8	0.057	0.006	56.65	1.64	3.10	2.53
9	12	7.57	10.8	0.036	0.007	59.27	1.45	2.50	2.07
10	10	7.29	10.72	0.027	0.009	57.89	1.42	2.78	2.26
11	12	7.45	10.88	0.028	0.009	56.5	1.40	2.80	2.34
12	10	7.63	10.72	0.04	0.008	56.26	1.34	2.56	2.11

Table2 - Indicators for water in trout farm - air temperature 20-28° C [1]

S`	Temp. °C	pH	Diss. O_2 mg/l	N_T mgN/l	P_T mgN/l	TDS 105°C mg/l	BOD_5 mgO_2/l	CCO-Cr mgO_2/l	CCO-Mn mgO_2/l
1	13	7,06	10.95	0.382	0.02	50.81	1.59	3.13	2.61
2	14.5	7,14	9.34	0.446	0.027	55.10	1.72	3.33	2.72
3	16	7.17	10.12	0.391	0.012	53.2	1.62	3.04	2.45
4	14.5	7,02	9.74	0.372	0.035	58.47	1.56	3.36	2.60
5	14	7.06	9.40	0.578	0.023	56.77	1.61	3.38	2.61
6	16	7.09	10.14	0.291	0.011	52.15	1.64	3.26	2.61
7	14	7.03	9.86	0.226	0.015	55.46	1.66	3.19	2.60
8	14	7.07	9.51	0.220	0.017	55.75	1.60	3.16	2.56
9	16	7.42	9.88	0.435	0.021	62.19	1.87	3.15	2.67
10	14	7.09	9.77	0.473	0.042	57.01	1.70	3.24	2.64
11	14	7.06	9.31	0.346	0.035	59.08	1.66	4.20	3.27
12	16	7.11	10.20	0.573	0.022	59.21	1.63	3.00	2.51

Tabel 3.Statistics for data of Table 1

Var.	Temp. °C	pH	Diss. O_2 mg/l	N_T mgN/l	P_T mgN/l	TDS 105°C mg/l	BOD_5 mgO_2/l	CCO mgO_2/l
Lowest value	10	6.58	10.08	0.25	0.031	50.81	1.26	2.48
Highest value	12	7.96	11.40	0.528	0.120	66.28	2.05	4.28
Arithmetic mean	11	7.28	10.908	0.3642	0.0687	56.995	1.55	3.073
95%C.I. for the mean	10.99 to 11.15	7.00 to 7.55	10.647 to 11.170	0.3072 to 0.4112	0.0516 to 0.0858	54.6821 to 59.3079	1.387 to 1.715	2.7025 to 3.4442
Median	11.6	7.35	10.99	0.3460	0.063	56.61	1.475	2.925
95% C.I.for the median	11 to 11.7	6.7 to 7.62	10.53 to 11.33	0.2772 to 0.4734	0.0464 to 0.0953	54.9019 to 59.0936	1.312 to 1.868	2.5273 to 3.7482
Variance	0.995	0.18	0.1696	0.008	0.0007	16.0464	0.0668	0.3406
Standard deviation	0.997	0.43	0.4118	0.0897	0.0269	4.0058	0.2584	0.5836
Relative standard deviation	6.84%	5.88%	3.77%	24.64%	39.23%	7.03%	16,66%	18.99%

Tabel 4.Statistics for data of Table 2

Variable	Temp. °C	pH	Diss. O_2 mg/l	N_T mgN/l	P_T mgN/l	TDS 105°C mg/l	BOD_5 mgO_2/l	CCO mgO_2/l
Lowest value	13	7.02	9.31	0.22	0.0110	50.81	1.5	3.0
Highest value	16	7.42	10.95	0.578	0.0420	66.28	1.87	4.2
Arithmetic mean	14.57	7.12	9.8264	0.3979	0.02271	56.995	1.63	3.256
95%C.I. for the mean	13.99 to 15.15	7.06 to 7.18	9.5753 to 10.077	0.3345 to 0.4613	0.01746 to 0.02797	54.6821 to 59.3079	1.575 to 1.683	3.085 to 3.4278
Median	14	7.09	9.78	0.3865	0.0205	56.61	1.615	3.175
95% C.I. for the median	14 to 16	7.06 to 7.16	9.4985 to 10.1221	0.3403 to 0.4736	0.01679 to 0.02783	54.9019 to 59.0936	1.552 to 1.691	3.0589 to 3.3529
Variance	0.995	0.01	0.1891	0.01206	0.000083	16.0464	0.0087	0.0881
Standard deviation	0.997	0.10	0.4349	0.1098	0.009101	4.0058	0.0935	0.2968
Relative standard deviation	6.84%	1.41%	4.43%	27.60%	40.07%	7.03%	5.74%	9.12%

C.I.- Confidence Interval
Relative standard deviation (RSV) = (Standard deviation/ Arithmetic mean) 100%

In statistical approach model, smallest values of relative standard deviation are for values of pH and dissolved O_2 (Diss. O_2) and greatest values of relative standard deviation are values for nitrogen N_T and phosphorus P_T. The maximum oxygen content of water is 11.40mg/l (data in Table1) and minimum value is 9.31mg/l (Table 2). For older age groups, the acceptable low oxygen content of water may be about 4–5 mg/l. The most common cause of low dissolved oxygen is a high concentration of biodegradable organic matter (and thus BOD_5) in water. Total nitrogen and total phosphorus were found higher in some sample points from cages and output pools than those at inlet of the farm.

3. CONCLUSIONS

Activity in artificial raising trout farms requires ensuring and maintaining an environment with clean water. Fish are the first recipients of water pollution, where they live. Fish are stringent for water conditions, especially temperature, pH and dissolved O_2.

In planning a system of ponds for trout farm must be thoroughly tested water quality and to determine the following adequate temperature conditions, cleaning state of water, the amount of available water. In statistical approach model, indicators of water for two different ranges of temperature are studied , but it may be extended for several ranges of temperature., for monitoring some of important physical and chemical water indicators.

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TECHNICAL EQUIPMENTS DESIGNED FOR THE CULTIVATION TECHNOLOGY OF MISCANTHUS ENERGY PLANT

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ABSTRACT

The main objective of using renewable energy is to reduce the greenhouse gases emissions. One of the main sources of renewable energy, available in abundance in Romania, is biomass. Within this category of renewable sources, the best perspectives for bioenergy production are posed by the dedicated crops. For the production of heat and ethanol, among the best crops include Miscanthus culture. Analyzing the works within the technology for establishing, maintenance and harvesting of Miscanthus crops, it has been found that the majority of works can be made with existing machines in operation, except for planting, stems harvesting and harvesting the Miscanthus rhizomes. For these works, there are needed new technical equipments, dedicated to the culture of Miscanthus. In this context, the paper presents the current state of the art regarding the technical equipments designed for the cultivation technology of Miscanthus energy plant, highlighting their technical characteristics and performances, information necessary for farmers interested in this domain.

1. INTRODUCTION

In the context of diminishing fossil fuel resources and commitment of European countries by 2020 to obtain a 20% renewable energy from the total energy production, the cultivation of energy plants can be a solution to achieve this objective.

One of the main sources of renewable energy, available in abundance in Romania, is biomass. Within this category of renewable sources, the best perspectives for bioenergy production are posed by the dedicated crops. Researches on energy plants in Europe have been concentrated on Miscanthus (Miscanthus X giganteus), energy Willow (Salix Viminalis), energy Poplar and Paulownia. For the production of bioethanol, biogas and biomas, among the best crops include Miscanthus culture.

Miscanthus plant, as a renewable resource, produces 15...20 t/ha dry matter, has a perennial growth of 10-15 years, efficiently uses nitrogen, water and other resources, is disease resistant and require little fertilizer pesticides and other chemicals maintenance.

2. METHODOLOGY

Miscanthus (fig. 1) is a perennial plant which, being sterile, is multiplying only vegetative, by dividing the rhizomes. Using quality materials is essential for good establishment of culture. Rhizomes should be obtained from Miscanthus fields especially dedicated for obtaining biological material and should be harvested from the young plants category, not from an old harvest.

Figure 1: Miscanthus culture and Miscanthus rhizomes

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The agro-technical works appropriate for the Miscanthus culture technology include:

A. Preliminary work, aiming to prepare the soil before the establishment of culture and their role is to improve soil fertility, since an established Miscanthus crop takes 10...15 years;

B. Establishment and maintenance works for Miscanthus crop are made in the first 2...3 years until the plant reaches maturity and culture can be exploited;

C. Harvesting, transport and storage works, starting after 2...3 years when the plants, dried following the cessation of the biological cycle are harvested to allow the development of the next growing season;

D. Harvesting, transport and storage works for Miscanthus rhizomes from 2…3 years old fields, especially dedicated for obtaining biological material, in order to establish new cultures.

The cost of establishing one hectare of Miscanthus is about 2000 Euros (of which about 60% represent the cost of Miscanthus rhizomes), investment payed off in about five years, the remaining time until the end of the exploitation of culture, being followed by profit.

Due to the specific characteristics of Miscanthus crop (irregular shape and various dimensions of rhizomes, the expantion of the culture between the planting rows) and the specific quality conditions imposed to the planting material necessary for the successfully establishment of the new cultures (without mechanical damage and having at least 3...4 viable buds), appeared the need to develop new specialized equipments to ensure the compliance with the qualitative working indices of the agricultural works within the cultivation technology, especially for planting, stems harvesting and harvesting the Miscanthus rhizomes.

Technical equipments for planting Miscanthus rhizomes

W.H.Loxton Ltd – UK, SPRIGGER'S Choice – USA, NOVABIOM – France are companies that produce Miscanthus rhizomes planters (fig. 2). NOVABIOM has developed a semi-automatic Miscanthus rhizomes planting machine, which allows a homogeneous distribution of the rhizomes and distribution norms compatible with current technologies. The other two companies have developed rhizomes planters which perform automatic planting, having a high precision and ensuring, at the same time, a low cost for the culture establishment.

Figure 2: Rhizomes planters - W.H.Loxton Ltd, SPRIGGER'S Choice, NOVABIOM

MECANICA CEAHLAU – Romania company, has developed a Miscanthus Planter, ETPM4, which is used within the technology for the establishment of Miscanthus crops.

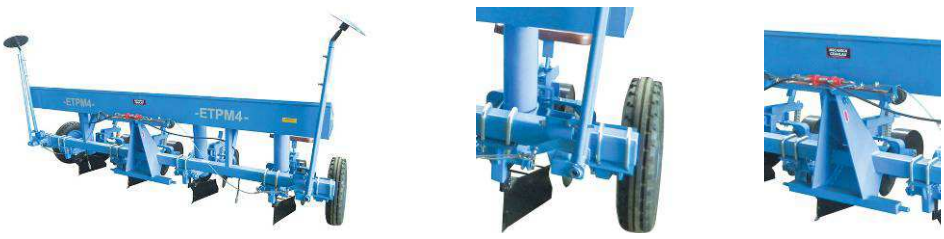

Figure 3: Miscanthus ETPM4 Planter

Miscanthus Planter performes the following operations: the coulter opens the channel, then the rhizome is introduced by the operator into the guiding tube and falls into the channel, at the time and in the proper position, after that, the rhizomes are covered with soil by a pair of spherical disks and pressed by a compaction metallic wheel, located behind the spherical disc.

Table 1: Technical characteristics of ETPM4

Necessary tractor [HP]	65
Working width [m]	4
Working depth [cm]	8...12
Distance between rows [m]	0.5...1
Number of planted rows [pcs.]	4
Productivity [ha/h]	1.5
Weight [kg]	850

Technical equipments for harvesting Miscanthus stems

Depending on the requirements for the use of the harvested material, there are two versions of harvesting technology, namely: direct harvesting technology, using forage harvester combines (towed or self-propelled), and divided harvesting technology, using rotary mower for cutting and laying strains on the ground and bundling them with balers.

When applying direct harvesting technology for Miscanthus, the forage harvester has to be endowed with an equipment for harvesting plants with high waist, that can perform the cutting of plants on the entire working width. Self-propeled forage harvesters, like CLAAS products or other companies products, can harvest Miscanthus properly if they are endowed with a special equipment, which cuts the plants on the entire working width, made by the Kemper company (rotors-type harvesting header from 300^{plus}/300 or 400 series).

A less expensive solution is to use towed or tractor mounted forage harvester combines with the same type of harvesting header (rotors-type) adapted to its needs.

The **Maschinenfabrik KEMPER GmbH & Co. KG - Germany** company, produces tractor mounted choppers, such as C 1200, C 2200 and C 3000, capable of harvesting Miscanthus strains.

Figure 4: Tractor mounted choppers – C1200, C 2200 and C 3000

Table 2: Technical characteristics of the tractor mounted choppers

	C 1200	**C 2200**	**C 3000**
Length [m]	2.80	2.55	2.80
Height [m]	3.95	4.20	4.20
Working width [m]	1.25	2.28	3.00
Weight [k]g	1,100	2,050	2,350

MECANICA CEAHLAU – Romania company, has developed a Miscanthus Harvester designed for cutting, chopping stems at the desired length selected by the user and loading harvested material into a mean of transportation. By installing different equipment, the cropper can also be used for harvesting field grass, corn silages, gathering green mass from the silages or everyday animal feed.

Figure 5: Miscanthus CRM Harvesting Cropper

Table 3: Technical characteristics of Miscanthus CRM Harvesting Cropper

Necessary tractor [HP]	65 - 125
Working width [m]	1.6
Chopping drum speed [rpm]	825
Chopping length [mm]	10 – 25 adjustable in 6 steps
Dimensions (LxWxH) [m]	1.75x1.73x1.35
Weight [kg]	2060

Technical equipment for harvesting Miscanthus rhizomes

Regarding the harvesting operation, worldwide, it is known the **Egedal** company (Denmark), which produces rhizomes harvesters adapted to Miscanthus, type RR and SR-2 and **Bermuda King** company (USA) which produces harvesters, type Road Ready and Rear Load.

The rhizomes harvesters, Egedal RR model and Egedal SR-2 model (fig. 6) are designed for lifting seedlings, saplings and other plants. Constructively, the machines are simple and robust, designed to work in any ground conditions. The equipments are equipped with a fixed front coulter, an adjustable vibrating system driven from the PTO of the tractor and a control system for the working depth.

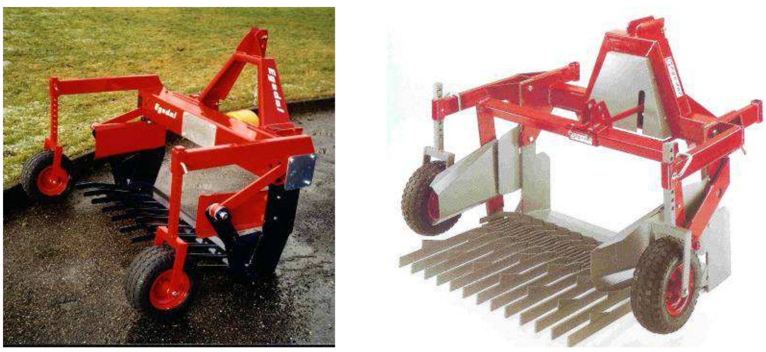

Figure 6: Egedal Plant Lifters – RR and SR-2 models

When the equipment is used for lifting seedlings, it is adjusted to its minimum effect so that the soil is only loosened from the plants. When is used for lifting perennials, the machine is set to its maximum shaking effect. Table 4 presents the main technical characteristics of the plant lifter Egedal model RR.

Table 4: The main technical characteristics of Egedal model RR

Working width [mm]	Garound clearance [mm]	Weight [kg]	Necessary tractor [HP]
1200	630	419	40
1350	630	425	40
1500	630	460	40

The Road Ready rhizomes harvester (fig. 7) offers side delivery of the rhizomes and is intended for the 40-90 hp tractors range. The hydraulically operated elevator can adjust its position quickly and easily without being detached from the harvesting machine. The Rear Load rhizomes harvester is used in aggregate with a transport trailer that will receive the harvested rhizomes. It is also intended for the 40-90 hp tractors range.

Figure 7: Bermuda King rhizomes harvesters – Road Ready and Read Load models

INMA Bucharest has designed and produced an equipment for harvesting Miscanthus rhizomes ERM, which is currently being implemented in SC Mecanica Ceahlau Piatra Neamt.

The technical equipment (fig. 8) works in aggregate with 70 ... 80 hp tractors on wheels, fitted with three point linkage mechanisms, Category 2 according to SR ISO 730-1 + C1. The equipment performs the dislocation of Miscanthus rhizomes from the mass of soil and their separation of soil, by the deep loosening the soil without turning it over, destruction of the links between soil and rhizomes and pushing upward of them toward the oscillating grates, which, by sieving, separates the rhizomes of impurities and soil and leaves on soil in furrow, following to be loaded into means of transportation. The separator with ecccentric is driven using a hydraulic motor, coupled to the tractor hydraulics.

Figure 8: Technical equipment for harvesting Miscanthus rhizomes ERM

Table 5: Technical characteristics of the equipment

Power of tractor in the aggregate [HP]	70...80
Working width [m]	1.2
Working depth [cm]	max. 25
Ground clearance [mm]	350
Mass, kg	565

3. CONCLUSIONS

Production of biomass is a resource of renewable energy and a significant opportunity for the sustainable rural development, to achieve independence from fossil fuels on farms and to reduce the greenhouse effect.

Miscanthus, as a renewable resource, produces a large amount of dry matter per hectare has a perennial growth, it uses efficiently the nitrogen, water and other resources and is resistant to diseases.

Harvested stems can be used both as biomass for energy production and plant for fiber. When the Miscanthus biomass is used for energy production, the chopped stems are directly burned into stoves or transformed into pellets and briquettes. As a plant for fiber, Miscanthus fibers can be used in various bioproducts, such as: insulation boards, plaster facade, windbreak, packaging materials, garden decorations, support for various crops, flower pots, etc.

Knowing the economical advantages of Miscanthus crop, the technology for cultivation and the equipments used for the mechanization of the agricultural works within the technology, the farmers have the opportunity to analyze and decide for themselves if such a crop could be an efficient investment for them.

ACKNOWLEDGMENT

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CONSIDERATIONS ON PHYSICAL AND MECHANICAL PROPERTIES OF SOLID ORGANIC FERTILIZERS

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ABSTRACT

The aim of the article is to analyze and synthesize the previous theoretical and experimental research that has been conducted on identifying the physical and mechanical properties of solid organic fertilizers that influence the spreading with specialized machinery. Since livestock manure spreaders have not included control systems, knowledge of these properties can provide information on their influence on the evenness of transversal and longitudinal product distribution, and on the crumbling degree.

1. INTRODUCTION

Natural fertilizers are various wastes (manure and other livestock waste, poultry manure, green fodder, composts from cow, poultry, pig manure and various plant waste) which, when used as such or prepared by composting, are an important source of nutrients for crop growth and development.

To ensure maximum efficiency and proper use without causing pollution to the soil, to the surface and groundwater with organic matter and mainly nitrates, natural fertilizers must be applied following agronomic rules and regulations based on long term experience, without exceeding certain amounts of nitrogen (170 kg / ha / year), regulations established by the "Directive on the protection of waters against pollution caused by nitrates from agricultural sources" D 96/676 / EEC.

The chemical composition of manure products and their effects on soils and/or crops are readily available. Fewer research studies have targeted manure products physical and flow properties, and most of the published results are for liquid manure and slurry.

Applying natural fertilizers for the fertilization of agricultural land may be done annually or periodically, in quantities that meet the nutrients needs of crops, without leading to accumulation (especially nitrates) that may become excessive in the soil and leachate waters. In order to ensure the sustainability of intensive livestock production and of agriculture in general, the operations of applying fertilizers should be as accurate as possible.

Available machines designed for applying solid and semisolid organic fertilizers have not provided control systems and therefore the distribution systems perform unequal longitudinal and transverse distribution [1, 2].

From previous researches it has become clear the influence of physical and mechanical characteristics of organic fertilizers on the quality of the fertilization work. Therefore this research were studied and drawn certain defining conclusions that will be discussed below.

2. METHODOLOGY

To clearly see the influence of the physical characteristics of fertilizers on the results of scattering, it is necessary for the distribution equipment to be adjusted identically for all types of fertilizers used. The lack of standard methods for taking measurements of physical and mechanical properties of organic by-products makes the characterization of manure very difficult [3].

Some test methods have been used successfully by some researchers, others proved to be more difficult to implement. According to research carried out in [3], to quantify the

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mechanical properties of solid organic fertilizers relevant for the design of distribution systems were measured following properties: *dry matter content*, *humidity*, *angle of repose*, *particle sizes*, *density of the fertilizers*, *static friction characteristics.*

Different types of fertilizers were tested and it was found a content of total solids (TS) with values between 34 and 76%, and the coefficient of variation (CV) of the mass of material deposited in the direction and across the direction of travel depends greatly of total solids values.

3. RESULTS

• *Dry matter content*

Behavior of manure during handling and distribution of varies, firstly depending on the solids content in the composition of the fertilizer. Manure is usually classified as a liquid, suspension, semi-solid or solid, depending on the total solids content. The limit between classifications is not fixed, but varies according to the specific composition.

Manure can be classified according to the dry matter content in liquid, paste, semi-solid and solid as in [4], as follows:

- *Liquid manure*: have up to 4% solids content and can be handled with irrigation equipment. These liquid fertilizers can be obtained by eliminating large manure solids using installations for liquid-solid separation or by adding dilution water.
- *Slurry*, in the form of *suspension*: have a content of solids between 4 and 10% and may require special handling pumps.
- *Semi-solid* waste: contains about 10 to 20% solids. Manure is too thick to be handled with a pump.
- *Solid* manure: has a content of more than 20% solids. This manure can be handled with a pitchfork or with grapple loaders.

The transition from one category to another does not depend exclusively on the solids content but also on the animal species, diet, type and amount of material used as bedding, water in the diet [5].

Table 1: Classification of organic fertilizers by their dry matter content [5]

Species	**Classification by the dry matter content**			
	Liquid	**Slurry**	**Semi-solid**	**Solid**
Cattle for fattening	0-3	4-9	11-15	> 19
Dairy cattle	0-2	3-8	10-14	> 16
Poultry	0-4	5-12	14-20	> 24
Swine	0-5	6-14	15-23	> 25

♦ ***Humidity***

Humidity or the content of liquid is expressed by the mass of liquid lost by the material during drying. It is determined by the relation

$$U = \frac{m_i - m_f}{m_i} \times 100 \quad [\%] \tag{2}$$

where: U is the humidity expressed in percentage [%];

m_i – initial mass of the sample before drying [Kg];

m_f – final mass of the sample after drying [Kg].

♦ ***Density of organic fertilizers***

Represents the ratio between the mass and the volume of a body, respectively the mass a volume unit and is expressed in kg/m^3. In practice, the density of the material that will be scattered is calculated by weighing the mass of manure loaded in the scattering machine relative to volume of the machine's body:

$$\rho = \frac{M_g}{V_m} \quad [\text{kg/m}^3] \tag{3}$$

where: ρ is the density [kg/m^3];

M_g – mass of manure in the machine,[kg];

V_m – volume of the machine, [m^3].

The method is a coarse one, requiring a large volume of material for the complete filling of the trailer, and because of the fact that the filling is not homogenous, the whole volume of the trailer is not occupied, the behavior of the organic fertilizers is not resembling to that of other materials that flow and occupy the whole volume that is at their disposal. The results determined by this method are imprecise.

The simplified method, of determining in the field, uses as reference volume a 10 liter bucket that is filled with manure. Measurements are repeated three times with samples taken from a cubic meter of material. The method is more precise than the first one, but it mostly depends on how the sample is taken by the designated person, but also by the type of material (goat or sheep fertilizers are very compact and the method can give large errors). In order to limit the big variations in density, the method of taking samples using a special sampling tool at desired depths is used.

Figure 1: Taking samples for the determination of density [6]

$$\rho = \frac{M}{V} = \frac{4M}{\pi D^2 H} \quad [\text{kg/m}^3] \tag{4}$$

where ρ is the density [kg/m^3];

M – mass of material,[kg];

V – volume of the calibrated cylinder, [m^3];

D – diameter of the cylinder, [m];

H – height of the cylinder, [m].

The density of the fertilizers influences constructively the choice of the volume of trailer, but also gives clear indications on the humidity of the material. The bigger the density of the material, the higher the content of humidity will be.

In paper [2] the authors noted that the density of the manure pile depends on two distinct factors. In the same farm, with manure obtained from similar animals, the density mostly depends on the length of the straws used as bedding. They differ depending on the type of bedding, the age of the manure and the position in the pile located on the storage platform. Other measurements are made in the interior of the manure scattering machine, in order to create the real conditions in which scattering takes place. The manure is taken from the pile in two ways: using a frontal loader or manually using pitchforks.

♦ ***Particle size***

This characteristic is very important because: after distribution, the aggregates in which the manure particles are presented must not exceed 6 cm in length (diameter). If the particles are in large aggregates, the fertilization is not done properly, being in surplus in those areas, according to [1, 3, 7].

In order to determine the distribution of the particle sizes, is used the system with sieves of different mesh sizes. The material placed on the sieve is shaken for 90 a period of 90 seconds and the quantity of material left on the sieve is weighed, then making the ratio between the total quantity and the quantity remaining on the sieve. The problems that can appear are given by the content of straws that do not allow the passing through the meshes of the sieve, but also by the presence of different foreign materials [3].

Figure 2: Sieve system for determining the distribution of particle sizes [3]

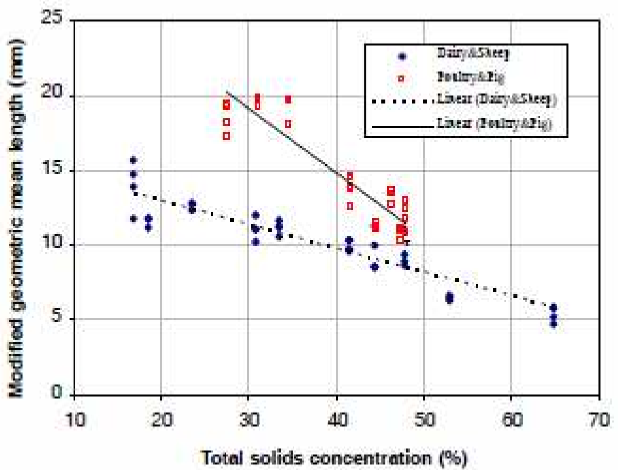

Figure 3: Distribution of particle sizes depending on the solids content [8]

Figure 3 shows the distribution of particle sizes for different types of solid fertilizers expressed in terms of the length of the particles in aggregates depending on the total solids content [3, 8].

The regression equations for the particle lengths depending on the solids content that researchers [10] have deducted, depending on the animals from where they come, are the following:

Dairy cattle and sheep: $X_{gm} = 16.1 - 0.16\ TS$; $R^2 = 0.83$

Poultry and swine: $X_{gm} = 31.9 - 0.43\ TS$; $R^2 = 0.84$

♦ ***Coefficient of friction***

The coefficient of friction between the material and different surfaces used in the construction of the equipment for administrating solid organic fertilizers is a very important factor because it gives indications on the distribution length and the moment of detaching the fertilizers from the pallets or spirals of the distribution equipment.

The materials chosen for the measure of this coefficient are: steel (painted or not), plastic material and plywood (wood). The classic method of the inclined plane where the solid surfaces are placed is used.

♦ ***The angle of repose***

In paper [9], the authors proposed for the determination of the angle of repose the use of a "characterization box" (fig. 4) with a capacity of 1.3 m^3 of manure. It was filled using a frontal loader, and then the material was allowed to fall freely and it was noticed that the angle of repose is in a tight correlation with the consistency of the material that can be actually observed visually, having values between 4° and 50°.

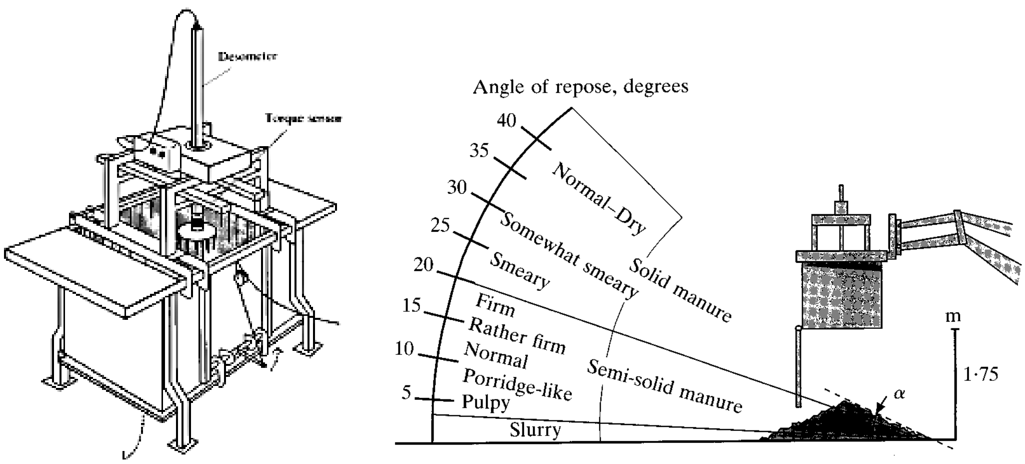

Figure 4: a) characterization box b) angle of repose measured using the „ characterization box" [9]

- ***Resistance to penetration***

The resistance to penetration is the ability of solid organic fertilizers to oppose the penetration of rigid body. It decreases as the humidity rises. The resistance to penetration is determined using a digital electronic static cone penetrometer for which the pressure force is created manually (by a human operator). The device measures the force of resistance to the penetration of the cone into the layers of fertilizers (expressed in pressure units, kPa or MPa) with an electronic force transducer and the penetration depth of the cone into the material with the help of a position (level) sensor with ultrasound generator.


Figure 5: Electronic penetrometer (left) and the determination of the resistance to penetration (right) [6]

- *Shearing resistance*

For the determination on field of the shearing resistance of organic fertilizers, a blade shearing device is used. The testing consists in introducing into the layer of material of blades (pallets) arranged crosswise, located at the end of rod which is subjected to a torsion moment high enough as to allow the rotation of blades and thus the shearing of the material on ending surface and on the lateral surface of the cylinder with a diameter *D* and a height *H*.

The shared area is $S=2\pi rH$ (it is considered that a cylindrical shaped piece of fertilizer is sheared in the system).

$$\tau = \frac{M}{2\pi rRH} \tag{6}$$

where: τ is the shearing resistance, [N/m^2];

M – shearing torque, [Nm];

R – radius of applying the moment, [m];

R – blade radius, [m];

H – blade length, [m].

The shearing resistance τ varies from 3 kPa to 50 kPa [2]. When introducing the device in the mass of material, a big problem for determining the shearing resistance was the big straw content. The straw layer widens the whole where the shearing device is introduced and it moves freely, resulting in inconclusive measurements. It is recommended that this measurement to be conducted for fertilizers without any straw content or with straws of very small length.

4. CONCLUSIONS

From researches previously conducted it became clear the influence of the physical-mechanical characteristics of organic fertilizers on the quality of the fertilization work.

Manure is usually classified as: *liquid*: has up to 4% solids content; *slurry*: has between 4 and 10% solids content; *semi-solid* manure: has between 10 and 20% solids content; *solid* manure: has a solids content of over 20%.

The density of the fertilizers influences constructively the choice of the volume of trailer, but also gives clear indications on the humidity of the material. The bigger the density of the material, the higher the content of humidity will be. The particle size is very important because, after distribution, the aggregates in which the manure particles are presented must not exceed 6 cm in length (diameter). If the particles are in large aggregates, the fertilization is not done properly, being in surplus in those areas.

The coefficient of friction between the material and the different surfaces used in the construction of equipments had values between 0.67 … 7.75 for plywood, 0.27 … 2.98 for plastic, 0.3 … 2.23 on painted steel, 0.33 … 1.51 on unpainted steel, the measurements being conducted for 4 types of fertilizers with different solids content. The angle of repose has values between 4 and 50º, the resistance to penetration is situated between 0.14 MPa and 1.6 MPa, while the shearing resistance varies between 3kPa and 50 kPa.

Constructively, the distribution equipments consisting of rotors with spires and cutters, fitted horizontally or vertically, or of rotors with blades that operate on the centrifugal principle do not offer the possibility of a precise adjustment for the fertilizer norm and the quality of the work is affected by the variability of the characteristics of fertilizers.

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MEASURING DEVICES, EXPERIMENTAL STANDS AND EQUIPMENT USED FOR THE STUDY OF ARTIFICIAL SOIL COMPACTION

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ABSTRACT

The phenomenon of artificial soil compaction occurs everywhere when moving on foot or by car and soils are covered by ponding water, even after relatively small rains (due to succesive passages on soil surface, succesive rains or the absence of adequate recovery works of soil structure). This phenomenon was intensively studied by researchers in our country and abroad, using specific equipment and instruments that allow to determine various parameters that characterize the artificial compaction of soil. This paper presents the most important devices, experimental stands and equipment used for the study of soil compaction, highlighting the measurement method and the parameters which can be determined.

1. INTRODUCTION

Quantitative evaluation of soil compaction is necessary to identify the adequate methods (mechanical, chemical or biological) to improve or restrain this phenomenon (fig. 1). In recent years were developed various prototypes of sensor systems for mapping certain indicators of soil compaction. These systems are based on sensors for soil strength, fluid permeability, moisture or combined sensors [8].

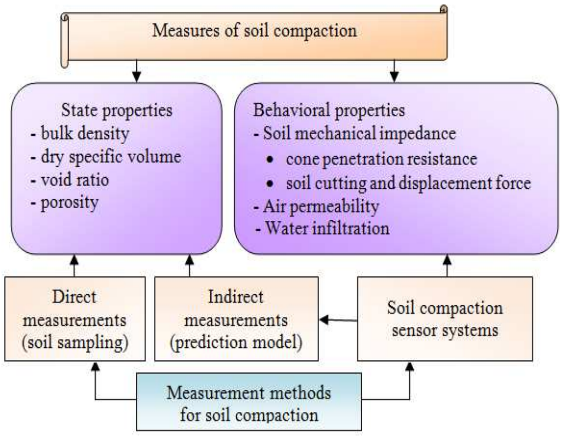

Figure 1: Principles of measurement of soil compaction [8]

2. MATERIAL AND METHOD

The study of soil compaction requires extensive research that can be performed using specific research equipment, measurement instruments and data acquisition devices, experimental stands and equipment designed specifically to determine this phenomenon. This paper presents various types of experimental equipment, stands and specific devices, designed by researchers who have studied intensively the phenomenon of soil compaction, using various methods and measurement sensors.

3. RESULTS

Widey used transducers to determine soil stress are strain gauges glued onto a membrane made of aluminium, steel or titanium and fixed in a housing of the same material. The membrane can be eighter in direct contact with the soil or the stress can be transmitted to the membrane by means of a piston [10].

- ***SST (stress state transducers) for the measuring of pressure in the soil***

Vandenberg and Gill (1962), Lamande et. al. (2007) have developed systems for the measuring of soil vertical stress, where the force was measured on a single side of the transducer [10]. Stress state in the

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soil can be measured in real time using pressure transducers (SST) which record the pressure in six planes (three mutually orthogonal planes: p_x, p_y, p_z and three non-orthogonal planes: p_1, p_2, p_3), and the recorded values are used to calculate the principal, normal and shearing stresses in octahedral plane. SST transducers are usually inserted into the soil, in the center of the tire, at depth of hardpan, or at half of the distance between the compacted layer of soil that prevents the development of roots and soil surface [1; 15].

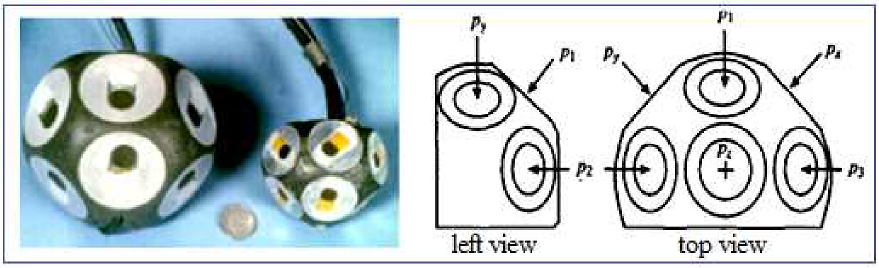

Figure 2: SST pressure transducers of different sizes [15], respectively the directions of the measured pressures [1; 11; 17]

- ***AgTech transducers for the measuring of pressure in the soil***

AgTech transducer (fig. 3) consists of a rubber ball with a diameter of 2,5 cm, filled with fluid and attached by means of a high pressure hose to a pressure transducer. The transducer, inserted into the soil under a certain angle, indicates pressure variation over time and hence, pressure distribution at the passage of agricultural vehicle on the soil, and also the maximum pressure and the residual pressure in soil after vehicle passage. Effects of contact area geometry, type of vehicle and vehicle load can be estimated using AgTech transducers.

Figure 3: AgTech pressure transducer [15]

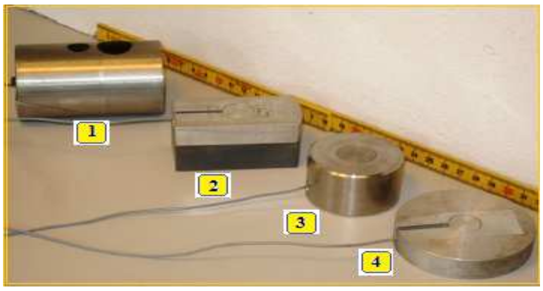

Figure 4: Stress transducers [10]
1.profile transducer (Denmark), load cell under the larger piston; 2.profile transducer (Sweden); 3.surface transducer (Denmark); 4.surface transducer (Sweden)

In paper [10] are presented transducers of different shapes and sizes, used to measure vertical stress in the soil (fig. 4). The "profile transducer" is used for measuring vertical stress in soil profile and the "surface sensor" measures the vertical stress at tire-soil interface.

- ***Modulas transducer for the measuring of pressure in the soil***

Gysi et. al. (2000) determined the distribution of pressure under agricultural tires using Modulas pressure cell (fig. 5), which contains 32 quartz sensors mounted on the central axis of a profile of aluminum alloy. In static regime, measurements are not possible with this type of sensor. The transducer is fixed in a rigid surface using a mortar of quartz sand and epoxy resin. Each channel can monitor a time-force function with a resolution of 7.777 Hz. For tires wider than 0,48 m, the cell allows measurements on half of tire, and the centerline of the tire should be aligned to the end of sensor [7].

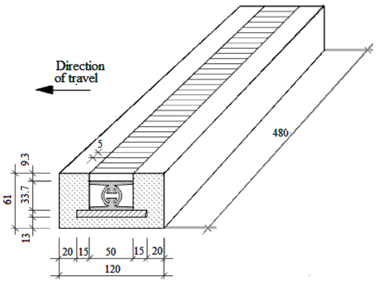

Figure 5: Modulas pressure transducer (sizes are given in mm) [7]

♦ ***Transducer for the measuring of stress tensor***

Bodman and Rubin measured the stresses on the surface of an element of volume, but to determine the stress tensor, stresses had to be measured on three mutually perpendicular surfaces. For this purpose was used the principle of circular symmetry, using several concentric circles (each circle represents an element of soil volume) located in horizontal planes under a loaded circular plate subjected to the same stress [6]. Fig. 6 shows the orientation of pressure transducers for the measuring of stress tensor. The experimental results showed that compaction followed the normal medium stress, maximum principal stress decreased while compaction intensified, maximum shearing stress showed no correlation to compaction, and mean normal stress did not correlate uniquely with compaction [6].

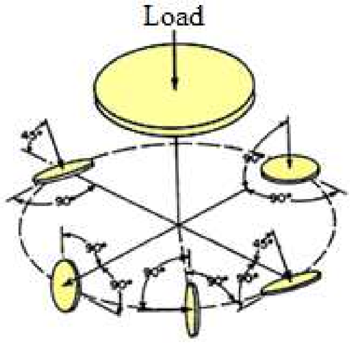

Figure 6: Pressure transducers under a circular plate for the measurement of stress tensor [6]

♦ ***Device for the measuring of stress at soiI-tire interface*** [1]

Burt et. al. (1987) developed a system fot measuring the size, location and direction of stresses at soil-tire interface (in the footprint), based on a bidirectional transducer using a pressure sensor of small dimensions, mounted at the end of a cantilever beam (fig. 7a).

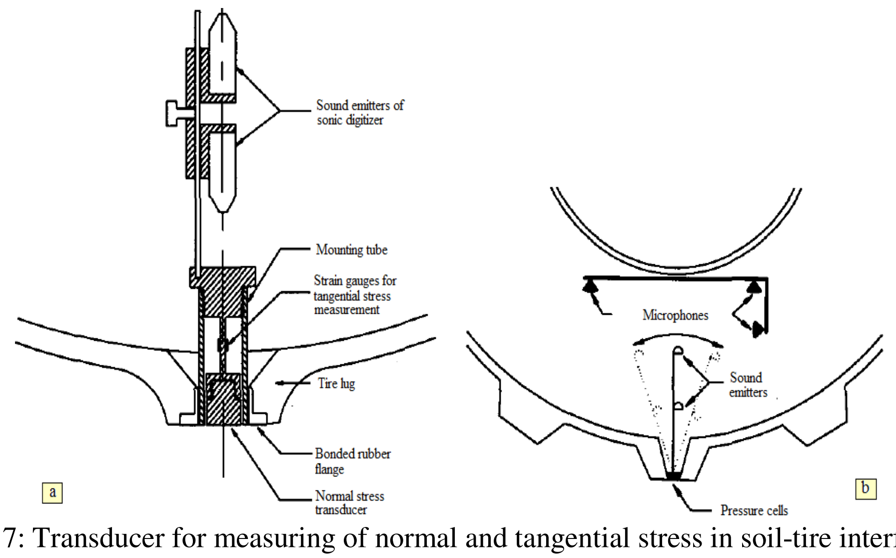

Figure 7: Transducer for measuring of normal and tangential stress in soil-tire interface (a) and the position of measuring system inside the tire (b) [1]

The pressure sensor measures the normal stress, and the strain gauges on the cantilever measures the deflection due to the bending moment created by the tangential force over the pressure sensor, and then making the conversion into tangential stress to the tire-soil interface. Three such sensors were installed along the protuberance of the tire, and other two sensors in the area between the protuberances, while a sonic digitizer installed in the tire measured the location and orientation of each of the five transducers towards a fixed point on the wheel rim (fig. 7b). After measurements, horizontal and vertical components of stress at soil-tire interface have been integrated into horizontal forces (pushing or pressure) and vertical forces [1].

♦ ***Field penetrometers***

Penetrometers are used to determine the penetration resistance. In particular, penetration resistance is influenced by soil properties: moisture content, bulk density, compressibility and structure [14]. The angle and diameter of the penetrating tip, its mode of advance into the soil, and the friction between the metal and the soil can affect the correlation between the values registered by the penetrometer and the normal resistance of the soil [5].

The *dynamic penetrometers* are formed from a metal rod with tip of defined size and shape. On the penetrometer rod a hammer is sliding and when it falls and hits the anvil, as a result of blows, the tip of the penetrometer penetrates progressively into the soil with variable speed. For *static penetrometers*, the load required for the penetration of the device into the soil is applied by pressing a spring provided with an indicator which shows the size of the load. The penetration cone is inserted into the soil with constant speed and the load is measured by a load cell [3, 9].

Figure 8: Field penetrometers [9]

a) static penetrometer; b) dynamic penetrometer
b) (hammer–left; metalic rod–center; cone tip–right)

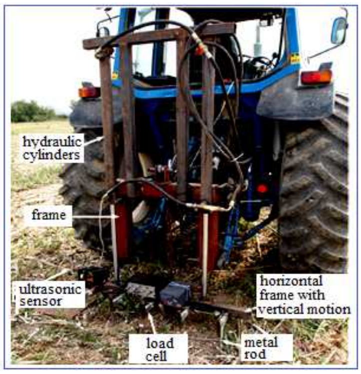

Figure 9: Penetrometer mounted on the tractor [4]

- ***Five-point penetrometer with GPS***

Fountas et. al. (2013) built a tractor-mounted multiple penetrometer to measure the vertical penetration resistance in field conditions, in combination with a GPS reciever to record soil variability. The penetrometer (fig. 9) incorporates a metal frame attached to the tractor via a three-point hook on which is attached a horizontal metal bar moving up and down by two hydraulic cylinders operated from the tractor's hydraulic system, which gives vertical movement to the horizontal bar over a distance of up to 850 mm. The direction of cylinders (up and down) and speed (30 mm/s) is adjusted by a hydraulic valve. Load cells were placed in five points on the horizontal bar with vertical movement. The distance between two adjacent load cells is 250 mm, so that the five probes cover an area of 1 m width. One end of the load cells is connected to the horizontal bar and the other end is connected to a metallic rod with length of 680 mm and diameter of 9,53 mm. At the lower end of each rod is a circular cone of 30° stainless steel with base diameter of 12,83 mm, according to ASABE Standard S313.3 (ASABE, 2010). An ultrasonic sensor is attached to the left side of the main frame to measure the penetrometers depth of work [4].

- ***Combined palette-cone penetrometer***

The penetrometer in fig. 10 can be used to evaluate the compressive behavior of soil and its shear strength. The palette-cone device is pressed into the soil and then rotated to a certain depth which remains constant [13].

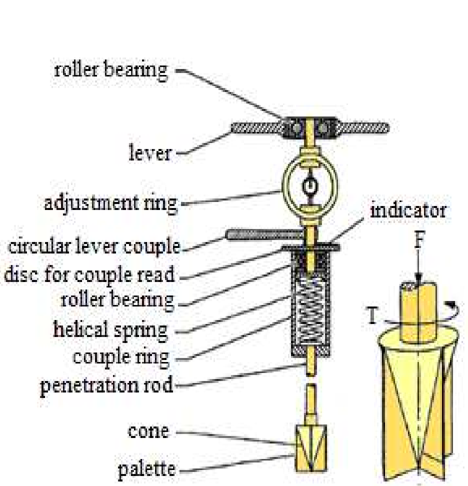

Figure 10: Combined palette-cone penetrometer
(after Yong and Youssef, 1978) [13]

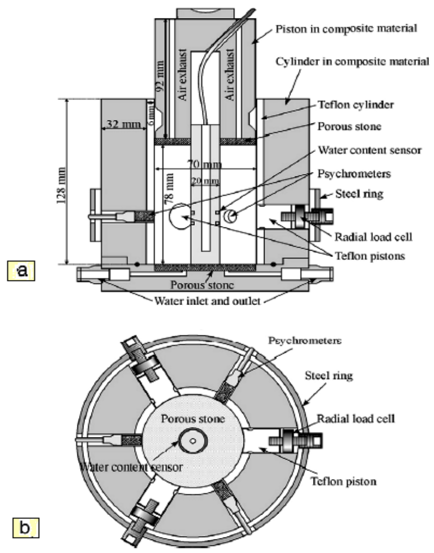

Figure 11: Edometric cell [2]

♦ ***Edometric cell for determining the relationship between radial stress and axial stress at uniaxial compression without radial strains*** [2]

Edometric cell (fig. 11) is useful to reproduce soil compaction through the increase of axial stress under uniaxial compression, allowing the measurement of radial and axial stress, soil porosity and soil moisture during compaction. The compression piston of the cell has high stroke, which allows compression tests on both loose and dense soils. The cell is provided with three Teflon pistons equipped with load cells for recording of radial load. At pistons level, into the cell walls are mounted three Peltier psychrometers in contact with the soil, the capacitive moisture sensor being mounted in center of soil sample, and the measuring electrodes are located at the same level as the radial load cells [2].

♦ ***Equipment for determining soil sinkage by multiple loadings*** [12]

The equipment comprises a soil bin and a rectangular plate for sinkage. Soil bin dimensions are: length 200 mm, width 250 mm and height 250 mm. The dimensions of the rectangular plate for sinkage are: width 40 mm, length 60 mm and length/width ratio is 1.5, similar to that of the contact area between wheel and soil [12].

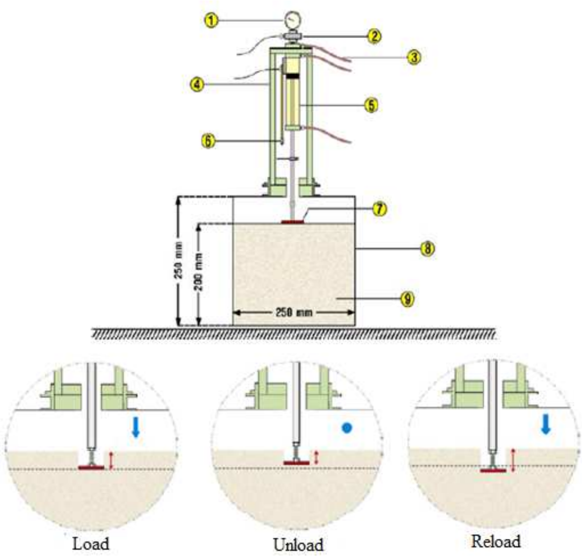

Figure 13: Equipment for determining soil sinkage by multiple loadings [12]
1.manometer; 2.pressure sensor; 3.delimitation line; 4.frame; 5.double action cylinder;
6.displacement sensor; 7.rectangular plate; 8.soil bin; 9.soil

4. CONCLUSIONS

Artificial compaction of soil is a phenomenon that leads to lower productivity in agriculture and to the emergence of ponding water in industrial areas or in localities, which is a problem in terms of comfort for people living in those areas.

Artificial compaction can be highlighted by determining certain parameters characteristic for the process, using different experimental equipment and stands, complex or simple, such as: *soil bins; stand for determining soil sinknage by multiple loading; edometric cell for determining the relationship between radial and axial stress at uniaxial compression without radial strains; equipment for measuring stresses at soil-tire interface*; *five points penetrometers, with GPS; combined palette-cone penetrometer; field penetrometers.*

Complex equipments use different devices for determining and measuring soil stresses, of which the most important are:

- *transducer for measuring stress tensor;*
- *Modulas transducer for measuring pressure in the soil;*
- *AgTech transducers for measuring pressure in the soil;*
- *SST (stress state transducers) for measuring pressure in the soil.*

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NON CONVENTIONAL MEASUREMENTS TO EVALUATE THE URBAN AND RURAL AREA POWDER POLLUTION

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ABSTRACT

The powder pollution is evaluated in a small urban center and in a rural areas utilizing: (i) the conventional gravimetric measurement techniques, and (ii) unconventional techniques as the thermal analysis, the X-ray Powder Diffraction (XRD) and the SEM-EDAX electron microscopy.
The obtained results assess that in these scenarios the thermal analysis gives information that are not possible to obtain with the conventional gravimetric analysis. In fact, the differential scanning calorimetry analysis shows in a rural area with a limited traffic, the presence in the air of carbonaceous powders probably due to the traffic of machine for agricultural use that are not in perfect conditions.

1. INTRODUCTION

The term particulate matter (PM or PS) refers to a complex mixture of organic and inorganic substances in solid or liquid state, which remain suspended in the atmosphere for longer or shorter periods, due to their small size [1,2].The size, shape, surface, density and the elementary chemical composition can be extremely different and depend strongly on the origin and on the formation process of the particle itself. According to the nature and size of the particles [3,4] we can distinguish:

- Aerosol (solid or liquid particles with diameter less than 1 μm);
- Powders (solid particles with diameter included in the range [0.25 and 500] μm);
- Sands (solid particles with diameter bigger than 500 μm).

Aerosols can be generated by natural sources and human activities [5]. The natural sources [6] results from wind erosion, volcanic eruptions, pollen, microorganisms, bacteria and evaporation of sea spray. Anthropogenic aerosols [5] mainly derives from combustion processes and to industrial processes. We must not ignore the sources due to the combined action of natural agents and human activity: agriculture, forest fires, resurgence of dust from the ground. There are also aerosols produced as a result of complex physical and chemical processes including gas, or between gas and solid or liquid particles [7]. In the atmosphere the particulate can change the chemical composition and the physical characteristics such as gas absorption with oxidation and acidification [8]. In the indirect reactions, the carbonaceous substances that are in the particulate, can act as catalysts inducing chemical reactions or can increase the rate of reaction [9]. In these photochemical reaction the solar radiation sustains the reaction.

Many studies are carried out to define the dispersion and the distribution of the particulate in the atmosphere [7]. In Italy the first data about the PM10 concentrations were obtained in Rome around the 1993, while interesting data, related to the concentrations in Rome of PM2.5 together with the concentrations of PM10 and the Total Suspended Powders (PTS) were published [10]. Usually the

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measurement campaigns are interested to big cities and considers the suburb and the rural areas not affected by environmental problems. The reason of these choices are attributed to the results obtained in the large town correlated with the intensity of the traffic flows and with the concentration of CO and NOx. The good correlation between CO and NOx allows the creation of a statistical model enough accurate, which is based on data about classical pollutants and atmospheric variables [11]. In this regards the large cities are monitored with a large number of sensors to evaluate the concentration of gas pollutants [7]. This type of measurements cannot be applied to the rural areas because the production of pollutant gases is very low but this situation does not exclude the possibility of environmental problems due to particulate matter [2], [12].

In this regards the aim of this paper is to define the environmental condition by monitoring the powder distribution in the air of a rural area and in a rural small town. The amount of the powders in the air is evaluated by gravimetric measurements by using a high sensitivity analytical balance. The nature of the powder is evaluated by using measurement techniques proper of thermal analysis (TG, DSC) and XRD analysis. The morphology and composition of the powders are computed by SEM-EDAX analysis. The obtained results confirm that in the rural area is better utilize a classical system of measurements based on gravimetric measurements and also the validity of the application of TA, XRD and SEM-EDAX analyses is confirmed .

2. Experiment

Two sequential samplers CF-20 SQ by Aquaria were used to collect the sample powders. The measurement instrument is equipped with a multi sequential sampler with 8 channels. Each channel is driven by electro-valves and a timer. The measurement instrument is able to work in slow air flowrate condition (0.2- 5) l/min and in high air flow rate (5–30) l/min. The flow rate is constant because the valves are calibrates to give a constant flow rate as a function of the variation of the load losses due to the filter clogging that is function of the time. The volume of collected air is evaluated by a flowmeter. The volume of collected air is normalized with respect to the external atmospheric pressure and the temperature of the air and of the measurement instrument. The apparatus is driven by a microprocessor. The amount of the powders collected on the filters is correlated to the volume of air utilizing the following relation:

$$V_{norm} = V' * P * 298/1013 * (273 + T) \tag{1}$$

where V_{norm} is the volume of air normalized at 25°C and pressure equal to 1013 mbar, V' is the collected air volume, T is the mean temperature of air and P the atmospheric pressure [13].

Tree cycles of monitoring were performed in different areas. The first monitoring was performed in a rural area (collection time 1, 2, 3, 6, 8, 24 hours), the second was performed in a suburban area (collection time 1, 2, 3, 6, 8, 24 hours), and the third one was performed in urban area (collection time 1, 2, 3, 6, 8, 24 hours). The filters were stored in a small boxes and then weighted with an analytical balance with accuracy 10^{-5} g. The filters are normalized by storing in a dry box, at room temperature, in dry atmosphere for 4 hours, weighted before and after the powder collection. After the programmed time, the filters were weighted and reweighted, to evaluate the weight of powders fixed on their surface. Owing the high accuracy of the balance, the measurement of the filter weight is given by the mean value of 5 measurements. The standard deviation of the measurement must be in the order of the 10^{-5}g, vice versa the filter must be discarded.

The simultaneous thermal analysis (TG, DTG, DSC) of the filters were carried out in air with a Netzsch STA-409 apparatus. The measurement condition are: (i) Reference sample: calcined caolin (ii); weight of reference and weight of sample: 20 mg; (iii) environment is the air with flow rate 15 ml/min; (iv) heating rate: 10 °C/min; (v) initial temperature: 20 °C; (vi) final temperature: 800 °C; (vii) crucible: Al_2O_3. The thermal analysis procedures are described elsewhere [14]-[16].

The experiments performed with the electron microscopy, SEM, were carried out with a Cambridge 360 equipped with EDAX to evaluate the chemical composition of the powders. The procedure to prepare the samples and the magnification are described elsewhere [17].

3. Result and discussions

The research starts by evaluating the trend of the powder concentration in the air in the suburban area at different atmospheric condition temperature and humidity, after 8 and 24 hours of collection. In this area were counted about 1000 car per day. The samples were collected in May from 20-26, and in June from 21-26. The results are valuated with statistical analysis.

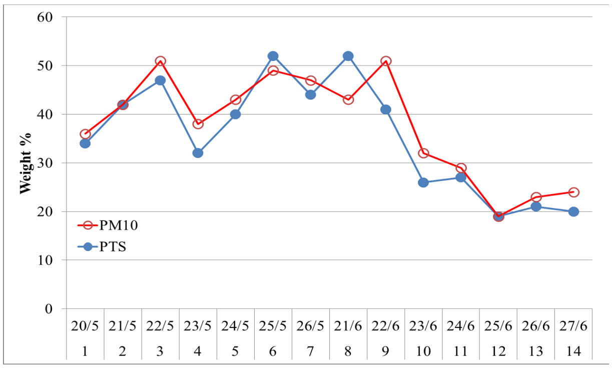

Figure1: Seasonal trend of the PM concentrations in the period 20-26 May and 21-27 June.

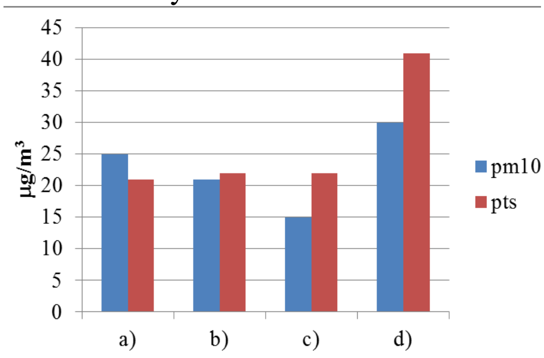

Figure 2: PM10 and PTS concentration in June 18: a) in Spezzano for 24h; in Camigliatello: b) 24h, c) first 6 hours, d) first 8 hours

The trend of the curves in Fig.2 shows that the PM10 and PTS powders have the same trend and that this trend is influenced by the temperature of the air and by the humidity. In particular the presence of the rain purify the air and then the powder concentrations from a value of about 50-60μg/m^3 detected in the end of May, beginning of June are brought to a value of about 20μg/m^3 observed the 24th of June. The observed mean concentration is about (36.5±2.0) μg/m^3.

The results showed in figure 2 indicate that the amount of the powders is higher compared with the values considered not dangerous by the European suggestion. Comparable values of PM-10 and PTS (about (30 ± 5) μg/m^3 suggest that in this area the total amount of powders is less than 10 μg/m^3 and is attributable to the anthropic emissions.

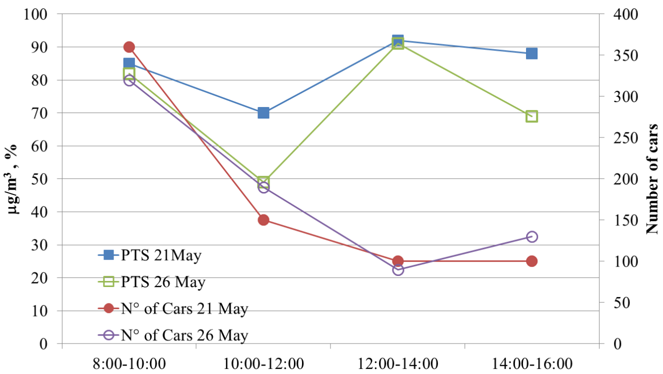

Fig.3 PTS concentration in a suburban area compared with the numbers of vehicles computed during the 8 hours of sampling

In figure 3 the relation between the powder concentration and the number of vehicles is reported. The measurements of the powders concentration and the vehicle number is registered every two hours. The numbers of vehicle per hour is not constant but the data shows that the concentration of powders in the atmosphere is not correlated with the number of vehicles probably because the concentration of powder remain in the atmosphere until there is no wind and the values of humidity and temperature of the air are constant. Also the turbulence due to the transit of the cars gives a contribution to the presence of the powder in the atmosphere. In this area the temperature of the soil does not produces variation in the flow rate of the air and then in the concentration of the pollutants.

Different trends are observed in big town where the concentration gradient is function of the level from the street. It is due to the orientation of the street and the displacement and number of floors of the buildings in the town. The turbulence due to the vehicles is less important [14].

Table: 1 Concentration (%) of the elements present in the powders collected for 8 hours, evaluated by X-ray energy dispersion analysis (EDAX).

	Ca	Cu	Fe	K	Na	Zn	other
P1					28.05		71.95
P2	21.78	1.74	0.83		33.36	3.91	38.38
P3	6.91	1.56			63.10	2.30	26.13
P4		1.35			58.30	5.96	34.66
P5	14.50	1.36		3.94	34.77	3.31	42.12
P6					77.77	2.43	19.8
P7		2.35	3.19		39.24	1.76	53.46
P8	10.33	1.27	3.97		21.49	1.74	61.20

Table 2: Powder typology and the weather conditions during the sampling, speed of the wind S (10 knots) -SSW (10 knots).

	Powders	Day	Weather
P1	PM10	May 27th	dry condition
P2	PTS	May 27th	dry condition
P3	PM10	June 20th	dry condition
P4	PTS	June 20th	dry condition
P5	PM10	June 24th	24 hours after rain
P6	PTS	June 24th	24 hours after rain
P7	PM10	June 24th	rain and wind
P8	PTS	June 24th,	rain and wind

The results obtained by atomic adsorption spectrophotometry analysis are reported in table 1, where the sample P1, P2 are referred at rural area, P3, P4, P5 and P6 referred at the sub urban area at different days. The samples P7 and P8 are collected during a rainy period in sub urban area. The EDAX analysis of the clean filter, used as reference, does not show the presence of metals. Table 2 shows the powder typology and the environmental conditions during the sampling.

The dry condition refers to experiments carried out ten days after the rain. From these results is obvious that in this rural area heavy metals are not present due to the absence of this type of pollutants sources. Therefore, the presence of limited number of cars is not influent on the pollution by heavy metals of the area. Others metals detected in the powders are attributed at pollens and silicates present in this rural area due to the wind, for example. The presence of carbonaceous residue due to traffic is evaluated by thermal analysis. This techniques are normally not used for the pollution evaluation. The filters, white before the analysis, were brown after the exposition to the air and the adsorption of the air. The intensity of the color was mainly function of the aspiration time. After the usage, a small piece of filter was analyzed by TG and DSC analysis. The temperature of the weight losses were detected by the peak of DSC. The differences between the temperatures of DSC peaks and the temperatures of DTG peaks are attributed to the amount of powder stored on the filter. The large part of the weight losses are attributed to the combustion of the filter. The amount of the powder stored on the surface of the filter produce a barrier to the heat exchange, this is the reason of the difference of the temperature between the DTG and the DSC peaks. The DTG curves are not reported because gives few further information and makes difficult the readability of the figures.

The difference of the residue (table 3) on the filter are in agreement with values computed with the balance. These confirm the hypothesis previously formulated.

Table 3: DSC/TG results of samples collected in different climatic conditions.

Sample	Total Weight loss%	Residue [mg]	DTG peak Temp. [°C]	DSC peak Temp. [°C]
P1	99.73	0.24	187.2	190.5
P4	95.67	4.11	190.3	195.6
P5	98.70	1.30	184.7	189.3
P6	99.78	0.26	187.3	190.6

P7	96.20	3.92	195.6	199.9
P8	87.64	12.37	189.2	196.7
New filter	99.1+0.2	-	194.8	194.9

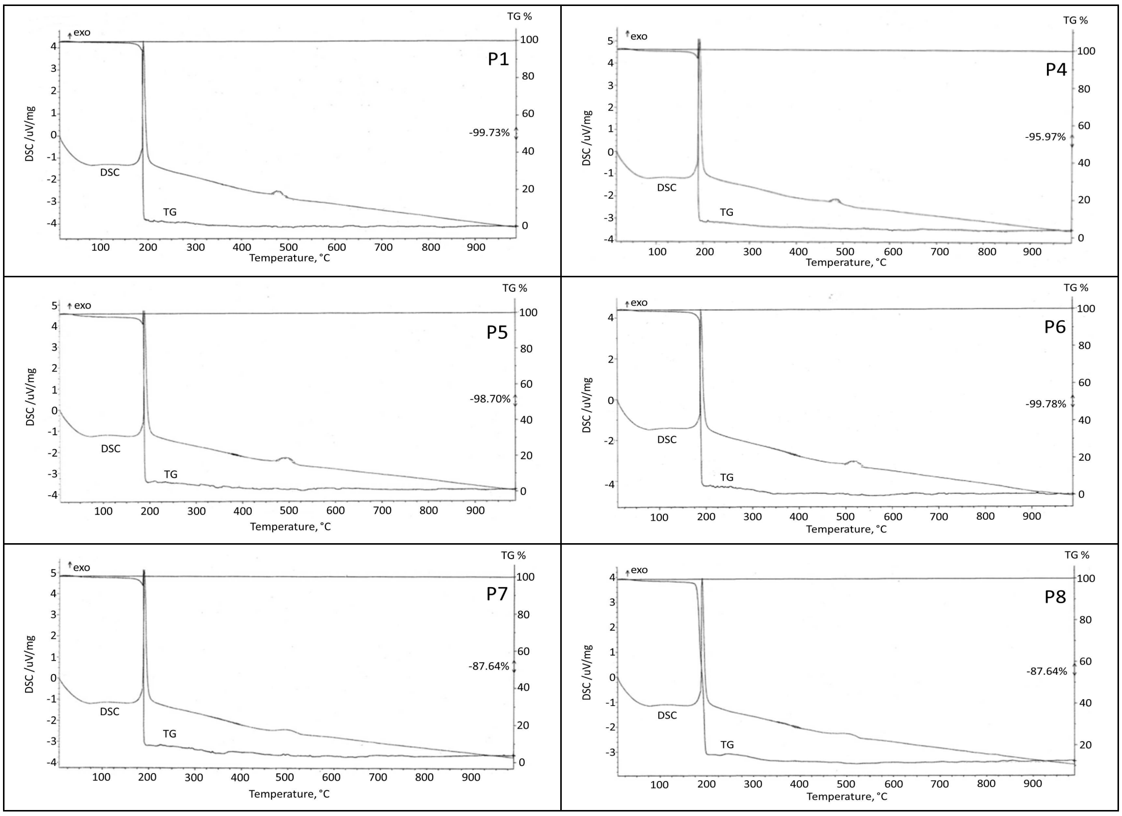

Figure 4. Thermal analysis, DSC/TG of the samples selected and reported in the legend of the table 2.

In figure 4 are reported the TG and the DSC curves of the filters listed in the table 2. In these figures are observed just peaks connected to the combustion of the organic part of the filters. The presence of residues of carbonaceous combustion are not detected by TG. Indeed, between 800 °C and 950 °C is not observed any decomposition. Then, the nature of the residue can be considered as silicates coming from the ground.

The TG patterns show in any case only one important weight loss (Fig.4) (the DTG peak temperatures are reported in Tab.3). This loss is attributed to the combustion of the filters and then the residual is attributed to the powders fixed on the filters. The amounts are reported in table 3 and they confirm the results obtained on filters before and after the sampling of the air. The DSC curves show one exothermic peak due to the combustion of the filters. These peaks are at about the same temperature of the DTG and of the TG curves. The differences of the temperature of the DTG and DSC peaks are not bigger than 5°C. It is attributed to the different amount of the powders on the filters and its distribution due to the atmospheric conditions. Another small exothermic peak, not well defined, is observed at about 500 °C. The weight loss attributed to this peak is not evaluable by TG and by DTG, because is very small. These peaks can be attributed to the combustion of the carbonaceous residual in the atmosphere produced by vehicles. This hypothesis is confirmed by the fact that this peak is not present in the DSC of the empty filter, than it is possible to assess that the combustion of the filter does not produce carbonaceous residual. In particular, the presence of these carbonaceous residue in the atmosphere is attributable not to the cars but to the agriculture machines. Probably, the engines of these machines are not very efficient and then the combustion of the fuel is not at the optimum. This justifies the presence in the atmosphere of the carbonaceous traces. In the DSC patterns of the samples collected in condition of wind and rain the peak at about 500°C are not present.

4. CONCLUSIONS

The reported experimental results confirm the best performance of the thermal analysis measurement techniques with respect to the traditional monitoring approaches to give indication of the air pollutants in the case of small urban and rural areas. Indeed, only with these measurement techniques is possible to evaluate traces of carbonaceous powders in the atmosphere.

Acknowledgments

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SPECIALIZED STRUCTURES FOR A CONTINUOUS MONITORING OF SURFACE WATER QUALITY

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ABSTRACT

In order to establish the ecological quality of the aquatic ecosystems based on the biological quality/condition/health it should be taken into consideration the following factors: hydromorphic, chemical, physico-chemical as well as the specific pollutants with role in modulating the biological factors/indicators, [2]. The analyses of these/above factors/data give information about the environmental conditions including their further modifications with an anthropic implications as well as water surfaces in a certain period of time. At the present, the growing diversity and number of intelligent sensors used in a dynamic monitoring, so called „on line”, of the surface water made possible a rapid intervention/reaction in/for fixing any environmental issue. This study shows/presents a special designed water monitoring structure which could be used as floating as well as submerged device. This particular structure shows autonomy and adaptability to meteorological conditions from continental-temperate areas. In addition, this structure is insulates and able to function/work longer times without high maintenance.

1. MONITORING OF SURFACE WATER QUALITY

In general, a monitoring system is based on three steps: (i) monitoring, (ii) data analysis and evaluation of the environment, (iii) predictions of the possible environmental changes. On one hand, from an ecological point of view, environmental monitoring is based on a continuous watching/monitoring of those components susceptible to anthropic and natural factors. On the other hand, from a technological point of view, the environment monitoring is based on a similar way as an informational system built on many levels [1].

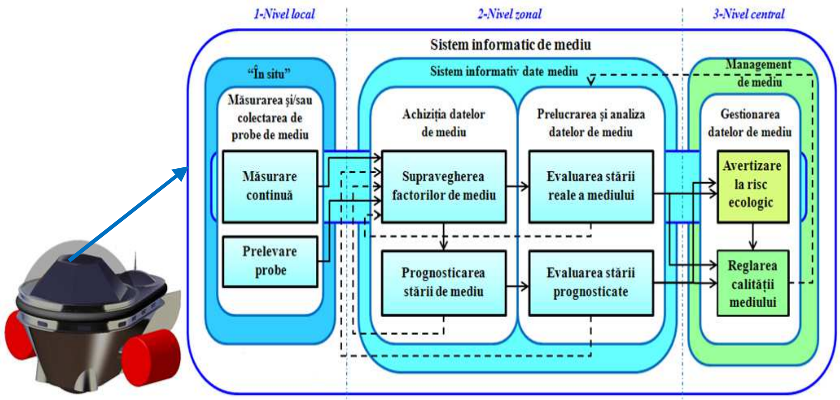


Figure 1: The functional scheme of a monitoring and warning system in case of environmental issues / pollution

In the figure 1 there is the functional scheme of a three levels monitoring system relied on an informational system of data acquisition, processing and analysis. In order to insure an efficient water monitoring, data collected was based on reliable measurements of various parameters and indicators from a particular time and area. At the first level (local in situ) there is a particular construction designed for a continuous measurement of a quality indicator. This construction enclosed sensors and/or last generation multiparameter (IQ) for a dynamic water (pool/body) monitoring. The special construction could be used in a floating (surface water analysis) or submerged mode (deep water analysis) [5].

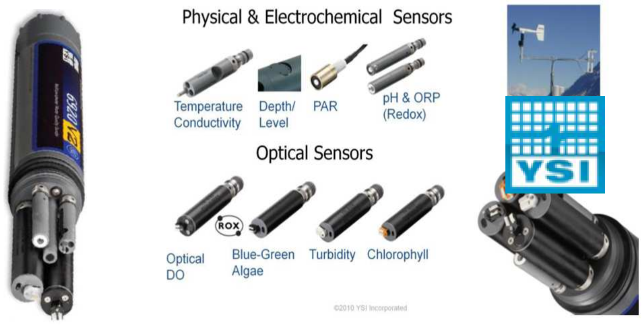


Figure 2: Intelligent sensors and YSI type multiparameters probes [7]

In the two figure we show that structure of SWQM (Smart Water Quality Monitoring) is based on devices equipped with sensors and multiparameters probes. Multiparameters probes were built by a pool of sensors easily assembled in situ. There probes are frequently used in integrate monitoring systems because they allow a dynamic (live) monitoring at the same time of many parameters from the same water area, [3]. The number and type of parameters monitored on-line (live-online-dynamic) by a single sample in a particular area are written in the equipment specifications such as multiparameter probes, type 6000, model YSI (fig.2).

The parameters and the specification of YSI-6820V2 multiparameter probe are:

- ROX (Optical Dissolved Oxygen): 0 la 500%;
- Dissolved Oxygen (DO): 0 la 50 mg/l;
- Conductivity: 0 la 100 mS/cm;
- pH: 2 la 14 units;
- Temperature: -5 la +50°C;
- Turbidity: 0 la 1000 NTU resolution 0.1 NTU;
- Redox Potential: -999 la +999 mV, resolution 0.1 mV;
- Depth: 0 la 61m, resolution 0.001 m;
- Ammonium/ammoniac/nitrate/azote: 0 la 200 mg/L-N;
- Chloride: 0 la 1000 mg/l, resolution 0.001 la 1mg/l;
- Rhodamine: 0 la 200 μg/l, resolution 0.1 μg/l;
- Chlorophyll: 0 la 400 μg/l, resolution 0.1 μg/l, [7].

2. DESIGN AND OPTIMIZATION OF THE MECHANICAL STRUCTURE FROM THE SPECIAL CONTRUCTION – SWQM

The research of the design to build the special construction to monitor surface waters was based on a two way flux between input data and output data modulated by the mechanical design, hardware-software and environmental conditions. It had been used 2D and 3D designs based on CAE (computer-aided engineering) and software's such as CAD (Catia V5); CFD (Ansys Fluent V6.3); FEM (Nastran Ansa V3).

2.1. Geometrical design of the SWQM

The geometrical shapes (cylinder, sphere, double cone) are frequently used as floater devices incorporated to the autonomous monitoring station, mode „Buoy Monitoring". In general, these stations are designed to monitor meteorological oceanographic and saline offshore parameters, but with some major modifications these stations could be used to monitor lakes and rives, too. In the figure 3 there are represented in horizontal plan the pressure distribution (right up) and flowing speeds (right bottom) from a cylindrical structure with an ovoid section (left up) submerged into the flowing tube (left bottom) 1.5x1.5x6 [m]. The size of the construction was comparable with the mock-up model $\{L, D, h\}$ = {0.750, 0.500, 0.500} [m] and the water flow speed from the experimental conditions was v_m ~ 1 [m/s]. The results of CFD simulation point on the fact the an ovoid section eliminated no flowing areas ($v_a \approx 0$ m/s) from behind submerged structure as well as levelling the water pressure from the top of the structure.

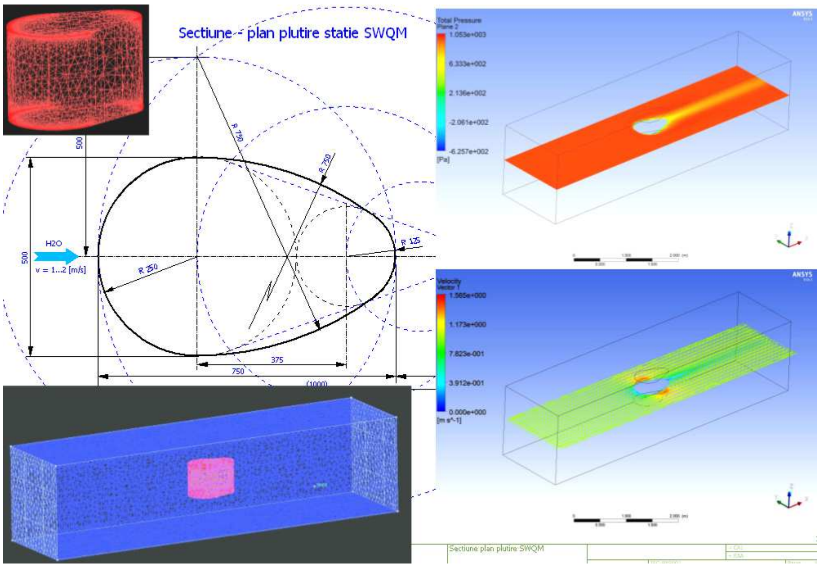


Figure 3: Hydrodynamics ovoid-shaped section structure

Based on the experimental data it was designed a special geometrical shape with a ovoid vertical section. In order to integrate the volume and displacement of a SWQM monitoring station, the 2D design of the monitoring station (Fig 4) was based on two very important parameters: diameter (D) and height (H). D and H were used by M.O. Excel to calculate the total volume of the monitoring station V [dm^3] as well as displacement (Δ) or total charge G [daN] of monitoring structure which includes the own weight of station or of fishing boats T = 2/3 H [m] and the volume of water V_{ai} [dm^3] pumped inside of flooding rooms for submersion.

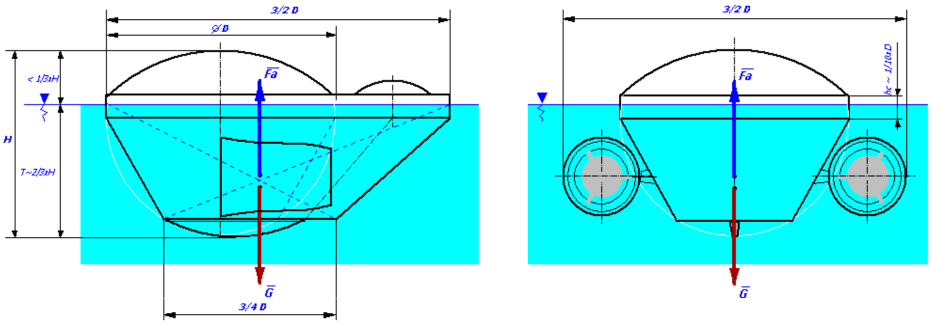
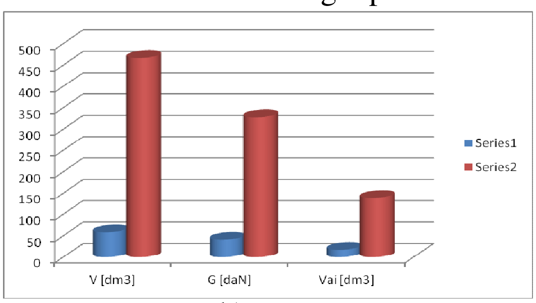


Figure 4: The design 2D of the special structure of a SWQM

Figure 5 (a. table; b, bargraph) shows the parameters {$D/V/G/V_{ai}$) of the two monitoring stations with diameters of 0.5 and 1 [m] respectively. It was suggested to use the first option because it is lighter, so easy to manoeuvre. For optional or watching monitoring, it was recommended the second option which is bigger and could accommodate larger probes.

Variante =>	1	2
D [m]	0.5	1
V [dm^3]	58.32	466.97
G [daN]	40.94	327.96
Vai [dm^3]	17.38	139.01

a)



b)

Figure 5: Typical {D, V, G, Vai} of the special structure of a SWQM

2.2. Variants of mechanical structures for the station SWQM

In the figure 6 there are three virtual CAD-3D variants (as shape and size) of the monitoring station for the surface waters.

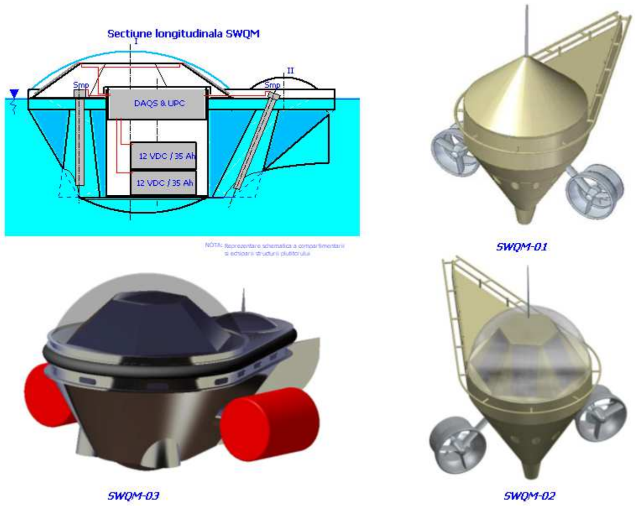


Figure 6: Variants of the special monitoring structure

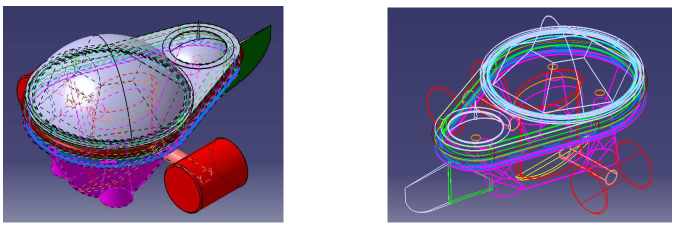
The longitudinal section CAD-2D (Fig. 5) shows the schematic representation of the blueprint design as well as the equipment from WSQM-03. There are the following items:

- permanent dry compartment bordered by central elliptical cylinder, ovoid floating scheme, spherical calotte, visiting hatch and the closing surfaces. In this area there are batteries, tapping water pumps, controller, acquisition and transmission data system, photovoltaic panels, sealed connectors, multiparameter probes, cables and other devices;
- permanent wet compartment bordered by the surface of three inversed circular truncated cones with a communication trap under the floating level for water circulation/flowing. This area has a role to protect the IQ sensors from mechanical stress;
- flooding compartment (painted in blue) is the volume border by careen and exterior surfaces from the other two adjacent compartments.

This compartment is used for submerging the monitoring station by inserting the water under the pressure provided by the flooding pumps. The immersion of the monitoring system is controlled automatically and it is activated to protect the monitoring station against frost, vandalism or underwater monitoring.

2.3. The design of the monitoring station for surface waters – SWQM

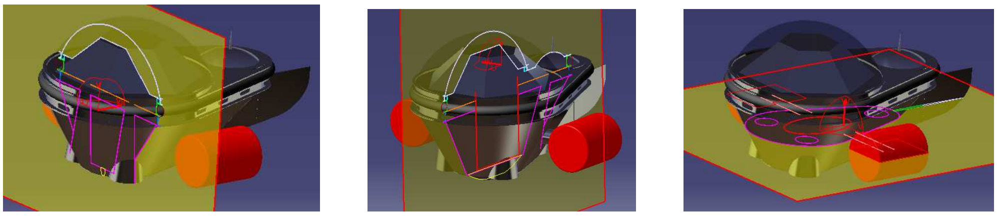
The raising interest for reduced size monitoring systems (AUV tendency) generate the creation of the SWQM-03 station designed to monitor the ecological impact on aquatic system. It was used CAE methodology and CAD (Catia V5) software. The characteristic of specific structure for monitoring is presented in figure 7: D = 0.500 [m], $\{L, B, H\}$ = {1 x 0.750 x 0.500} [m], where: L is the length of the monitoring station equipped with directioning and anchoring devices; B is the width of the monitoring station equipped with hydro generators; H is the height of the monitoring station equipped with a landing and holding platforms.



a) b)

Figure 7: The design CAD-3D of the special structure of a SWQM

In order to visualize inside the compartments described above (see 2.2 section) the following sections were made (Fig. 8): a) transversal section/plan (‖yOz); b) longitudinal plan (xOz); c) horizontal plan (‖xOy). At this stage the monitoring station isn't equipped.



a) b) c)

Figure 8: Sections through the station structure of a SWQM

The construction of the monitoring station will be made by Al metal panels/sheets with 1.5 mm thickness and density of 2.7 [kg/dm3]. Based on CAD-3D analysis it was calculated the total mass of the monitoring station is M_{sc} = 20,968 [kg] and its gravity center CG compared to vertical central axis and to the holding platform (Fig. 9).

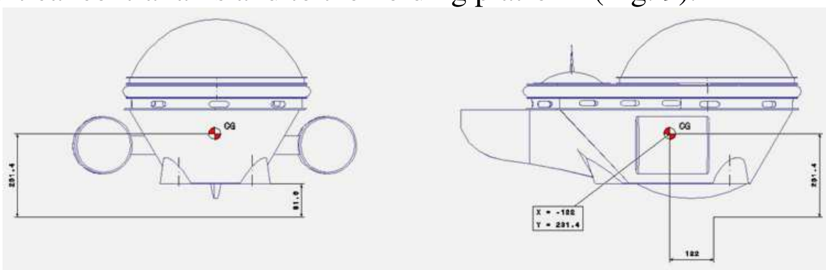


Figure 9: The center of gravity of the structure not equipped monitoring station

The items added to the monitoring system (sensors and/or multiparameter probes, energetically equipment, IT components as well as other components/equipments) will be placed in such a way that the gravity center of the monitoring system will on the intersection between the vertical axis (*CG*) and under the (*CC*) in order to assure the stability and the floatability of the monitoring station/system.

2.4. Preliminary results of the SWQM monitoring station displacement

The physical model type "mock-up" at the scale (1:1) was built in order to test the preliminary displacement parameters. SWQM monitoring system was attached on a flexible/mobile device which allows floatability of the structure as well as loading of the monitoring station for immersion. The device has a power cell which measures at lengthening or compression on the scale (0÷100) [daN] and a sensor based on vibrations (called velomitor) with a measurable range (0÷10) [mm/s]. Two temperature sensors (for air and water) and a data acquisition system NIcDAQ-9172 were added to the SWQM monitoring system (Fig 10). The assays were performed at temperature of $T_{apa} \approx 10$ [°C]; $T_{aer} \approx 8$ [°C]. In the figure 11 there are shown load measured in [daN] force cell (green line) for three distinct scenarios: a) suspended structure (weight); b) floating structure; c) submerged structure. The aims of the assays were to determine the maximum accepted/allowed size board equipment for a displacement in which the floating section/height should not be above the hatch level from the ovoid cylinder.

The displacement of the SWQM monitoring station was giving by the weight of the displaced water volume by a certain floatability condition which in fact it is weight of fully equipped monitoring station. Based on the taken measurement we have:

$$\Delta = G_{sc} + G_{ma} = 21 + 18 = 39 \text{ [daN]}$$

where: G_{sc} – weight station fairing structure SWQM; G_{ma} – weight of boat sizes (equipment).

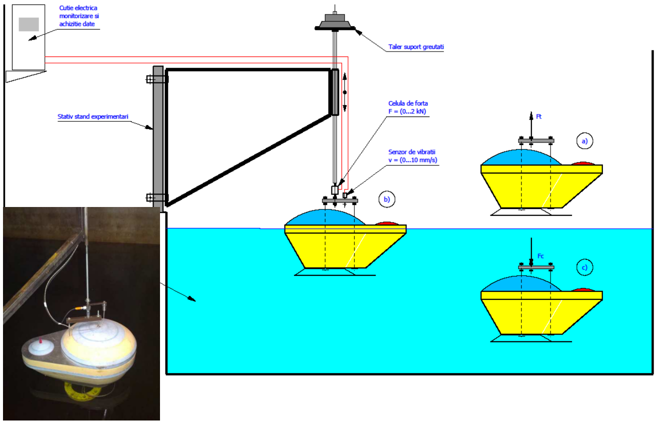


Figure 10: Stand experimentation hydrostatic for station SWQM

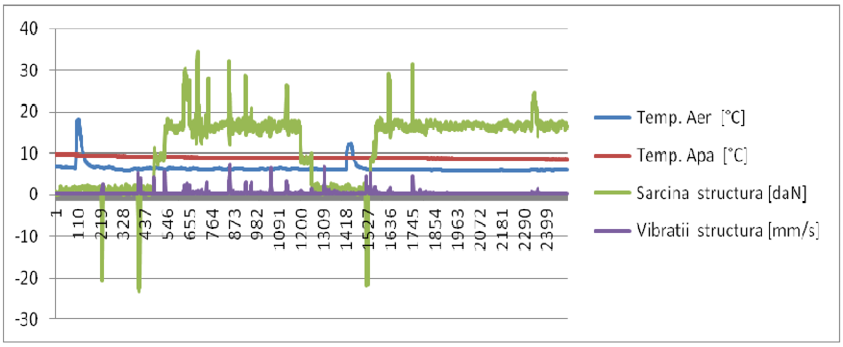


Figure 11: Graphs measurements for displacement determining station a SWQM

3. CONCLUSIONS

The continuous (special) monitoring structure is adding new features (such as versatility) to the already existing water quality monitoring systems. SWQM is easy to install in situ (Δ = 39 daN) and to manoeuvre as well as it allows a dynamic monitoring of the aquatic system (surface and deep waters) based on a variety of multiparameter probes carried by the monitoring instrument. In function of the on-board equipment, it can be used for research and monitoring mode on all surface waters. A network of monitoring systems is very useful in providing continuous information regarding the characteristics of the aquatic system allowing a specific and fast reaction to solve any potential harmful situation from the monitored area.

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CONSERVATIVE SOIL TILLAGE TECHNOLOGIES

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ABSTRACT

The most important component of conservation technological systems, as in the case of conventional ones, is soil tillage – loosening and processing – and the introduction of seed into the soil. Conservative systems are based on the less intense loosening of soil, made by different methods, without furrow return and only while maintaining a given amount of crop residues on soil surface, is being considered for this reason as environmental protection strategies. In this paper are presented conservative tillage technologies use in our country and in the world.

1. INTRODUCTION

Soil tillage were an integrated part of agriculture from the beginning and served several important purposes: seedbed preparation, reducing soil compaction to increase aeration and better development of the root system of plants, reducing the weed growth, fertilizer incorporation and amendments, crop residues management [1].

Soil conservation concept covers a range of activities, measures and technologies that contribute to the maintenance of soil fertility without significant decrease in crops or without high costs. This system covers a wide range of agricultural methods aimed at keeping the crop residues on the surface of arable land to reduce erosion. Soil conservation technologies are characterized by the fact that leaves on the soil surface more than 30% of crop residues of the previous crop. During plant development, crop residues protects the soil from sun and wind, reducing water loss by evaporation and increases soil moisture in winter by retaining snow on the ground surface [2].

Soil conservation technologies, which leaves a large amount of crop residues on the soil surface, reduce erosion rate by 95% (no-till) compared with conventional soil tilling systems. Crop residues that are uniformly distributed on the soil surface and in greater quantity on slopes where erosion is greater, by intercepting raindrops, absorb their energy and reduce the detachment of soil particles (the first step in the erosion process), slow water flow on sloping soil surface and reduce soil particles transport (the second step in the erosion process) [3].

2. METHODOLOGY

Variants of conservative soil tillage technologies [4]: soil tillage rationalized technologies, minimal soil tillage technologies (minimum tillage), technologies with protective layer (cover crops, catch crops), ridges tillage technologies (ridge-tillage), technologies with strips or narrow strips works (strip till, till areas) and technologies with no tillage or direct sowing (no - tillage).

3. RESULTS

3.1. Soil tillage rationalized technologies

Reducing soil tillage number and their execution under optimal moisture conditions falls within the general objectives pursued in terms of physical conservation. Rationalized soil tillage systems keeps the plowing with moldboard as soil basic work but in comparison with the classical system, involves the use of combined aggregates, which at one pass it carries out several technological processes. Depending on soil characteristics, climatic conditions, cultivated plant, fertilization system, weed control and machines used, there are two alternatives:

- *Plowing - sowing technology:* consists in making a single pass, using combined aggregate soil tillage (plowing and seedbed preparation) and sowing. The aggregate can be provided with equipment to apply fertilizers, herbicides and soil compaction on the sowed row.

- *Sowing – cultivating technology:* it consists in the execution of two operations: at first pass it apply fertilizer and it is plowing, and at second pass is prepared the seedbed (total processing cultivator, disc harrow, combined rotary harrow) when sowing. Optional, can be attached an equipment for applying herbicides.

3.2. Minimal soil tillage technologies (minimum tillage)

Because of the numerous works that are applying in current technologies, soil compaction breaks down its structure, becoming dusted and losing fertility, in a word worsen its physical, chemical and biological properties. To reduce these disadvantages, has appeared a tendency in agricultural practice to minimize the preparation of the soil, for sowing and for crop care works. The work of preparing the soil for sowing, application of fertilizers, herbicides and sowing can be done in two or only in one operation. Reduced tillage system applies both at plants sown in spaced rows (hoeing crops) and at plants sown in dense rows. For the reduced soil tillage system to succeed, certain measures are required, some mandatory:

- agricultural holding needs to have ensured machinery systems for proper purpose;
- soil does not contain a high percentage of clay;
- to apply fertilizers on sown rows, to hasten the growth of young plants;
- to be applied the pressing device to the soil after sowing, because the surface layer of the soil is loosened and is quickly dried and by pressing is ensure rapid and uniform emergence.

Reduced soil tillage relate to the processing or loosening the entire surface of the soil, but decreasing the intensity and frequency of work, mainly by eliminating mechanical work practiced in the conventional system. In this category are classified three major types of different practices for reduced soil loosening, namely: soil disking followed by sowing, work with other rotary machines, followed by sowing and work with chisel plough followed by sowing [5].

3.2.1. Reduced soil tillage technology made by disking

In this technology, for primary and secondary soil loosening is applied one or two disking works and sowing is done with conventional seeder. The most important advantages of such a system are, on the one hand, the reduction of energy consumption, especially fuel, and manpower compared with the conventional system, and on the other to achieve better conditions for sowing, germination and emergence, the incorporation of fertilizers towards direct sowing. The major disadvantage is that usually at the soil surface remains a small amount of crop residues, thus the area covered is below 30%, which is function the number of operations performed and the approach angle of the disc. In this way, the soils surface remain uncovered a long period of time, being predisposed, on long-term, to degradation by destructuring or crusting and greater losses of water by evaporation [6].

3.2.2. Reduced soil tillage technology with harrows and / or milling

The major advantage of such technology is to reduce energy consumption, especially fuel and manpower for the work of deep soil loosening. The main limiting factors are determined by excessive grinding in the first 10 cm of the soil and the amount, usually reduced, of crop residues which after sowing covers less than 30% of the area, increasing the risk of destructuring, crusting and erosion. Depending on climatic conditions, cultivated plant, fertilization system and weed control, has developed two versions of the reduced tillage system:

- **Variant I:** Innovative technology to establish straw cereal crops with technical equipment to prepare the seedbed and sowing in plowed field (Fig. 1) is characterized by:
  - deep plowing is done with PR5 reversible plough tractor in aggregate with the tractor of 180 HP;
  - seedbed preparation and sowing of straw cereals are made concurrently with technical equipment for seedbed preparation and sowing in plowed field in aggregate with tractor SGR of 150 HP on wheels.

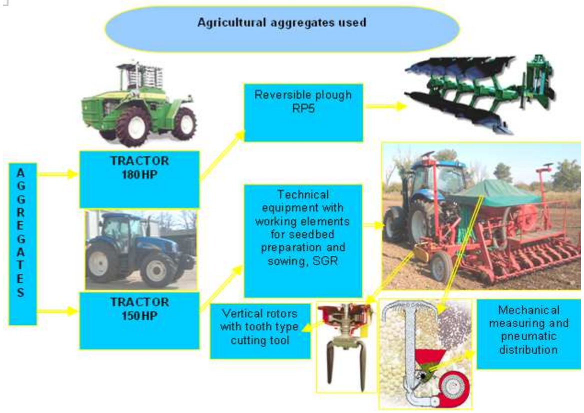

Figure 1: Innovative technology to establish straw cereal crops with technical equipment to prepare the seedbed and sowing in plowed field

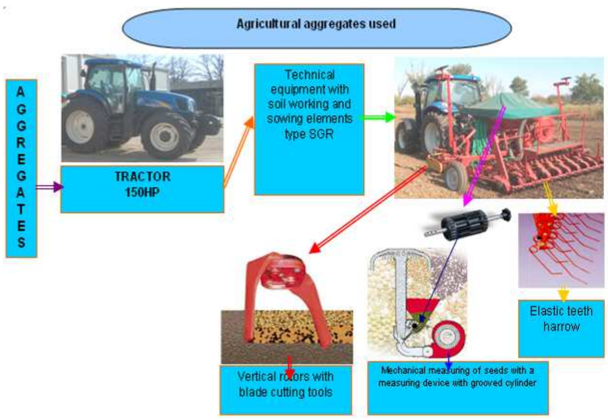

Figure 2: Innovative technology to establish straw cereal crops with technical equipment for working the soil and sowing in unprepared terrain

- **Variant II:** Innovative technology to establish straw cereal crops with technical equipment for working the soil and sowing in unprepared terrain (Fig. 2) is characterized by the fact that the work is performed in a single pass with technical equipment for soil tillage and sowing in unprepared terrain, SGR.

3.2.3. Reduced soil tillage technology with chisel plough / paraplough

This technology is made usually in two passes, the first being made with chisel plough, furrow or with paraplough without turning the furrow for primary work of soil and the second for sowing. The soil tillage without turning the furrow is a basic agropedology requirement which applies on certain soil types, as agro-ameliorative measure for protection or restoration of fertility of these soils. Based on the research made so far, this system of working the soil is recommended under the following conditions:

- on salty soil or with a tendency of salinization, with the salt layer near the surface, which rises about to 1 million ha in Romania;
- on slopes, to loosen the soil in order to storage the water in the soil and prevent leaks of soil;
- on mobile and semi-mobile sand to keep the stubble unincorporated in order to conserve soil;
- for superficial seedbed preparation on cultivated land, but compacted by rain.

The major advantage of such loosening technologies is that, after sowing, over 30% of the area remains covered with crop residues, providing favorable conditions for protection against destructive and also the level of soil tillage (loosening and shredding) is reduced. The important limiting factor is generated by the soil surface inconsistency, which affects pre-emergence herbicides incorporation and seeds during sowing, with negative consequences for germination [8].

3.3. Soil tillage system with protective layer (cover crops, catch crops)

Conventional soil tillage methods have several drawbacks to be eliminated or at least to reduce their negative effect. The soil surface layer remain, after plowing, completely uncovered, raindrops at high speed falling apart soil aggregates, soil becomes compact, with much reduced permeability and the amount of water stored in the deeper layers is reduced. These disadvantages can be eliminated if, at the soil surface, is set a layer of organic matter consisting of chopped straw or corn stalks (decomposed manure, peat etc.). During the period in which the vegetation layer covers the soil, the crop maintenance work required are made with special tools which loosens the soil without burying the vegetal protective layer [8].

3.4. Soil tillage system with ridges (ridge-tillage)

This system is preferred on slopes and cold soils with poor internal drainage. On the slope lands the soil tillage with ridges (the ridges orientation is in the direction of the contour line) allows rain water retention between the ridges, favoring infiltration and reduces erosion.

Crop residues and weeds are covered with shallow soil between the ridges. Carried out the sowing in the ridge system is dependent upon the appropriate machine systems: cultivator with ridge organs and sowing machine. Advantages of the soil tillage system with ridges are:

- in spring the ridges are heating faster by about 4 ° C to normal worked soil due to organic mass remaining on the soil and excess water drainage, allowing earlier sowing;
- water stored in the ground at intervals between ridges is used by plants that grow vigorously;
- obtained crops are superior or at least equal to those obtained in the conventional system and the fuel consumption per total technology reduces up to 48%.

Within the INMA Bucharest was developed an innovative technology for sowing and fertilizing on ridges (Fig. 3) which is a variant of hoeing plant cultivation technology that allows the realization of ridges used as seedbed where the seed is to be inserted alternately in lower areas that can be used as a watering furrows or areas of movement of agricultural machinery for making other agricultural operations.

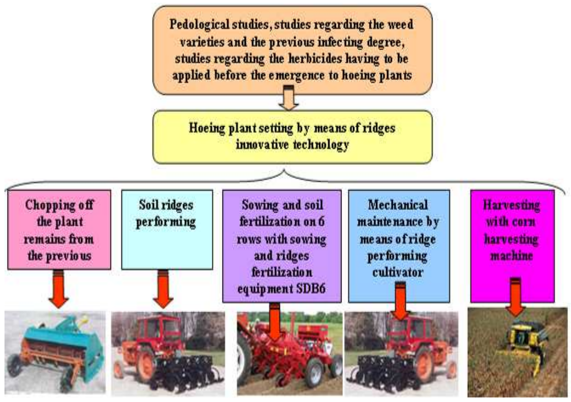

Figure 3: Sowing and fertilization technology for hoeing plants on ridges

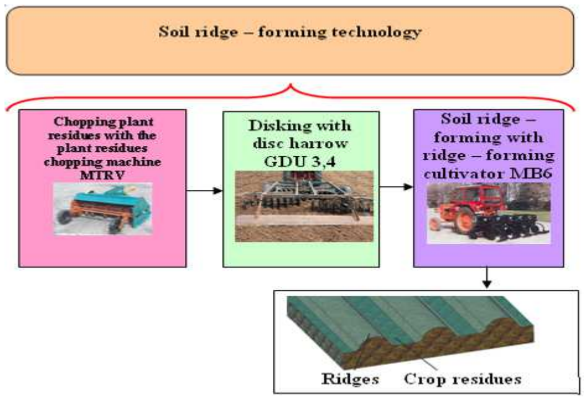

Figure 4: The flow sheet for soil ridge-forming cultivator

The flow sheet for soil ridge-forming cultivator is shown in Figure 4.

Ridge-forming cultivator MB6 consists of a wheel that adjust the working depth, three disc organs type knife (one straight and two spherical), followed by an organ for ridge type ridge-plough. Distribution scheme of working organs of the ridge-forming cultivator is shown in Figure 5. Sown on ridges technology requires only superficial soil work on ridges top (Fig. 5) in this way only 1/3 of the total area of land is being worked.

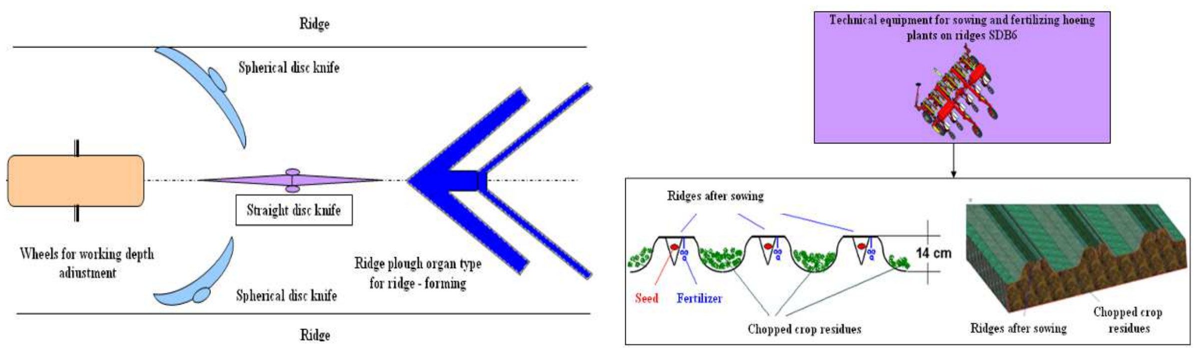

Figure 5: Distribution scheme of working organs of the ridge-forming cultivator and of the sowing and fertilization technology on ridges

In the soil tillage system with ridges, the weeds are controlled with herbicides usually applied when sowing or before sowing by covering the soil with restoring ridges or during hoeing plants work. It is recommended plowing with plough with moldboard every four years [8].

3.5. Soil tillage technology in strips narrow strips (strip till, zone till)

The system consist in processing the soil in form of strips with a width of 15 … 20 cm, while also is being performed the sowing. The work is performed by a combined aggregate with organs for soil tillage type rotary harrow or with loosening organs specific to chisel cultivator. Sowing machine coulters open the gutter to the sowing depth and deposit seed in the middle of worked area. Between processed strips remains completely undisturbed soil, uncultivated and covered with crop residues over 30% leading to lose and granular retention of soil surface. Treatment with granular insecticides when sowing seed is the most effective way to control pests. The innovative technology for plant cultivation in narrow strips (Fig. 6) uses a machine that allows soil loosening and processing in narrow strips, followed by fertilization and administration of granular insecticides simultaneously or independently with sowing of hoeing plants. Between processed strips remains completely undisturbed soil, uncultivated and covered with crop residues. In this way on the soil surface after sowing remain over 30% crop residues resulting in loose and granulated form of the soil surface in order to reduce erosion and improving soil-water relations.

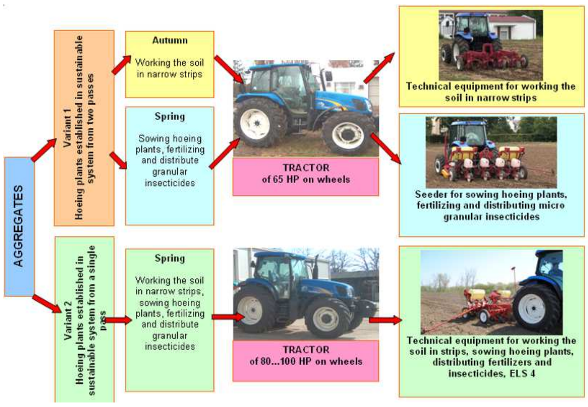

Figure 6: Innovative technology for hoeing plant cultivation in narrow strips

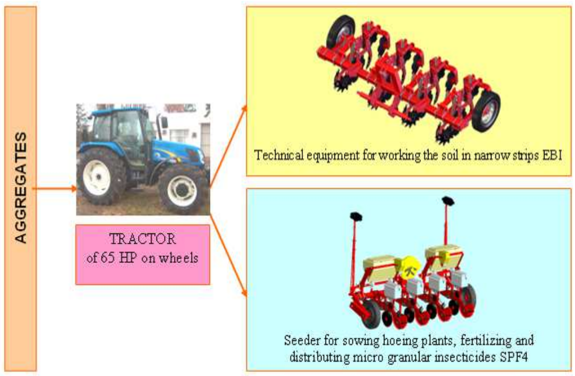

Figure 7: The aggregates used for sowing hoeing plants in Variant 1

During the growing season, the presence of vegetation layer, the thermal fluctuations are smaller and therefore the water stress is less intense, because of decreasing soil water evaporation. Treatment with granular insecticides applied when seed sowing is the most effective way to control pests. Depending on climatic conditions, of cultivated plant, fertilization system and pest control, were developed two variants of innovative technology:

- Variant 1, when using, in autumn, a machine that allows soil loosening and processing in narrow strips and, in spring, a seeder for fertilization and administration of granular insecticides applied when sowing hoeing plants.
- Variant 2, when using, in spring, a machine that execute from a single pass soil loosening and processing in narrow strips, followed by fertilization and administration of granular insecticides when sowing hoeing plants.

The aggregates used for sowing hoeing plants in Variant 1 are shown in Figure 7. The technology carried out the classification with the optimum period of making the work of setting up the hoeing plant, because seedbed preparation period is shorter than in conventional systems because the loose area is heating more quickly (thus sowing can be done sooner), which lead to crops increases to 15% / ha [8].

3.6. „No – tillage” system or direct sowing (no – tillage)

Direct sowing means that the seed is placed in the uncultivated soil, meaning that is no soil tillage. The only "processing" of soil is a slit created by sowing machine coulters in which are introduced the seeds and fertilizers. In this system the sowing is made direct into stubble or on land with plant residues from the previous plant. When switching from conventional technology in direct sowing technology it requires a transition period of about 3 ... 4 years. During this period the production decreases, but the soil adapts to the new tillage system.

Working organs of direct sowing machines executes the following: chopping crop residues in the area of the row; cleaning the row of crop residues; opening the slit (gutter) where seeds are to be submitted and slight pressing the seeds, covering with soil and compaction the row for their better germination. Technological flow-chart for corn crop establishment and maintenance through an innovative technology for sowing and fertilizing directly into stubble is shown in Figure 8.

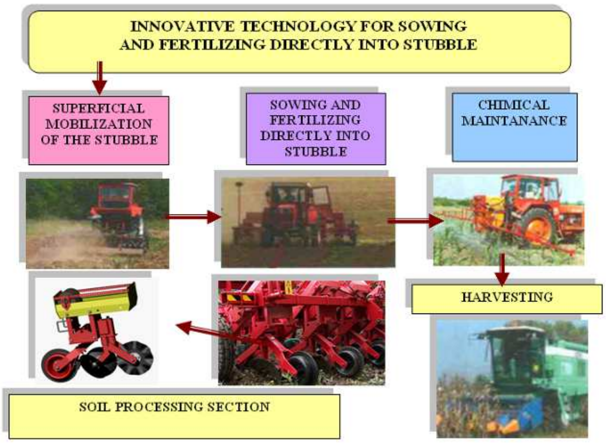

Figure 8: Technological flow-chart

The establishment of hoeing crops through innovative technology for sowing and fertilizing directly into stubble generates the following works: superficial mobilization of the stubble; sowing and fertilizing on 6 rows with sowing and fertilizing machinery directly into stubble, SDM6; chemical maintenance and corn harvesting with the combine.

4. CONCLUSIONS

There are numerous concerns of some famous companies in the construction of agricultural machinery, for example Vaderstad (Sweden), Horsch (Germany), Kverneland RAU LLG Groupe (France) Lemken (Germany), Kuhn (France), in the development of new working organs with incresead durability for soil tillage machinery in conservative system.

Conservative soil tillage technology adapted to the climatic conditions specific to Romania will use innovative technical equipment that will ensure competitive production quantitatively and qualitatively with those of conventional agriculture.

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APPARATUS AND EQUIPMENT FOR DETERMINATION OF SOIL PHYSICAL AND MECHANICAL CHARACTERISTICS

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ABSTRACT
Preventing soil degradation, of the environment, and improving degraded soils by conventional technologies, reducing energy consumption, increasing the productive potential of the soil, increasing the efficiency of water usage will depend to a large extent of knowledge of soil physical and mechanical characteristics. In this paper we present some equipment, devices and modern, cutting edge, used worldwide and in our country (in recent years) to determine the physical and mechanical characteristics of soils [1] for use for design, construction modernization and optimization of soil processing equipment.

1. INTRODUCTION

Soil is a natural body with fertility traits [2], formed by the action of creatures long and climatic factors on the rocks mineral material from the surface of the land. Earth ensures food products, raw materials for industry and not least, unsuspected energy. Soil is the support of human life and well-being, life on earth, soil, atmosphere, water and landforms have been developed together; none would be the same without the other.

Soil is an exhaustible resource, also can be heavily eroded, but will remain living epidermis of the planet Earth, on which earthly life. Man tends to consider soil as inexhaustible resource; he can learn to spare this resource, but in most cases, man exploits land without paying any attention to its qualities.

2. MATERIALS AND METHODS

To determine soil characteristics using equipment, devices, appliances and measuring systems that allow highlighting the most important parameters characterizing soil [3] [4].

The knowledge of these parameters is required then it is performed experimental research aimed at determining the tensile forces, friction forces Soil and machine, spinning, etc.

3. RESULTS

Systems that are used most frequently to determine the most important soil physical and mechanical characteristics are:

- *Soil auger*: standard or special;
- *Cone penetrometer*: done either manually or semi-fitted with cone 30^0, length of 35 mm and weight of 100 grams. The semi-automatic version of the device by introducing a counter automatically during penetration can be covered before;
- *Hygrometer:* soil moisture content can be determined by several methods, the most commonly used being the gravimetric method, respectively cm method.
- *Casagrande device*: flow can be determined limits of natural soil samples, respectively soil samples were removed from the particles retained on the sieve of 425 µm. The device is made either manually motor respectively.
- *Type pile driver proctor / CBR and press out sample*: Use Proctor and CBR tests in order automatic compaction. The device is made in two versions. At one of the devices drop height can be set at 300 and 450 mm and the other device this value is 305-475 mm. Table pile can vary between 2.5 and 4.5 kg. Int a minute number of blows is about 26 and the amount of rotation between shots is 43.7 degrees. After performing standard number of strokes previously established, functioning machine stops automatically.
- *Determination of the shear apparatus of the soil*: all the control functions of the microprocessor and is suitable to shear distributive boxes 60 and 100 mm, square-shaped and with a diameter of

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2.5 inches. Shear rate can be set to between 0.0001 and 9.99999 mm / minute. The shear force may be 3.3 and 4.5 kN.

- *Disc device to determine the bearing capacity of the soil*: the method is implemented using a disc pregnancy can cause the main characteristics of the soil bearing capacity based on resistance to compression, commonly used. During the measurements determine the sinking of a rigid disc diameter set in steps following the application of the load. From the relation between the applied load is formed and sustained compression can be characterized by capacity to mirror the road, the road structures or complete structure on a particular stretch of road or change the overall shape, elastic or resulting change residual form, represented by change of form factors.
- *Dynamic device for determining carrying capacity*: slight spicy weight, which is suitable for accurate classification and instant on-site field work embankment. The results can be output to the printer locally. Memory control unit can receive and store many measurement results, which can also be transmitted on different computers to draft the minutes and for further processing.
- *Dynamic device with light spicy weights to determine the bearing capacity and density*: suitable for determining bearing capacity and density of earthworks. This device can successfully replace methods of density determination using isotope allow for instant and accurate classification field, and of course the results can be printed on the spot. Memory control unit can receive and store many measurement results, which can also be transmitted on different computers to draft the minutes and for further processing.
- *Oven*: drying can be done both of aggregates, as well as finished products (eg the execution of measurements on moisture content gravimetrically).
- *Mechanical sieve shaker*: the analysis of aggregate size distribution of materials. The devices are endowed with simple timing device and the control devices developed include intensity and amplitude of vibration.
    - mechanical sieve shaker type S for driving the 12 sites with diameter of 200 mm, or 300 mm by 6 website;
    - mechanical sieve shaker type Minor, simple, inexpensive and portable drive for 8 site with diameter of 200 mm;
    - mechanical sieve type of site Octagon to drive 200/300 mm diameter, with device for regulating the intensity and amplitude;
    - mechanical screen vibratoar particular site diametrru 350, 400 or 450 mm.
- *Installation of soil moisture measurement*: the land consists of a humidity sensor that works on any of the above principles and a display device and recording the measured value thereof (data logger). If we want to humidity variation over time, humidity sensor can be connected to a special monitoring system. Sensor (Fig. 1) is modern, robust, used for measuring humidity, temperature, conductivity or dielectric constant of the soil. Its use is via direct input measuring point. The resulting signal from the sensor can be analog or digital. The measured data reading and recording is done with a data logger (Fig. 2).

Figure 1: Sensor for measuring soil moisture

Figure 2: Reader Portable Data

Such an instrument (sensor and data logger) can be used for field measurements, short or long term. The measured values in real time, are made and recorded instantly. Connection of the sensors (one or more) in a data logger (Fig. 3) that allows monitoring of the quantities mentioned above.

Figure 3: Data logger for recording, storing, data coming from the sensors to monitor

A recording and reading device can be used in different places, being portable. Display and measurement record is instantly on the device. Registration can be measured by data logger, a computer located in the monitoring station.

• pycnometer density determination of solid bodies: requires weighing and measuring the volume of the table body. Of these two weighing operations can be done with an accuracy far greater than the volume assessment, and difficult operation affected by significant errors, the most accurate method of determining the density pycnometer method. The pycnometer is basically a container (bottle) bottle "A" known capacity, unchanging and well defined.

• Digital electronic cone penetrometer FIELDSCOUT SC 900 (Fig. 4): measures the force cone penetration resistance in soil layers (expressed in units of pressure, kPa) with an electronic transducer force and depth (position) of the cone penetration in the ground by means of a position sensor (level) of the ultrasonic generator. Data on penetration resistance values and the depth of penetration of the cone penetrometer into the soil can be viewed on the device can be stored in the "data logger" and can be transferred to computer memory (for processing). Cable can be connected to a GPS / DGPS for the location of the sample.

Figure 4: Digital electronic penetrometer cone FIELDSCOUT SC 900

- Ground the analyzer capacitive FIELDSCOUT TDR 300 Z (fig. 5): is designed to monitor and record soil moisture and functions include "data logger" (storage / processing of data) [5]. Use for any soil in all climatic conditions. It has two display modes: volumetric water content and relative water content. Cable can be connected to a GPS / DGPS for the location of the sample.

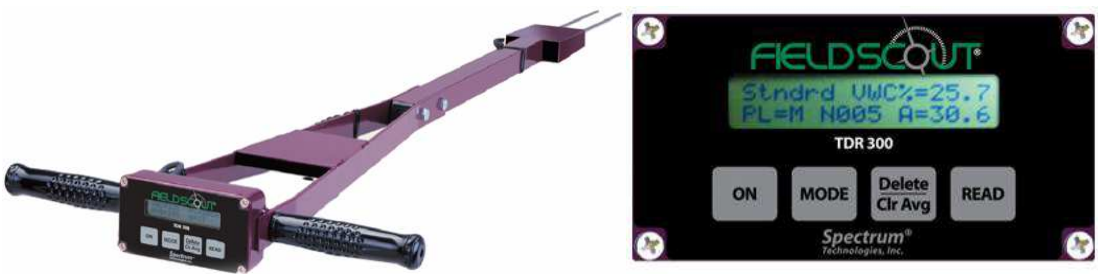

Figure 5: Soil moisture meter capacitive FIELDSCOUT TDR 300

- Navigation device Garmin GPSMAP 60CSx (fig. 6): has a 12-channel receiver that can communicate continuously with up to 12 satellites to compute and update your position.

Figure 6: Garmin GPSMAP 60CSx navigation device

The device also has an altimeter, barometer and electronic compass, which can indicate the correct direction even if upright. It includes a 64 MB microSD card that is loaded maps in Mapsource format, and BlueChart CityNavigator.

Tools can record and store hundreds of field data, and through its program installed on your computer, the computer can enter data in the form of text files which can then be written in vector form using, eg MS program Office Excel. The same way of working and connecting with the computer is characteristic for GPS device, which, in addition, can work independently or coupled with the analyzer. Then, using a variety of general purpose programs can be generated from moisture.

a) b)

c) d)

Figure 7: Instruments used in measuring activity: a - penetrometer and the analyzer; b - the analyzer GPS device; c - ministration weather; d - agenda notations electronics and computing, coupling the mobile computer and internet speed data transmission remote wireless

- Complex system for determining soil properties - VIS-NIR spectrophotometer: manufactured by VERIS - USA (fig. 8) allows control and data acquisition soil quality using specialized software.

It is used in agriculture for soil to infrared measurements to determine the properties, such as carbon and nitrogen.

Figure 8: VIS-NIR Spectrophotometer made VERIS

When light hits the ground - molecules react - vibrates. This vibration absorbs some of the light - how much light is absorbed or reflected depends on what comprises ground. Soil with strong chemical bonds CH, NH and OH absorbs more light, so moist soil or soil with high organic matter looks darker - even to the naked eye. The spectral data, particularly in the near infrared spectrum, are even more useful.

The reflectance spectrum can be used for measuring carbon, nitrogen and water content in soil and can also be put in contact with certain chemical properties of the soil. Veris soil reflectance spectrophotometers measure the bandwidth of 350-2200 nanometers. It covers the visible part of the spectrum and further in the near infrared spectrum. Every second, the system 20 spectra recorded Veris - each range comprising 384 measurements of the soil. After processing, all spectral data are transformed into land maps (Fig. 9). These operations are completed, the results are translated into maps of soils, particularly detailed, precise calibrated levels of soil constituents [6].

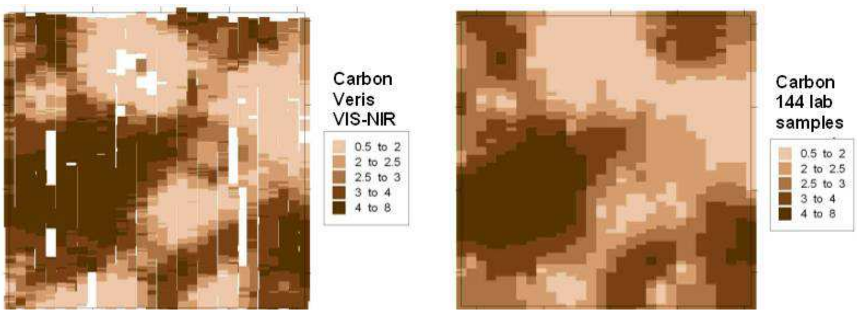

Figure 9: Land maps calibrated C content

• Equipment for the determination of pH and electroconductivităţii (EC) soil: mobile platform VERIS sensor (fig. 10) equipped with a sensor electrical conductivity (EC) and soil pH, which can simultaneously detect soil properties at two depths using technology electrical conductivity of the soil. The device performs about 10 soil samples on 0.4 ha, and thousands of samples per day, producing accurate maps of variation in pH (Fig. 11).

Figure 10: Mobile platform VERIS sensor for determining electrical conductivity (EC)

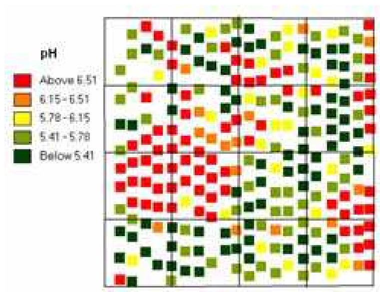

Figure 11: Precise maps of pH variation

4. CONCLUSIONS

Knowledge of soil properties are important because they help finding practical general physical condition of the soil (aeration, texture, structure) and the calculation of water and nutrients.

Soil, over time you may suffer different processes may affect the structure and quality, these processes can be physical, chemical or biological; Romania has information on-ground system, but many of the data are old, less accurate, not adapted to reality and less accessible.

Knowledge timely suffered soil processes is essential to ensure optimal matching between human society and nature, this can be achieved only through the use of appropriate measurement devices and modern.

"ACKNOWLEDGMENT

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RESEARCHES REGARDING ORGANIZATION OF THE EXPERIMENTS FOR ENERGETIC CHARACTERISTICS DETERMINATION WHEN USING MISCANTHUS PLANTER

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ABSTRACT

In this paper is exposed a methodology for conducting experiments in order to estimate the main physical units that define the energetic performance parameters of the miscanthus planter MPM-4 and its working bodies, in order to establish some relations between performance parameters and basic parameters that describe the process. More specifically, have been proposed and tested several structures and ways of equipping the machine in the field and the energetic parameters were determined and also those involved in their estimation, such as tensile force, the power required to tow, fuel consumption, working depth and working speed of aggregate.
These parameters are to be used to estimate the percentage by which each working body of the planter contributes to their total amount (for the whole machine).

1. INTRODUCTION

Determining the essential parameters of the working process performed by the tractor – miscanthus planter aggregate, the expression of some relations connecting these parameters and the optimization of working regime, can constitute three research priority directions.

The main working parameters can be deduced theoretically, either using the experience acquired in the literature in the field of agricultural machinery, or highlighting possible new parameters, formed, some of them even from combinations of those already known.

If the parameters are, easily to highlight theoretically (they come, most of them, from mathematical models), relations between these parameters are less evident within the models, and the coefficients that characterize certain properties of theoretical achievements are determined almost entirely by experiment. Therefore, both a part of the relationships and a large part of the coefficients appearing in these are determined only experimentally.

In the case of the agricultural aggregates, when aiming to determine relationships that characterize the mode of operation from mechanically point of view (kinematic, dynamic and energetic), basic computing relations are known from the literature, but the coefficients characterizing the soil or the combination soil - working bodies are much less known. Even the structure of some relations, possibly particularized to a specific aggregate, remains partially unknown without performing specific physical experiments, [5].

Therefore, once formulated theoretical model, remain a number of relationships and process parameters that must be determined experimentally. For this purpose there are various physical experiments, varying some parameters and determining others, in a research method well established. Then, once determined the relations and the process parameters can be try optimizing processes designed to reduce the energy consumption, increasing the working capacity or improving the work quality. Subsequently, extrapolation should, at least partly, experimentally tested, [5].

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Tests on the opening bodies furrows were conducted by several researchers worldwide, both in terms of coulter geometry effects [1,8,9], and in the terms of soil characteristics, the working depth and the working speed [3].

Regarding the coverage of planting material and the soil compaction over it, it was found that press wheels with double ribs are more effective at coverage of planting material and appropriate compaction of the soil, [2].

2. METHODOLOGY

The general relation to estimate the tensile strength of a working body which processes the soil is of the form, [4]:

$$R = \mu G + k\, s(a) + \varepsilon \rho\, s(a) v^2 \qquad (1)$$

where: k - soil resistance to cutting, separation and / or deformation; S (a) – processed cross-section area, as a function of the working depth *a*, assuming constant working width; μ – coefficient of movement resistance of the respective body; G – the working body weight and additional load acting on its vertical; ε – coefficient which takes into account the kinetic energy imparted by the body to the displaced soil; ρ – soil density (the specific mass); v – working speed of the aggregate, [4,7,10,11].

The remarks from technical literature and the main purpose which covers the use of such relationship in optimizing the energetic working processes of some agricultural aggregates can be taken into account in developing the experimenting strategy of miscanthus planter aggregates which includes several processes which are not necessarily natural, in the sense that in practice, the machine will never work in some experimental configurations. One of the main objectives is to determine the tensile strength force for each of the working sections components of miscanthus planter.

The way to solve subsequently approached starts from theoretical fundaments accepted in the literature, and by using the experimental data can be identified the coefficient values of the relations that define the dependencies between various parameters used in the mathematical model. The coefficients thus determined have accurate physical dimensions and must fit within a physical acceptable range.

For this study, experiments (in number of 75) were carried out in a variety of structure of the four sections of the planting machine MPM-4, designed and built of INMA Bucharest, (with all the working bodies or without some of these), the machine being completely or incomplete equipped, and therefore, they were processed depending on the respective categories of structure of working bodies and the machine as a whole.

For clarity are given in Table 1 the categories of experiments performed and the sections structure with the used working bodies, and in Table 2 are presented the primary results obtained in experiments regarding the tensile force and fuel consumption for the miscanthus planter sections and their working bodies at different working depths and speeds.

Table 1: Categories of working bodies used in experiments

Exp. index	Number of active sections	The structure of the external sections	The structure of the central sections
1 - 27	2, fig.1	Coulter + coverage disks + press wheels	Without central coulters
28 - 48	4	Coulter + coverage disks + press wheels	Coulter + wheel with wings in V
49 - 60	4	Coulter	Coulter
61 - 68	2, fig.2	Coulter + wheels with wings in V	-
69 - 75	2, fig.3	Coulter + coverage disks	-

Fig.1: Experiments 1 – 27 (at central sections were removed the coulters and the press-coverage wheels in V were lifted)

Fig. 2: Planter equipping for the experiments 61–68 (coulters and press-coverage wheels in V)

Fig. 3: Planter equipping for the experiments 69 – 75 (coulters and coverage disks at the external sections), [7]

Table 2: Tensile force, fuel consumption and the power required to tow the aggregate planter, for the experimental measurements performed in the field, [7]

No of sample	Machine equipping		Working depth a, (cm)	Working speed v, (m/s)	Tensile force F_t, (kN)	Fuel consumption (l/ha)	The power for towing P_t, (kW)
	at external sections	at central sections					
1	coulter + coverage disks + press wheel	without central coulters	0,06	1,01	5,077	3,7	5,13
2			0,06	1,13	3,904	3,7	4,39
9			0,06	2,50	3,768	2,96	9,42
10			0,09	1,33	4,027	3,7	5,37
18			0,09	2,64	5,215	2,96	13,79
19			0,12	1,29	6,416	5,18	8,29
20			0,12	1,34	6,551	4,44	8,79
27			0,12	2,57	5,907	2,96	15,18
28	coulter + coverage disks + press wheel	coulter + wheel with wings in V	0,06	1,27	7,039	5,18	8,92
36			0,06	2,65	8,513	3,33	22,54
37			0,09	1,38	7,682	4,07	10,63
45			0,09	2,50	8,318	3,7	20,80
46			0,12	1,32	8,38	5,18	11,08
48			0,12	1,27	8,379	4,4	10,61
49	coulter	coulter	0,06	1,36	7,761	4,44	10,56
60			0,06	0,83	7,615	5,5	6,28
61	coulter + wheels with wings in V	-	0,06	1,32	4,165	4,07	5,51
64			0,06	2,65	4,111	3,75	10,88
65			0,09	1,34	5,085	3,33	6,84
67			0,09	2,57	5,03	2,963	12,94
68			0,12	1,36	5,488	4,07	7,49
69	coulter + coverage disks	-	0,06	1,41	3,737	3,33	5,25
71			0,06	2,57	4,281	2,96	11,01
72			0,09	1,32	4,325	3,33	5,72
74			0,09	2,73	4,812	2,96	13,13
75			0,12	1,41	5,453	3,33	7,66

3. RESULTS AND DISCUSIONS

The experimental results of interest are: working depth and width, slippage, working speed, fuel consumption and tensile forces (recorded using a tensometric bar). Among the records, the most interesting were those in lateral tie rods and the central one of tractor, information on which the experimenter can calculate the tensile force. For calculation it starts from the records of forces from the two lateral tie rods and from the central one, by plotting. Thus, is obtained the variation during each experiment of the tensile force for the established equipping variant.

A typical signal sequence recorded and then mediated for determining the instantaneous tensile force is that from Fig.4, [7].

Since only interested the stabilized working process, for each signal was made a cutting of a main sequence so it does not include transitional portions, and the time between the start and end of the sequence was chosen so that the ratio between the working route length and the time of selected sequence be equal to clocked working speed. There were thus obtained, the sequences which were calculated main statistical characteristics: minimum and maximum values, the average value and the standard deviation, [7].

Fig. 4: Variation of the total tensile strength force, [7]

Thus, for each of the 75 experiments, raw signals (at the three specified tie rods) were processed, and the basic signal, resulting from separate calculation, represents the time variation of the tensile force. At the same time, for each of the 75 experiments, in the calculation from the mathematical model should be specified also the main statistical characteristics, the maximum importance having the average value, [6,7]. The data processing can be done in Mathcad, and further can be done analysis regarding the influence of each parameter (working speed and depth), but also of each working body in the total value of agricultural machine tensile force.

The average values of the three main working parameters of the tractor - miscanthus planter aggregate: the tensile force, specific fuel consumption of worked surface and average speed of work are given in Table 3, and correlation of the five parameters (the tensile force, fuel consumption, working speed, average power and effective area of working bodies) are given in Table 4.

It is observed that the tensile force and fuel consumption are highly correlated, while the tensile force and working speed, on the one hand, and the working speed and fuel consumption, on the other hand, are in absolute value as well correlated, but the correlation value is negative.

Table 3: Statistical characteristics of the main parameters in the five categories of experiments

Exp. index	The average value of the tensile force, kN	Average fuel consumption, l/ha	Average speed work, m/s	Average power consumed by planter, CP	Average effective area of working bodies, m^2
1 - 27	4.888	3.775	1.870	12.421	0.276
28 - 48	7.233	3.924	1.795	17.525	0.428
49 - 60	7.590	4.467	1.595	16.422	0.067
61 - 68	4.527	3.522	1.786	10.945	0.169
69 - 75	4.492	3.171	1.878	11.498	0.171

Table 4: The correlation matrix of the average values of the five main parameters of tractor – miscanthus planter aggregate

Parameter	Tensile force	Consumption	Working speed	Power	Working surface
Tensile force	1	0.867	-0.752	0.973	1
Fuel consumption	0.867	1	-0.847	0.774	0.867
Working speed	-0.752	-0.847	1	-0.58	-0.752
Power	0.973	0.774	-0.58	1	0.973
Working surface	1	0.867	-0.752	0.973	1

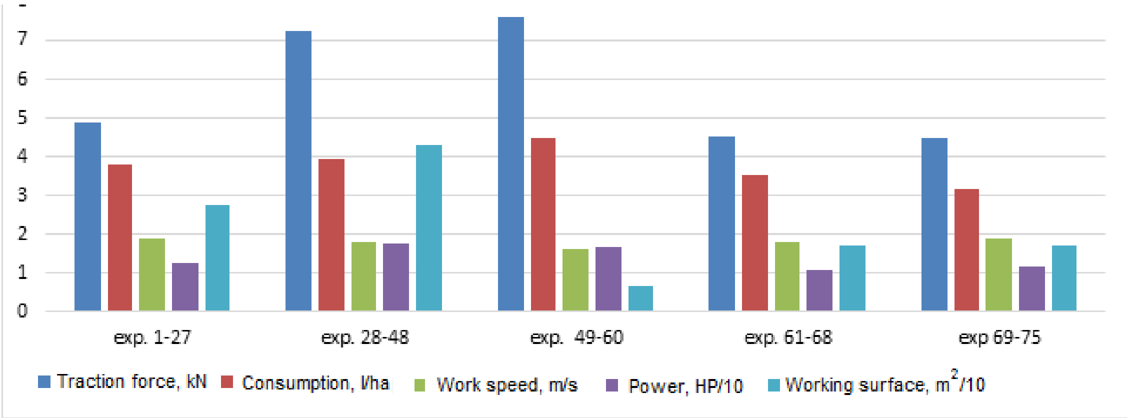

Fig. 5: The average values of tensile force, specific fuel consumption, working speed, average power consumption and effective area of working bodies (the projection area of their surfaces on the perpendicular plane in the moving direction), multiplied by 10 for scaling, for each of the five categories of experiments

From the graph given in the Fig. 5 it is noted that while the tensile force and fuel consumption increases and then decreases for the given order of experiments categories, the working speed has an inverse variation. This may be an explanation for the negative correlation value, large in absolute value, but suggests the existence of critical points of interest in the energetic area of tractor – miscanthus planter aggregate working process. Also, the tensile force and fuel consumption are significantly correlated with the total area of the working bodies' projection surfaces on the normal plane to the forward direction.

4. CONCLUSIONS

Using the data from this paper can be obtained data about the resistance opposed by each of the working bodies or combinations of working bodies of the planter sections (based on tensile forces recorded in the tractor tie rods). Based on these can be established correlations between parameters and the contribution of each working body in the total value of energetic parameters.

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THEORETICAL ASPECTS REGARDING THE PROCESS OF DRYING THE FODDER PLANTS

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ABSTRACT

Harvesting and preserving fodder plants are important steps in the preparation of animal nutrition and ensure good quality forage throughout the year representing the basic concerns of livestock producers to reduce costs, decrease harvest losses and obtaining superior nutritional quality forage. This paper presents some theoretical aspects and elements of calculation that interfere with the aeration of forage plants to storage and conservation in optimum conditions for a fully exploitation hay.

1. INTRODUCTION

A very important role in the process of harvest, preparation and conservation of feed as hay we have weather during the harvest. They influence both the first stage of drying on stubble and the second stage of finalization of drying.

Elimination of water from forage is based on hygroscopicity atmosphere, to saturate the property of steam when it enters contact or is directed through forage mass. The hygroscopicity of the air is inversely proportional to its relative humidity and temperature is directly proportional, [3]. The drying conditions imposed on the relative humidity and temperature during the drying are critical for the transfer of water to the plants. Plant cell gives the more water the stronger is the slope of evaporation of water inside the plant saturated and unsaturated water outside air. If there is this slope, then there is a state of equilibrium, without drying action, which is reflected by a hygroscopic equilibrium, Figure 1.

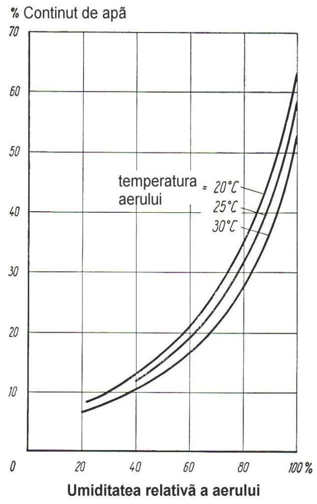

Figure 1**:** Meadow grass hygroscopic equilibrium temperature of 20 ... 30°C, [3]

This applies to all substances hygroscopic, which includes and hay. A powerful action of the extraction of water are at a low air saturation, thus at low relative humidity air at a high temperature.

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The relative humidity of the air, also called the degree of saturation is the water that it contains in comparison to that air which the air would have at the temperature existing in a state of saturation, then to 100% relative humidity. Warmer air can take at the same relative humidity, water in quantities greater than cooler air.

This explains the high impact that weather has on the success stubble hay drying in the first stage. On a warm day, with low humidity, hay dries faster than a cold day with high humidity.

During hot, dry summer weather can be obtained by drying hay on the ground in two days, while in the cold and wet winter, traditional soil drying time increases to 6 ... 8 days, and with atmospheric moisture an important role (Figure 2).

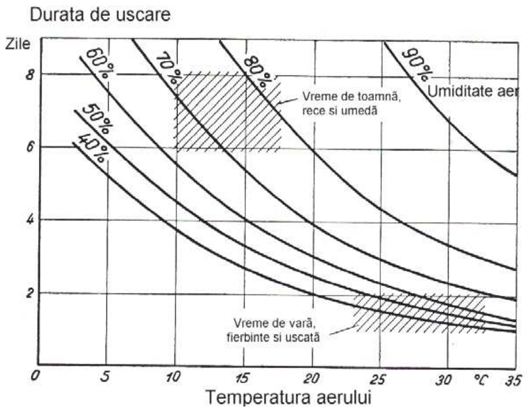

Figure 2: The duration natural drying of hay in different weather conditions [3]

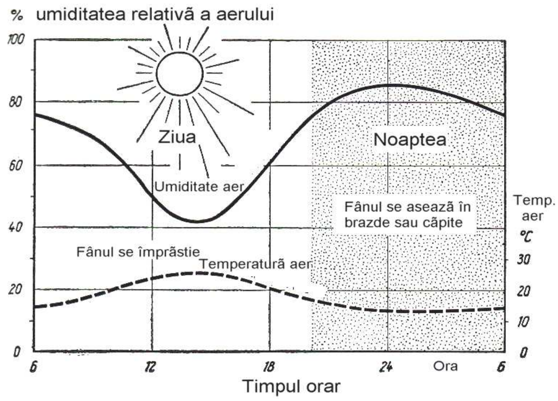

Figure 3: The evolution of atmospheric humidity and air temperature during the day and night [3]

Even during the day drying conditions (relative humidity and air temperature evolution) changes continuously, as represented, for a normal day average summer (Figure 3). Best drying conditions are during lunch, when air at a high temperature prevail a low humidity, [3].

2. METHODOLOGY

In the first stage the drying of the hay on the field evaporate most of the water, about 90% (Figure 4) [3]. This stage arises relatively soon, about 1 ... 2 days if favorable time because of favorable gradient of humidity.

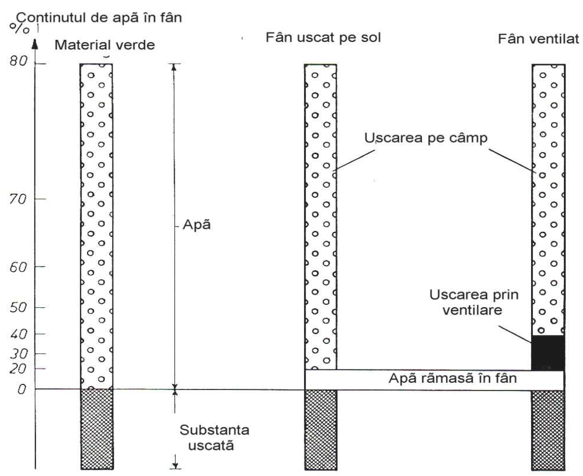

Figure 4: Evaporation of the dry water by aeration [3]

The second stage, which aims to remove the remaining approx. 10% water, requires much more time because moisture gradient becomes smaller continuously.

After stage is completed first forage gather on the field, transported and stored on platforms provided with facilities for completing the drying air ventilation cold or hot. That forage on the ground to gather humidity 35 ... 45% completely eliminates qualitative and quantitative losses caused by crushing and shaking forage on soil rich in protein leaves.

On completion of the mass ventilation drying fodder stored in special drying platforms, is sent to forced hot or cold air. The air is distributed throughout forage mass using fans and network channels to achieve uniform dispersion. [5]

3. RESULTS

Aspects of fodder drying process by aeration in storage

The drying process begins where the air enters the hay. The air picks up moisture as hay until equilibrium is reached hygroscopic. The drying process is completed in a drying zone which moves slowly from the bottom to top, from the place of entry to place of exit of air in the forage mass (Figure 5). When the bottom the boundary layer (mirror drying), moved to the top layer, drying is completed.

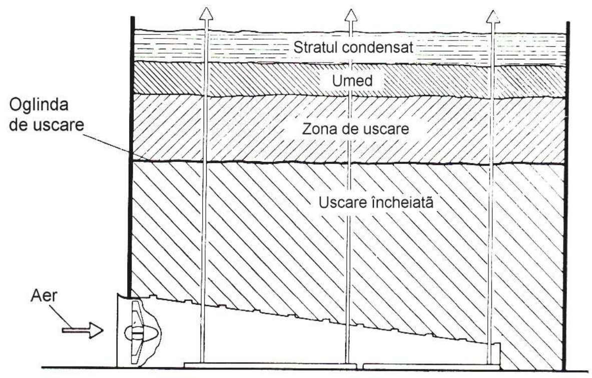

Figure 5: The cycle of drying in the mass of hay [3]

Uppermost layer is dried so the last and therefore is the most compromised. The more so since in this layer is formed by condensing water out of the mass forage air saturated with moisture and entered into contact with cooler outside air. Drying the condensate layer is slow not only because the grass is wet here, but also because the air soon on his way through this dense layer has little time for taking water [3]. Depending on the size of the layer and conditions of the total length of the drying time of a layer of hay is 4 to 14 days.

The phenomenon of respiration of plants, which is very pronounced in green plants, longer operates even during drying, resulting in the release into the air of a quantity of heat. This heat is opposed breathing air cooling by evaporation of water extracted result drying. Depending on the quantity of ventilated air can be one or the other of these actions to dominate or both to be equal, so that the air can have a temperature goes higher or lower or the same incoming air temperature.

From the specialty literature a result of experimental investigations, it can rely on the evaporation of water 1 to 2 g / m^3 of air, and in favorable weather conditions for 3 to 4 g water / m^3 of air ventilation. Placing the next layer forage when humidity is subjected to drying the previous layer has fallen below 25%. Dry forage is considered complete when the last layer of low humidity below 20%.

Capacity of the water by air can rise when the air is preheating input. It is necessary to preheat 5 ... 8 ° C, to increase so much that the amount of water extracted during the drying to be reduced to one-third to one-half of the total time of drying with cold air.

Compared to the cold air drying, hot air drying has the following advantages:

- Further reduce dependence on weather conditions during the harvest;
- Reduces drying time fodder;
- Initial moisture content of the forage can be subjected to drying by 10 ... 15% higher which results in a even better hay quality.

These advantages are explained by increased hygroscopicity of air directly proportional rise in temperature. Thus, it was found experimentally that a 1 ° C increase in air temperature from ambient temperature to a lowering its relative humidity to about 3 ... 5%. If the hot air used for ventilation is 5 ... 8 ° C temperature higher than ambient temperature results in a reduction in its relative humidity of about 15 ... 40%. To produce warm air using different heat sources as: Heat; Electrical resistance; Heat engines; Solar collectors; Geothermal etc. [3].

In general, the installation of venting hot air drying is not much different from that used in cold air drying, the differences consisting of: introducing it in the air of a room where the air heated homogenization heat generator mix with atmospheric air, air temperature to achieve a modest 5 ... 8 ° C above ambient temperature [3].

Theoretical aspects of the process of aeration and calculation elements which intervene in the process

On completion aeration drying forage mass deposited on special platforms drying is sent to forced hot or cold air. For storage and preservation of nutritional quality conditions over winter it must be subjected to drying process so that the humidity is reduced to below 18% [3].

The actual quantity of water to be removed from the forage to obtain a fan with the moisture retention of 18% was calculated with (1), [3]:

$$m_a = \frac{u_i - u_p}{100 - u_p} \cdot m_i \text{ [kg]}, \tag{1}$$

Where:

m_a – is the mass of water to be removed from the forage [kg];

u_i – is the initial moisture (from mowing) of the forage[%];

u_p – the final moisture content of the hay storage (less than 18%)[%];

m_i – initial mass harvesting of green forage[kg].

Forage moisture (initial or during drying plant) is determined as follows: weigh a sample of 200 grams of forage that is placed in a cheesecloth bag and then placed in an oven at 105° C, which takes for three hours. Remove from the oven and weighed after cooling.

Forage moisture resulting from the relation (2), [3]:

$$u_f = \frac{200 - m_{pu}}{2} \text{ [\%]}, \tag{2}$$

Where:

u_f – is moisture forage[%];

m_{pu} – is the mass of the resulting sample after drying and cooling [g].

The flow of air, the air speed should not exceed the amount 5 m / s, [2], and resistance of the grass layer which face the air flow fan to the thickness and type of hay. The hay made from a structure of grasses and legumes mixtures opposes greater resistance to airflow.

The flow of air through the topper layer is plausible three flow regimes: laminar flow, turbulent flow and the overall laminar-turbulent flow [1], [4]. It is present in summary the three flow regimes:

The laminar flow The flow is laminar if the air flow through existing channels is laminar layer, then we can apply *Fanning's equation* for each channel and can be put in the form:

$$\frac{(\Delta P)}{\rho_a} = \frac{64}{Re} \cdot \frac{h' \cdot v_c^2}{2 \cdot D_e} \tag{3}$$

Where the *Reynolds's number*, that v_c are shown in the following formulas:

$$(Re) = \frac{\rho_a \cdot v_c \cdot D_e}{\eta} \tag{4}$$

$$v_c = v \cdot \frac{h'}{h \cdot \varepsilon} \tag{5}$$

Where:

- ρ_a - air density;
- v_c - air velocity through the channel;
- v - velocity of the air through the conventional equal area covered mass surface;
- D_e - equivalent diameter of the channel;
- h' - channel length (usually less than the thickness of the layer h);
- ε - porosity layer.

After a series of calculations equation (3) becomes the final form:

$$v = \frac{(-\Delta P)}{\eta \cdot h} \cdot \frac{\varepsilon^3}{K''(1-\varepsilon)^2 (a_{so})^2} \tag{6}$$

Equation (6) is known *Kozeny-Carman equation.*

Where:

- *K"*- *Kozeny constant*, which depends on the porosity and the specific surface area and has been found experimentally, K' = 5 ± 0.5;
- a_{so} - particle specific area, defined by a_{so} - (particle surface) / (particle volume);
- η - is the dynamic viscosity of air;
- (- ΔP) - pressure drop across the thickness.

Turbulent flow

If airflow is turbulent channels can be applied *Fanning's equation* [4]:

$$\frac{(-\Delta P)}{\rho_a} = 4f \cdot \frac{h' \cdot v_c^2}{2 \cdot D_e} \tag{7}$$

Where:

f – the friction factor.

In accordance with the considerations in [4]:

$$D_e = \frac{4 \cdot \varepsilon}{a_{so}(1-\varepsilon)}, \quad a_{so} = \frac{6}{d_e} \tag{8}$$

Taking into account the relations (6), (7) to be included in (8), and after performing calculations we obtain:

$$\frac{(-\Delta P)}{\rho} = 3(K')^3 \cdot f \cdot \frac{\rho_a v^2 (1-\varepsilon)}{d_e \varepsilon^3} \tag{9}$$

Where:

- $K' = h'/h$ so called tortuosity factor bed;
- d_e - the equivalent diameter of the particle.

If notes: $f' = f(K')^3$ a modified friction factor, the equation (9) becomes:

$$\frac{(-\Delta P)}{\rho} = 3f' \cdot \frac{\rho_a v^2 (1-\varepsilon)}{d_e \varepsilon^3} \tag{10}$$

This equation is known as *Burke-Plummer's equation* and the value of *f'* is obtained experimentally and depends on the *Reynolds's number* [4].

Global flow laminar – turbulent

This is the case when both modes are present at the same time the air flow through the bed. Characterization of flow regime is modified by particle *Reynolds's number*:

$$(Re) = \frac{\rho_a \cdot v \cdot D_\varepsilon}{\eta} \tag{11}$$

Where v is not the actual speed, is conventional speed.

According to data from [4] if: Re_p <40 then flow regime is laminar and Re_p > 40 turbulent flow regime is laminar-turbulent or global. After some considerations detailed in [4], it is recommended to estimate where solid granular materials using the equation:

$$\frac{(-\Delta P)}{h} = 150 \cdot \frac{(1-\varepsilon)^2 \eta}{\varepsilon^3 d_p^2} \cdot v + 1{,}75 \frac{(1-\varepsilon)\rho_a}{\varepsilon^3 d_p} v^2 \tag{12}$$

Known as *Ergun's equation*. This equation can be used to estimate both the pressure drop (-*ΔP*), the current flowing through the bed forage air independent of the type of flow, if all parameters on the right of the equation can be evaluated, as well as the conventional speed v an estimated pressure drop (-*ΔP*) [1].

4. CONCLUSIONS

Following investigations the following conclusions:

- Green fodder from mowing contains a large amount of water, generally between 70% and 85%. To keep the winter it must be subjected to drying process, so that's humidity is reduced below 18% as result storage will be achieved under optimal conditions without causing undesirable phenomena.
- To finalize hay drying in special storage facilities is required ventilation drying with hot air or cold air. On completion ventilated drying forage mass, placed special drying platforms, is sent to forced hot or cold air. The air is distributed throughout forage mass using fans and network channels to achieve uniform dispersion.
- In theoretical research aeration process fodder plants for air flow through the layer of feed, they are plausible three flow regimes: laminar flow, turbulent and laminar-turbulent global flow.
- In cercetarea teoretica a procesului de aerare a plantelor furajere, pentru curgerea aerului prin stratul de furaje, sunt plauzibile trei regimuri de curgere: curgere laminară, curgere turbulentă şi curgere globală laminar-turbulentă.
- It is important to additional drying of hay with mechanical ventilation systems because it estimates the nutritional components minimizing the loss of up to 25 ... 30% or even 50 ... 70% in bad weather conditions.

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EXPERIMENTAL RESEARCH ON ANAEROBIC DIGESTION OF DISTILLERY WASTEWATERS

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ABSTRACT

Promotion of energy from renewable sources is an important goal of energy policy for Romania as EU member state. Biogas is a significant energy resource, obtained from renewable sources (biomass) that can bring great benefits, both in terms of energy and environment. In this paper the authors present the results of an experimental study on anaerobic digestion of distillery wastewaters. There were determined the biogas production, its composition and calorific power. Also, there were determined the physical-chemical properties, respectively the organic substrate removal efficiencies of the raw materials used.

1. INTRODUCTION

In order to ensure the energy required for the progress of humanity, the last decades have brought to the foreground of technological development a reconsideration of existing energy resources. The drastic reduction of conventional fuel reserves required even more insistently the approach to renewable energy sources (solar, wind, biomass, etc.). Romania as an EU Member State has already reached 24% RES target in consumption in 2014, which is commendable given that this target has been set for 2020. Since the wind energy was the one who has grown the most in the last years is expected that in the future energy policies try to make biomass energy production a more attractive option for investors Considering that the technologies of using these resources led also to solving environmental problems (treatment of wastewater from different industries), their use is even more beneficial.

The process of biogas production by decomposition of organic substrates in anoxic environments is a process which occurs naturally. In controlled environmental conditions, the biogas biochemical decomposition of organic substrates (anaerobic fermentation) takes place in special equipments called anaerobic digesters. Due to the diversity of raw materials used for the production of biogas, the technical systems are of many types, using different technologies [1]. Also, the vast quantities of existing organic substrates and, especially, organic wastes produced by human activity provide a wide market for such plants. The superior valorization of these residues can be made both by converting biogas to heat and/or electricity and by obtaining byproducts that can be used safely in agriculture or for other purposes (energy production, building materials, etc.).

Improving equipments and technologies used to enhance fermentation processes are a continue concern of the researchers in the field of anaerobic digestion. Current research aims to improve the performance of anaerobic bioreactors to enhance digestion processes, respectively to increase the treatment efficiency of organic substrate, reducing hydraulic retention time, and, not least, increasing the volume of biogas and its quality [2].

This paper presents an experimental study on anaerobic digestion of alcohol corn distillery wastewater. Discharge of these wastewaters into surface emissaries without previous

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treatment leads to the decrease of dissolved oxygen content, which has a damaging effect on aquatic flora and fauna. The alternative implying their application directly on the land is also harmful, as it results in increased soil alkalinity and, consequently, in plant growth inhibition. So far published studies present either modeling or experimental research processes in laboratory conditions [3, 4].

2. METHODOLOGY

The paper presents the results of an anaerobic digestion experiment conducted on an operational model plant with a capacity of 133 dm^3 (Fig. 1). This model has a higher volume than laboratory facilities (4-5 liters), so that the experimental data obtained can be more accurately transposed to an industrial plant with the same operating conditions. This has practical importance because for the anaerobic digestion reactors there are no similitude criteria, as exists for reactors from chemical industry and other industries.

The model is a cylindrical metal tank with the ratio D/H of about 1.5, externally provided with an insulating layer of mineral wool, fitted with a protective coating made of aluminum. In order to achieve hydraulic and thermal homogenization of the mixture, it has been opted for a free propeller mixing system. Experiments have been performed in stationary regime, respectively the installation was fed and left to operate until the depletion of organic substrate.

Figure 1: Operational model of anaerobic digestion reactor

2.1 Organic substrate preparation

The substrate used for the anaerobic fermentation experiment was pot ale from a grain alcohol distillery (corn). This material is discharged from the alcohol distillation unit at a temperature of about 80°C, having a low microbiological load. The analyses carried out revealed the absence of methanogens [5]. Consequently, the substrate was inoculated with fermented organic sludge effluent from a biogas installation of a municipal treatment plant. The proportion of inoculum used was 10% and the organic substrate used had 89.8% humidity. Knowing that the optimum humidity from anaerobic digestion substrates is between 90 and 95% [6], it was chosen an organic substrate with a humidity of 92% and the substrate was diluted up to the established concentrations.

Substrates resulting from alcoholic fermentation of cereals are highly acid, with a pH between 3 and 4 [7]. The initial pH adjustment to the range favorable to the development of fermentation process (6.8-7.2) was made by controlled addition of 1N NaOH solution. This adjustment was continued during the first days of experiment by successive additions of alkaline solution until the pH reached the normal level.

2.2 Experimental procedure

The working parameters adopted for the experiment were: pH = (6.8-7.2), stirring = 60rpm and the temperature = 39°C.

Thus, the experiment was conducted at a temperature of 39±0.5°C. As a heat source was used an electrical resistance utilized to pipe heating, provided with a protective screen, having the specific power of 20W/m (low power resistance was chosen to protect the inside biological environment against high temperatures, namely up to 50°C). The constant temperature of the digestion process was maintained by using a digital thermostat, connected to a temperature sensor. The hydraulic and thermal homogenization of plant material was provided by a free propeller mixing system. Through a programmable timer, the operation regime was set as follows: 2 hours operation/2 hours break.

2.3 Temperature control

The initial temperature of the mixed material (distillery wastewater, inoculum and alkaline solution) used for installation feeding was 15°C. Reaching the proposed temperature range took 4 days. The factors that negatively influenced the temperature growth were low outside environmental temperature and proposed initial propeller stirring (40 rpm) speed, which did not provide complete homogenization of the substrate. By modifying the stirring from 40 rpm to 60 rpm, the increase of temperature until the proposed value was achieved in 2 hours.

3. RESULTS AND DISCUSION

The anaerobic digestion experiment with biogas production took place over a period of 120 days, and it was considered completed when the installation did not produce biogas for five consecutive days.

The parameters monitored during the experiment were: obtained biogas quantity, its composition, superior calorific power and physical-chemical evolution of the organic material used.

3.1 Analysis of the produced biogas

During the experiments it was monitored the amount of biogas produced in the digestion reactor. The results are shown in the chart below:

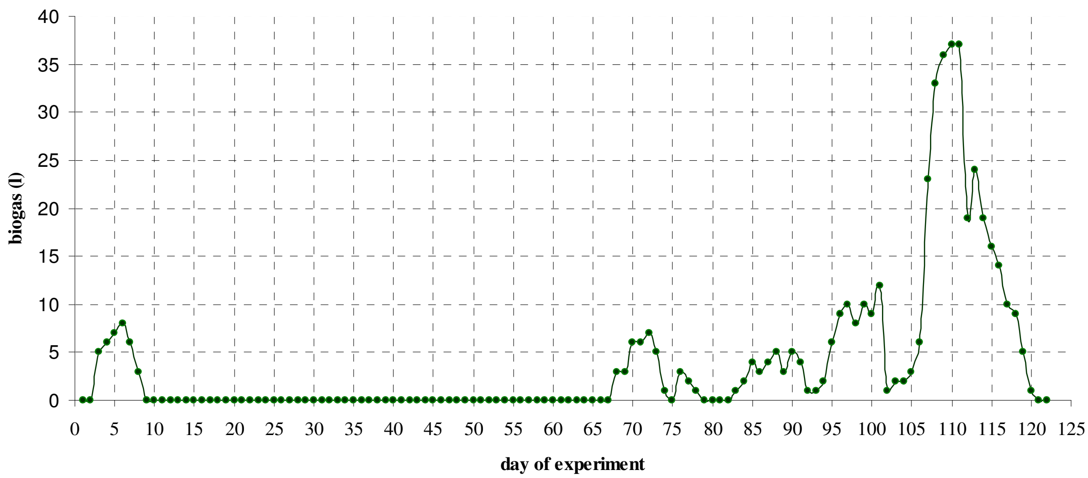

Figure 2: Dynamics of biogas production

Also, 4 gas samples were taken from the reactor and their composition is given in Table 1.

Table 1: Evolution of biogas composition during the digestion experiment

Day	CH_4 (%)	CO_2 (%)	O_2 (%)	CO (%)	H_2S (ppm)
day 7	13.40	30.20	8.08	20.00	296
day 73	74.30	13.40	2.70	0.00	10,000
day 84	63.90	18.40	3.60	0.00	0
day 115	58.00	39.30	0.10	2.00	5

As it can be seen, there are two stages of fermentation process evolution: an acidogenic fermentation phase, followed by a period of stagnation and then by a fermentation methanogenic process, with biogas generation. This development process is similar to the experiments carried out in laboratory conditions [8]. Reduction of biogas production in some days can be explained by scum formation on the substrate surface, which blocked the release of biogas for a given period of time. Under these conditions, the biogas accumulated in the fermentation substrate up to a certain pressure which caused the breaking of the scum. This phenomenon resulted in a significant rise of the produced biogas amount (e.g. 12 liters on day 101).

The calorific value, calculated at 15°C and 20°C, had an average of 4,700 kcal/m^3, with a maximum of 6691 kcal/m^3 for a concentration of 74.3% CH_4. The obtained values are similar to the ones reported in literature, being higher than the biogas produced in anaerobic digesters operating with manure [5].

Table 2: Superior calorific power of analyzed biogas

Day	CH_4 (%)	Superior calorific power	
		P = 101.325 kPa t= 15°C	P = 101.325 kPa t= 20°C
		kcal/m^3	kcal/m^3
day 7	13,4	1207	1185
day 73	74,3	6691	6570
day 84	63,9	5755	5651
day 115	58,0	5227	5132

3.2 Analysis of organic substrate

The chemical analysis required for the control process was carried out according to standard analysis methods. During the experiment, substrate samples have been collected and analyzed in terms of physical-chemical characteristics. The analyzed parameters were: pH, CCOCr (mgO_2/l) BOD_5 (mgO_2/l), total residue at 105°C and 550°C, volatile fatty acids (VFA-mg/L), total phosphorus (mg/l), total nitrogen (mg/l), calcium (mg/l), magnesium (mg/l), sodium (mg/l), potassium (mg/l), ammonium (mg/liter), nitrate (mg/l) and nitrit (mg/l). The results obtained are shown in Table 3

Table 3: Evolution of physical and chemical parameters of the substrate during the anaerobic digestion experiment

Quality indicators	U.M.	day 2 (feeding substrate)	day 7 (fermented substrate)	day 73 (fermented substrate)	day 119 (fermented substrate)
pH	-	6.68	7.05	8.53	7.68
CCOCr	mgO_2/l	75900	61600	33000	52800
BOD_5	mgO_2/l	32220	24165	18468	21062
total residue 105°C	mg/l	38354	29010	24620	34696
total residue calcinate	mg/l	25192	15264	11176	16464
VFA	mg/l	398.5	8064.5	8791.2	9785
Ptotal	mg/l	389.5	294.0	321.5	13.7
Ntotal	mg/l	1764.0	1720.0	1815.2	2170
Ca^{2+}	mg/l	78.22	77.8	83.6	94.3
Mg^{2+}	mg/l	42.0	40.5	35.4	10.3
Na^+	mg/l	1372.0	1236.0	6082.4	362.8
K^+	mg/l	153.0	149.0	198.0	29.8
NH^{4+}	mg/l	54.0	178.0	185.4	245.5
NO^{3-}	mg/l	5.3	18.3	<0.01	3.73
NO^{2-}	mg/l	0.42	7.3	<0.01	3.85

The removal efficiency of the organic content was 30% for CCOCr, 35% for BOD_5 and 35% for the calcined residue.

Volatile fatty acids (VFA), the initial value of 398 mg/l increased until the end of the experiment at 9785 mg/l. The final amount of VFA proves that the digestion process was carried out under optimal conditions and indicates that steady state is reached and maintained in a complex community of microorganisms, that contribute to methanisation reaction.

4. CONCLUSIONS

This paper presents the results of an experiment of biogas production from distillery wastewaters (corn residues). During the experiment it was examined the physical-chemical composition of the feed material and composition of the biogas produced. The quality of the biogas produced by the anaerobic digestion of grain wastewater is superior to the one resulting from the anaerobic digestion of municipal sludge and quite similar to the one produced from slaughterhouse waste. Calorific power of biogas obtained from studied substrate is about 5900 kcal/m^3 which is relatively close to the one of the bottled gas. The content of CO_2 is within reasonable limit and the content of H_2S is negligible. The treatment efficiency of the analyzed substrate is close to the value of treatment efficiency by anaerobic digestion of other types of liquids waste. In conclusion we can say that the distillery waste anaerobic digestion is a possibility of recovery of such wastes both in terms of energy and environmental protection.

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EXPLOSION RISK ASSESSMENT IN WASTE TREATMENT AND RECOVERY PLANTS

Liviu Valentin Bălănescu[1], Anghel Ion[2], Manuel Şerban[3], Cătălina Raluca Mocanu[4]

Abstract

The assessment of the explosion risks focuses on the formation of hazardous explosive atmospheres in the presence of ignition sources. In evaluation processes, the fact of examining the consequences is a secondary important thing, given that, it is expected always to cause considerable damages, from property damages to some damages that can harm your body, or even it can cause death. Regarding to the protection against explosion, the quantitative assessments are secondary in relation to the prevention of the formation of explosive and hazardous atmospheres.

1. Introduction

Biogas production from agricultural, municipal and industrial wastes contributes to sustainable energy production, especially when nutrients are used to keep the agricultural production process (Figure 1), [1].

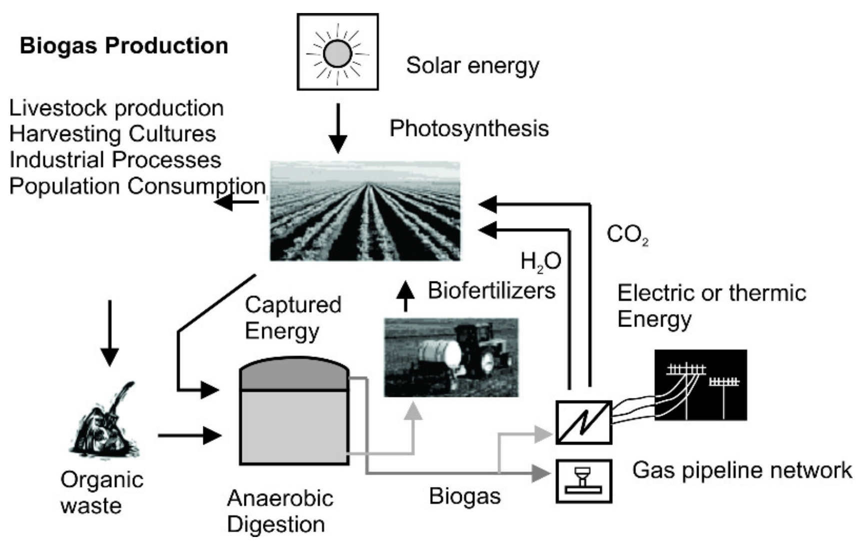

Figure 1: Schematic diagram of the biogas cycle

Following the production, process consumes little energy, so all the energy resulting from the production of biogas is large compared to the energy produced by other conversion technologies. The technology for the production of methane was imposed globally because of a wide range of raw materials from organic waste; the most frequently used is the animal manure from the stables. The main hazards associated with the production of biogas are possible explosion, asphyxiation, toxicity and other diseases. There are two forms of biogas,

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"landfill gas" which deposits are formed spontaneously in household and "fermentation gas" which are produced in bioreactors or fermenters.

Table 1: Biogas chemical composition

Compound	**Chemical formula**	**Concentration (%)**
Methane	CH_4	50-75
Carbon Dioxide	CO_2	25-50
Nitrogen	N_2	0-10
Hydrogen	H_2	0-1
Hydrogen sulphide	H_2S	0-3
Oxygen	O_2	0-1
Ammoniac	NH_3	0-1
Water	H_2O	0-10

Biogas composition depends considerably on the nature of the waste and processes and also varies over time. However, it is composed mainly of methane (CH_4) and carbon dioxide (CO_2). Also contain trace amounts of many other compounds, in particular hydrogen sulphide (H_2S) and / or organosulphur (mercaptans) in small portions (Table 1), [2].

2. METHODOLOGY

2.1. Methods for assessing the explosion risks

The methods to evaluate processes and technical facilities in terms of explosion risks should be based on a systematic approach to check the safety of installations and processes. A systematic approach means in this context that proceed in a structured manner on the basis of logical and rational considerations. The analysis is performed for existing sources that may lead to the formation of hazardous explosive atmospheres and possibly the presence of ignition sources active.

Evaluation criteria – assessment of risks explosions are performed whether or not known if ignition sources are present or may arise. For an explosion to occur dangerous nature, must be met following four conditions:

- A high degree of dispersion of the flammable substances;
- Concentration of flammable substances in the air within the combined explosion limits;
- Explosive atmospheres in dangerous concentrations;
- Active ignition sources.

To verify these conditions, in practice it can assess the risks of explosion through seven questions. The first four questions are used to check first if there is an explosion risk and whether explosion protection measures are absolutely necessary. If so, the following three questions for determining whether the safeguards provided reduce the risk of explosion at a safe level. When passing the assessment must take into account that safety criteria applicable for explosion protection are not valid, in general, than under atmospheric conditions. Security criteria can vary considerably other than atmospheric conditions.

2.2. Specific aspects of the explosion risk assessment in biogas plants

Methods of protection against hazardous materials are basic principles to prevent explosion. For biogas plants it consists in determining the explosive limits of mixtures of air-biogas. Explosion Limits pure substances can be found in literature, [4, 5]. However, security features are physicochemical properties such as mass or density, but depend on test methods, leading to the creation of an extensive database. To prepare the documents necessary for carrying device intervention in case of explosion, taking into account the characteristics of plants that have been determined by standard test procedures. If possible, the applicability of these data for biogas plants should be reviewed by authorized experts. The most important safety features of biogas components are summarized in Table 2, [3].

Table 2: Safety features of biogas components

Characteristic	**Measure unit**	**CH_4**	**CO_2**	**H_2S**	**NH_3**	**H_2**
Lower explosive limit (LIE)	Volume (moll %)	4.4	n.i	3.9	15.4	4.0
Upper explosive limit (LSE)	Volume (moll %)	17.	n.i	50.2	33.6	77.0
Auto ignition temperature	°C	595	-	270	630	560
Minimum Ignition Energy	mJ	0.29	-	n.c.	14	0.017
MESG	mm	1.14		0.83	3.18	0.29
Material class		2A	-	2B	2A	2C
Temperature class		T1	-	T3	T1	T1
Toxicity level	ppm(V)	n.t	>8 vol%*)	712	7338	n.t
Gas density		0.55	1.53	1.19	0.60	0.07

For explosion protection in biogas plants, it is often necessary to know the exact amount of explosion limits of gases in the air process. The composition of biogas produced from agricultural plants vary significantly, so each composition, explosion limits are determined experimentally, and this requires a lot of time and resources. A method is presented here, which shows that the explosion limits for different compositions of biogas can be evaluated using two charts. In addition to methane and carbon dioxide contained in the biogas can also find the water vapour. Limits, upper and lower explosion (LSE / LIE) are calculated based on airborne concentration of biogas, which, after spark ignition flame propagation does not appear. The interval between the lower explosion limit and the upper limit is known as the radius of the explosion. The area bounded by curves explosion limits is called blasting area.

Mixtures of any of the composition from the explosion area have an explosive and dangerous character. Explosion limits for substances such as methane, can be taken from previous experimental determinations, found in books or in some databases. For more complex mixtures of gases, such as "biogas", this data is not available, therefore, limits the explosion of methane are commonly used in practice. Take the LEL of methane because it has a LIE less than biogas. Upper explosion limit no longer do the same as for lower because biogas LSE is much higher than that of methane, which requires greater attention to the flow of air in contact with biogas. If it is known composition explosion limits of biogas can be estimated using the so-called "explosion diagrams". The interval between the LEL and LSE can be determined using several types of charts, the most common being triangular diagrams and charts using Cartesian coordinates, [4].

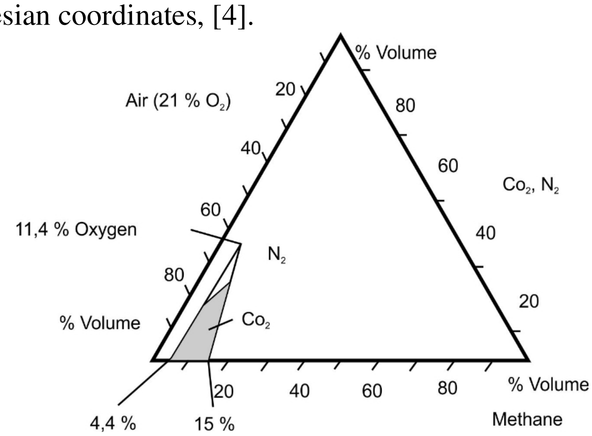

Figure 2: The range of explosion methane-carbon dioxide mixture-air at 25 °C

Already the first specification can be made using key data obtained from measurements. In case of biogas spillage in the environment, an explosive mixture may be formed only when it is exceeded the lower explosion limit of methane. The gases contained in biogas, with very low concentrations are added to methane concentration in the calculation procedure. For a better representation of the intersection points of the range of explosion limits usually used a diagram with Cartesian coordinates is used instead of a triangular diagram. This representation has the advantage of more accurate measurements and the intervals of explosion limits can be displayed in optimum size. The disadvantage of Cartesian diagram is that the representation of the axis of the third element is missing. Therefore, the concentration of air in the mixture can be achieved by decreasing the concentration of methane and carbon dioxide to 100 moll%.

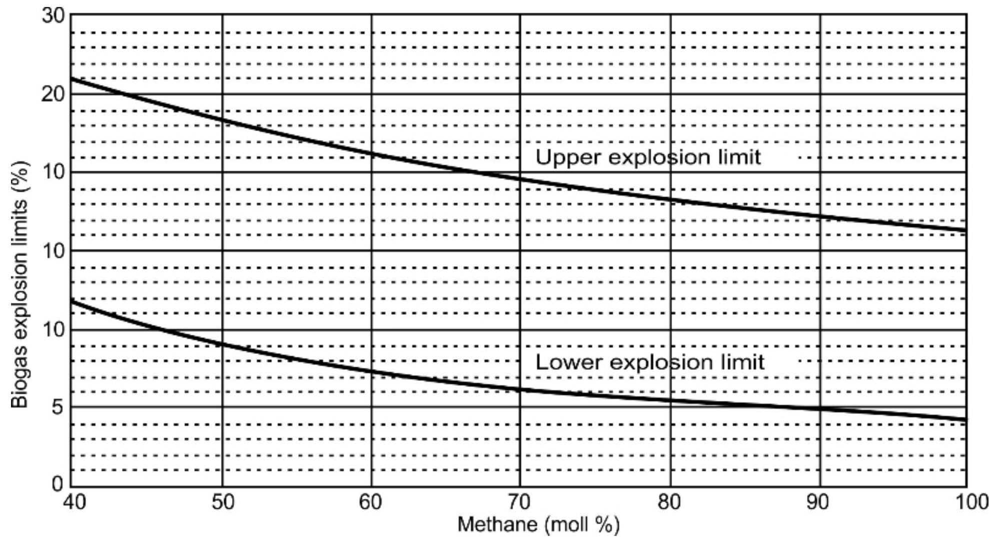

Figure 3: Explosion Limits of known biogas methane content [5]

Areas with explosive potentially explosive are classified according to the likelihood of a hazardous explosive atmosphere. There may be the possibility of a hazardous explosive atmosphere in a room, in this case the whole space is considered to be very explosive (Figures 4 and 5), [6, 7, 8, 9,10].

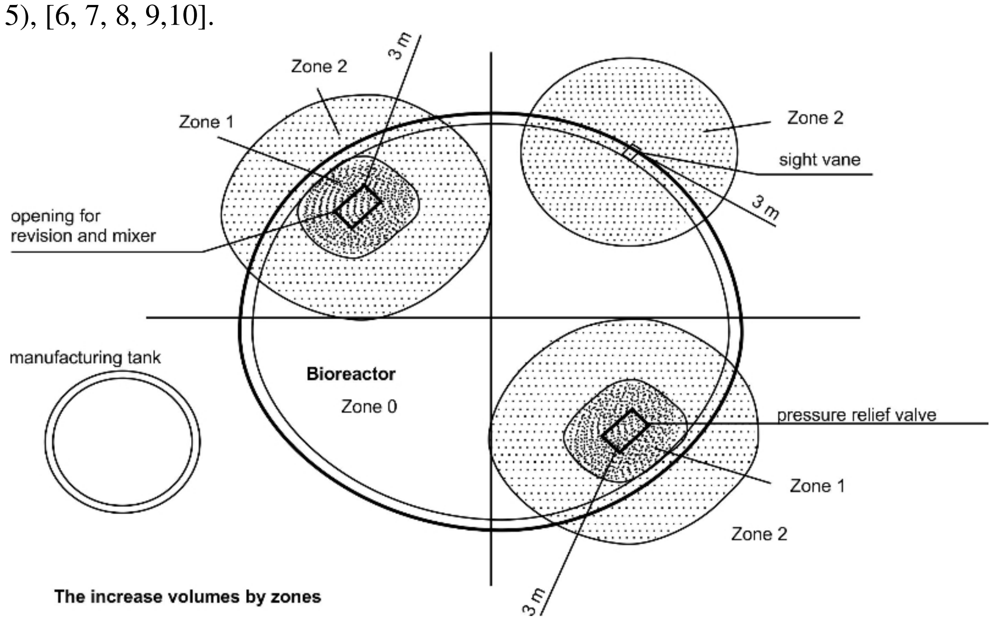

Figure 4: Classification in hazardous areas of a biogas plant places

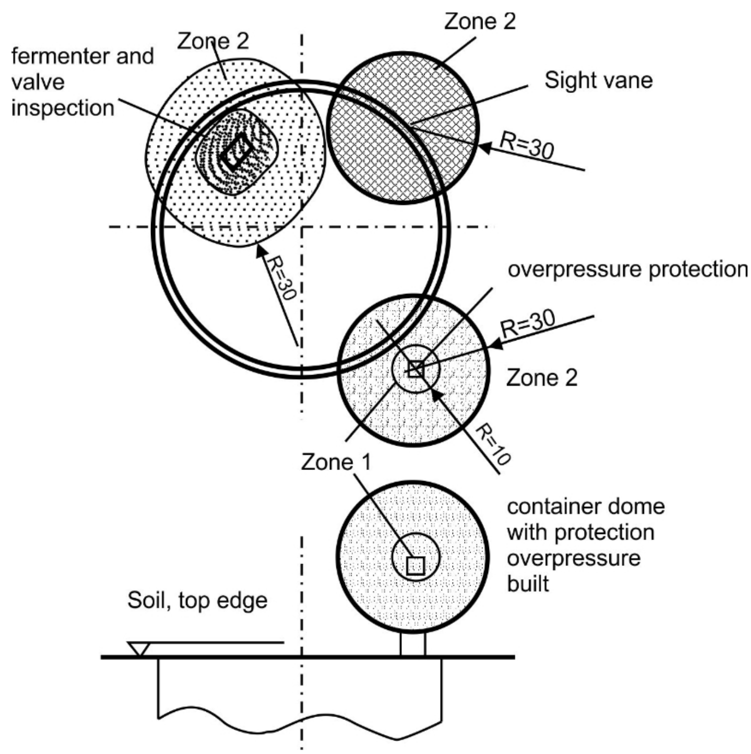

Figure 5: Top view of the fermentation vessel components

In biogas plants, gas tank, engine air intake for combustion chamber burner flame signal intermittent and found bioreactor operating under special conditions, are parts of the zone 0.

In terms of effective ventilation, zone 1 is placed up to 1 m from the components of plant, equipment, connections, fittings, sight glasses and access for maintenance and gas tank bioreactor, but only if the biogas leaks possible[11]. The area around the mouth of the exhaust pipe pressurized safety devices and gas burner are considered to be located in zone 1.

Zone 2 is located in the region of 1 to 3 m from the factory sealed components, equipment, connections, fittings and service outputs[12]. The holes (eg, holes for pumps used in the transport of raw materials) or basins, enclosed spaces where gas pipelines are installed and not venting are in zone 2.

Operating staff of biogas plants must ensure that no air enters the container or tank fermentation gas. All piping and equipment must be properly sealed to prevent gas leakage. There should be no place for smoking or equipment, including light switches, flashlights etc. All equipment must be explosion-proof type, because even the smallest spark can ignite the gas[13].

3. CONCLUSIONS

In biogas plants results large amounts of toxic and combustible gases, which generates fire and explosion hazard due to defects in design, materials used or because the checks. Methane is highly flammable and form explosive mixtures with oxygen in the air. Therefore, explosion protection is very important in biogas plants. For these reasons, the biogas must be prevented from entering work areas. Specific safety measures must be guaranteed during construction and operation of biogas plants.

The risk of explosion is particularly high close to digesters and gas reservoirs. In Europe bursts on safeguards set out in the European Directive 1999/92/EC. Potentially explosive areas are classified according to the probability of an explosive atmosphere. Source of ignition must be prevented and thus a small positive pressure prevents air into the bioreactor. A minimum pressure is fixed to avoid this event. The pressure inside the container for storing biogas is measured and transmitted to the control centre. Safety devices intended to prevent the huge increase in pressure that could lead to the destruction of the gas membranes.

Therefore, biogas plants are usually equipped with a hydraulic pressure valve. Moreover, in situations where there is an excess of biogas, which cannot be stored or used emergency ventilation device is the final solution to eliminate the risk of pressure biogas tank.

Acknowledgment

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ENERGY RECOVERING FROM TANNERIES BY BIODIESEL PRODUCTION

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ABSTRACT

Currently the most important environmental problem is even his protection. Biofuels have great potential for reducing pollution and improving engine performances. Biodiesel is a synthetic liquid biofuel that is obtained from natural fats such as vegetable oils or animal fats. Biodiesel can be mixed in different amounts with diesel derived from petroleum refining. Biodiesel provides large reductions in emissions of carbon monoxide, particulate matter, unburned hydrocarbons and sulphates.

1. INTRODUCTION

The degree of contamination of the resulting waste from tanneries is very important to treatment processes, reuse or their disposal. Most waste from tanneries are stored directly on the field or thrown in the woods. Some wastes are sold or their decontamination is being tried out for their use as raw materials in other industries. The nature and origin of imports skin are two factors on which the amount of fatty substances from the hypodermic tissue is decided. The content of fat cattle hides is low compared with pigs or sheep skins [1]. The fat content of the skin depends also on the geographic area. The skin of European countries have a low fat content of between 5% and 10% while the skins of Australia have a fat content between 20% and 40% [2].

Biodiesel fuels are an environmentally friendly alternative to diesel being much less pollutant. European Union imposed that by 2020, 20% of fuel used to be biodiesel, [3,4]. The processing of skins that contains fats, include mandatory recovery and removal of this animal fat into the environment. Biodiesel ensures proper engine lubrication thereby increases its lifetime. This biodiesel acts as a solvent releasing deposit from the combustion of diesel fuel submitted in fuel filters. When we use a diesel fuel, this filter should be checked regularly and changed more often, [5].

We can say that biofuel from animal fat is the most durable product because uses as raw material secondary products. The use of biofuels made from animal fats contributes to reducing greenhouse gas emissions, an idea supported by scientific studies done in this area. If biodiesel made from animal fat does not suffer any modification or if not any treatment is applied, it can sediment. However, the greater amount of saturated fat biodiesel made from animal fat provides greater stability to oxidation compared to its counterparts obtained from plant. Biodiesel is a fuel that can be used pure or mixed with diesel, [6,7].

2. METHODOLOGY

We use animal fats as feedstock for biofuel production. We must mention that animal fat is a residual product has many uses and is a valuable resource. As product, we have biodiesel which is not based on oil, it is composed of animal fats or vegetable oils. Approximately 8-

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10% of rendered fats available in the US are currently used for biofuel production, producing over 450 million litters of biodiesel. About 90% of Canadian production of biodiesel comes from animal fats [8]. Biodiesel based on animal fat has a higher cooling point than the herbal one.

Biodiesel is an alternative fuel that can be used in pure form or in mixture with the classical diesel fuel when it is burned in an internal combustion engine, or fuel for boilers when it is used for domestic purposes [9]. Animal fats are a significant amount of waste from tanneries. The amount of energy that they have transforms these animal fats into an important energy source with great possibilities of recovery, either as raw material or as oils.

Table 1: Characteristic properties of biodiesel fuel obtained from animal fats

Property		Fuel*)								
		Diesel	MER	EER	MEC	EEC	MEGA	EEGA	MES	EES
Characteristic properties of fuels										
Density		0,8495	0,8802	0,876	0,881	0,878	0,874	0,869	0,886	0,881
Viscosity at 40°C mm^2/s		2,96	5,65	6,17	4,754	4,892	4,814	5,036	3,891	4,493
Cloud point °C		–12	0	–2	1	–1	16	14	3	0
Freezing point °C		–16	–15	–10	–9	–6	16	12	–3	–3
Flash point °C		74	179	124	163	177	160	185	188	171
Boiling °C		191	347	273	334	346	313	327	339	357
Water and sediments %v		<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Coke number %m		0.16	0.06	0.06	0.065	0.07	0.056	0.052	0.068	0.071
Ash %m		0,002	0,002	0,002	0,002	0	0,001	0	0	0
Sulphur %m		0,036	0,012	0,014	0,009	0,009	0,01	0,009	0,012	0,008
Iodine index g/100g,cb			91,9	96,7	102,8	101,6	49,1	47,2	103,6	nedet.
Cetane number CC		49,2	61,8	64,9	57,9	59,6	72,7	72,4	54,8	52,7
Caloricity H_i MJ/kg		42,90	37,77	38,00	37,23	37,62	37,25	37,63	37,04	37,44
Impurities, mg/ℓ	Total	0,9	1,0	1,9	0,9	1,1	1,9	0,8	0,9	1,1
	incombustible	<0.1	<0.1	0.9	0.1	0.1	0.9	<0.1	<0.1	0.1
Composition %m	Nitrogen ppm		6	11	12	12	9	10	1	2
	Carbon	86,67	78,7	76,83	77,67	76,71	76,42	76,58	82,44	83,4
	Hydrogen	12,96	12,66	11,8	12,57	11,38	12,59	11,57	12,9	11,87
	Oxygen	0,33	9,22	11,36	9,75	11,9	10,98	11,84	4,65	4,72
Characteristic properties of esters										
Esterification proportion			98,02	94,75	96,35	92,31	97,8	95,62	98,17	94,54
Free glycerine %m			0,4	0,72	0,71	0,52	0,2	0,2	0,62	0,7
Total glycerine %m			0,86	0,93	0,87	1,18	0,6	1,42	0,75	1,88
Free fatty acids %m			0,57	0,58	0,42	0,42	0,37	0,39	0,6	0,21
Monoglycerides %m			0	0,58	0,78	1,55	0,22	1,42	urme	1,85
Diglycerides %m			1,35	1,33	1,88	1,54	0,81	1,68	1,41	2,02
Triglycerides %m			0,45	2,17	0,76	2,42	1,16	0,99	0,05	1,38
Content of alcohol %m			<1	<1	<1	<1	<1	<1	<1	<1

Composition in fatty acids	Miristic (14:0)		0,0	0,0	0,0	0,0	3,0	3,0	0,0	0,0
	Palmitic (16:0)		2,2	2,6	4,0	4,0	23,3	23,6	9,9	10,0
	Stearic (18:0)		0,9	0,9	2,4	2,4	17,9	18,0	3,8	3,8
	Oleic (18:1)		12,6	12,8	65,0	65,1	38,0	38,5	19,1	18,9
	Linoleic (18:2)		12,1	11,9	17,3	17,4	0,0	0,0	55,6	55,7
	Linolenic (18:3)		8,0	7,7	7,8	7,6	0,0	0,0	10,2	10,2
	Eicosenoic (20:1)		7,4	7,3	1,3	1,3	0,0	0,0	0,2	0,2
	Behanic (22:0)		0,7	0,7	0,4	0,4	0,0	0,0	0,3	0,3
	Erucic (22:1)		49,3	49,5	0,1	0,2	0,0	0,0	0,0	0,0

*) Compared to diesel produced by the American company Phillips 66; MER - methylester of rapeseed oil; EER - ethyl ester of rapeseed oil; MEC - canola oil methyl ester; EEC - canola oil ethyl ester; MEGA - beef fat methylester; EEGA - ethyl ester of beef fat; MES - methyl ester of soybean oil; EES - ethyl ester of soybean

Animal fat is often the largest share of waste from the tannery. Animal fats contain largely triglycerides of saturated fatty monocarboxylic, even number of carbon atoms (C12-C18) that are predominantly palmitic and stearic acids [10]. Oils of animal nature are part of oxygenated fuel containing between 4 and 12% oxygen according to the origin of the oil, table 1. The use in whole or in mixture with diesel emissions can improve smoke and particulate matter PM, carbon monoxide CO and CO_2 carbon dioxide, but also sulphates SO_4. Howell and Weber argue that biodiesel is biodegradable in 95% in 28 days while diesel is biodegradable at a rate of only 40% in the same time [8]. We can say that this fuel are 98% biodegradable in 21 days and therefore does not affect environmental quality.

Raw animal fat contains a large amount of fat, salt free fatty phosphatides, wax etc, this resulting in a very high viscosity about 10 times longer than diesel, which is associated with a final raised boiling point about 4 - 5 times higher than diesel which creates difficulties in the engine functioning in good conditions favouring the formation of deposits: spraying will be impaired resulting droplets with an average diameter that will vaporize relatively high weight and fuel air mixture will be difficult and will be very heterogeneous. In high-temperature conditions part of the gas molecules recombines to form other compounds that enhance the deposition of carbon into the holes of the injector of the combustion chamber, etc. On the other hand, at the use of raw animal fats the engine has less power than when oil supply because of the low calorific value, is about 10% lower than that of diesel.

We can determine the properties of biodiesel from animal fat oil mixtures in different proportions and by calculation [11]. In Table 2 we presented the comparative properties of diesel and biofuels animal nature. Limiting fat weight mixed with diesel required viscosity is up to 40% (weight %). On the basis of the additively rule, physical characteristics of mixtures can be determined. The mixtures were coded by two letters and two numbers: FF-XX-XX FN1 and Fn2-XX, who meanings: FF -it refers to edible fats, NF 1 and NF 2 refers to two types of inedible fats and numbers (10, 20, 30, 40) are percentages by mass of animal fats in the mixture [12].

Describing each of the mixtures made, based on the knowledge of the properties of pure components that make up the mixtures (theoretical), the properties of the mixtures were determined by the additive rule on a physical property:

$$P_{(T)} = x\ P_{1(T)} + (1-x)\ P_{2(T)} \qquad (1)$$

where: $P(t)$ is the theoretical physical property of the mixture, $P_{1(t)}$ and $P_{2(t)}$ are the respective physical properties of the gas oil and animal fat, and x is the mole percentage of animal fat in the mixture [1].

Table 2: Properties of animal fat and diesel

Property	Method	Type of fat / diesel			
		FF	**NF1**	**NF2**	**Diesel**
Density at 15°C (kg/m^3)	ASTM D-4052	912	916	910	848
Density at 35°C (kg/m^3)	ASTM D-4052	899	904	898	636
Kinematic viscosity at 40°C (mm^2/s)	ASTM D341-09	40.88	51.97	41.64	2.71
Kinematic viscosity at 100°C (mm^2/s)	ASTM D341-09	8.45	9.06	8.64	1.2
S [%] weight	ASTM 1552	0.03	0.04	0.03	0.07
C [%] weight	ASTM 5291	76.7	75.1	75.2	86.6
H [%] weight	ASTM 5291	11.6	11.6	11.7	12.33
O [%] weight	ASTM 5291	11.4	12.9	13.0	1.04
N [%] weight	ASTM 5291	0.2	0.16	0.05	-
Ash	EN 6245	0.002	0.17	0.002	-
Low calorific power (MJ/kg)	ASTM 240	36.89	36.3	36.5	42.3

Because diesel mixtures - animal fats cannot be considered Newtonian liquids for viscosity are used the measurement results from laboratory, [11]. Because of the high viscosity, use of animal fat from diesel engines is now possible to mix with fuel oil to provide a low viscosity which can be used in conventional mechanical injection diesel engines [13].

Table 3: Properties of different mixtures of animal fats-diesel

Name	C [%]	H [%]	O [%]	S [%]	Density (15°C) (kg/m^3)	Viscosity (100°C) (mm^2/s)	Low calorific power (MJ/kg)
FF-10	85.61	12.23	2.06	0.06	854.3	1.36	41.7
FF-20	84.63	12.17	3.08	0.06	861.6	1.62	41.3
FF-30	83.65	12.09	4.12	0.05	865.9	2.05	40.6
FF-40	82.67	12.03	5.14	0.05	873.2	2.45	40.1
FF-50	81.75	11.95	6.18	0.05	889.5	3.12	39.6
FF-100	76.80	11.6	11.3	0.03	911.0	8.61	36.9
FN1-10	85.48	12.24	2.23	0.07	854.8	1.36	41.7
FN1-20	84.30	12.16	3.40	0.05	861.6	1.64	41.11
FN1-30	83.15	12.09	4.59	0.06	868.4	1.95	40.57
FN1-40	82.05	12.02	5.78	0.05	875.2	2.44	39.98
FN1-50	80.85	11.94	6.965	0.06	882.0	3.13	39.32

FN1-100	75.1	11.6	12.9	0.04	916.0	9.06	36.31
FN2-10	85.43	12.24	2.23	0.06	860.3	1.38	41.76
FN2-20	84.30	12.18	3.42	0.06	860.4	1.60	41.1
FN2-30	83.15	12.12	4.62	0.06	866.6	1.89	40.55
FN2-40	82.00	12.06	5.82	0.05	872.8	2.46	40.08
FN2-50	80.83	12.00	7.02	0.03	879.0	3.10	39.40
FN2-100	75.12	11.73	13.2	0.03	910.0	8.64	36.53

The properties of the three types of fats in Table 2 show that they are very similar. The main difference with diesel appear viscosity value and oxygen content, which influences spraying and burning. In view of higher oxygen content compared to gas oil, the theoretical amount of combustion air is reduced. Due to the high viscosity, use of animal fat from diesel engines is now possible to mix with fuel oil to provide a low viscosity which can be used in conventional diesel engines with mechanical injection, as the properties shown in Table 3, mixtures of oil and fats. From Table 3 shows that all 3 types of animal fat mixed with diesel have approximately equal value for inferior calorific heat.

Density at 15°C for all types of blend has similar values. What appears to be different but not too much, is viscosity: for FF-100 viscosity of 8,61mm^2/s, for FN1-100 viscosity is 9.06mm^2/s and for FN2-100 viscosity of 8.64mm^2/s. According ASTM, users recommend 5% biodiesel mixed with animal fats, while some of them go even further with 20%. In the future biodiesel wants to be used in local public transport, public vehicles, agricultural vehicles, military vehicles and tanneries.

3. CONCLUSIONS

One of the main advantages of biodiesel is that it is a clean fuel and its use considerable reduces emissions compared to diesel. Other advantages are that successfully replaces diesel or petrol, is safer to handle than diesel, is biodegradable because it is made from renewable resources and its quality is regulated by the ASTM D 6751. The disadvantages are that it has a high viscosity and thus pumping more difficult, higher cloud temperature value that can pose problems when starting the engine at low temperatures, has a rate of emissions of nitrogen oxides higher.

If we take into account the advantages of biodiesel regarding environmental protection through both lower amount of pollutants they emit diesel engine fuelled with such a fuel, but also because it is biodegradable and its burning follows in natural cycles of CO_2, we would be tempted to believe in an immediate and massive replacement of diesel but we also must have in mind the sources to obtain this fuel and their price compared to oil.

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THE ANIMAL FATS USE AS FUEL AT DIESEL ENGINE

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ABSTRACT

Bio-diesel fuel is an alternative on petrol base fuels being obtained from vegetable oils, animal fats, used oils from restaurants etc. Animal fats represent heavy wastes in tanneries. With a high energetically value, animal fats may constitute an energetically source with big capitalization possibilities as raw material (used with high precaution) or even as oils obtained from ester interchange with an alcohol (biodiesel) with higher perspectives in use as fuel at diesel engines. Animal fats utilizing can be done in raw state or manufactured. In the paper are presented some results of raw animal fats use at IT9-3M experimental engine. The applied method for the use of animal fats as fuel for diesel engine was the method of preheating and blending of animal fat with gas-oil in different proportions. Were used animal fat-diesel fuel blends in volumetric proportions up till 15%. At the use of animal fats in engine a slightly decrease of maximum pressure and indicate mean effective pressure and of the pollutant emissions were obtained.

1. INTRODUCTION

Continuous reduction of non-renewable petrol reserves, increasing costs and the more severe regulations for pollutant emissions and greenhouse gases intensify the preoccupation with some energy alternative sources developing. In this context the biodiesel derived from biological sources as animal fats and oils has received a special attention. Different procedures for biodiesel produce from prime materials as fats and oils with different compositions and properties are used [1].

In 2007, the European Council establish a series of ambitious objectives for 2020, under the name of ***„20-20-20"***, which prescient the reduction with 20% of greenhouse gaseous emission, of primary energy consumption by energetically efficiency increasing and to promote the increasing at 20% of the energy consumption from renewable resources. The European Parliament by 2009/28/CE Directive establishes as objective for 2020 that 20% from the final energy should be from renewable sources. The directive promotes the energy generated by biofuels and bioliquids. Thus, increases the interest for energy alternative resources, with a special interest for animal fats due to a high potential in prime materials of animal fats provided from abattoir and merchantry, prime materials that can be capitalize in this way in an efficient way. Capitalization of the used oils and greases from restaurants and of the animal fats for biodiesel production is also justify by the relative high prices of 34-59 €/ton for removing these materials by burning or depositing [2].

Animal fats are majority constituted from triglycerides of saturated monocarboxylic fat acids with even number of carbon atoms (C12-C18) in which palmitic and stearic acids are predominant [3]. Vegetable and animal oils are in the category of the oxygenated fuels (with a content of 4 till 12% oxygen, depending on provenance), table 1. By using them integral or in blends with diesel fuel it can be reduced the emissions level of smoke, particles PM, nitric oxides NO_x and sulphates SO_4 (due to the absents of sulphur in their composition). These fuels are biodegradable comparative to the fossil fuels (98% in 21 days versus only 50% for

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diesel fuel [4], [5]) so therefore they don't affect the environment quality. During the worldwide show in 1900 Rudolf Diesel used the pecan oil as fuel for a diesel engine fuelling, [6], [7] and even since 1912 he prescience the possibility of use vegetable oils and of other fuels instead mineral oil fuels [5], [6].

Table 1: Characteristic properties of the biodiesel fuels obtained from animal fats [9]

Property		Fuel*)								
		Diesel fuel	MER	EER	MEC	EEC	MEGA	EEGA	MES	EES
Specific properties of the fuels										
Density [g/mℓ]		0.8495	0.8802	0.876	0.881	0.878	0.874	0.869	0.886	0.881
Viscosity at 40°C [mm^2/s]		2.96	5.65	6.17	4.754	4.892	4.814	5.036	3.891	4.493
Thick point [°C]		–12	0	–2	1	–1	16	14	3	0
Congealing point [°C]		–16	–15	–10	–9	–6	16	12	–3	–3
Ignition point [°C]		74	179	124	163	177	160	185	188	171
Boiling point [°C]		191	347	273	334	346	313	327	339	357
Water and sediments [%(v)]		<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Coke number [%(m)]		0.16	0.06	0.06	0.065	0.07	0.056	0.052	0.068	0.071
Ash [%(m)]		0.002	0.002	0.002	0.002	0	0.001	0	0	0
Sulphur [%(m)]		0.036	0.012	0.014	0.009	0.009	0.01	0.009	0.012	0.008
Iodine number [g/100g, fuel]			91.9	96.7	102.8	101.6	49.1	47.2	103.6	undefined
Cetane number **CN** [-]		49.2	61.8	64.9	57.9	59.6	72.7	72.4	54.8	52,7
Caloric power $\mathbf{H_i}$ [MJ/kg]		42.90	37.77	38.00	37.23	37.62	37.25	37.63	37.04	37.44
Material impurities, [mg/ℓ]	Total	0.9	1.0	1.9	0.9	1.1	1.9	0.8	0.9	1.1
	Incombustible	<0.1	<0.1	0.9	0.1	0.1	0.9	<0.1	<0.1	0.1
Composition [%(m)]	Nitrogen ppm		6	11	12	12	9	10	1	2
	Carbon	86.67	78.7	76.83	77.67	76.71	76.42	76.58	82.44	83.4
	Hydrogen	12.96	12.66	11.8	12.57	11.38	12.59	11.57	12.9	11.87
	Oxygen	0.33	9.22	11.36	9.75	11.9	10.98	11.84	4.65	4.72

*) diesel fuel for comparison produced by American company Phillips 66; MER – methyl ester of colza oil; EER – ethyl ester of colza oil; M EC – methyl ester of canola oil; EEC – ethyl ester of canola oil; MEGA – methyl ester of beef fat; EEGA – ethyl ester of beef fat; MES – methyl ester of soya-bean oil; EES – ethyl ester of soya-bean oil

Oils of animal origin are secondary products of food industry and of the tannery. The capitalization of animal origin oil for fuel production (biodiesel) for diesel engines is tantalizing not only due to its properties closer to diesel fuel properties but also for stabilization in furnishing, the meat production assuring an increasing flux of suet and animal fats.

Even in a comparative way to fossil fuels biofuels are available only on a niche market, they have a great potential on environmental pollution reduction and engine performance improvement, preoccupations in this way being more intensive. In Germany at Malchin, at the end of 2001, SARIA Bio-Industries GmbH starts to produce biodiesel fuel from animal fats (TME) at high standards in accordance with EN 14214 regulations for methyl esters of fat acids. The annual production capacity is over 12000 tone of biodiesel from animal fats. In order to use animal fats at low ambient temperature, under 8^{o}C, the TME diesel fuel mixtures were be used. The developed tests on a fleet of 1000 trucks show that TME is a biofuel which can be used at diesel engines with benefic effects on environmental pollution reduction and without affecting the engine reliability [8].

Raw animal fats contain a great quantity of lipids, free fat salts, phospholipids, stearines, wax, etc. which makes that their viscosity to be very high (of 10 times higher versus diesel fuel) which associated with a rise final boiling point (of 4-5 times higher comparative to diesel fuel) implies difficulties in engine running in good conditions favoring deposits forming: the atomization will be defective resulting drops with relative high average diameter which will vaporize difficulty, and the air-fuel mixture will be hardly developed and will be very heterogeneous; at high temperature a part of fuel molecules starts to recombine and form other compounds which amplify the carbon deposits inside the injector nozzle, combustion chamber, on piston and valves, etc.

On the other hand at the raw animal fats use the engine produces a lower power comparative to diesel fuelling (the animal fat lower heating value is with almost 10% lower comparative to diesel fuel, but the stoichiometric air quantity for combustion is lower which allows the attenuations of power reduction thru the increasing of the fuel cycle dose at the same air-fuel ratio) and emits a larger quantity of particles PM because of the autoignition delay increases and because of a very heterogeneous mixture, exists the great possibility of missing ignitions occurs which leads to the unburned fuel that one part of it will be evacuated with the exhaust gases and of the other parts that will be deposited on the cylinder walls and reaching to the oil. In this way also the oil quality may be affected.

A major difficulty that appears on raw animal fats use is constituted by the higher filterability number (CFPP) which makes them improper to use at temperatures bellow +10°C.

The main difference between diesel fuel and animal fats is the viscosity. At 40°C, the viscosity of animal fats is over 10 time’s higher comparative diesel fuel. This property has a major impact on atomization and combustion process. At ambient temperature, the animal fats are generally solid.

Methods that allow the use of vegetable oil and animal fats with high efficiency at diesel engines are [10]:

- biodiesel – alcohol blends use;
- use of emulsions biodiesel with alcohols and water;
- fuel preheating;
- use of diesel fuel-biodiesel blends;
- fuel chemical modification (transesterification).

Oils blending with alcohols is a simple process, but from the speciality trade literature data’s with this procedure was not obtaining a significant improvement of the energetically performance and pollution reductions. Also, the increase of alcohol quantity in blend with oil leads to the separation of the phases.

Emulsification is an attractive method of animal fats use as fuel for diesel engines since is a simple method that don’t require engine design modifications, and the knowing results shows the simultaneous reduction of smoke and NO_x emissions. The properties of emulsions are improved by blending alcohol with oil and with water in different proportions during the preparation process.

The preheating method offers the advantage of high viscosity fuel use at diesel engines without major design modifications. The known researches show that by preheating of the animal fats and of the vegetable oils an effective efficiency improvement was obtained and the reduction of smoke and particle emissions is achieved.

The use of blends from diesel fuel and biodiesel obtained from animal fats, in different proportions at the diesel engine fuelling, represents a viable solution for pollution reduction with the maintaining of the power performance. Not requiring engine design modification is an advantage of the method. When the fats are melted at a temperature over 38°C, these are completely soluble in diesel fuel, the blending being very homogeneous [2].

The method of chemically preparation by esterification significantly reduces the viscosity and improve cetane number and other physical properties, but is a complex and difficult process. This fuel, generically named biodiesel, has the viscosity closer to the diesel fuel and the final boiling point lower comparative to raw oils (t_{90}=327°C for ethyl ester of beef fat, cetane number closer or even higher comparative to diesel fuel, table 1, and a low CFPP, which allow the use of its during the cold season.

Raw animal fats can be use as single fuel or in addition with diesel fuel at diesel engines with the condition of preheating at relative high temperatures so that their viscosity to be closer to the diesel fuel, or by emulsifying with alcohols, methanol/ethanol.

Experimental researches regarding the animal fat use were performing in the laboratory of internal combustion engines from the University POLITEHNICA of Bucharest.

In the paper are presented some results of raw animal fats use in the IT9-3M experimental engine. The method applied for animal fats use as fuel for diesel engine was the preheating method and blending with diesel fuel in different proportions.

2. METHODOLOGY

The method applied for the use of animal fats as fuel for diesel engine was the method of preheating and blending with diesel fuel in different proportions.

Properties of autoignition and combustion of the animal fats were determinate on an IT9-3M experimental diesel engine (swept volume 652 cm^3, speed 900 rev/min, compression ratio ε= 7...23). Blends of diesel fuel and animal fats in different volume percents of 5%, 10% and 15 % were used. In order to realize these blends, the animal fats were heated at a temperature of 45-50°C.

For engine in-cylinder pressure recording an AVL real time data acquisition system was used. The used angle encoder is a speed incremental transducer, Kübler type, model 5802 A, mounted on the engine crankshaft. The analysis of the burned gaseous was achieved by a gas analyzer AVL DiCom 4000 type. The experimental researches were effectuated in conditions of maintaining constant the compression ratio, ignition timing and volumetric cycle dose of fuel. In figures 1…4 are presented the variation diagrams of maximum pressure, of indicate mean effective pressure, NO_x and smoke emissions versus the volumetric percent of animal fats in blend with diesel fuel.

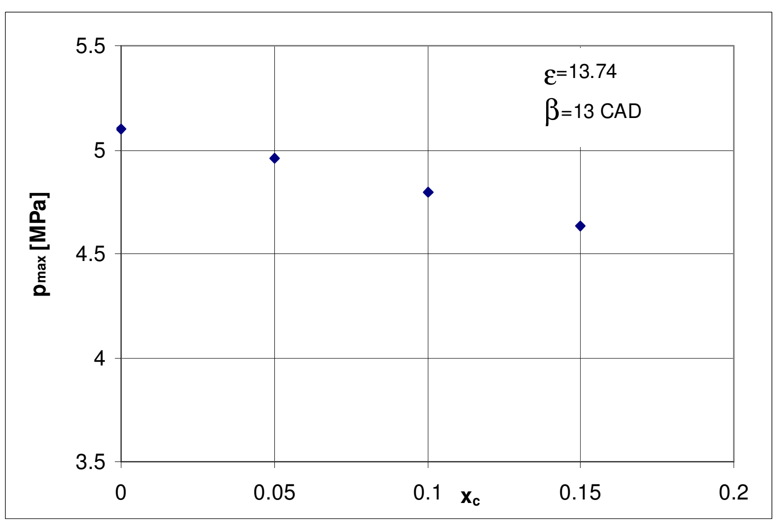

Figure 1: Maximum pressure vs. different substitute ratios $\mathbf{x_c}$

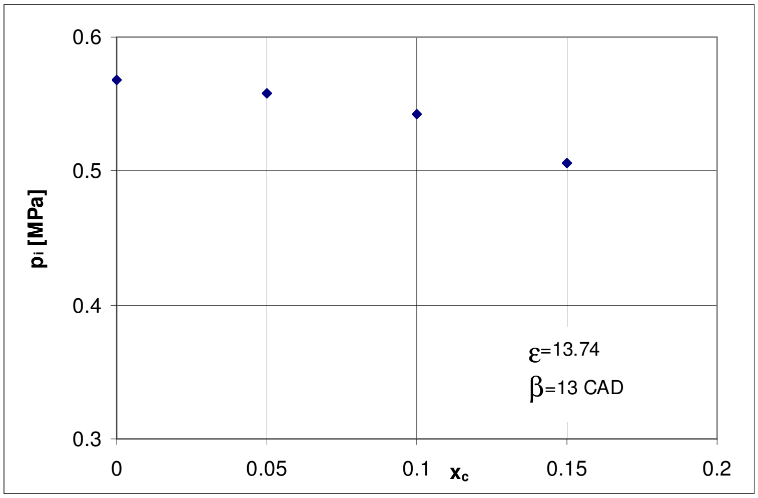

Figure 2: Indicated mean pressure, p_i, vs. different substitute ratios $\mathbf{x_c}$

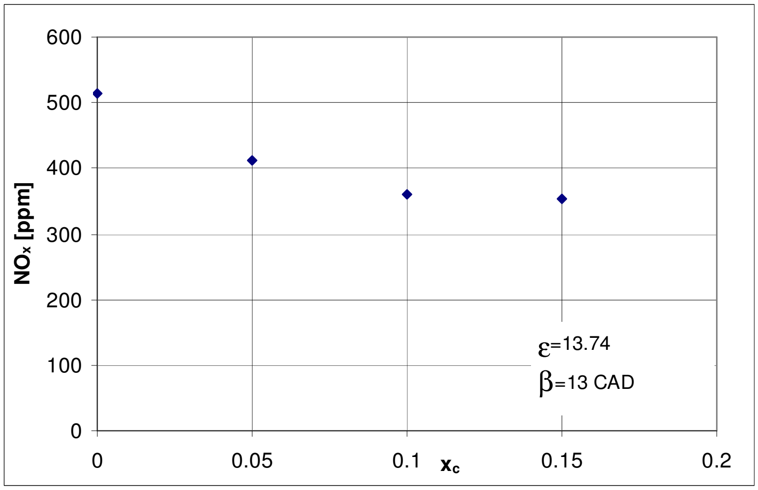

Figure 3: NO_x emissions level vs. different substitute ratios $\mathbf{x_c}$

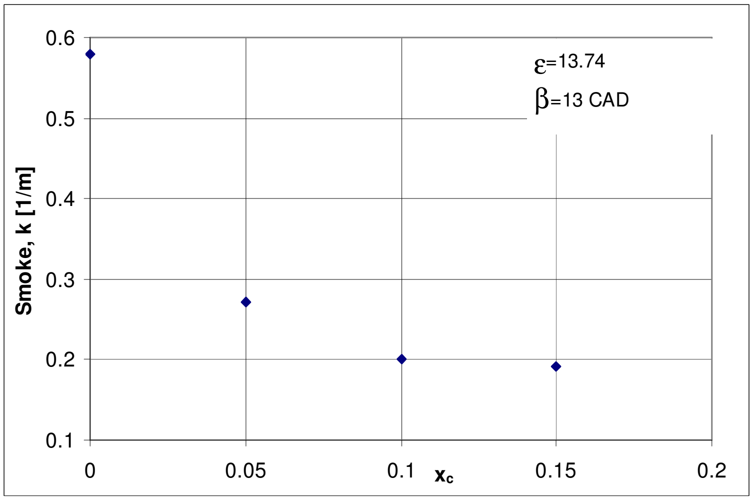

Figure 4: Smoke emission level vs. different substitute ratios $\mathbf{x_c}$

At the increase of the animal fats percent in blend with diesel fuel the maximum pressure and indicated mean effective pressure because of the autoignition delay increases, the combustion being displaced into the detent process and of the reduction of the combustion heat release quantity per cycle, figure 1 and figure 2.

Reduction of the NO_x emissions, figure 3, is determinates by the reduction of the premixed mixture quantity which burns during the rapid combustion phase due to a more difficult vaporization of the animal fats and by the reduction of the gases temperature.

The higher oxygen content from animal fats and the increasing of the air excess coefficient at the increases of the animal fats percent in blend with diesel fuel explains the smoke emission reduction.

3. CONCLUSIONS

Animal fats existing in the discards of the tannery's, abattoirs and from the food industry may be energetically capitalized by their utilization as fuel for diesel engines. Raw animal fats can be use as fuel in addition to diesel fuel for diesel engines by preheating at relative high temperatures so that their viscosity riches the diesel fuel viscosity. At the use of animal origin fats in blend with diesel fuel on an experimental diesel engine the following conclusions can be formulated:

- increasing of the autoignition delay at the increment of the animal fats percent
- the gases maximum pressure decreases
- NO_x emissions decreases at the increases of animal fats percent
- smoke emission decreases at the increases of animal fats percent.

For diesel fuel-animal fats blends engine fuelling are not required modifications of the engine design.

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IMPROVEMENT OF WASTEWATERS TREATMENT PROCESSES – KEY FACTOR OF ENVIRONMENTAL PROTECTION

Gheorghe Coara [1], Catalina Raluca Mocanu [2], Ferit Ölçer[3], Margareta Stela Florescu[4]

ABSTRACT

Wastewater treatment is a complex process based on physical, chemical and biological phenomena by which materials are dissolved and dispersed in the aqueous medium retained and neutralised so that their discharge into the environment should not bring any harm to people, flora and fauna. Given the large share that biological stage has in the total energy consumption throughout the treatment plant - over 50% - , this paperwork focused on increasing the efficiency of the treatment in this area. This study was made using the Greenbass energy efficiency program for adjustments of activated sludge aerations system. This program is used to fight climate change by reducing greenhouse gas emissions and thus the environmental impact.

1. INTRODUCTION

Romanian strategy for adapting the European Union standards implies the necessity of solving the problems involving the environmental issues by upgrading existing technologies, developing and commissioning of new installations, raised performances of services offered tailored to the requirements of environmental norms. Given the existing studies, the biological reactors from the wastewater treatment biological stage use about 40-70% of total energy consumption of the treatment plant [1, 2].

Treatment efficiency refers to the entire plant - the overall effectiveness of the treatment, or as unitary process: restraint grills, sedimentation, fat separation, removal of organic matter, etc. For each unitary process is determined the efficiency of restraint which can have values between 50...98% depending on the installation and proper equipment technology, [3]. It is obvious that under present conditions it is desired that the efficiency of restraining and neutralizing be as high as possible in order to protect the environment.

2. METHODOLOGY

For research, it was chosen Mangalia Wastewater Treatment Plant, which were pursued all technological processes that occur, the problems of the treatment plant design, monitoring and functioning, treatment technologies and also design problems using numerical programs calculation.

Mangalia Wastewater Treatment Plant has as first treatment the mechanical stage (manual cleaning of the grate, sand separator and pumping station). The following steps are: biological treatment stage and sludge treatment stage. Primary clarifiers, specific equipments for biological treatment stage and sludge treatment were completed later in 1979. Since then, minor changes and extensions have been made, and in 1998 was implemented water line rehabilitation program.

Biological treatment stage consists of an activated sludge treatment process, which is divided into 5 lines that run in parallel. Since the entrance, the wastewater is distributed to each line using manual activated gates..

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Aeration basins have 5 lines equipped with fine aeration system and control system of the oxygen. In winter time the total age of the sludge is estimated to be more than 30 days, when all 5 basins work, which means that in the winter there could appear a nitrification and partial denitrification process when the temperature is higher than 7-10°C.

Nitrification-denitrification process will take place in the same tank by alternating the aeration. Nitrification process is oxygen consuming, which means that the oxygen control system that regulates the air supply must be at the minimum level of oxygen of 1.5 O_2 mg/l. Denitrification process, requires creation of conditions without oxygen which means that the air supply system must be disconnected and the activated sludge stored in the tank.

Wastewater treatment technologies are based on a series of unitary processes of physical, chemical and biological nature. To achieve the ultimate goal of retaining and neutralization of mineral and organic bodies dispersed in the aqueous medium, since the stage of conception and design, should ensure the following requirements:

- establishment of a good and normal succession in treatment technology according to the wastewater flows and discharges; in this context it is noted that it cannot be established a general scheme - project type - because each category of waste water has its specific characteristics;
- correlation between the shape and size objects in wastewater treatment plant (fat separator, and storage tanks, aeration tanks, etc.) with equipment needs and unitary process that takes place in them; wrong design of object shapes and sizes technological may not lead to water purification or imply undue consumption of energy and chemical agents;
- correlation of factors such as hydrodynamic with the chemical, physical and biochemical so that operations may take place under optimum and energy efficiency conditions [2, 6].

In biological technologies are established technical expressions that allow calculation of unitary process based on organic loads expressed in BOD_5. The coefficients of these relationships, especially that biochemical kinetics, are based on laboratory experiments performed on pure cultures of bacteria. In practice, many problems which arise makes the estimated results by calculation differ from reality [1]:

- microbial cultures are mixed - mixed populations of bacteria to metazoars whose kinetic coefficients differ from those in the laboratory on pure cultures;
- entire microbial activity is carried out in aqueous medium and all calculation expressions does not consider hydrodynamic factors – there are no coefficients to consider moving from multiphase system that exists in biological reactors;
- current calculation methodology is based on BOD_5 indicator that reflects the organic load in the aqueous medium, does not meet the needs of programming, control and automatic control of wastewater treatment plants that require determining the values of operational parameters in time real.

In the last two decades, research conducted by mixed groups of engineers and biologists have tackled down different hydrodynamic and biochemical problems [3, 4]. In these theoretical research conducted by modelling and simulation of the experimental unitary processes has been looked for answers in favourable ways of correlation of these factors to optimize and streamline technology. Theoretical researches have established the optimal correlations between geometric, hydrodynamic, chemical and biochemical factors because simulations can study cases much more different from reality. In this way it will get development processes, which certainly will lead to optimal areas.

Biological process models predictive or adaptive types are suitable for automatic control of the process [4, 6]. They shall be based on composition, concentration and biological activity of bacterial population. Models of this type are relatively simple, robust and rapidly respond to changes in organic loading and hydraulic parameters.

In modelling biological processes is very important to describe the composition of the wastewater. Being impossible to consider all detectable compounds, these are grouped according to their characteristics. In general, modelling biological wastewater treatment are three groups: bacteria, organic matter and nitrogen compounds.

Modelling and simulation of biological processes is one of the most used methods to specify the influence factors involved and determine a process or technology. Biological processes can be studied at low cost and with sufficient accuracy by mathematical modelling, [7]. There have been developed and designed exclusively biological processes modelling and simulation, such as the BABE (Bio Augmentation Batch Enhanced). An accurate description of biological processes from all points of view can lead to a very complicated system of equations very difficult to solve. Therefore, we use the simplifications, within reasonable limits, so as not to be altered the structure and evolution studied. It should not be forgotten that the mathematical model is actually a simplification of reality. Thus, it can be removed from natural reality, due to the multitude of different parameters such that only one side can be included in mathematical relations, but he must accurately describe a particular process so that the results can be used practically.

2.1. Finding new strategies to control the aeration process in order to save energy in biological wastewater treatment

Wastewaters generated by human activities are treated for removal of suspended solids, organic matter (COD / BOD) and nitrogen. This requires biological treatment using aerobic bacteria in order to remove the organic load and nitrogen, [7, 8].

The aeration process reactors with air insufflation are the main energy used in water treatment. Usually it is about 40-70% of total energy consumed by the plant.

Further, were analysed various ways to control the aeration process by removing nutrients, ensuring a high quality of treated water. This process uses an algorithm that saves energy by using sensors of ammonium and nitrogen, and after, the characteristics of sludge and treated water quality are displayed.

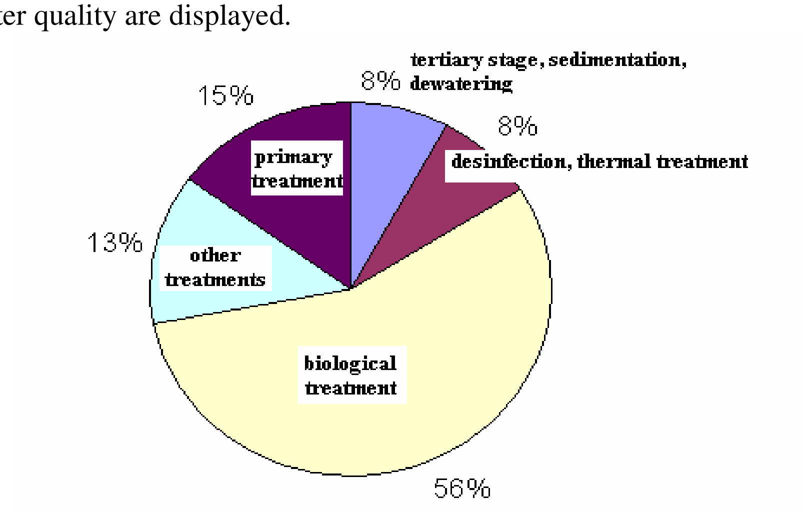

Figure 1: Greenbass program utilisation

The experiment is considering a case study for two municipal wastewater treatment plants were equipped with a new control system called Greenbass on a period of 10 months:

- experiment was performed in parallel and in the same conditions on the water treatment plant A, were recorded also in plant B, using Greenbass process (experimental group)
- experiment on another aeration basin controlled by the classical method (reference group).
- both methods were tested before.

The equipment consists of:

- ion sensitive electrodes (ISE) for ammonium and nitrate (VARiONPlus700IQ-WTW)
- a controller with programming logic (PLC) using Greenbass (based on an algorithm patented aeration PCT IB2010 / 051125).

Doses of ammonium nitrate were checked weekly to assess the value estimated by online sensors. Energy consumption is expressed through rate "of electricity consumed (kWh)/day/(m³) treated water/day. Different cases were studied during the experiment, corresponding main process control modes chosen for aeration. Chosen values of aeration control parameters are common values used in these cases.

In the present study, by adding a controller, the amount of air supplied decreases by about 30%, leading to a better management of air necessary for operation (Figure 2).

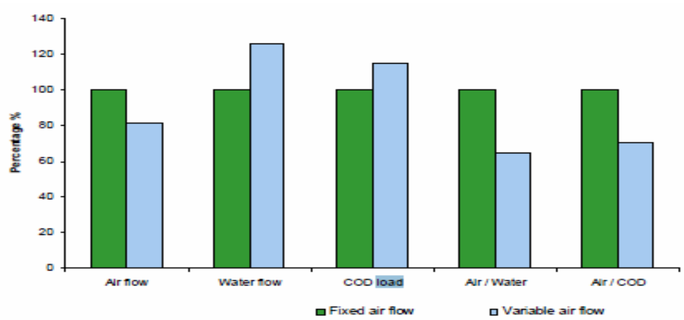

Figure 2: The supply of air through a constant and a variable air flow (base 100)

2.2. Obtained optimization and controlled air-flow through on-line ammonium / nitration sensors

In this case, a group is controlled by a conventional program based on the reduction potential of the oxidant (oxygen-concentration - where the air flow is variable), and the other is controlled by Greenbass program based on the monitoring of samples of ammonium and nitrogen.

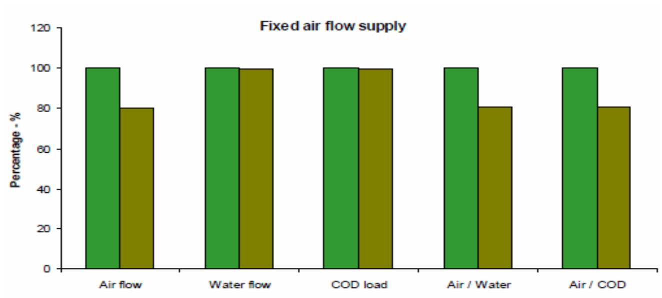

Figure 3: Comparison between supply systems for constant air flow achieved using conventional controller and Greenbass

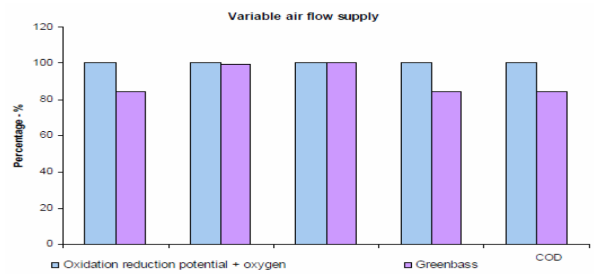

Figure 4: Comparison of variable flow injection system with variable air achieved using conventional controller and program Greenbass

The ratio of air flow required and the flow of treated water is used to compare the energy required in each group, taking into consideration that the purified water has the same quality in both cases. This report is presented for supplying constant air flow (Figure 3) and variable air flow supply (Figure 4) .In both cases, is achieved energy savings of 15% for the same quality of treated water.

2.3. Analysis of the biological parameters

The oxygen supplied is always in excess of the aeration basin in order to ensure that the nutrients are removed under aerobic conditions. The lack of oxygen in the area of the biological treatment can induce a biological disturbance or sludge bulking and foaming. Also, it reduces the properties of the dewatered sludge leading to an increase in consumption of polymer.

As shown in Figure 5, there is a slight difference in the speed setting file to the software control of conventional and used Greenbass.

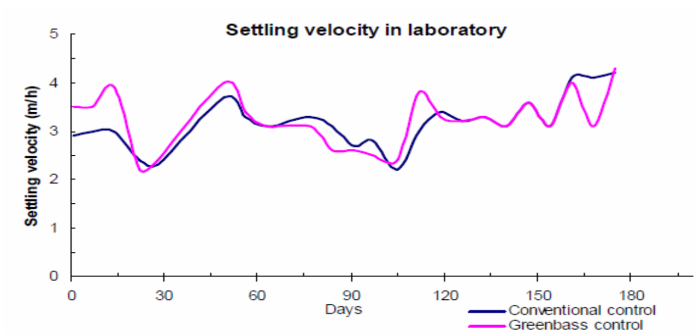

Figure 5: Setting the speed using conventional controller and Green Bass

In the test on sludge dewatering properties have revealed differences in consumption of polymer and the concentration of suspended solids.

3. CONCLUSIONS

Environmental factor most affected by socio-economic activities is water or natural emissaries where are discharged wastewater from industrial sites or urban settlements. To protect natural emissaries, both major cities and most industrial sites, have wastewater treatment plants so that they meet the quality requirements imposed by law.

Modelling biological process cannot be analysed in all its complexity. Using the proposed model requires determination and using the kinetic parameters of the technological process which varies for each case subject to the water treatment process. In this case study was conducted energy self-improvement and treatment plants was achieved by reducing the energy consumption during the biological treatment aeration basins by removing excessive peak air and energy waste by 15% and reducing energy consumption compared to conventional aeration systems.

Acknowledgment

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COST-BENEFIT ANALYSIS FOR GREEN TANNERY IMPLEMENTATION

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ABSTRACT

Using Cost-Benefit Analysis the Green tannery effectiveness will be evaluated, in whose justification must be included both quantitative aspects as well as the qualitative ones. The value resulting from the prior assessment of the environment it is used in the prior assessment of the projects and environment policies. In the Cost-benefit analysis, were identified direct costs and externalities (market price and price substitute). Direct cost refers to the value of the investment. External costs relate to the direct and indirect effects that bring pollution in economic sector; involves assessment of damage caused by pollution of the natural environment and human-created and quantifying the results of economic and social development which will take place through the removal or reduction of emissions of pollutants into the environment and efforts required, on the other hand.

1. INTRODUCTION

The new processes have been developed with the aim of reducing pollution without incurring any negative impact on leather quality. The typical primary targets are: lower water consumption, improved uptake of chemicals, better quality / re-usability of solid waste and reduced content of specific pollutants such as heavy metals and electrolytes.

Theorem which underlies Cost-Benefit Analysis (CBA) can be summarized as follows: the benefits are defined as an increase in welfare of humanity (useful) and a reduction in welfare costs humanity. Over the years have developed various techniques for analysing environmental impacts, such as: Environmental impact Assessment (EIA) or Environmental Assessment (EA); Strategic Environmental Assessment (SEA); Life Cycle Analysis (LCA); Risk Assessment (RA); Comparative Risk Assessment (CRA); Risk-Benefit Analysis (RBA); Risk-Risk Analysis (RRA); Health-Health Analysis (HHA); Cost-Effectiveness Analysis (CEA); Multi-Criteria Analysis (MCA), [1, 2, 3, 4].

EIA is a systematic procedure for collecting information on the environmental impact of a project or a policy, and to measure their impact, but not a comprehensive assessment procedure. EIA is an essential part of any evaluative procedure. SEA is similar to EIA but it helps to be applied at a higher level of decision making for the overall assessment that includes project usefulness and feasibility of the solution. LCA is similar to EA in that it identifies the environmental impact of a policy or project and trying to measure. Major difference between EIA and LCA is that LCA measures the impact overall project cycle or applied policy. RA involves assessing the risks to health and / or environment related to a product, process, policy or project. RA cannot be easily translated into decisions. CRA is analysed various risks through risk normalized to a reference, but does not include benefits. RBA can take two forms, either similar CBA or similar CRA, as the risks, benefits and costs are expressed in monetary units or not.

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RRA focuses on health risks if they adopt a project or policy in comparison with the case when not adopt. HHA is similar to RRA, but rather to compare the risks with and without behavioural reaction to a project or policy, changing risks or risk compared with the costs of the project or policy. CEA is to assume that there is a single indicator of effectiveness, E, and this is to be compared to a cost of C. CEA would require that E be compared to C, CER=E/C. MCA is similar CEA, but consider a variety of indicators of efficiency. The spread of cleaner technologies and processes has been neither spontaneous nor extensive. For all the claims about favourable cost-benefit ratios and/or environmental benefits can be derived from many of these technologies.

As a result of the implementation of Green tannery will result two experimental systems, one of separation and concentration of fat and proteins from raw leather wastes and a co-digestion of fats-sludge fermentation in order to produced biogas. These facilities can be used by the beneficiary in order to improve the operational performance, [5, 6].

2. METHODOLOGY

Environmental externalities are difficult to assess because some degradation of the environment are not yet fully known, either are irreversible, or their effects are not immediate. That's why it is necessary to firstly take measures to prevent the environment degradation, and secondly to identify all the ecological losses. These installations can be recovered later by the other economic operators from the leather processing industry, and not only. The co-digestion installation of fats and sludge for obtaining biogas may be used by economic operators from the various fields but also by the municipal wastewater treatment plant operators. In the co-digestion installation can be recovered biodegradable waste from restaurants, from zoo-technical farms, in this way are created new possibilities for economic recovery of the waste in order to minimize operating costs and the negative impact of businesses over the environment and to maximize the economic activities that generate wastes. Also, the compost obtained from co-digestion along with separate proteins is used in agriculture.

The impact of using compost of agricultural crops will be surveyed. If the impact is going to be a positive one, the partners will work towards the compost utilization and the potential beneficiaries (farms, cattle-breeding, and horticulture) will be informed over the economic advantages of using the compost in their activities.

We consider the total costs (C) associated with the operation of a tannery as consisting of direct and indirect costs.

- ✓ Direct costs in turn are made up of fixed costs (Equipments, Design etc) and variable costs (utilities, personal etc).
- ✓ Indirect costs considered are only those associated with health.

To compare costs with benefits fixed costs were reported lifetime annual fixed costs resulting only presented in Table 1. Annual benefits (B) brought by the tannery and especially waste energy recovery from it are shown in Table 2.

Considering a certain production capacity of tannery Q, then we consider C(Q) cost function and B(Q) function benefit. Applying cost-benefice in the context of producing a certain amount, net profit maximization implies $\frac{\partial B}{\partial Q} = \frac{\partial C}{\partial Q}$.

Calculation of the Cost-Benefit report and Benefit-Cost results:

C/B=0.83 and B/C=1.19

Following this analysis, it can be asserted that implementing the concept of Green Tannery will have a beneficial effect on potential beneficiaries.

Table 1: Direct costs for tannery functionality

	Costs	[Euro/year]
Direct costs	Consulting and design	12 000
	Equipments	110 000
	Management	12 000
	Utilities	4 500
	Personal	12 000
	Promotion	4 500
Externalities	Health costs	2 500
	Total Costs [Euro/year]	157 500

Table 2: Economic benefices for one year tannery functionality

	Benefices	[Euro/year]
Economic Benefices	Provision of services	12 000
	Grease recovery	7 000
	Thermal energy recovery	9 000
	Compost recovery	7 000
	Reduce the explosion risks	4 500
Externalities (market price)	Health benefices	7 000
	Fuel reduction	7 000
Externalities (substitute price)	Increasing the property value	110 000
	Reducing quantities of polluted water	9 000
	Removing the transport phase of waste to the landfill	9 000
	Reducing energy costs	7 000
	Total Benefices [Euro/year]	188 500

2.1 Green tannery impact over the environment factors

The impact over the environment and the concept of environmental sustainability has become in recent years one of the most important legal principles regarding the sustainable development. Increase the efficiency by harnessing waste and reducing energy consumption of equipment and installations are one of the priority directions laid down by the legislation in force, so implementing the green tannery concept fits perfectly into these requirements.

Through its implementation, will be facilitated the alignment of Romania, from the point of view of the scientific and technological level in the field of environmental protection, to the best practices and requirements of the European Union.

The main pollutants and their effects on the environment are presented in Table 3, based on data available in literature, [5, 6, 7].

Table 3: Assessing the Green tannery impact over the environment factors

No.	Pollution factor (source vector)	The effects over the environment				Observation
		Air	Water	Sol - UG	Human factor	
1	The location and manner of land employment	+1	0	+1	0	Work spaces for the demonstrator model
2	Water source	0	+1	0	0	It uses a centralized network supplied from aquifers, independent system
3	Energy source	+1	0	0	+1	Using biogas resulting from co-digestion facility as heat contribute to limiting and avoiding the burning of fossil fuels, that pollutes the air
4	Pollutant concentration in air	-1	0	0	0	Air quality is affected in the allowable limits
5	Pollutant concentration in water	0	-1	0	0	Light pollution effect the receptor surface waters due to the lack of necessary capacity to process its own wastewater treatment plant
6	Phonic pollution	0	0	0	-1	The indoor comfort is not ensures
7	The waste and packaging circuit in the environment	0	0	+2	0	Waste is collected and transported to the landfill. By using the technologies proposed the biodegradable waste resulting from tannery platform will be used by the beneficiary, so energy costs

						will be reduced. Compost produced will be used as fertilizer in agriculture..
8	Crashes and accidents risks	0	0	-1	-1	Minimal risks can be eliminated through the development of new rules to prevent the biogas plants.
9	Effects on environmental factors	0	+1	+1	+1	Positive effects on water, soil and subsoil by implementing new technologies for wastes recovery. The creation of new jobs through the manufacture new technologies at large-scale.
TOTAL IMPACT of Green tannery		+1	+1	+3	+1	

As a result of this evaluation it can be asserted implementing the concept of Green Tannery will have a positive effect on the environment factors.

CONCLUSIONS

New challenges related to environmental protection and consumer safety are coming to the fore, confronting industry in industrialized and developing countries alike. The current high cost in leather industry will rise still further with the introduction of new regulations, jeopardizing the sustainability of the industry. Survival and/or further expansion of the tanning industry depend on its ability to meet the current and future environmental challenges in an innovative and cost-effective manner.

Benefit cost ratio is large enough so that we can consider as energy recovery from tannery waste is feasible even multy economic benefits.

Acknowledgment

This work was supported by a grant of the Romanian National Authority for Scientific Research CNCS – UEFISCDI, project ID PN-II-PT-PCCA-2013-4-1017, “Green Tannery – Methods for energetic recovery of biodegradable wastes”

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ENERGY RECOVERING FROM TANNERIES BY BIOGAS PRODUCTION

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ABSTRACT

Environmental issues have been at the top of tanners' agenda for the last few decades, since dealing properly with tannery wastes is expensive. Overall, the leather industry should be able to reposition itself as a solution to environmental problems rather than a contributor, as there is no other industry that can make use of the total volume of hides and skins yielded by the livestock and meat industries. This has caused concerns about the fairness and appropriateness of demands made by governments, and about whether it will be possible for tanneries to operate on a level global playing field regarding the environment. In dealing with these challenges, the tanning industry had to come up with some environmental friendly solutions. Anaerobic digestion is a favorable technological solution that degrades a substantial part of the organic matter contained in tannery sludge and solid waste, biogas, helping to alleviate environmental problems.

1. INTRODUCTION

Most of the main issues of solid and liquid waste are now well understood, but the tanning industry does have a number of evolving areas of concern:

- common salt (NaCl) and some other water-soluble salts getting into water recipients – rivers, lakes and/or ground water – and making the water unsuitable for drinking and other uses;
- the lack of environmentally acceptable and cost-effective solutions for solid waste disposal; landfill for solid wastes in some European countries and the associated trend to increase the cost of landfill via taxes or other methods;
- growing consumer pressure and associated regulations regarding an increasing number of chemicals now deemed harmful for various reasons;
- high levels of water consumption [1].

The industry can be expected to put more effort into making better use of solid wastes such as hides and skins from tanneries, and to look for new possibilities. One of the new methods is based on anaerobic digestion (AD). Digesters (or anaerobic fermenters) are well-known process plants which have the potential to efficiently transform the energy from the tannery waste, contributing into achieving the objectives of preventing/reducing pollution, elimination of uncontrolled emissions of methane and odour recovery bio-potential energy in the form of biogas production with stabilized waste which can be used as a fertilizer [2].

Anaerobic digestion is a biochemical process during which complex organic matter is decomposed by various microorganisms in the absence of oxygen. By carrying out these processes under controlled conditions the organic matter in the form of stabilized digested sludge and biogas, which is a mixture of methane (65%), steam (5%), sulphureted hydrogen

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(to 1%) and the rest is carbon dioxide [3]. Application of anaerobic treatment for decomposition of COD in wastewater from tanneries is an innovative and attractive method of energy recovery.

2. Methodology

The slurry resulting from the primary treatment is usually mixed with the one from the secondary treatment before thickening up to 5% total solids. In the case of the AD process, this is not necessary because the maximum solids content in the best conditions for the process has to be around 10%. The sludge contains about 60% organic matter, while the remaining inorganic material is mostly lime. Although much of raw leather wastes may be used for other applications, their use in applications AD is very attractive due to the high fat content, which gives high yields of methane [4].

Experiments worldwide on anaerobic fermentation process led to the following conclusions:

a) 1 kg of dry solid substance containing volatile dry solids 0.67kg;
b) 1kg of solid results in 0.713 kg volatile fermentation gas;
c) 1 kg of fermentation gas is methane, and 0.6 kg 0.4 kg carbon dioxide;
d) fermenting technical limit corresponds to a degree of decomposition of the organic matter of about 59%.

Undergoes biodegradation of organic waste and emit greenhouse gases, especially methane (a greenhouse gas more than 20 times greater than carbon dioxide) and to a lesser extent, nitrous oxide (300 times higher greenhouse effect). In addition, it has the potential odor and soil contamination problems [5]. Waste disposal is therefore a serious problem and the importance of technological measures to tackle environmental challenges is now increasingly recognized. Given current developments adoption of green technologies to recycle waste into energy has become an attractive option for leather.

More than 80% of the organic pollution load in terms of BOD is from pre-tanning. Much of this comes from the degradation of raw skin and hair. During the tanning add at least 300 kg of chemicals (lime, salt, etc.) per ton of skins. The excess salts that are not used will appear in the waste water. Because of the pH change, the compounds may precipitate, and contribute to the amount of solid or solids in suspension. Each step of the tanning process produces wastewater approximately 35 m^3 per ton of raw leather, except finishing operations. Resulting wastewaters have a high concentration of salts, chromium, ammonia, dyes and solvents etc. Trimmings (cracks, chips) are less attractive due to lower total quantity and quality (in terms of organic matter and methane yield), but can be handled efficiently with AD. Fleshing and trimmings items have a high content of total solids therefore solids dilution water to an acceptable level should come from sewage sludge. Hair and some skins are also considered as biodegradable and have been linked to AD treatment, but their use should be avoided as they can cause more harm than good, especially since better solutions for these materials can be found.

Some concerns have been expressed in the past by potential inhibitory effects of certain compounds in sewage sludge, especially salinity and high chromium content. However, tests have shown that the salinity is not a problem as long as the level is maintained below 3000 mg/l, which can be easily achieved by proper handling of the hides before processing [6]. In addition, chromium has no real effect of inhibiting the concentrations of less than 500 mg/l. In addition to conventional digesters, single reaction chamber there are other types of digesters, performing with two reaction chambers. Since anaerobic fermentation organisms are found in the "former acid" and "methane former", is the reaction of the acid in the first chamber and then the basic reaction in the second chamber. This process is easier to control and more efficient. There are also UASB (Upflow Anaerobic Sludge Blanket Digestion) type reactors that have better performance for effective treatment of tannery sludge and residues compared to conventional reactors.

2.1. Pretreatment

No special pre-treatment is required in addition to the measures that allow it to flow freely for pumping and mixing. As a result, waste water sludge does not have to be dehydrated. Materials results in fleshing should be hydrolysed while the skin remains should be cut 2-5 mm (to improve the digestibility of the material), with means for grinding and industrial leaching from various suppliers. Different substrates should be mixed to form a homogeneous mixture, which is then digested. Mixing can be done in the digestion vessel or in a separate mixing tank, before introducing the mixture in the digestion vessel. Where necessary, such a tank may have a volume sufficient to hold the substrate for a few days of operation. In such cases, inevitably, the hydrolysis of organic matter occurs and helps the digestive process. However, the hydrolysis it is not necessary in the pretreatment stage.

2.2. Working temperature

There are two possible arrangements of the temperature at which the process of AD can run: mesophilic conditions (around 37°C) and thermophilic (about 55°C). Although the efficiency of degradation of substrates is similar at both temperatures, thermophilic operation seems to offer several advantages when it comes to processing tannery waste[7]. The rate of degradation of organic matter is considerably faster, requires a retention time of about 15 days, which is half of that required for mesophilic operation; therefore, digestion vessel volume needed would be twice as small, as a result, low costs of investment. Moreover, fleshing and, to some extent, a part of the shredded scrap skin, liquefies at temperatures above 50°C and are therefore much easier to keep in suspension in the digestion vessel bacterial. Finally, thermophilic conditions also ensure sanitation through sterilization effect.

On the other hand thermophilic operating conditions are less robust and more sensitive to variations in operating conditions [8]. Temperature fluctuations and increasing the concentration of ammonia is known to have an adverse effect on the rate of methane production: control of the conditions near the input operation and the quality and quantity of the substrate should be maintained. However, a relatively modern tannery should not be foreign to such industrial control systems, and thus, the operation process to be effective. Specific methane production potential at 55°C is estimated to be 0.617 m^3/kg of volatile suspended solids tannery sludge waste, 0.377m^3/kg for leather tannery waste and 0.649m^3/kg for fleshing tannery waste. Additional concerns such as chromium content, salinity and temperature fluctuations were also addressed [9]. The chromium content and salinity showed no adverse effects; however a reduction in the temperature of the reactor 4.4°C led to a decrease in biogas production of 25%, indicating a requirement to keep the temperature constant at 55°C.

2.3. Installation process

The conventional way to run an AD process is continuously stirred reactor using an extraction tank effluent digest, followed by an addition of the same amount of fresh substrates. This happens several times a day. There is a maximum rate of organic loading in the process operates in a stable manner; biodegradable waste from tannery this is between 3.5 and 4.0 kg org/m^3. However, the organic loading rate is not the only criterion for determining the volume of digestion. With the decrease in retention time decreases, which decreases the rate of removal of organic matter and, as a result, yield of methane. Final required volume is usually determined by performing a careful analysis of the costs and taking into account all economic benefits; this should be done on a case by case basis. Ideally, digestion chamber must be fed at regular intervals, seven days a week. If not operating in a tanning seven days a week, a storage tank should be added to the digestion chamber to provide a sufficient buffer in the supply of substrates to cover a non-working day, when not produced waste. This obviously increases the cost of investment. As an alternative, a batch process was considered that can engage directly the discharged waste according to the dynamics of the production process of tanning rendering a buffer [10]. Such a process does not perform as well as the total yield of methane.

2.4. Use of Biogas

The main advantage of using an AD for wastes treatment is the fact that there are two final products: fermented waste that can be used as a fertilizer and the biogas that can be used for energy production.

The recovery of biogas and its quality depends on the raw material processed and the facilities used. Studies today are an order of magnitude from 100 to 200 Nm^3 per ton of biodegradable waste. The composition of the biogas introduced varies depending on the fractions and fermentation process employed, i.e., one-step or two steps.

Depending on the type of recovery and the content of methane, biogas has to be treated and possibly enriched in methane content. The first step is to remove the sulphur as hydrogen sulphide is a colourless, poisonous and irritant, which turns into SO_2 by burning corrosive and harmful for the environment. It is common to all processes for removal of sulphur that regenerates the cleaning media using oxygen. A separation of carbon dioxide for the enrichment of methane is absolutely necessary to supply this gas for gas network

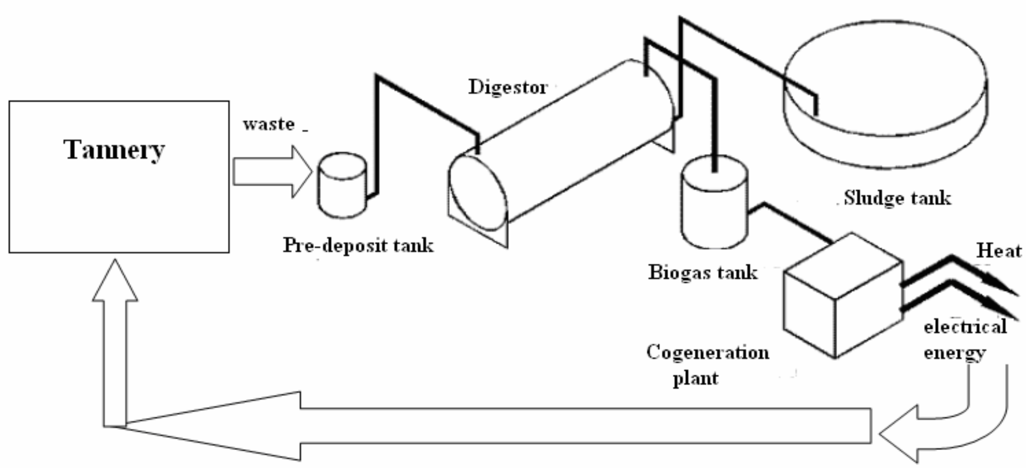

Figure 1: Biogas facility settlement

Biogas, which contains about 65% methane, became the main object of attention in recent years because of its energy from renewable sources. It is a source of income for tanning. Therefore, attention should be paid to find the best way to use its potential energy. One option is to be used as fuel in a CHP unit for the production of electricity and heat. Such a use involves the investment and operating costs relatively high, also low-grade heat (hot water at 90°C instead of steam) [11]. Since the tanneries are large consumers of primary energy sources for heat production, biogas is best used in existing plants to replace some of the fuel and contribute to a reduction in emissions of greenhouse gases.

Technical and economic studies were performed in order to evaluate that all of tannery waste fermented have a defined value as a fertilizer based on nutrient contents. However, this option is usually only possible to process for low-chrome tanning as high chromium content in waste prevents eventual use as fertilizer [12].

3. Conclusions

The energy generated by anaerobic digestion or gasification of tannery waste can be used for beneficial for both dry waste but also as a source of energy for its own needs tannery, CHP or export of electricity. A large amount of energy recovered is excess to the requirements of the energy conversion process and can be reused directly by the tannery. In fact, the use of waste for energy production system has the potential to make leather self-sufficient in terms of thermal energy needs. The waste processing plants in tannery energy promotes the production of electricity from renewable energy sources, decentralized, apart from serious environmental problems caused by waste from leather processing industry.

According to the examples found in the literature a 20 m tall anaerobic reactor of 6 m diameter is capable of treating about 20 t of COD per day. Such a digester would generate about 6000 m^3 methane per day (assuming 80% CH recovery based on average full-scale treatment efficiencies), with an energy equivalent of about 250 GJ/day. A modern combined heat and power (CHP) gas engine reaching 40% efficiency can convert it into 1.2 MW of electric power. The overall energy recovery could even be higher (reaching up to 60%) if all the excess heat can be used on the factory premises or in its neighbourhoods.

Because the generated energy is renewable the system can obtain certified emission reduction (CER) credits. An average coal-driven 1 MW power plant emits about 20 t CO; CER credits accrue for saving this emission. This aspect should provide a strong incentive in developing countries to start treating wastewaters using high-rate anaerobic reactors. There are numerous other benefits which lead to energy saving over the life cycle if anaerobic reactors are used for wastewater treatment, [13,14].

The direct and indirect benefits can be itemized as follows:

1. Sludge production is lesser than in high-rate aerobic processes to the extent of up to 90%. The sludge that is produced requires much lesser energy-intensive processing and has market value.
2. Up to 90% saving in reactor volume is achievable when expanded sludge bed systems are employed—thereby proportionately reducing the capital costs and carbon footprints.
3. Advancements in the anaerobic reactor technology now enable COD concentrations varying in a very wide band to be treated—form as low as 0.001 to 35 kg/m day.
4. Very little use of fossil fuels occurs for reactor operation, that too indirectly, saving about 1 kWh/kg COD treated.
5. There is production of about 13.5 MJ CH_4 energy/kg COD removed, giving 1.5 kWh electric outputs (assuming 40% electric conversion efficiency).
6. Very little or no addition of chemicals is needed.
7. High-rate systems facilitate water recycling in factories (towards closed loops).
8. Crop macronutrients like NH_4 and PO_4^{3-} liberated and conserved during anaerobic treatment. This provides a valuable pool of precious nutrients for use in agricultural fields.

For all these reasons, anaerobic digesters are relatively easier to install and operate. When using for agriculture they can be kept dormant in off-season and can be easily started up when needed.

Acknowledgment

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LEATHER CARBON FOOTPRINT

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ABSTRACT

Interest in international climate change has increased over the years. Data and research results add weight to the common conclusion that clear long-term trend is global warming. Most of the observed global average temperature increases since the mid-20th century is due, most likely, increase in concentrations of anthropogenic greenhouse gases. Of these, particular attention is paid to carbon dioxide. Manufacturing accounts for 19% of greenhouse gas emissions (GHG) emissions. In the last years the interest to estimate the total amount of GHG emitted during various stages of the product life cycle grew. The results of these calculations are called carbon footprint products. In the present paperwork, we review the available scientific literature on the concept and calculation of carbon footprint and its application to the leather industry, especially tanning sector.

1. INTRODUCTION

One of the biggest environmental and developmental challenge of the present time is the climate change, which has a great influence over the concept of sustainable development. The effects of climate change have already been felt all over the world, in diverse forms ranging from shifting weather patterns, receding ice caps, crop losses, altered distribution of precipitation, increased frequency and intensities of floods and droughts, and serious ecological imbalances. All of these effects also have resulted in significant economic losses. To prevent projected and unforeseen disasters, global temperature must not exceed 2°C more than 1990 levels. For this, the atmospheric stock of greenhouse gases (GHGs) should be controlled to remain below 550 ppm in terms of CO equivalents (CO_2-e). Among different GHGs, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulfur hexafluoride (SF), perfluorocarbons (PFC) and hydrofluorocarbons (HFCs) are the six important anthropogenic GHGs. GHG inventories can identify, quantify and manage all sources and sinks of GHGs, [1,2,3].

Among different quantitative indicators, the carbon footprint has gained popularity and widespread application. The concept of carbon footprint has been widely used to communicate about the climate responsibility, by its easy methodology of conveying information about the GHG intensity of variety of products and activities among the general public. Because of its encreased use, scientific analyses of carbon footprint have been conducted for consumer products and industrial processes in then last years.[4,5]

Carbon footprint, being a quantitative expression of GHG emissions from an activity helps in emission management, but also in evaluation of measures to reduce the impact over the environment. In the present paperwork, we review the available scientific literature on the concept and calculation of carbon footprint and its application to the leather industry, especially tanning sector.

Leather industry consists of a series different sectors, since markets hides, which tanneries supplying raw materials from slaughterhouses producing meat for consumption, and finished production of consumer goods leather. Some sectors are heavily industrialized, others involve a high degree of craft, while for others, is the core business trade and support services.

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In order to estimate the total amount of greenhouse gas emissions emitted during various stages of the product life cycle are obtained carbon footprint products. The carbon footprint of a product is defined as "the sum of the weighted emissions of greenhouse gases and removal of a process the sum of the weighted emissions of greenhouse gases and removal of a process, a process or product system, expressed as CO_2".

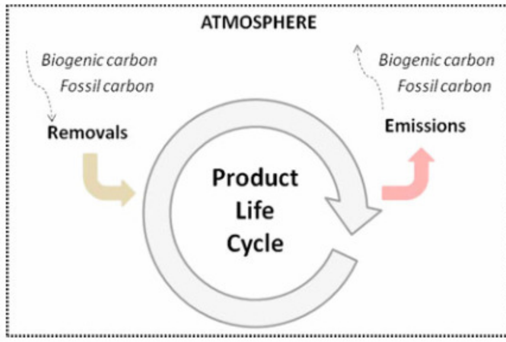

Figure 1. Flows considered in the product carbon footprint [1]

The carbon footprint is a globally accepted tool for quantifying the environmental burdens of products. This indicator can be obtained through the implementation of an Life Cycle Assessment (LCA) analysis, like other environmental business activities. The goal of the method is to quantify the global GHG emissions related to the entire life cycle of a product, process or service. This quantification is expressed in CO_2 equivalent (a unit for expressing the irradiative forcing of a GHG to carbon dioxide) and has become a common indicator for environmental assessment. [6].

2. METHODOLOGY

Currently, there is no single methodology and no international agreement on methods for calculating carbon footprints skin. Report developed by UNIDO (United Nations Industrial Development Organisation) technical offered some very clear indication about the environmental footprint and skin. Especially since all calculations, by definition, must be implemented in all processes contributing to the product (what it calls the "cradle to grave" method), one of the most important factors on which it must reach an international agreement is to define" system boundaries". According to studies found in literature in the case of finished leather the carbon footprint is expressed as Kg CO_2 / m^2 of finished leather.[7]

Researchers previously discussed whether to include or exclude environmental footprint of farming and animal skin (which can be up to 80% of the carbon footprint to 99% of the water mark). The approach proposed by UNIDO involves exclusion of these processes upstream. Technical analysis is complex, but the final approach is easily understood by answering 2 simple questions:

- Hides are co-produced renewable materials?
- Hides replace, at least partially, other products?

To answer the first question, it is considered that a process of co-production is a main product (product which determines the production of the process), and more co-products. The fact that a product determines the production of a process is the same as this process will be affected by changes in demand for this product. There can only be one main product at any time. A renewable resource is "a natural resource with the ability to reproduce the natural and biological processes or recover the passage of time" [7,8,9].

Combining these two definitions, the hides of cattle, sheep and goats are co-products of a renewable material (meat). Answering the second question, as it is known in the literature of the leather sector, only 20-25% the weight of the raw material is transformed into finished leather. The rest are other products and animal waste. At the same time, the skin replaces other materials (mostly synthetic) in making shoes, handbags, clothing, automotive interiors and furniture upholstery, [4].

The finished leather made from the hides from animals reared for milk production and/or meat, it must be concluded that the system boundaries begin slaughterhouse, where activities and treatments are performed in order to prepare skins to be used by tanneries (eg. the preservation of hides by cooling or curing) and ends at the exit from tannery. Therefore, the life cycle skin starts to "swing" (slaughterhouse) and ends at the "gate" (exit gate of tannery). Of course the large share of impact over the environment is assigned to the tannery. [3]

By tanning, skin gelatin which is a putrescible material is converted into so-called tanned leather. After tanning occurs a fiber separation due to the interposition of fiber skin tanning. For structural elements of gelatin skin are characteristic attractive forces acting between them; in wet gelatin skin these attractive forces are weakened due to water adsorption. In the process of tanning pore water is replaced by the tanning substances that react chemically with the structural elements of the skin at the same time separating them from attaching and increasing the fluid and hygrothermal resistance of the skin, and the ability to resist bacterial assault. [10]

Tanning hides can be done with very different chemically substances - minerals, vegetable tannins, fat, aldehydes - complex structure which is different from skin proteins. Chromium III salts, plant tanants are the most common tanning agents. There are available also other agents, such as aldehydes chemically modified or aluminum salts, zirconium and titanium, but currently they are only a small part of the tanning agents used for special purposes in the world. By controlling the amount and type of chemical used, are obtained various types of skins.

Chrome tanning, it is by far the most widely used process in the world (90% of the skins) of chromium involves the use of salts (usually sulfate, basic chromium III), which can cross-link and stabilize the collagen molecules in the fibrils. The reason for this lies in the supremacy posed by numerous advantages compared to other tanning products. It is sufficient to recall two major qualities - skin quality and efficiency of the process. It is relatively inexpensive, has a well-established technology and all auxiliary chemicals used to enhance the performance of the finished skin were made for chrome tanning substrate. The unique feature chrome tanned skin is a shrinkage temperature of over 100°C that allows him to "withstand boiling" time (1-3 minutes). [9].

One of the biggest advantages of chrome tanning in tanning compared to other technologies is the degree of flexibility that it can bestow. A chrome tanned leather can be used as a basis for producing very different products, such as leather for uppers and clothing.

Beside all of these advantages and it’s popularity, chrome tanning poses the most significant and difficult environmental problem. The main objective of the researches is to develop a an innovative tanning system without chrome.

There were made several experiments and simulation of LCA for tanning using chrome and tanning using environmental friendly solutions (vegetable compounds that can be used for tanning). As a basic knowledge to calculate the carbon footprint is the calculation of Global Warming Potential (GWP). Because there is no leather specific standard for carbon footprint calculation, the generalised standard three-tier approach of the GHG protocol must be followed in order to maintain uniformity among different studies. The selection of the boundary depends on the level up to which carbon footprints are to be calculated. GWP of all the tiers is calculated individually using the conversion factors of IPCC [7] corresponding to a 100-year time horizon. The formula for the calculation of GWP of tier i (i=1,2 or 3) is given by [8]:

$$GWP(tier_i) = \frac{emission}{removal} CH_4 x25 + \frac{emission}{removal} N_2Ox298 + \frac{emission}{removal} CO_2 \left[kgCO_2 / m^2\right] \quad (1)$$

Emissions are taken as positive while removal as negative. Values are given in kg/m^2. Carbon footprint is calculated by adding the GWP of all tiers.

$$CF = \sum_{i=1}^{3} \left[GWP(tier_i)\right]\left[kgCO_2 / m^2\right] \quad (2)$$

These calculation are to be used in order to make a complete comparison between the applications of new tanning possibilities and treatment of solid wastes into new value-added products that can lead to improvements of life cycle assessment, by creating close loops in terms of sustainable utilisation, increasing the eco-effciency and economic efficiency of the leather industry.

3. CONCLUSIONS

Carbon footprinting has appeared as a strong and popular indicator of the GHG intensity of any activity or organization. Due to its important role in raising awareness regarding responsibility toward global warming, scientists and policy makers are trying to use it as a management tool. However, its application over the tanning sector is still limited. A standard methodology is required to address the emissions associated with the leather industry, especially tanning sector, where there is a strong need of evaluation in order to evaluate and action towards the reduction of impact over the environment.

The lack of sector and region specific methods adds some uncertainity in the current studies on carbon footprint.

According to studies made all over the world in the leather industry, by using alternative solutions in tanning there can be obtained an reduction of approximately 15% of the carbon footprint. However, not existing a globally accepted method, may consider this comparison unappropiate.

Acknowledgment

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ENERGETIC AND ECOLOGIC ANALYSIS REGARDING THE PRODUCTION AND USE OF BIOGAS FROM FERMENTATION OF TANNERY WASTE

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ABSTRACT

The paper presents an analysis regarding energy recovery from biogas produced by tannery waste fermentation in a dual fuel motor diesel without boiler. Besides the energetic and ecological analysis, there are considered technical and financially aspects. There are presented the main parameters to be considered and the optimum participation of biogas for a dual-fuel engine using biogas from fermentation of tannery waste.

1. INTRODUCTION

The chemical process of conversion organic matter into biogas is called anaerobic fermentation or anaerobic digestion and takes place under the influence of anaerobic bacteria.

Biogas recovery chain contains the necessary steps to obtain energy, which beside anaerobic fermentation include storing, filtering and actual production of energy. Chain of energy recovery is associated with reduction of pollutant emissions, which are only in flue gas components.

For tannery waste processing industry, a unit is processing about 60-70 t per month, resulting in an average of 12 to 15 t/month of protein and fat. 10% of fats (mass ratio) will be processed on a new branch in order to produce biogas for energetic purpose (average amount of remaining protein is about 10.5 to 13.5 t/month).

Production of energy from biogas is considered to be achieved by combustion in a heat engine coupled to an electric generator.

Economic calculations are based on environmental aspects, as incineration on the channel protein Protan that costs 120 Euro/t, plus transportation. As a result, the chain for energy purpose must be related to the costs of waste incineration.

Biogas production includes the following processes: hydrolysis, fermentation, reducing metabolized products from fermentation stage in acetate, bicarbonate and hydrogen molecular and final methanisation.

Gas-producing composition will include CH_4, CO, H_2S and H_2 within the following limits:

$CH_4 = 40 – 70\%$
$CO_2 = 30 – 56\%$
$H_2S = 0 – 3\%$
$H_2 = 0 – 1\%$

For an average composition: $CH_4 = 52\%$, $CO_2 = 45\%$, $H_2S = 2\%$, $H_2 = 1\%$, the low heating value will be:

$$LHV = 0{,}52 \cdot 37500 + 0{,}02 \cdot 23697 + 0{,}01 \cdot 10760 = 20080\, kJ / m_N^3$$

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For the amount of processed protein, the gas-producing flow rate is estimated at about 3000 m^3_N/month. Important monthly variations that could appear depending on the temperature (± 40%) should be considered. For a constant production of 3000 m^3_N/month, the resulting production is about 4 m^3_N /h.

Particulars of animal proteins anaerobic digestion will influence in the following:

- Digester volume;
- Affluent flow rate;
- Hydraulic residence time;
- Residence time for solid;
- Fixed solids;
- The amount of volatile solids;
- Alkalinity;
- Volatile organic acids.

Volumetric biogas production is a parameter to be correlated with "volumetric methane production" because there are important various in methane concentrations

For energy production, a dual motor, diesel – biogas is proposed. Basically, the simplest solution involves injection of biogas into the air intake, achieving the combustion with diesel into the engine cylinder. This solution takes over the variations of biogas flow rate, as well as the variations in biogas quality.

The engine for this solution does not present changes on diesel supply circuit. Diesel engines will be sized as power according to the needs for energy. The diesel fuel economy by using 4 m^3_N/h biogas produced is about 2 l/h, since the ratio of calorific value is 1: 2.

By reducing 2 l/h of diesel fuel, for the current price of diesel, the economy obtained is about 10-12 lei/h. For properly function, the conversion ratio should be 14 - 16. The specialists in the field recommends for current engines a consume up to 1000 m^3_N/day The engine must be placed near the biogas producing station in order to reduce investments in biogas supply lines.

Of particular importance is the value of motor efficiency. Up to 100 kWe, power efficiency varies in the range of 30-33%, yielding higher values for higher power range. It is recommended for partial loads to use biogas for no more than 40% of engine power. Depending on engine consumption characteristic, it can be attached maximum recommended set of values for biogas participation in energy production.

Worldwide were obtained positive results in dual engines that use up to 100 kWe power. Over this power are recommended the spark ignition engines.

If the biogas has low methane content, which may fall to 20% is recommended for use in hot water or steam boilers. For a flow rate of 4 m^3_N/h, the required power of the hot water boiler will be 20 kW.

Financially, the main costs will be related to the investment in the digester, including storage system and energy production facility. Investments in a digester with a reduced flowrate are about 250 Eu for 1 m3 volume of it.

For storage equipment, specific investment relative to the amount stored is about 450-700 Eu. For the amount of biogas that will be produced, a flow rate of 100 -200 m^3 storage is recommended.

To use for energy purpose, biogas system should include a gas filtration system. Specific investment for filtration system for the estimated flowrate to be produced is about 120-150 Eu for 1 m^3_N/h.

These expenses also include maintenance, which is estimated at 0.02 Eu/kWh electricity produced.

In terms of energy recovery from biogas can be considered the possibility of storing a larger quantity of gas and use of a dual engine for fewer hours than a continuous operation at a higher share of biogas. Biogas participation must not exceed 80% heat rate comparing with liquid fuel.

Regarding the pollution from methane combustion (originated from biogas), can be considered the CO2 emissions, by equation:

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

It results a quantity of 1 m^3_N CO_2 emissions per unit of methane. Financial aspects from electricity production were not considered because it depends on the diesel engine power.

2. ANALYSIS OF COGENERATION FROM BIOGAS

Sizing engine or boiler that works on biogas must be done considering hourly energy content of the biogas produced by anaerobic digestion.

The parameters to be determined are installed power in biogas engine P_{coge} or boiler thermal power q_{boiler} in biogas boiler. It starts from the daily energy potential of biogas:

$$P_{coge} = \frac{B \cdot \eta_e}{r_s} \quad [We]$$

Estimated maximum capacity of the boiler is calculated by the following equation:

$$q_{boiler} = \frac{B \cdot \eta_{boiler}}{24} \quad [Wt]$$

Two possible cases have been considered, with or without excess electricity produced by biogas resale.

Without resale the excess electricity produced by biogas: the basic condition for sizing the equipment is daily balance of the fuel:

$$B = B_{engine} + B_{boiler} \quad [Wh / day]$$

The limits of biogas flow rate variation changed with storage tank are presented below. The balance for 24 hour storage must be zero. It follows that the sum of the quantities of biogas which is stored in a day must be equal to the sum of the quantities of biogas consumed from the tank on the same day.

$$0 < b_{stoc}(t) < b_{stoc}^{\max} \quad [W]$$

The flow rate of biogas consumed by the boiler, has the following limits of variation:

$$0 \le b_{boiler}(t) \le \frac{B}{24} \quad [W]$$

The flow rate of biogas consumed in the engine is given by the expression:

$$b_{engine}(t) = \frac{P_{coge}(t) \cdot r_s}{\eta_{el}(t)} \quad [W]$$

and the flow rate of liquid fuel consumed in engine, at a given moment is:

$$b_{mot}^{liq}(t) = \frac{P_{coge}(t) \cdot (l - r_s)}{\eta_{el}(t)} \quad [W]$$

Cogeneration will depend on the valorization of electrical and thermal power produced on the industrial platform with specific technical particularities.

Considering the reduced flow rate of biogas B, it is estimated, the installation of a electric dual engine with power between 40 and 80 kW. This electricity will be possible to be use internal without taken into account the exit towards centralized consumption.

Cogeneration will not include the use of a boiler, only the heat from engine cooling water.

For thermal energy still not considered user flow.

Energy criteria values will be correlated with the size of biogas station that will be designed by experts in the field.

Acknowledgements

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TANNERIES WASTEWATER TREATMENT

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ABSTRACT

The amount of wastewater from tannery is great, if it is proposed that for getting a ton of finished leather is consumed an average of $70m^3$ of water. The concentration of production in high-yield tannery involves special problems of environment protection, given that virtually all of the technologies of processing of hides and pelts are sources of pollution. Waste waters have a complex chemical load, made up of proteins and fats from the skin, and the gross excess chemicals used in various phases of processing.

1. INTRODUCTION

Tanneries generate effluents that are typically high in organic and inorganic pollutants. Since tanneries employ a sequence of batch processes, and a wide range of raw materials, their effluent is complex in nature with variation in characteristics from time to time, process to process and tannery to tannery [1].

Tannery effluents have to be treated before they can be discharged to surface water. Depending on local economic conditions and their geographic location, tanneries may treat waste water on site, discharge directly to sewer or use a combination of these options. Furthermore, some tanneries can discharge their treated effluent directly to surface water.

Usually the first treatment of the raw effluent is the mechanical treatment that includes screening to remove coarse material [2]. Up to 30 – 40 % of gross suspended solids in the raw waste stream can be removed by properly designed screens. Mechanical treatment may also include skimming of fats, grease, oils and gravity settling. After mechanical treatment, physicochemical treatment is usually carried out, which involves the chrome precipitation and sulphide treatment. For final purification of waste water the reducing aerobic biological treatment of organic matter is necessary [3]. The final stage in the wastewater treatment processes is the sludge treatment. The sludge resulting from sedimentation process obeys certain thickeners and treatments with chemical and then transported to an anaerobic reactor to obtain biogas.

2. METHODOLOGY

Chemical processing of hides and fur is an important source of environmental pollution through wastewater due to the great diversity of chemical products used in fabrication (salts, acids, caustics, dyes, grease products, degreasing, etc.), but due to the removal of the skin, during processing of the organic compounds in an appreciable proportion (from gross skin lies only 60% in the final product). Generally, water consumption is greatest in the pre-tanning areas, but significant amounts of water are also consumed in the post-tanning processes [4].

Large volumes of effluent wastewater are also generated. Beamhouse effluent is alkaline and may contain hide substance, dirt, blood, or dung and therefore have significant loads of organic matter and suspended solids. Organic matter is oxidised by bacteria and this can

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deplete oxygen levels in the water killing fish and other biodiversity. Beamhouse effluent may also contain curing salt and grease, in addition to unused process chemicals (particularly dissolved sulphides) [5]. These can cause contamination and, particularly in the case of sulphur, unpleasant odours.

Wastewater from deliming and bating and tanyard processes may contain sulphides, ammonium salts, and calcium salts and is weakly alkaline. After pickling and tanning, the main wastewater contaminants depend on the tanning techniques used but will mostly be acidic [6]. Finishing wastewaters may contain lacquer polymers, solvents, colour pigments and coagulants. Local communities and the environment may be affected by pollution due to discharge of untreated wastewater.

Due to sulphide discharged from the unhearing process, hydrogen sulphide is released at a pH value lower than 8.5. This gas has an unpleasant smell even in trace quantities and is highly toxic to many forms of life. In higher concentrations, fish mortality may occur at a sulphide concentration of 10 mg/l. Sulphide in public sewer can pose structural problems due to corrosion by sulphuric acid produced as a result of microbial action [6]. Sewage contains sulphide in the range of 15- 20 mg/l and composite tannery wastewater contains 290 mg/l.

In table 1 are presented the pollutants from the tannery effluent.

Table 1: Pollutants from the tannery effluent

Solids			
Suspended Solids		Settleable solids	Goss solids
Solids with a rapid settling rate	Semi-colloidal solids		
Oxygen demand			
Biological Oxygen Demand (BOD)		Chemical Oxygen Demand (COD)	
Nitrogen Compounds			
Total Kjeldahl Nitrogen (TKN)		Ammonium Content as Nitrogen (N)	
Sulphides			
Neutral salts			
Sulphate		Chlorides	
Oil and Grease			
pH			
Chrome (Trivalent Chrome, Chrome III)			
Other Metals			

Effluents from raw hide processing tanneries, which produce wetblue, crust leather or finished leather, contain compounds of trivalent chromium (Cr) and sulphides in most cases [7]. Organic and other ingredients are responsible for high BOD and COD values and represent an immense pollution load, causing technical problems, sophisticated technologies and high costs in concern with effluent treatment [8]

The basic effluent treatment principles and stages are worldwide quite similar and typically comprise:

• Physical-chemical treatment to segregate settleable solids:
  - ✓ Mechanical pre-treatment, including grease and grit removal.
  - ✓ Equalization with pH correction and sulphide oxidation using forced aeration.
  - ✓ Chemical treatment: coagulation, flocculation[9]
  - ✓ Solids separation by sedimentation or, less frequently, by diffused air flotation, DAF.
  - ✓ Dewatering and disposal of the primary sludge (plate and belt filter presses, centrifuges;

Figure 1: Romanian tannery wastewater treatment plant

• Activated sludge-based biological treatment to eliminate organic matter:

- ✓ Forced aeration by surface aerators, fine bubbles bottom diffusers or (Venturi) ejectors[10]
- ✓ Recycling of the activated sludge (floc).
- ✓ Nitrogen removal by nitrification (extensive aeration) and denitrification (anoxic conditions)
- ✓ Fine tuning of the process by adding nutrients (phosphorus), antifoaming substances etc.
- ✓ Sedimentation and removal of excess sludge.
- ✓ (Secondary) sludge dewatering and disposal.

However, considerable differences can be encountered in the level of sophistication of the equipment installed, the extent of on- and off-line monitoring and the manner in which the process is implemented. For the same reasons, performance as well as investment and running costs also differ considerably [11, 12].

• Tertiary treatment:

- ✓ Extensive chemicals treatment, including Fenton/wet oxidation, mainly to destroy the hard to break, residual COD [13]

CONCLUSIONS

Due to their impact over the environment the tanneries may need permits, licences or authorisation to prevent their activities from causing pollution or harming human health. An environmental permit from a national or local authority may be required where an installation is a large consumer of organic solvents and significant VOC emissions may be released. Water use and discharge and trade effluent permits may also be required, particularly for those facilities where there is potential for effluent to be contaminated with heavy metals.

The fundamental principles of technology for treatment of tannery effluents all over the world are very much alike, especially for the primary (physical-chemical) stage; for the secondary (biological) step it prevails the activated sludge method. However, many tanneries in industrialized countries enjoy the advantage/benefit of the municipal sewage and wastewater plants carrying out the biological treatment; in addition to it, dilution with urban wastewaters mitigates the problem of salinity of tannery effluents being a serious constraint in arid regions.

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POLLUTANT FACTORS IN PROCESSING OF HIDES AND SKINS

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ABSTRACT

Leather sector is an important source of materials for various industries and fields, some of them being listed as top fields. Waste from the leather industry and leather clothing can be realised by using several processing methods in different areas of interest. European tanneries produce, on average, 2.14 kg of waste per square meter of leather produced. This figure could be an apparently significant environmental value, but we must consider the overall management and final destination of waste from tanneries. Waste problem as a whole is not simple, it requires a comprehensive approach in all aspects of management - identification and inventory, the proper treatment to annihilation, recycling, reuse, which implies concern, financial and technological support, strength working properly qualified and not least the existence of a legal framework, institutional and administrative framework.

1. INTRODUCTION

Leather goods industry has experienced the strongest growth in the period 1965-1980. Since 1989, the Romanian leather industry was faced with an open competitive market. It was passed to a process of restructuring and reorganization which, due to the accession to the European Union, must also include the environmental protection-related regulations, , waste management, water treatment and waste water treatment. It took a few steps to greening in main processes of tannery but in the leather processing filed are still serious problems in technology to solve [1].

Tannery operations consists in the processing of hides and pelts, powerful products in leather putrescible, finite leather products, a stable material that can be used in the manufacture of a large number of products. The whole process of processing involves a complex sequence of chemical reactions and mechanical processes. Among these, tanning is the main step, which gives the skin its stability. Leather and fur quality depends on the animal population and the effectiveness of their processes. The tanning industry is a potentially pollution-intensive industry [2]. The environmental effects that have to be taken into account comprise not merely the load and concentration of the classic pollutants, but also the use of certain chemicals: e.g., biocides, surfactants and organic solvents.

The amount of fatty substances from hypodermic tissue that is removed from the skin during processing depends on their nature and origin. It is known that the hides and skins of swine and sheep have a higher content of fatty substances than those of cattle. The fat content of the skin depends on geographical area. The skins coming from European countries, have a lower fat content (between 5% and 10%), while the hides of Australia have a higher content (between 20% and 40%). Processing of skins with a high fat content, includes, necessarily, fat recovery and removal from the environment.

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2. METHODOLOGY

Currently, most wastes are deposited on the field, being the most economic method. Some wastes, such as meats, fats, shavings, ash can be sold as raw materials for other industries. Depending on local conditions, some waste can be treated before storage or sale. Among the treatment processes that can be used are drying, compacting, degreasing, anaerobic digestion, composting and heat treatment [3].

Due to the high investment costs required for the implementation of these techniques, they are not feasible economically only at small scale. For this reason, there is a wastewater treatment plant for many tanneries or they carry the wastes in other locations to be treated along with other wastes [4]. Among the issues that may occur as a result of storing this waste are contaminating, unpleasant odours and infectious materials.

From the technical point of view, treatment processes, reuse or storage depend on the degree of contamination of the waste from tanneries.

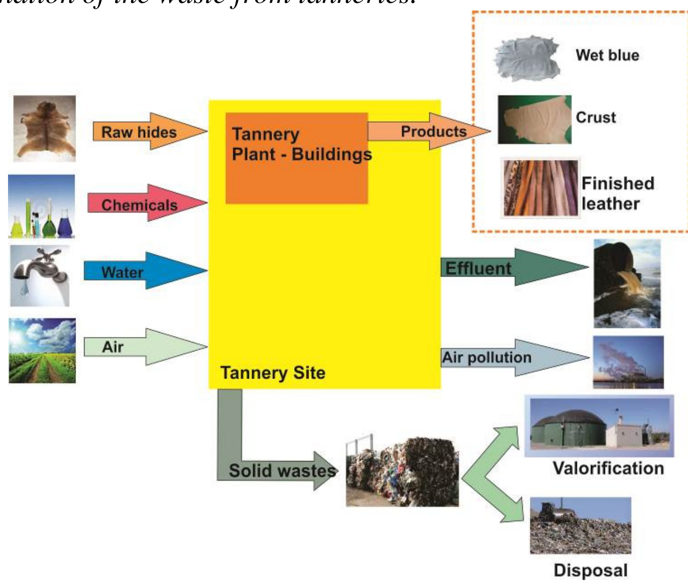

Figure 1: Input-output streams from the tannery platform

Wastes from skins are fully recovered by simple technologies and destinations well known.

Concerns are directed specifically to find new technological solutions for efficient recovery of waste containing chromium, which is a serious source of environmental pollution [5].

Taking in consideration the advantage that waste skins have, that they are composed of stabilised collagen fibre's, lately they are increasingly used in different areas such as:
- building materials[6]:
  - acoustic and thermal insulation panels;
  - waterproof and weatherproof panels;
  - special cardboards;
  - ceramic pastes;
  - resistant to heat and pressure plates;
  - plates with high absorption capacity;
  - roof plates.
- filler material for laminates with bitumen;
- compounds for rubber (used for obtaining tires).

Waste recovery solutions from leather-footwear industry are applied depending on the economic potential and regulations [7].

From a technical standpoint it is estimated that the recovery of waste is feasible in obtaining high quality protein hydrolyses without chromium, salt, light coloured, which are used in various fields as fertilizer, animal feed, cosmetics or production of chemical auxiliaries for leather processing or textiles industry; lately have been created collagen biomaterials with applications in medicine, cosmetics, dermatology [8].

The problem of sludge from leather processing, which is an important source of waste, is proposed to be solved in the future by incineration for obtaining heat or chromium separation and its use in agriculture [9].

The analysis of global data on the processing of animal hides within companies in Romania shows that the total quantity of raw hides processed annually are obtained approx. 11,000 t waste with the following structure [10]:

- 5500 t/year waste rawhide;
- 3500 t/year waste tanned leather and unfinished;
- 1800 t/year waste tanned leather and finished;
- 200 t/year waste of leather with fur.

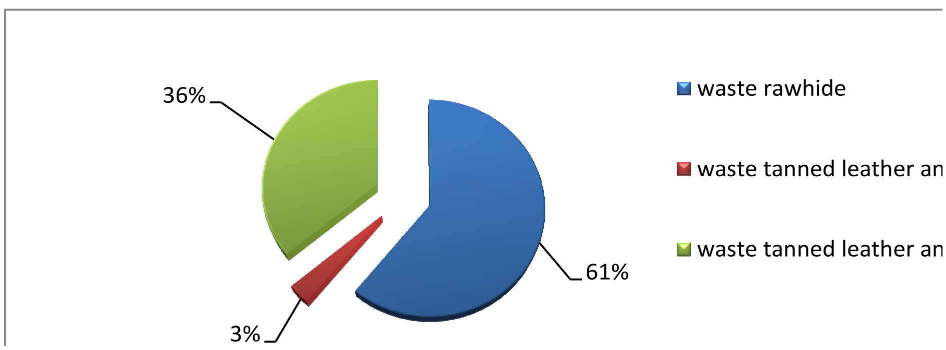

Figure 2: The distribution of waste on different stages of processing

<u>Chemical composition of waste leather:</u>

Waste from raw skins and hides have the same chemical composition as that known from animal skins. Preliminary operations of preparing the leather processing changes chemical composition depending on the type of operation, that is, after each stage of processing, the refuse will have different chemical compositions. According to the different selection criteria skins (race, age, sex, nutrition, group, etc.), chemical composition leather vary widely, taking first the relationship between proteins, fats and water. Thus, in the sheep skins, the content of fat reach 15-20%, while in the pig can reach up to 30-35%. According to the mass balance in a typical tanning process, out of a total of 1000 kg hides are obtained 300-400 kg of finished leather, 600-700 kg of solid waste and wastewater 40-50 m^3.

Table 1: Chemical composition of raw hides of cattles

Class of components		Protein components	
Component	%	Component	%
Fat	1 – 10	Keratin	0,5 – 1
Water	60 – 65	Albumin + globulin	4 – 6
Proteins	30 – 35	Muscular Protein	< 1
Carbohydrates	1	Collagen	90 – 95
Mucopolysaccharides	0,5 – 1	Elastin	2,5
		Reticulin	1 – 2
		Other categories	0,6

The largest economic interest in the recovery of waste presents collagen, followed by keratins from sheep and goats, with a share of up to 10% of the total protein. Also mucopolysaccharides present their economic interest because of their exceptional properties.

Reduction of pollution from tanneries' wastes and leather processing finished products can be achieved in several ways[11]:

- optimization and reduction until replacing toxic chemical auxiliaries;
- alternatives to the use of chromium based tanning;
- recovery and recycling of solid waste from the processing of leather.

3. CONCLUSIONS

In the context of continuous reduction of renewable oil reserves, price volatility, increasingly stringent regulations for pollutant emissions and greenhouse gas emissions and availability of raw materials, have increased concerns for developing alternative sources of energy. Biodiesel derived from biological sources, including materials with lipid, such as fats and oils, have received increased attention.

Biofuel is an alternative fuel that can be used in pure form or mixed with diesel oil, when it is burned in internal combustion engines or fuel for boilers, or used for residential purposes.

The development strategies for biofuel use to direct sensitive areas from the environmental point of view, as for example:

- local public transportation: taxis, buses, services;
- public vehicles: public sanitation blocks, garbage collection, maintenance of green spaces;
- agricultural vehicles and transport in agricultural areas;
- army vehicles and railways.

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ENERGETIC CHARACTERISTICS OF ANIMAL FATS WASTE FROM TANNERY FOR ENERGY PRODUCTION

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ABSTRACT

The paper aims to present the specific characteristics of fat animal waste from tannery industry that recommends its use for energy purpose. The main properties of interest presented (viscosity, cloud point, melting point, elemental analysis, calorific value) for this specific waste from tannery industry were determined in TMETF laboratory and the results represent practical information for waste from tannery industry recovery for energy purpose.

1. INTRODUCTION

The impact of the wastes on the environment and how to manage them differ from one type of material to another. The potential benefits are more important if the recovered materials are of high quality, so the material maintains its integrity and raw material consumption can be avoided. Regarding energy recovery, there are significant benefits when we can recover heat or electricity.

Waste fractions that do not meet the standards for recycling, but have a high calorific value can be and should be subjected to a heat treatment in special designed plants with energy recovery, properly equipped.

Nowadays there are many technical options (with varying degrees of maturity) for energy recovery from waste with useful potential.

The choice of this technology, in respect to European and national regulations, depends on the benefits associated with each option, in terms of environmental protection, but also depends on knowledge of key data such as the composition and calorific value of the specific waste. Implementing a technology or another for power generation could further enhance the use of renewable energy derived from waste.

2. BIODEGRADABLE WASTE FROM TANNERY INDUSTRY SIUTABLE FOR ENERGY RECOVERY

From the multitude of tannery waste there are two with possible application for energy production:

- Animal fat waste;
- Biogas from fermentation of tannery waste.

This paper is focused on the animal fat from tannery, a waste that due to its characteristics (high calorific value) can be successfully used for energy purposes.

3. ENERGETIC CHARACTERISTICS OF BIODEGRADABLE WASTE FROM TANNERY INDUSTRY

a) The consistency and melting point of animal fats from tannery

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Since natural fats are mixtures of different glycerides, they do not have a net melting point, as chemical substances. Fats, at first, are gradually soften, and after few degrees, become completely clear. Since last point can be determined more precisely, it is taken as the melting point.

The melting point is determined by the capillary tube method: the fat is cooled, then heated abruptly and it is determined the temperature at which the melting occurred.

In terms of consistency, this is given by the content of fatty acids in composition, the unsaturated fatty acids (oleic, linoleic) having a fluid consistency at room temperature.

The consistency of saturated fatty acids depends on the complexity of their chemical structure. Those acids which have in their composition a number of C less than eight are in liquid state, followed by the acids with a soft consistency (caprylic, lauric acid), and then others more complex acids which are in solid state.

Lard has a balanced proportion of palmitic acid, stearic and oleic acids, which explains its soft consistency. In contrast, the ruminant's fat, has a low content of oleic acid, resulting a consistency that is more firm.

b) The solidification point of the fatty acids

The fats melted and their fatty acids are not completely solidified at once, but gradually, first being cloudy due to the poorly soluble components separation until the entire mass solidifies

The temperature that marks a standstill point in cooling process is considered as the solidification point.

The cloudy point is marked by the temperature at which appears first, a cloudy state in the cooling process of melted fats. The cooling point is marked by the temperature at which appears first in oil the solids separation.

The cloudy point index is time in minutes required for fats cooling from 50^0C until a certain intensity of cloudy state. The solidification rate is the time, in minutes, passing up until fat solidifies.

Both wastes have a calorific value capable to produce energy in economic limits. In addition, by burning, their complete neutralization is achieved.

For using this waste in energy purpose are recommended the following technologies:

- fermentation of proteins for biogas production;
- burning filtered fats in mixture with diesel into an internal combustion engine.

The animal fat was subjected to laboratory tests for determination of their specific characteristics that are necessary for energy production by burning.

All measurements were performed in the laboratory TMETF;

It has been determined:

- the freezing point (the temperature of fat solidification): 14.3 - $15{,}3^0$C.
- cloudy point: 17.4 - $18{,}8^0$C;
- melting point determined in the laboratory indicated values in range of 32 - 45^0C;
- flashpoint has values in range of 165 - 188^0C;
- viscosity has been determined with an Engler viscometer.

There are presented below images of a sample of animal fat subjected to tests and laboratory equipment used for viscosity determination.

In Figure 2 is presented the variation of viscosity with temperature. Fuel viscosity is a parameter affecting atomisation of fuel. Fuels viscosity is an important parameter used to determine the appropriate design of auxiliary fuel supply systems such as centrifuges and pre-heaters. Changes in viscosity have an impact on the efficiency of the fuel pumps, for higher viscosities leaks are reduced resulting in increased efficiency accompanied with larger fuel dose.

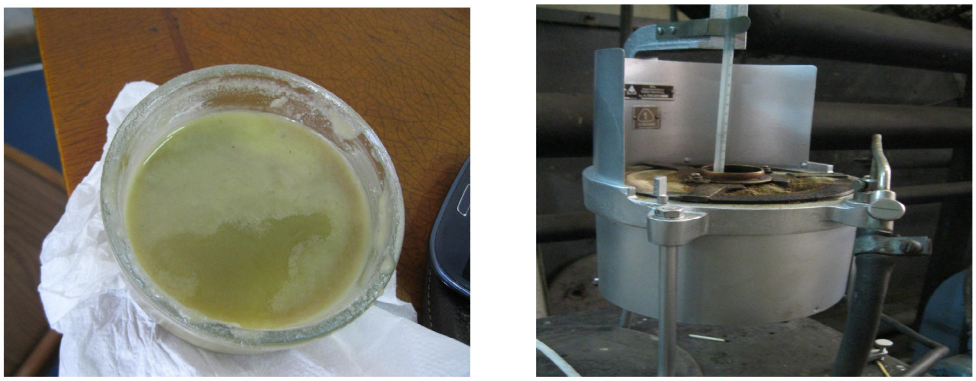


Figure 1 Sample of fat animal from tannery; laboratory determination of viscosity

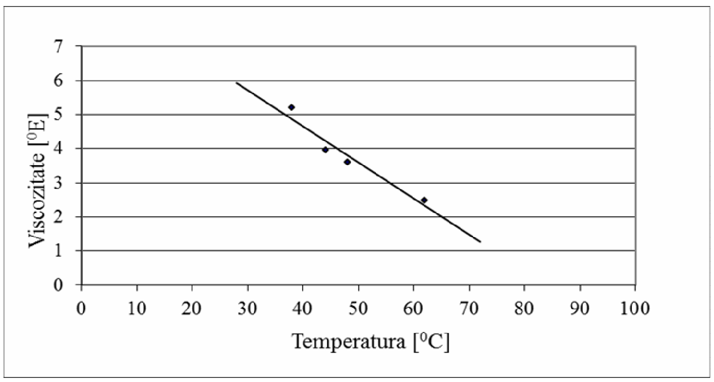


Figure.2. The variation of the viscosity with the temperature determined in the laboratory

The results are closed with those from literature where are indicated values for fat animal viscosity of 5^0E at a temperature of 37.7^0C and 10 E for 93.3^0C.

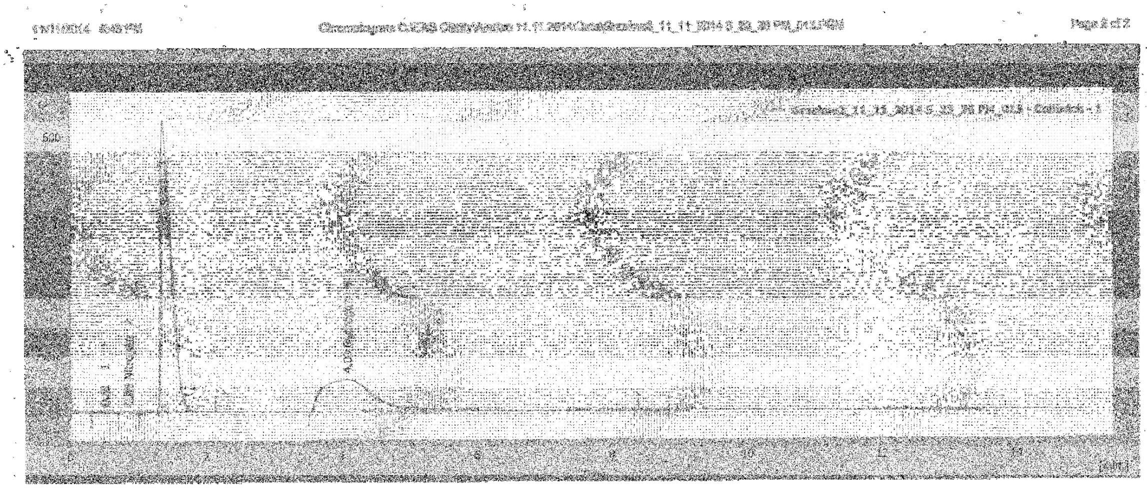
c) Elemental analyses

The chemical analysis has been performed using a COSTECH ECS 4010 laboratory equipment. This unit uses the principles of gas chromatography of the combustion products of solid biomass. This complex approach is composed of two main stages: first, the quantitative determination of the carbon, hydrogen, nitrogen and sulphur content by combustion, followed by the quantitative determination of the oxygen content by pyrolysis.

Considering that may be a lot of variation within the composition of this specific waste from tannery, 50 samples characterized by masses between 1.0 and 4.0 mg have been extracted. The average values from the main components of the samples analyzed are presented in the table below. Considering this elemental analyses, LHV of the analyzed waste has been calculated.

Table 1. Elemental analysis of fat animal waste from tannery

Waste type	Elemental composition				
	C	H	S	O	N
UM	[%]	[%]	[%]	[%]	[%]
Fat animal from tannery	68 - 74	10 - 11	-	14.8 - 17.8	0.18 - 0,25



Result Table (ESTD - Grasime3_11_11_2014 5_23_36 PM_013 - Colibrick - 1)

	Reten. Time [min]	Response	Weight [mg]	Weight [%]	Peak Type	Element Name	Carbon Response Ratio
1	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]
2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Nitrogen	[illegible]
3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Carbon	[illegible]
4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Hydrogen	[illegible]
	Total		[illegible]	[illegible]			

Figure 3 Chromatogram with C,H,N,S content in a sample with fat animal waste from tannery

In none of the samples has not been identified sulfur which means less pollutant in the combustion process.

From calculations it results a calorific value of the specific waste from tannery (animal fats) ranging from 33500 to 35000 kJ/kg, values that recommend the use of this type of waste for energy purposes preferably in mixture with fossil fuel

3. CONCLUSIONS

The use of wastes like animal fats from tannery industry in energy purpose, eliminates the need to dispose them and plus, their use in mixture with fossil fuel can reduce the SOx emissions from the combustion process.

Acknowledgements

This work was supported by a grant of the Romanian National Authority for Scientific Research CNCS – UEFISCDI, project ID PN-II-PT-PCCA-2013-4-1017, "Green Tannery – Methods for energetic recovery of biodegradable wastes""

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EQUIPMENT FOR WATER TREATMENT IN RURAL AREAS WHERE THE SOURCES ARE POLLUTED BY NITRATES

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ABSTRACT

Intensive use of chemical fertilizers in agriculture has led to significant pollution of water resources in ground- or surface water and this has sometimes led to serious illnesses of people, especially children in rural areas who drink this water.

This paper presents the technical solution of an equipment focused on rural communities with which is achieved by reverse osmosis potable water for consumption and at the same time there is also performed denitrification of the concentrate resulted from this process.

1. INTRODUCTION

Providing drinking water in areas with a state of vulnerability due to contamination of ground- or surface water is a problem faced by all countries. In particular, the nitrate content increased in almost all countries, the World Health Organization (WHO) finding that 30% of the 2000 watched water sources around the world exceed the nitrate content of 24 mg/l (data from 2004), the main causes being the use of fertilizers, the change in the way / destination of the land's use and the increase of wastewater recycling.

In the case of Romania, where the legal limit is 50 mg NO_3^-/ l, there are currently 358 significant point sources of water pollution and 255 areas vulnerable to nitrate pollution from agricultural sources [1] - Fig 1.

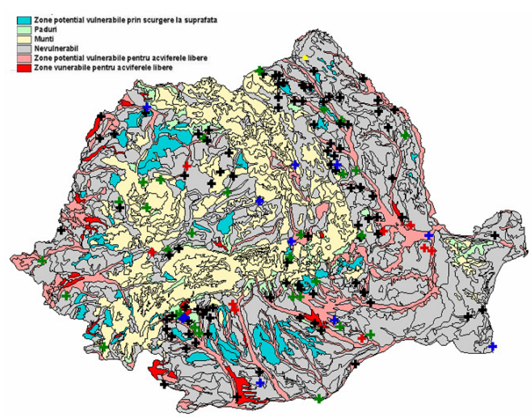

Fig. 1. Position of villages towards areas potentially vulnerable to nitrate pollution

Nitrate vulnerable zones are land areas that drain diffuse water leaks to polluted waters or waters exposed to nitrate pollution and contribute to their pollution. These areas cover about 59.5% of the agricultural area of the country. 1955 localities were designated and grouped into 42 nitrates vulnerable zones [2], representing 57.8% of the country's surface. Regarding the assessment of nitrates concentrations in the groundwater, this was made taking into account the average concentration and the maximum concentration recorded in the period 2008 - 2011 (1-4 years) in all 1809 national monitoring sections. At the national level: 76.62% of this points have values below 25 mg/l, 8.13% between 25 and 39.99 mg/l, 3.75% between 40 and 50 mg/l, 11.50% above 50 mg/l. High average nitrate concentrations are recorded in the plain areas (Romanian Plain – Southern Oltenia, West Plain) and less in the plateau areas (Plateau of Moldavia and Transylvania hill Depression) – *Fig.2.*

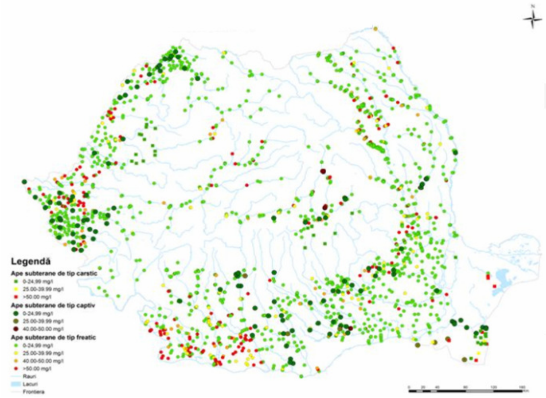

Fig. 2. Average concentrations of nitrates in groundwater monitored sections (2008-2011) [2]

Water consumption with high concentrations of nitrates has serious effects on health; from the syndrome of the newborn blue to increase in high incidence of cancers and for this reason there is urgently needed the researching and development of equipment to provide drinking water for rural communities where deep or surface sources are polluted.

The experimental model development of such equipment has been assumed in a research project financed through "PARTENERIATE 2013" programme by a consortium of two universities (Politehnica University of Bucharest -UPB, prof. Adrian Ciocanea and prof. Nechifor, University of Bucharest - UB, prof. Stamatin), a research institute (Hydraulics & Pneumatics research Institute - INOE 2000-IHP, Dipl. Eng. Radu Sauciuc and Ph.D eng. Ioan Lepădatu), two companies (TEHNOPREST Bucharest and ARMAX GAZ Medias). The technical solution chosen for the development of the filtration equipment - experimental model is the reverse osmosis. Osmosis is defined as passing the solvent through a semipermeable membrane separating two solutions of different concentrations, from the more diluted solution to the more concentrated solution until there is reached balance of osmotic pressures.

After more than 40 years, NASA experts have developed a method through which they were turning into drinking water all substances containing water on the space ship board, in order to lighten the space ship weight regarding drinkable water requirements. It is an artificial membrane similar to cellular membranes, which allows passing through its pores only pure water molecules under the influence of pressure applied to the fluid containing water. The method was called **Reverse Osmosis**. The experimental model is expected to be developed in three modules (see Figure 3):

- the ultrafiltration module
- the reverse osmosis module
- the denitrification module

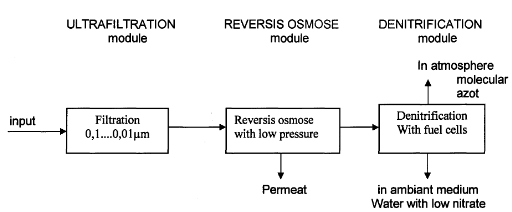

Figure.3 Hybrid system: reverse osmosis – denitrification with biofuel cells

2. **ULTRAFILTRATION MODULE**

Before osmosis could be there the contaminated water must pass through a process microfiltration. Without this pre-filtration, the life of osmotic membrane is drastically reduced. The integral picture of water filtration is presented in Figure. 4.

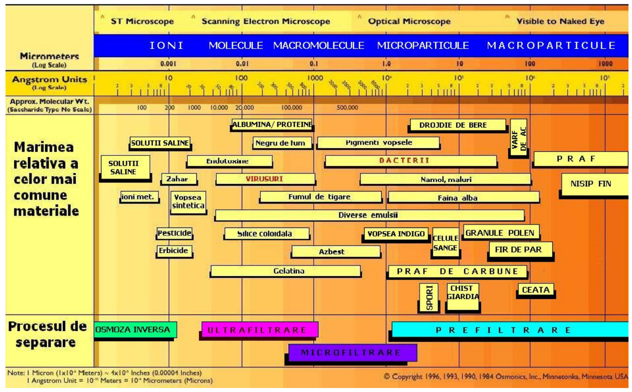

Fig. 4 Water filtration levels and contaminants retained

Through microfiltration there are retained particles sized between 0.1 and 10μm. For microfiltration there are commonly used ceramic filters. Ultrafiltration is carried out with ultrafiltration membranes that have the ability to retain particles with a size of 0.001 ÷ 0.1μm. Ultrafiltration is used as a pre-filtering for reverse osmosis.

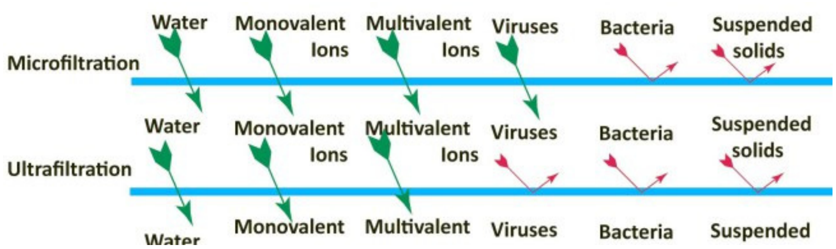

Fig.5 Restraint capacity in the micro and ultrafiltration process

The purpose of pre-filtering water entering the reverse osmosis process is to reduce the amount of organic matter and bacteria which are deposited on osmotic membranes. Micro and ultrafiltration membranes have several beneficial effects on osmotic membranes:

- The membranes will have longer lifetime
- Time for using the equipment will be higher
- Servicing operations are occasionally
- Cost of employees is lower.

3. **REVERSE OSMOSIS MODULE**

An installation for the reverse osmosis water filtration, highly provided with equipment, is shown in Figure 6, and it has in the structure.

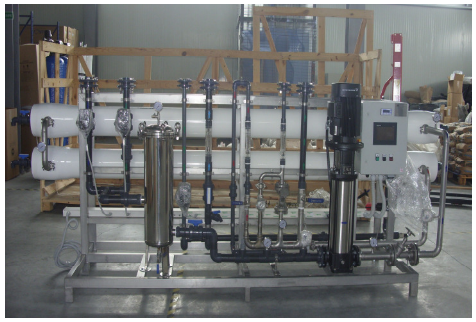

Fig. 6 Reverse osmosis model

Dosing unit chemical specifications:

- Dosing system of the antiscalant
  - Dosing pump
  - Chemical tank

Reverse osmosis equipment technical specifications:

- Cartridge filter
- High pressure pump (HPP)
- Reverse osmosis membranes
- Reverse osmosis vessel

Analyzer group:

- Permeate conductivity controller
- Permeate and concentrate flow meter
- Low and high pressure control
- Pressure gauges
- Autoflush unit
- Permeate rinsing unit

Piping and valve groups of the unit:

- Valve group
- Piping group
- System mount frame

Membrane cleaning system:

- Washing pump
- Washing tank
- Pressure gauges
- Piping group
- Valve group
- System frame

The “heart” of the equipment is the osmotic membrane (Figure 7).

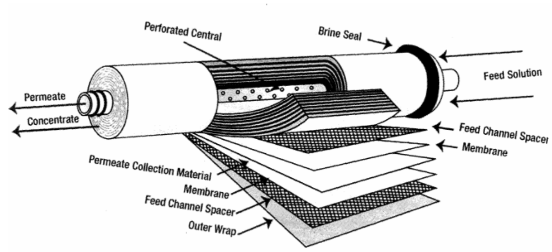

Fig.7 The reverse osmosis membrane

The reverse osmosis membranes are polymer membranes. Filtering on the principle of reverse osmosis is performed with cylindrical filter cartridges in which are inserted osmotic filtering membranes (see Figure 7).

4. DENITRIFICATION MODULE

The denitrification module is intended for the post-treatment of the concentrate waste, in order to reduce the nitrate concentration to a level at least equal or lower than that recorded at the entry point of the reverse osmosis system.

The bio-fuel system will consist of two electrodes (an anode and a cathode) to be positioned as follows: the anode - on the bottom of the tank, and the cathode - at its surface, and will consist in grids supporting a carbon felt structure (*Fig. 4*). By polarizing the cathode electrode, namely by applying a potential for its activation, the electro-active bacteria existing in the waste water will attach to the electrode and will use it as the end acceptor of electrons, in order for them to capture nitrates and remove excess nitrogen.

The biological reduction of nitrate (NO_3^-) to molecular nitrogen (N_2) is called denitrification and is performed, generally, by facultative anaerobic bacteria. These require in their metabolic processes a source of carbon and oxygen, which they can take from the oxygen dissolved in water, or by taking it from the nitrate molecules. [3]

Denitrification occurs when the oxygen level in the solution is at minimum values or exhausted, and nitrates become the main source of oxygen for the microorganisms. The denitrification process is carried out under anoxic conditions, when the dissolved oxygen concentration is less than 0.5 mg/l, and ideally less than 0.2 mg/l [4]. Bacteria degrade nitrate to take up oxygen that occurs via a series of intermediates (oxides of nitrogen), necessary for their metabolism, which leads at the end to obtaining molecular nitrogen (N_2). This respiratory process for the nitric oxide reduction occurs in response to the oxidation of an electron donor (for example, organic matter). In terms of thermodynamics, the forms of nitrogen used by microorganisms as electron acceptors include: nitrate (NO_3^-); nitrite (NO_2^-); nitric monoxide (NO^-); nitrous oxide (N_2O), and eventually resulting in molecular nitrogen (N_2), thereby completing the nitrogen cycle in the microbial cells. As molecular nitrogen has a low solubility in water, it will pass into the atmosphere as gas, and since nitrogen is a major component of the air, this will not entail any environmental concerns. [4]

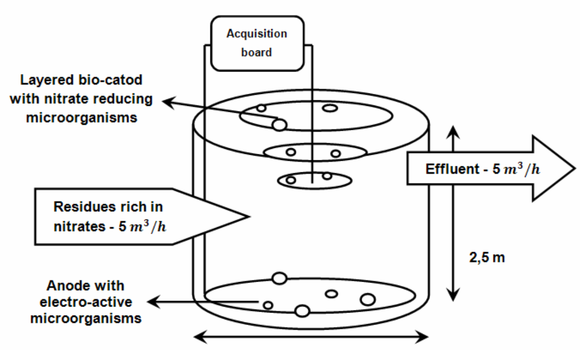

Fig. 4. Wastewater denitrification using fuel cells

The tank for the post-processing of residues with high concentration of nitrates will have a total volume of 15-20 m^3, taking into account the amount of concentrate waste to be reduced and thus to provide a development environment for the electro-active microorganisms. The chosen method is taken from the known experience of bio-fuel cells and the system model used will be one optimized for operation through consumption of organic matter present in the water through the use of microorganisms species capable of reducing the toxic organic compounds from aqueous ecosystems. It consists in placing an anode electrode in the sediment with microorganisms, connected through an external circuit to a bio-cathode with a three-layer carbon fibre structure starting from the water surface and followed by two submerged structures in an aqueous medium at distances of 20 cm. The denitrification process is mainly carried out by heterotrophic bacteria, such as Paracoccus denitrificans and various types of Pseudomonas. Denitrification can be achieved also by autotrophic species such as Thiobacillus denitrificans. Many types of bacteria (Alcaligenes faecalis, Alcaligenes xylosoxidans, Bradyrhizobium japonicum, Blastobacter denitrificans and species of the genus Pseudomonas) are involved in the complete reduction of nitrate to molecular nitrogen and there were found several enzymatic ways in the microbial metabolism involved in the processes of nitrate reduction [5].

5. CONCLUSIONS

The equipment proposed in this paper solves the problem of drinking water in rural areas where the exposure of population to high nitrate concentrations increased the level of risk to public health on the medium and long term. The solution chosen for purifying water - reverse osmosis - has the advantage over the other methods of low energy consumption and reasonable operating and implementation costs. If many years ago, reverse osmosis was considered an expensive and highly technical purification process, nowadays, thanks to the ongoing development of mechanical-chemical techniques, we can say that it has become a process of elimination of impurities available to everyone. In addition compared to other installations of the water purification, where waste water results from reverse osmosis process, which has a high concentration of nitrates and is discharged in ambient causing pollution, at the proposed equipment there is achieved reducing of nitrate concentrations of waste water up to the legal limit of 50mg/l accepted Romania.

Implementation of equipment in rural areas vulnerable to nitrates will be made by the City Halls which will acquire the facility and will produce and distribute bottled drinking water to the population.

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EU 2020 TARGETS FROM THE MEMBERS STATE PERSPECTIVE

Oana Udrea[1], Gheorghe Lazaroiu[2], Mariacristina Roscia[3], Dana Andreya Bondrea[4]

ABSTRACT

The European Union's (EU) vision implies tremendous changes in the power systems. These should contribute to sustainable development and protection of the environment by enabling the EU to achieve its targets of a 20% reduction of greenhouse gas emissions, 20% increase in energy efficiency and 20% of renewable energy in final energy consumption by 2020. Renewable energy is considered energy from inexhaustible sources.

1. INTRODUCTION

Types of renewable energy are solar, wind, geothermal, water energy and biomass energy. These types of energy have appeared more than 10 years to reduce emissions of pollutants with the advantage that they never exhausts, [1,2].

Under the Kyoto Protocol, the 15 Member States that made up the EU until its enlargement to 27 Member States have to reduce their collective greenhouse gas emissions by 8% below 1990 levels during 2008-2012. This target is shared among the 15 Member States under a legally binding agreement (Council Decision 2002/358/EC of April 25, 2002). Most of the 12 new Member States have individual targets under the Kyoto Protocol. The exceptions are Cyprus and Malta, which have no targets. In the figure below the Kyoto-targets for each Member State are shown as well, [3].

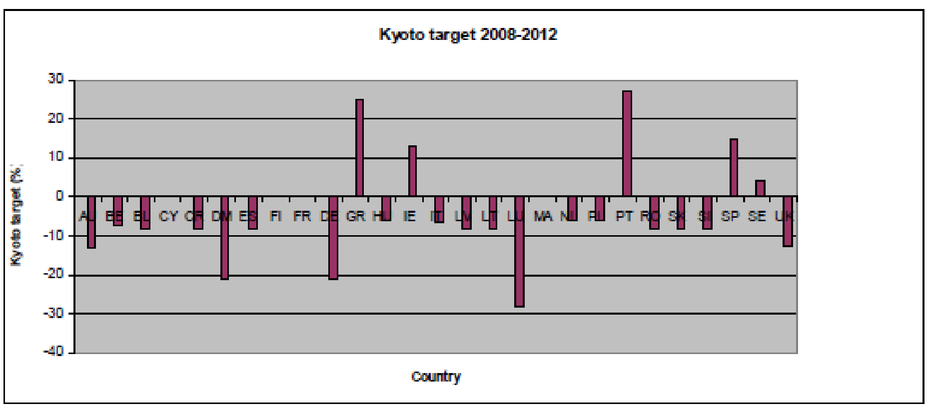

Figure 1: Kyoto-targets 2008-2012 for each Member State

At the end of 2007 the Commission's annual report on progress towards meeting the Kyoto objectives concluded that the EU is moving closer to achieving its Kyoto Protocol targets for reducing emissions of greenhouse gases but additional initiatives need to be

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adopted and implemented swiftly to ensure success. The latest projections from Member States indicate that measures already taken, together with the purchase of emission credits from third countries and forestry activities that absorb carbon from the atmosphere, will cut EU-15 emissions in 2010 to 7.4% below levels in the chosen base year (1990 in most cases) - just short of the 8% reduction target for 2012. Additional policies and measures under discussion at EU and national levels will allow the target to be reached and even take the reduction to 11.4% if implemented promptly and fully, [4].

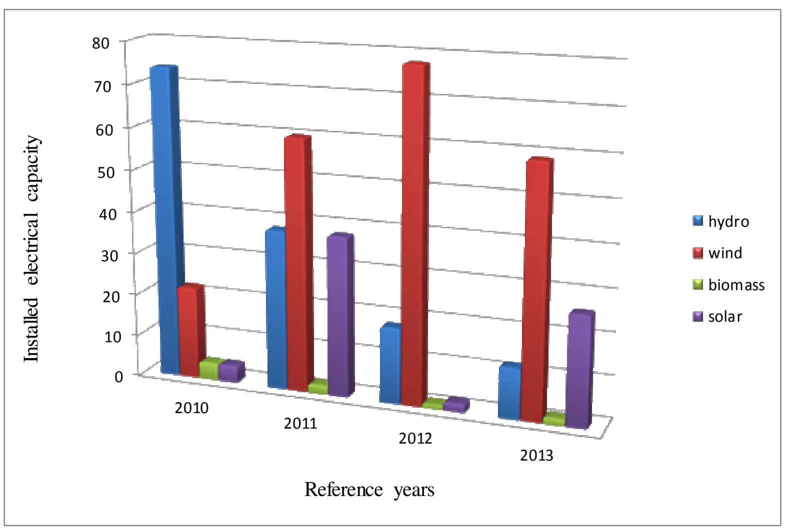
From December 3 to 14, 2007, the thirteenth Conference of the 192 Parties to the United Nations Framework Convention on Climate Change took place in Bali in Indonesia. The objective was to set a timeline for negotiations (if possible with emissions reduction targets) in order to produce a successor agreement to the Kyoto Protocol by year-end 2009. An agreement was reached for post-Kyoto negotiations but no emissions reduction targets were formulated. Instead, the countries attending the Bali summit finally adopted a “road map” setting the agenda that they would be following until the Copenhagen summit in 2009.

However the United States, initially taking a defensive stance, finally entered into the multilateral discussion process. Some developing countries have accepted the eventuality of emissions reduction targets, which is necessary. Reduction targets have yet to be defined and implemented and, as we know from experience, this is not easily done.

The installed capacity of renewable energy in the world reaching an estimated 1,560 gigawatts (GW) in the energy sector in 2013. Globally were invested considerable sums in renewable energy has continued to focus primarily on the electricity sector. Number of E-RES licensees and accredited at the end of 2013 was 559 manufacturers of which: 73 uses wind, 77 uses hydropower, 14 uses biomass and 395 uses solar energy

The following table presents a statistical E-RES producers licensed in the last four years[3].

Tabel 1: Number of E-RES producers licensed in the last 4 years in Romania



2. NATIONAL OVERALL TARGETS FOR THE SHARE OF ENERGY FROM RENEWABLE SOURCES

In its Proposal for a Directive of the European Parliament and of the Council on the promotion of the use of energy from renewable sources (23-01-2008) the Commission aims to establish an overall binding target of a 20% share of RES in energy consumption and a 10% binding minimum target for biofuels in transport to be achieved by each Member State, as well as binding national targets by 2020 in line with the overall EU target of 20%.

Additionally, the following targets have been set: 20% energy savings and 20% CO2-reduction. The main purpose of binding targets is to provide certainty for investors.

European Union has increased wind energy capacity by more than 11GW reaching a total of 117GW of which the most important are: Germany with about 34,7GW, England with 10.5 GW, with 0,7GW Romania, France with 0.6GW and Italy with a capacity of 0,4GW in 2013.

At the time of the publication of the Proposal 8.5% of all energy is renewable in Europe. This covers not only the electricity production, but also heating and cooling and transportation. To be able to meet the 20% RE target in 2020, Europe needs another 11.5%.

Memeber State's starting points, RE potentials and energy mixes vary. It is therefore necessary to translate the overall 20% target into individual targets for each MS, with due regard to a fair and adequate allocation taking account of different national starting points, including the existing level of RE and energy mix[4]. This is being done by sharing the required total increase in the use of energy from renewable sources between Memeber States on the basis of an equal increase in each Memeber State's share weighted by their Gross Domestic Product, modulated to reflect national starting points, and by accounting in terms of final energy consumption[5]. Each Member State shall ensure that the share of energy from renewable sources in final consumption of energy in 2020 is at least their overall target for the share of energy from renewable sources in that year.

The figure below shows these targets too.

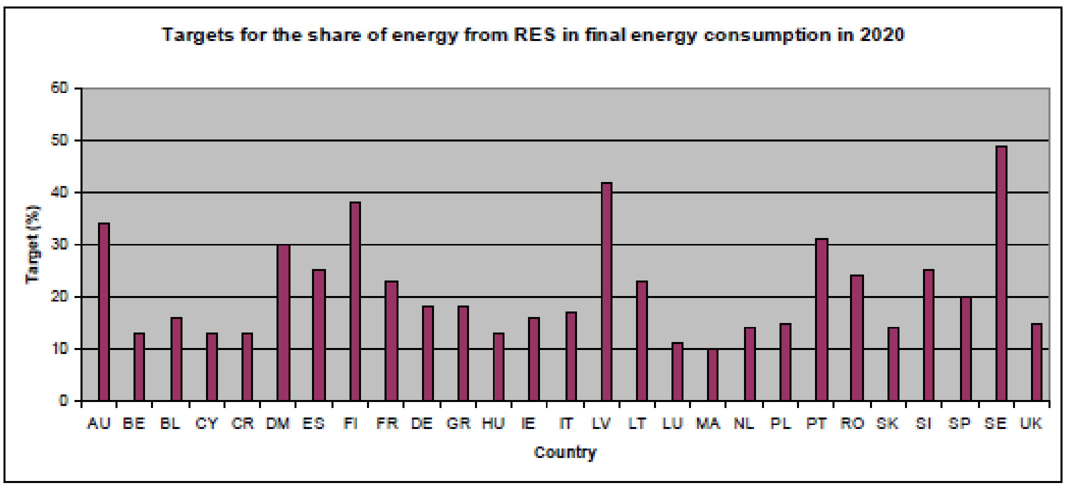


Figure 2: Targets for EU-27 countries for the share of energy from RES in final energy consumption in 2020

These targets have yet to be agreed, but they are proposed by the European Commission in January 2008. It is expected the targets will be set by the EC in spring 2009. For each trading period, each Member State is obliged to notify a national allocation plan to the Commission. The national action plans shall set out Member States' targets for the shares of energy from renewable sources in transport, electricity and heating and cooling in 2020, and adequate measures to be taken to achieve these targets, including national policies to develop existing biomass resources and mobilize new biomass resources for different uses, and the measures to be taken to fulfill the requirements of Articles 12 to 17.

In the NAPs for the first and the second trading periods, Member States determined the total quantity of allowances to be issued, the cap, and how these would be allocated to the installations concerned. This approach has generated significant differences in allocation rules, creating an incentive for each Member State to favor its own industry, and has led to great complexity.

In its legislative package on climate and energy (Climate Action Plan4) that the Commission presented on January 23, 2008 the Commission proposed to set a single EU-wide cap on ETS emissions and to allocate allowances on the basis of fully harmonized rules. National allocation plans will therefore not be needed any more. To provide companies still with a long term view, the emissions cap is reduced every year with the same percentage: 1.74% per year, until 1,720 Mton in 2020. The table below provides an overview.

Table 2: Emission gap after 2012

Year	Mton CO_2
2013	1,974
2014	1,937
2015	1,901
2016	1,865
2017	1,829
2018	1,792
2019	1,756
2020	1,720

The starting point of this line is the average total quantity of allowances to be issued by MSs for the 2008-12 period, adjusted to reflect the broadened scope of the system from 2013. Also after 2020 the 1.74% reduction per year will be applicable; in 2025 at the latest the EC will review if this percentage works well (MEMO/08/35).

In implementing the national targets in practice, MSs will need to set their own specific objectives for electricity, biofuels and heating and cooling, which would be verified by the Commission to ensure that the overall target is being met (Renewable Energy Road Map, 2007) [6, 7].

3. RES-E TARGETS

In 2001 the European Union issued after long discussions between the different institutions the Directive on the promotion of electricity produced from renewable sources (RES-E directive)6. This Directive sets out to create a framework that will facilitate, on the medium term, a significant increase in renewable generated electricity within the EU. It constitutes an important milestone in shaping the regulatory framework for RES-E generation in the EU.

The Directive set the target that 22.1% of renewable electricity in comparison to the overall electricity consumption should be reached by 2010.

As Romania and Bulgaria joined the EU at a later stage, their RES-E targets for 2010 were set separately. The Romanian RES-E target is set at: 33% of gross electricity consumption in 2010 and for Bulgaria this target equals: about 11% for electric energy consumption in 2010 (Renewable Energy Fact Sheets, January 2007).

In the figure below the above mentioned RES-E targets are shown too for all EU-27 Member States, [8].

Romania as one of the State Members has to fulfill its obligations related to EU's targets in terms of RES integration. The incentive support scheme for RES has been enacted by Law no. 220/2008 for establishing the promoting scheme for energy produced out of RES, Law no. 139/2010 (modifying Law 220/2008) and a series of four governmental orders dated November 2011. As a result of the supporting scheme mainly based on green certificates, since 2007, the National Grid Company – Transelectrica, received a large number of applications for connection.

Most of them are located in Dobrogea, Moldova and Banat areas as in Figure 4.

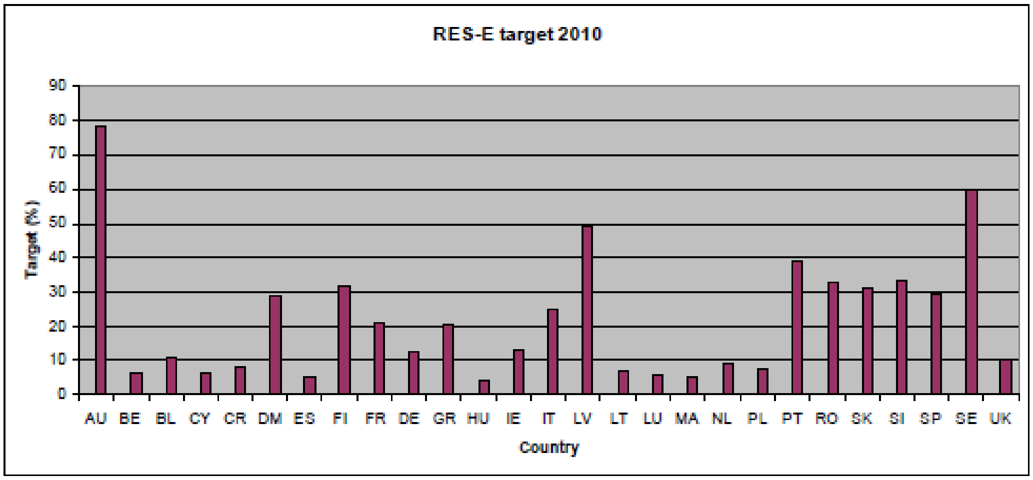


Figure 3: RES-E targets 2010 for EU-27 countries

Figure 4: Areas with large projects in Romania

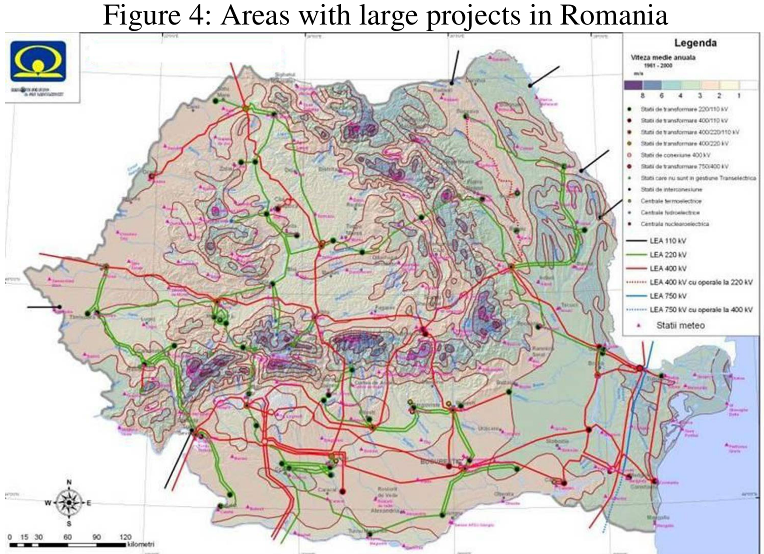


Figure 5: Wind potential in Romania

This concentration of interest from the private investors coincides with the wind potential map as in Figure 5, [9].

Starting from 2010, installed power increased from 13 MW to 400 MW by the end of the year. In 2011, the installed power was almost double (700 MW) compared with the previous year, therefore by the end of 2014, the installed power in wind was up to 2600MW, [10].

4. CONCLUSIONS

In this chapter an overview is provided of the different targets agreed on in the EU-27 countries. The relevant targets that have been discussed are: Kyoto-target, targets for the share of energy from RES in final energy consumption in 2020 and the RES-E target. At the end of 2007 the Commission's annual report on progress towards meeting the Kyoto objectives concluded that the EU is moving closer to achieving its Kyoto Protocol targets for reducing emissions of GHG but additional initiatives need to be adopted and implemented swiftly to ensure success. The RES target has just been published in January 2008. These targets have yet to be agreed, but they are proposed by the European Commission in January 2008. It is expected the targets will be set by the EC in spring 2009. In the meantime MSs have to prepare plans how to achieve the proposed targets. In 2001 the European Union issued after long discussions between the different institutions the Directive on the promotion of electricity produced from renewable sources (RES-E directive). This target is set for the year 2010 and the progress made in the different MSs varies. In 2004, investment in renewable sources was $ 39.5 billion but the amount of regrown in 2013 invested amount is about 5 times higher, reaching a total of 214 billion. Investments in renewable energy in 2013 declined for the second consecutive year, reaching 214 billion dollars, 14% less than in 2012. In the last 10 years has grown installed electric capacity from 85 GW in 2004, reaching 2013 to 1560 GW. Refer to the fact sheets in Appendix II for more information on the progress.

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