THE APPLICATION OF STATISTICAL AND MATHEMATICAL METHODS OF ANALYSIS TO REAL DATA PROCESSING OPERATION OF A BLAST FURNACE

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Abstract: In this paper presents a model for application of statistical and mathematical processing real data of a blast furnace, the centralization of data, statistical and mathematical processing, trace correlation diagrams of the main process parameters and functions of significant performance, interpretation of the results.
Keywords: consumption coke, correlation, blast furnace, cast iron.

1. INTRODUCTION

The data collected for the analysis come from the F5 blast furnace from ARCELOR MITTAL Galati, are representative for a period of 30 days, in which he worked and furnace with coal powder injection on at the mouth of windy, to replace a quantity of metallurgical coke, fuel expensive and deficient.

2. EXPERIMENTAL

For interpretation of results obtained from real data processing operation of a blast furnace from ARCELOR MITTAL Galati, have been used in mathematics and statistical methods of modern data processing**.**

Table 1

Dust coal comsumption, kg/day	Technical cokeconsumption , kg/tpig iron	Daily production of pig iron, t/day	Dust coal specifical consumption, kg/tpig iron	Specific consumption of equivalent fuel , kg/tpig iron
0	534	2392	0	534
64633	507	3469	18,63159412	525,6315941
25644	537	3151	8,138368772	545,1383688
318210	476	4347	73,20220842	549,2022084
367291	474	4490	81,80200445	555,8020045
368365	488	4658	79,08222413	567,0822241
354711	488	4600	77,11108696	565,111087
377001	496	4491	83,94589178	579,9458918
346822	478	4300	80,65627907	558,6562791
341380	487	4116	82,93974733	569,9397473
160856	544	3868	41,58634953	585,5863495
320664	472	4556	70,38279192	542,3827919
365907	469	4639	78,87626644	547,8762664
363706	456	4547	79,98812404	535,988124
366193	456	4663	78,531632	534,531632
361724	450	4609	78,48210024	528,4821002
365034	450	4701	77,65028717	527,6502872
367805	451	4589	80,14926999	531,14927
366306	451	4568	80,18957968	531,1895797
370388	469	4391	84,35162833	553,3516283
369281	442	4508	81,91681455	523,9168146
374979	445	4688	79,98698805	524,9869881
6716900	15145	128450	1497,601237	16642,60124
216674,1935	488,5483871	4143,548387	48,30971732	536,8581044

3. REZULTS

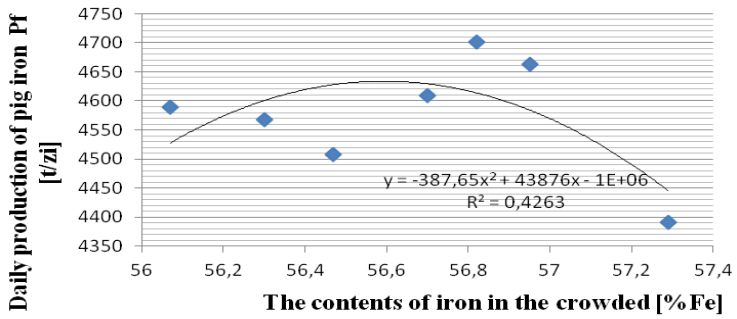
The objective functions of the correlations were analyzed elected those technological indicators that have a connection and a significant implication on leveraging process iron in blast furnace [1,2,3], namely: daily production of pig iron; daily consumption of coke; specific consumption of fuel equivalent of physical technical; coke pulverized coal methane gas; coke-specific consumption; the yield of carbon dioxide in the gas furnace.

Technological parameters that have a notable influence on the performance of these functions and whose correlation with trial functions have been carried out and plotted were:

- the percentage of crowded, iron
- flow zone of air introduced into the furnace through the mouths of wind
- dust daily consumption of coal used as a substitute for coke,
- specific consumption slacking,-air temperature in a furnace, instilled
- content pig iron Silicon
- simply and complex basicity of ferrous sinter.

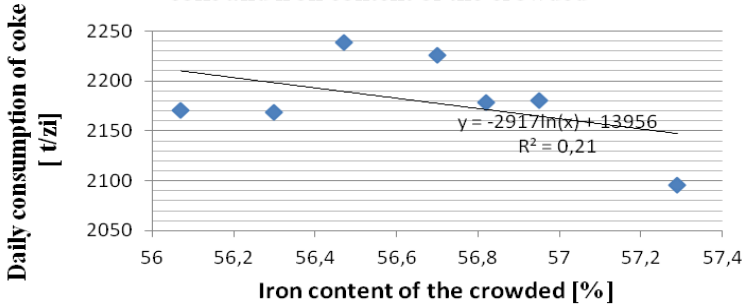
Correlation charts, results are presented in figures 1-11 shown in R^2 values appearing on each chart between 0.20 and 0.9441 (which means the values of the coefficients occurring between 0,45 and confidence 0.99) that all the correlations can be admitted.

Fig.1 Correlation between daily production of pig iron and iron content of the crowded



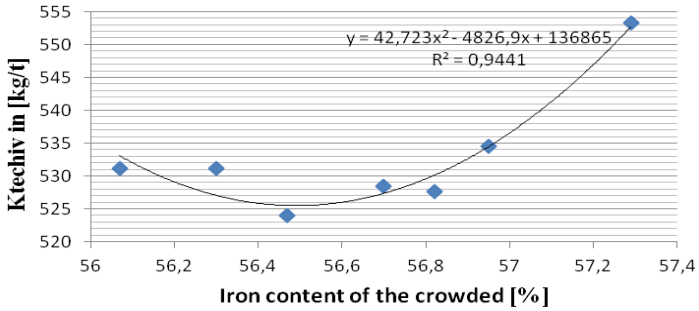
From the diagram presented in Figure 1 it is observed that an increase of the content of iron in crowded close to the optimal value of 56.6% leads to an increase in production of cast iron, because the same yield iron crossing of cargo in cast iron, a greater amount of iron in the blast furnace generates a greater amount of cast iron.

Fig. 2 The correlation between daily consumption of coke and iron content of the crowded



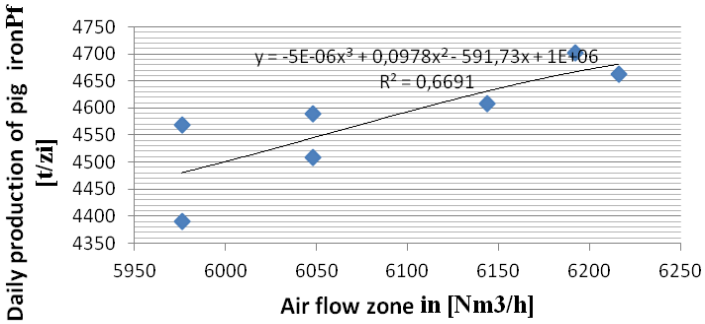
In the diagram presented in Figure 2, an increase of the content of iron in the crowded lead to a decrease in the daily consumption of coke, which is beneficial, but decreased conţinutui of coke is better motivated by improving the Reducibility of indicators aglomeratului and its permeability.

Fig.3 The correlation between specific consumption of fuel equivalent and the content of iron in crowded



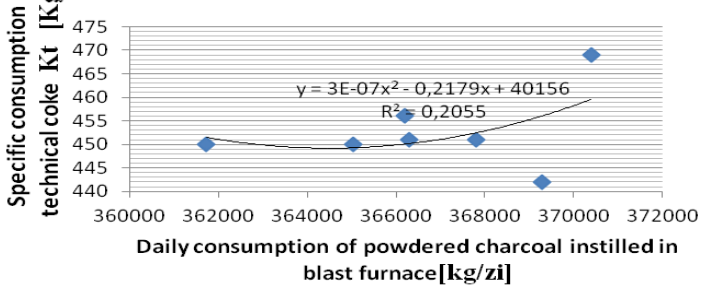
In the diagram presented in Figure 3, an increasing content of iron in crowded at about 56%, has a favorable influence on consumption of fuel equivalent.

Fig.4 Correlation between daily production of cast iron and air flow zone



In the diagram presented in Figure 4, it is observed that an increase in air flow zone leads to increased production of pig iron, which is fully in line with the theoretical and technological logic because the air flow in the blast furnace is the engine of the furnace process.

Fig.5 The correlation between the specific coke consumption technical Kt and daily consumption of powdered charcoal instilled in blast furnace



In the diagram presented in Figure 5, it is observed that an increasing amount of slacking introduced daily until approx. 36400 kg/day has a favourable influence on the efficiency of process furnace in specific consumption downside of Coke.

In the diagram presented in Figure 6, it is observed that an increase in consumption of coal powder introduced in a furnace has a favourable influence on the efficiency of process furnace in specific consumption downside of Coke, since the aim of the introduction of dust coal fuel auxiliary role is just to replace a quantity of Coke.

In the diagram presented in Figure 7, is observed that an increase in air temperature in the furnace up to a value of about 1018^0C on the specific consumption of coke and specific consumption of fuel equivalent, what is explained by bringing a additional intake of heat due to air enthalpy, leads to a refilling of a quantity of heat which would derive from the combustion of a carbon amounts entered in a furnace with Coke, leading to lower consumption of coke or fuel equivalent.

Fig.6 The correlation between specific consumption of coke and Kt technical specific consumption dust coal Pc

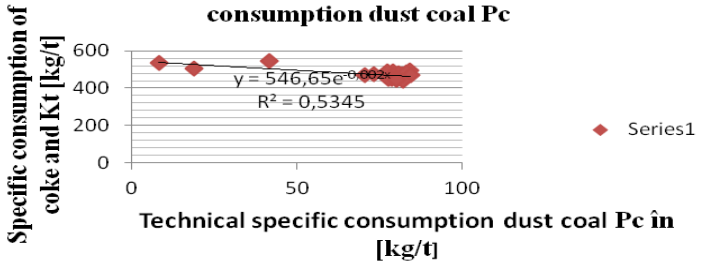


Fig.7 The correlation between specific consumption of fuel equivalent equivalent Ktechiv and instilled in furnace air temperature

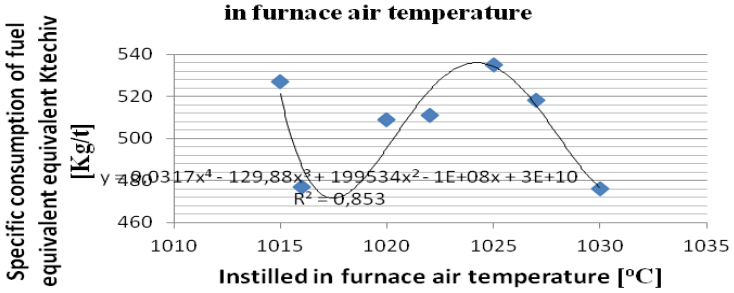


Fig.8. The correlation between the specific coke consumption Kt and content of technical Silicon in pig iron

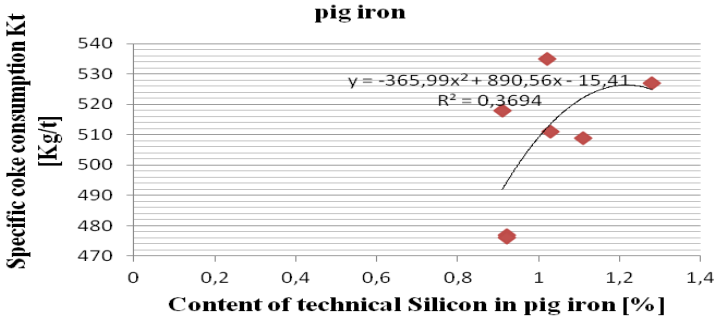
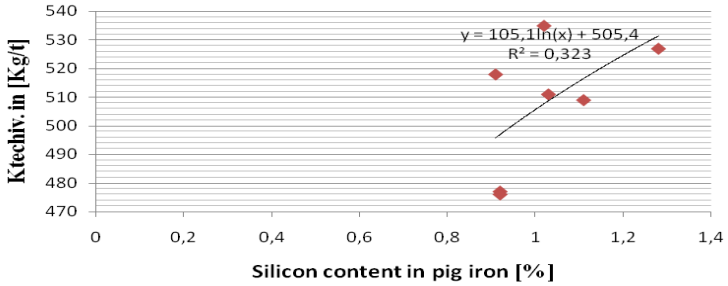


Fig.9 The correlation between specific consumption of fuel equivalent (coke + Kt technical slacking Pc) and Silicon content in pig iron



In the diagrams presented in Figure 8 and 9 it is observed that an increasing percentage of the amount of Silicon in cast iron raises specific consumption of coke and fuel equivalent, which is explained by the fact that getting in Silicon cast iron is made from a strong endoterme reactions, who needs heat what can be ensured only by a greater amount of carbon in the load, retrieved from fuel, so a larger amount of fuel.

In the diagrams presented in Figure 10 and 11, argue it is noted that the value of the sinter ferrous basicity B over 1,15 or a simple basicity Ib over 46 leads to an increase in the efficiency of carbon dioxide in the gas furnace, which means a process of blast-furnace

efficiency through effective use of the potential of reducing the gases inside the furnace, which means an increase in the share of indirect reductions with carbon oxide in a furnace and a decrease in the share of direct discounts and a decrease in the specific consumption of fuel to the furnace.

Fig. 10 The correlation between the yield of carbon dioxide in the gas furnace and complex basicity B to ferrous sinter

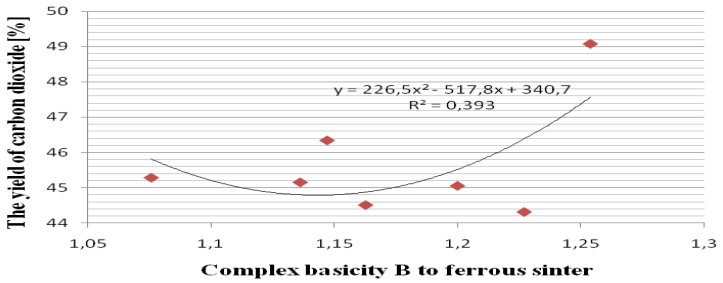
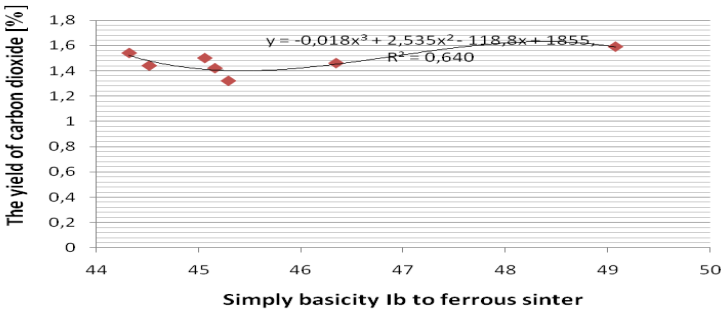


Fig. 11 The correlation between the yield of carbon dioxide in the gas furnace and simply basicity Ib to ferrous sinter



4. CONCLUSIONS

The analysis of correlation diagrams of the main factors and functions of performance of the process you can deduce the value ranges of variation factors of influence so that for performance functions to obtain the optimal technological values.

The conclusions drawn from the analysis of technological parameters and process functions derived from the calculation of the balance of materials and energy [4,5] to getting the first fusion iron furnace in F5 from Galati in the reporting period are as follows:

- Load furnace was of good quality, consisting of crowded, pellets and Brazil ore with high content of Fe. Basicity index has remained constant (almost 1).
- Blast furnace operation was characterized by a number of stops (small repairs, a low number of hours of work (lack of raw materials, less intensive operation of converters)), which led to a value of index use of time of the order of 95-97%. Under the conditions shown, utilization of production capacity of blast furnace no. 5 ARCELOR MITTAL Galati was 80-85%.
- Of technological calculations made on the basis of oxides reduction processes of Fe took place in favourable conditions due to the fact that the operation of the blast furnace was not forced, size of sinteri and pellets loaded and good quality of the value in use (in terms of resistance and size). η_{CO} = 53 %,, comparable to what ηWas achieved a yield of carbon monoxide is accomplished at blast furnaces with very good indicators.

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THERMAL MEASUREMENT AND CALCULATION OF GREEN ROOF AND NORMAL FLAT ROOF

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Resume:
Installing green roofs on building tops is an important part of energetically conscious planning. This has many energetic advantages, while it is simply aesthetic. Opportunities of green roofs are in use in Western-Europe for a long time, and nowadays, more and more fine examples can be caught in Hungary, as well. In this article we present a specific series of measurement and computer calculation on a certain building, which has two different cover on the same roof surface. One part is green roof, the other is normal paved flat roof. We compare measured results with numerical calculation and draw conclusion for further examination.

1. Introduction

With a series of measurement we examined the change of temperature of each layer of a green roof, which belongs to a nursery school built in the 1970's. The roof is shown on Figure 1. Similar examples in [10].

Figure 1 - Green roof and normal flat roof

On the picture we can see the green roof with the measuring equipment and the other side of the fence there is the paved flat roof.

During the series of measurement for almost a year we gathered temperature data of each layer of both roofs. This way both summer and winter data are available. Figure 1 shows the layers of the roof structures. We can see that lower layers are the same, only the covering layer is different.

Layers from inside: reinforced concrete slab panel, concrete inclination layer, moisture proofing, thermal insulation, 2 layers of waterproofing

- normal flat roof – broken stone embedding layer, concrete pavement
- green roof – plastic drainage layer with geotextile, 10 cm of soil (vegetation layer).

Green roof directives are defined in [3], [4] and [9].

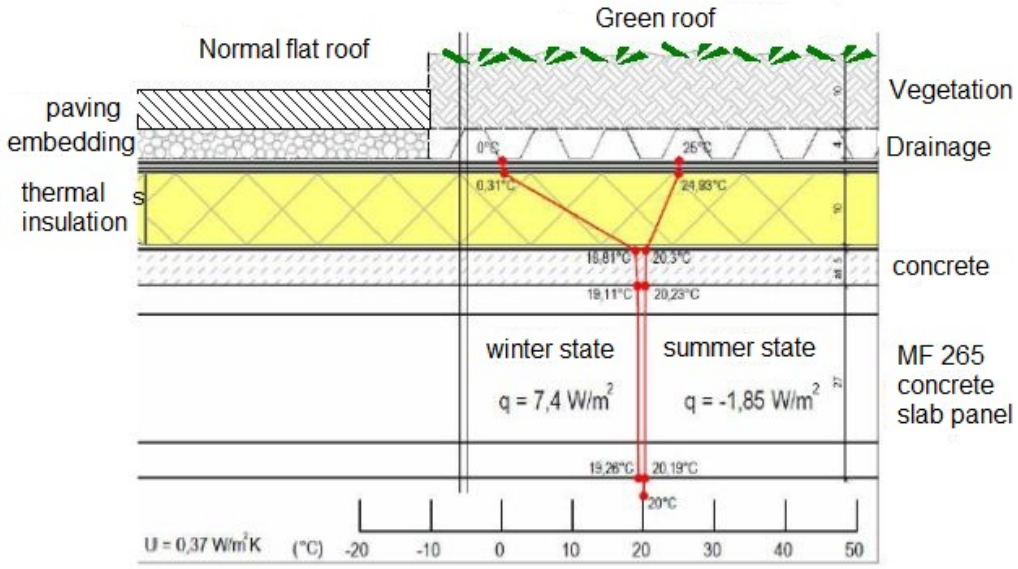

Figure 2 - Layers of normal and green roof and steady-state temperature distribution of green roof

On figure 2 we can see the temperature distribution of the green roof layers for both summer and winter conditions. The temperature values show a steady-state heat transport. However our real measured values show a much different temperature distribution.

2. Measuring equipment

The electronical unit had been installed with proper weather protection, which means a covering tile roof and base to avoid contact with the soil. This way we could keep it dry and protect from direct sunlight. This unit includes the probe to measure air temperature.

Figure 3 - Electronical unit with weather protection, battery, and wires

There had been installed two measuring units on the roof of the nursery school building. One to the green roof, the other to the paved roof. Eight measuring sensors had been attached on each units with wires in order to get a temperature map as wide as possible. These sensors had been put to the different layers of the structures.

We got temperature values from each points in every minute, and each value was calculated as an average of 20 measurements. The same measuring method was used in [6]. Accuracy of measuring was +/- 0,3°C.

We planned to measure temperature values not only inside the roof structures, but on the inside and outside of the walls of the building. This way we can calculate the whole heat transport of the building, so we get more precise data for the roofs.
The following elements had been used to build up the electronical measuring unit:

- PIC18F4550 type micro controller unit
- LM 35 thermistor, resistance based temperature measuring unit
- Micro SD memory card
- RS5C348 realtime clock, trigger
- CR2032 battery for the clock, 4 pcs of AA type batteries for measurement
- double layer galvanized printed circuit

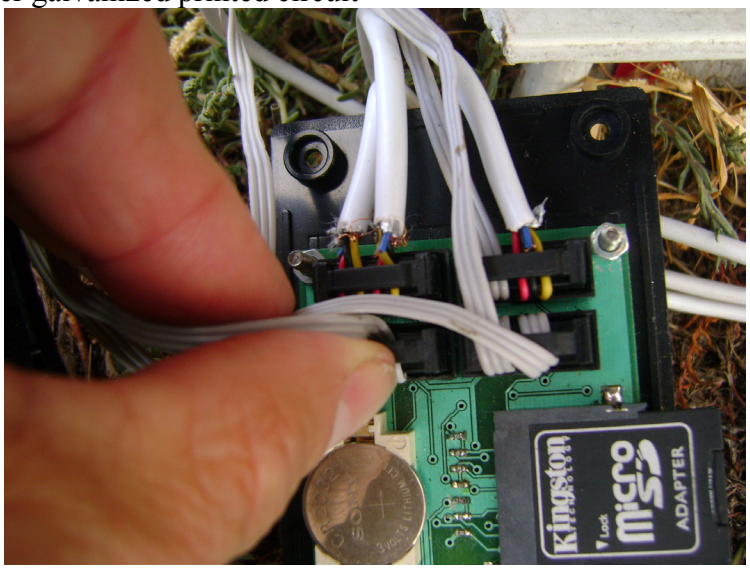

Figure 4 - PIC18F4550 type micro controller unit with wires, SD memory card and CR2032 battery for the clock.

2.1. Temperature sensor and accuracy

LM35 IC type thermistor had been built in to each measuring point. Main properties of this sensor made by Texas Instrument are the following:

Figure 5 - LM35 thermistor

Output voltage of this sensor is linear to measured temperature in celsius degree. It do not need any calibration, tipical accuracy is ±0,25°C on room temperature and ±0,75°C on the whole scale between -55°C + 150°C. The sensor has low output impedance, linear characteristics, relatively simple controller circuit. LM35 requires only 60 µA of currency, therefore several units can be put on one single battery. This way it has only 0,1 °C of self heating in calm circumstances. Accuracy is less influenced by the length of the wire. This means that with a proper wire this length can be almost 100 m without any substantial loss of accuracy. Temperature values had been gathered throughout a whole year with this unit.
There had been also performed a computer simulation of the measured values, which is presented in the following chapter.

3. Mathematical model

Equation 1 shows the law of conservation of energy in mathematical form, which is a partial differential equation about the energy transport. We considered all of the thermal parameters (ρ, λ, c_p) of the equation steady for all materials (concrete, thermal insulation, broken stone embedding) except soil which has varying density, heat capacity and heat conductivity depending mainly on the water content. This is altering by evaporation and precipitation. Evaporation is also an inside heat source of soil. In present essay we are negligent of the change of these parameters during a one-day examination. We consider density and heat capacity steady, but heat conductivity is regarded as varying in time. This serves to model the cooling effect of the vegetation. In summer conditions this can be considered as a better thermal insulation. Similar theory than in [1].

$$\frac{\partial}{\partial t}(\rho c_P T) = \frac{\partial}{\partial x_i}\left(\lambda\left(\frac{\partial T}{\partial x_i}\right)\right) + q_v \qquad (1)$$

We used the following constants for the equation to get the heat conductivity,

$$\lambda = \begin{cases} c_1 & 0 \le t < 7 \\ c_2 & 7 \le t < 19 \\ c_1 & 19 \le t < 24 \end{cases}$$

, where t is time in hour unit. Validating the model, night heat conductivity value proved to be $c_1 = 0.03$ W/mK, day value $c_2 = 0.1$ W/mK.

Before performing numerical calculations, we generated numerical grid for each layer of the roof structure. All of these grids are flat except the one on the slab panel, which is shown on Figure 6. These flat grids had been generated with a relatively small resolution, and these grids were pulled out vertically. This was necessary to be able to decrease the number of lattice points and cells. We used the fact that only the vertical derivative value is considered as a big number.

$$\frac{\partial T}{\partial x} \cong 0, \quad \frac{\partial T}{\partial y} \cong 0, \quad \left|\frac{\partial T}{\partial z}\right| > 0 .$$

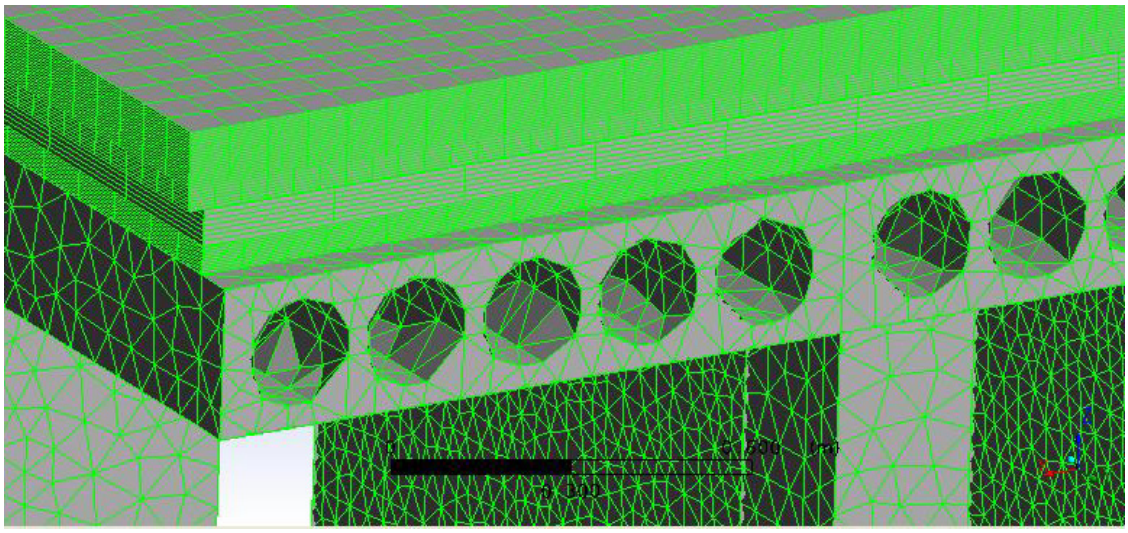

Figure 6 – Generated numerical grid of the roof structure

4. Measuring results

Firstly, without any specific explanation we present a series of measurements during a week. First eight diagrams show temperature values of green roof layers, the last five diagrams show the same values of the normal flat roof.

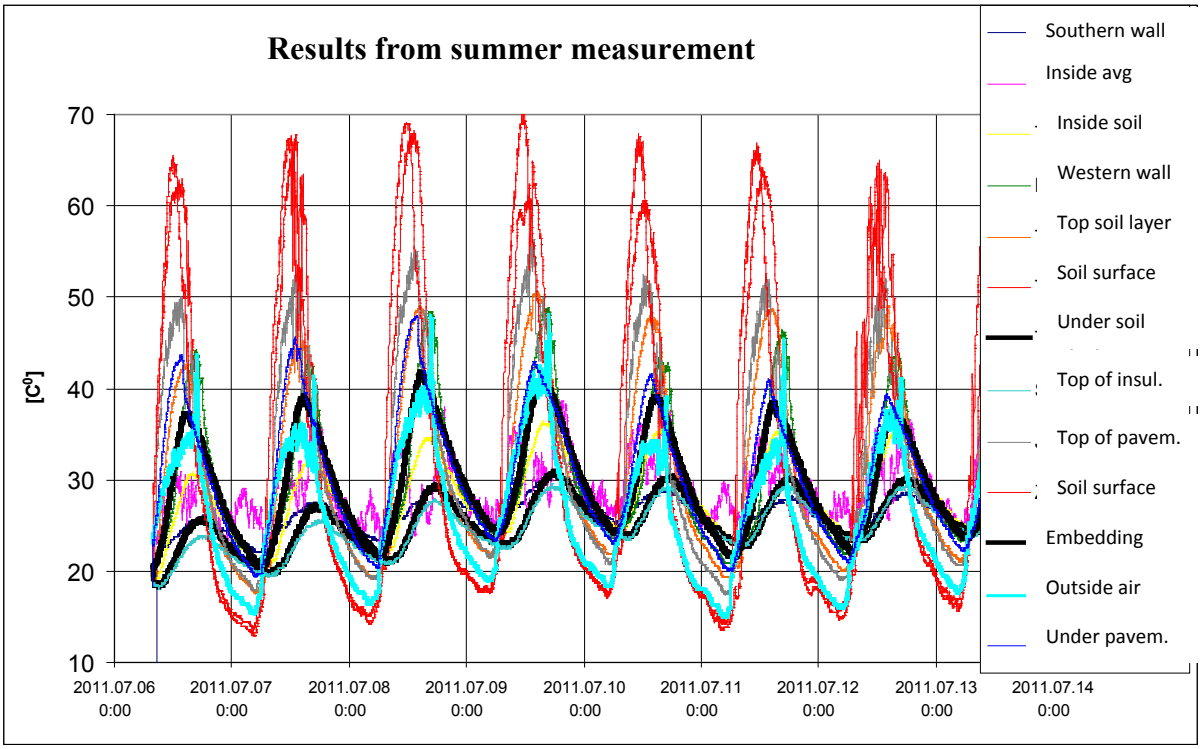

Figure 7 – Synoptic diagram with all values of green and paved roof

Based on this summer diagram we can make several important statements comparing green and paved roof.

Top layer temperature of both roofs follows the change of outside ambient temperature. Top layer of green roof (red line) is much warmer in daytime and much cooler at night than outside air, which is caused by radiation. On the other hand the pavement is warmer than air, both day and night. This is because the black grade of soil is higher than of concrete.

We can see the better thermal insulation property of the soil comparing the temperature values of the layer under the soil on the green roof and the broken stone embedding on the paved roof. The rest of the structure contains the same layers of both types of roof.

We can read the daily rate of temperature change on Figure 7. It can be clearly seen that at the same level of each roof, at the top of the heat insulation, this daily change is substantially lower in case of the green roof. While the daily maximum temperature difference on the paved roof is 25°C, on the green roof this value is only 15°C. On the diagram both values are black.

This difference is caused on one hand by the mass of the soil, which can be described with the heat capacity, which depends on the water content as we mentioned above. Also a big quantity of air is inside the soil, which enhances thermal insulation ability.

On the other hand, cooling effect of the evapotranspiration of the vegetation cannot be neglected either, when examining the green roof thermal properties. [2]

Bottom of the soil layer remains 3-5°C cooler at night than the bottom of the pavement. Green roof layer is a more effective thermal insulator than the concrete pavement with the broken stone layer. The bigger difference is between the daily temperature values, when it can be 10-15°C. As a conclusion we can declare that green roof is an effective insulation in the summer period.

5. Comparing measurement and calculation

We performed a temperature simulation for one single day of summer. For the calculation we took the temperature values of the top of the green roof and inside the building as boundary conditions. For the other layers calculated temperature values have been compared to

measured values. Calculation resulted in varying isotherms in time, as well. We chose three representative measuring points – on the top of the soil, inside the soil and under the drainage layer. This way we practically got the thermal insulation and heat balancing effect of the green roof, which is shown on Figure 8.

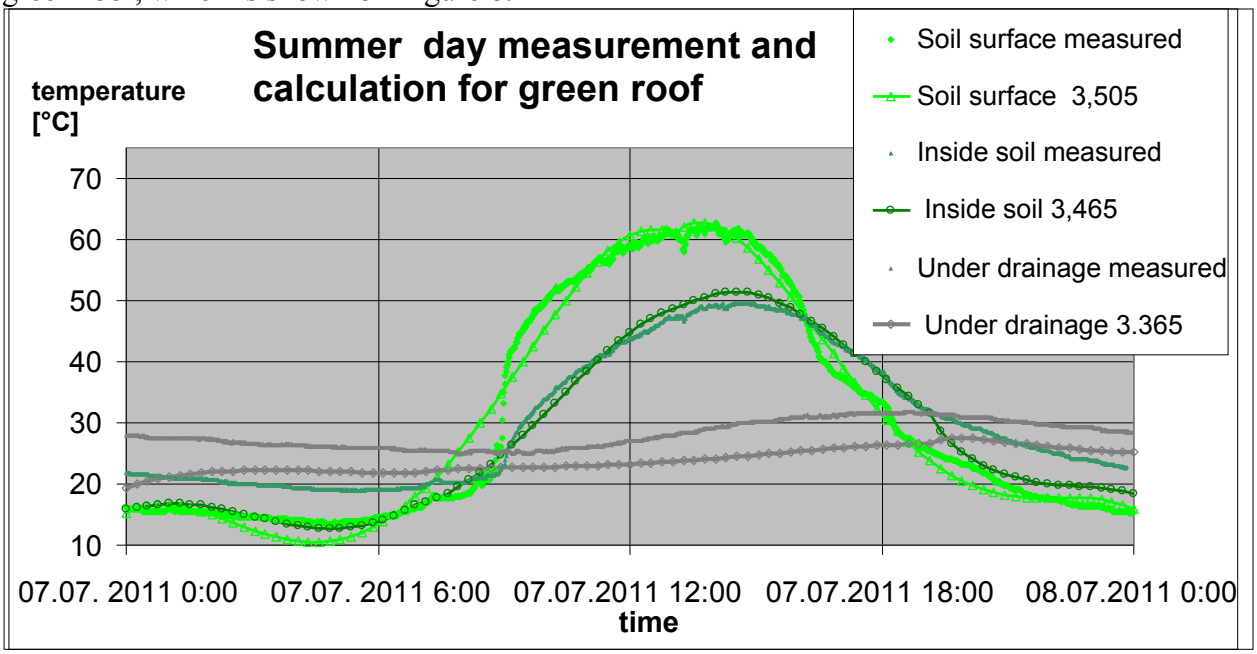

Figure 8 – Comparing measurement and calculation on a sunny summer day

We used thermal parameters of chapter 3 for the calculation. It is clear that calculation result follows measured values both on the top of the green roof and inside the soil layer.

We know that heat conductivity of day and night soil is different. During the validation of this parameter we experienced that green roof behaves different at night than during the day, therefore we had to set different values in order to get appropriate results from calculation. The main cause of this phenomenon is that the evaporation of vegetation is much stronger at daytime under heavy sun radiation. This means that thermal parameters of green roof are varying in time. [7], [8]

On behalf of further refinement of mathematical model we have to declare that green roof heat conductivity is varying not only in time but along thickness, as well. Inside the top layer of soil, where evaporation of the vegetation distracts much more heat than deeper layers, we have to calculate with a less value of heat conductivity. On Figure 8 we can see the difference of the grey lines, which proves this declaration.

6. Summary

It can be settled that both measuring instrument and mathematical model are useful for the examination of thermal properties of green roofs. Measuring unit shows appropriate results for the changing temperature of roof structure while the model follows pretty well these values. The soil layer cannot be handled as simple as other structural elements and materials, which have their own single value of heat conductivity. This has to be varying both in time and in thickness. Change of water content makes this more complicated, which is going to be the topic of further examinations.

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OPERATION AND SUPPLY CHAIN OPTIMISATION FOR SMALL COMPANIES

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Abstract: These days small companies follow a pre-defined path on the market: they start their activity, they prosper and, in the end, most of them lose their competitiveness and leave the market. Small companies cannot compare themselves with the large companies, as large ones can upgrade their technologies and processes at lower prices, without time consuming and with available financials to change the direction when the actions taken deviate from what was planned. That is why small companies suffer from disadvantages on the market. To overcome these situations and start competing, especially these days, small companies must incorporate creativeness in their way of thinking and acting. It is mandatory for small companies to design the daily activities performed based on new technology, historical data, up-to-date know-how etc., mostly because technology is more and more present, products have less life days and global trends are heading towards globalization and integration. In this paper a small electronics manufacturing company will be analysed. There will be applied simulation techniques and the result will provide a good view over the things needed for a small company to have efficient operations. Nevertheless, as any other good analysis, the paper will include some take away notes and proposals for future analysis.

Introduction

In an ever-changing environment, small businesses are frequently seen to start, activate and finally lose their competitiveness. In case of small companies these steps seem to be shorter as they are affected by the larger companies. This is why small companies need to be more creative in order to be competitive on the market. It is a must for them to start integrating technology in their operations, as it becomes increasingly available. This paper discusses a small business, an electronic manufacturing company located in Hungary operating in three shifts five days per week. Currently, it servesthirty-five customers with 600 products, including high product versions as well.

This complexity poses a challenge to the small company as compared to Amazon in terms of the customer service. Small and big companies have different resources and capital to improve their processes. Large companies show a tendency toward industry segmentation, like Amazon as they want to ship your product before you even think about it. Finding a way to maximize the customer service level while minimizing both inventory and resources might help to keep this small business running long into the future.

Literature review

In today's business climate, it is imperative for companies to remain competitive to stay viable and show a reasonable profit. The current trend for any business to maintain successful operations is for it to utilize current technologies. In June 1994, the Boeing 777 was built with computer-aided design tools that were linked among 2,200 computers. They were able to design and even simulate the assembly of the plane, which was something that was never seen before. Supply chain, inventory, and demand simulation software are three different business

processes that actually influence one another [1]. The supply chain can be defined as having items flowing from one stage of supply to the next, both within the business and outside. The supply chain is more of a high-level optimization. It has a varied focus, including decisions such as warehouse location, truck usage, and choice of supplier. Inventory optimization is more focused on just how much inventory a company should maintain to make the most profit. Both supply chain and inventory software need an accurate forecast of demand to be implemented properly and that is why we begin with demand planning software. Seasonal demand, which is dynamic, is a difficult thing to predict but it is worth the effort because it directly affects inventory costs and labour costs. An important part of managing a business supply chain is identifying whether or not seasonal demand is an actual force that affects the company or if the seasonal demand is a result of business practices. This false sense of seasonal demand could be caused by businesses over-compensating for what they believe is a pattern in demand for their products. For example, a business can „maintain minimum level of capacity …. and operate the plant at maximum production level" in order to satisfy current demand and obtain a level of inventory that would satisfy the supposed demand. In other words, businesses should produce what is currently needed while inventory levels are obtained for what will be required later. Supply chain management and optimization are very complex and intricate issues that continue to grow both in importance and acceptance, and are unique to each company that adopts these ideals. New technologies are critical to obtaining an optimal supply chain for businesses. There are, however, obstacles that complicate matters. Inventory levels and seasonal or stochastic demand heavily influence decision making for supply chain management and optimization. Any seasonal business has the challenge of determining how the issue of inventory optimization should be utilized. The inventory needs to be optimized not only for the weekly demands, but also the seasonal demand as a whole year. This business needs to optimize the necessary amount of supplies, passive, active, mechanics, and other supplied products, taking into consideration the fluctuations of customers throughout the week and throughout the high and low seasons. The business must also consider that once the high season comes to an end, remaining supplies are minimized. Several years of recorded data were available for review and analysis to build a model as well as forecast sales. To optimize inventory investment, a business needs to account for all of the variability in the supply chain. There are many different factors in a seasonal business that can determine a demand for a given time period.

Evolution of manufacturing paradigms

Historically, manufacturing paradigms, driven by the change of the environment in which they operate, change in character and evolve in patterns over time (Fig. 1). The various patterns witnessed up to now can be roughly correlated to movements between three stages:

(i) craft shops that employ skilled artisans,

(ii) long-linked industrial systems using rigid automation and

(iii) post-industrial enterprises characterised by flexible resources and information intensive intellectual work.

The most prevailing manufacturing paradigms are in chronological order of appearance: Craft Production, American Production, Mass Production, Lean Production, Mass Customisation and Global Manufacturing. Apart from American Production, all other paradigms are still "operational" today in different industrial sectors. Research nowadays focuses on strategies and methods for managing product, process and production systems development capable of supporting lean production, mass customization and systems for product personalization. Lean production is an integrated socio-technical system, whose main objective is to eliminate waste by concurrently reducing or minimizing supplier, customer, and internal variability.

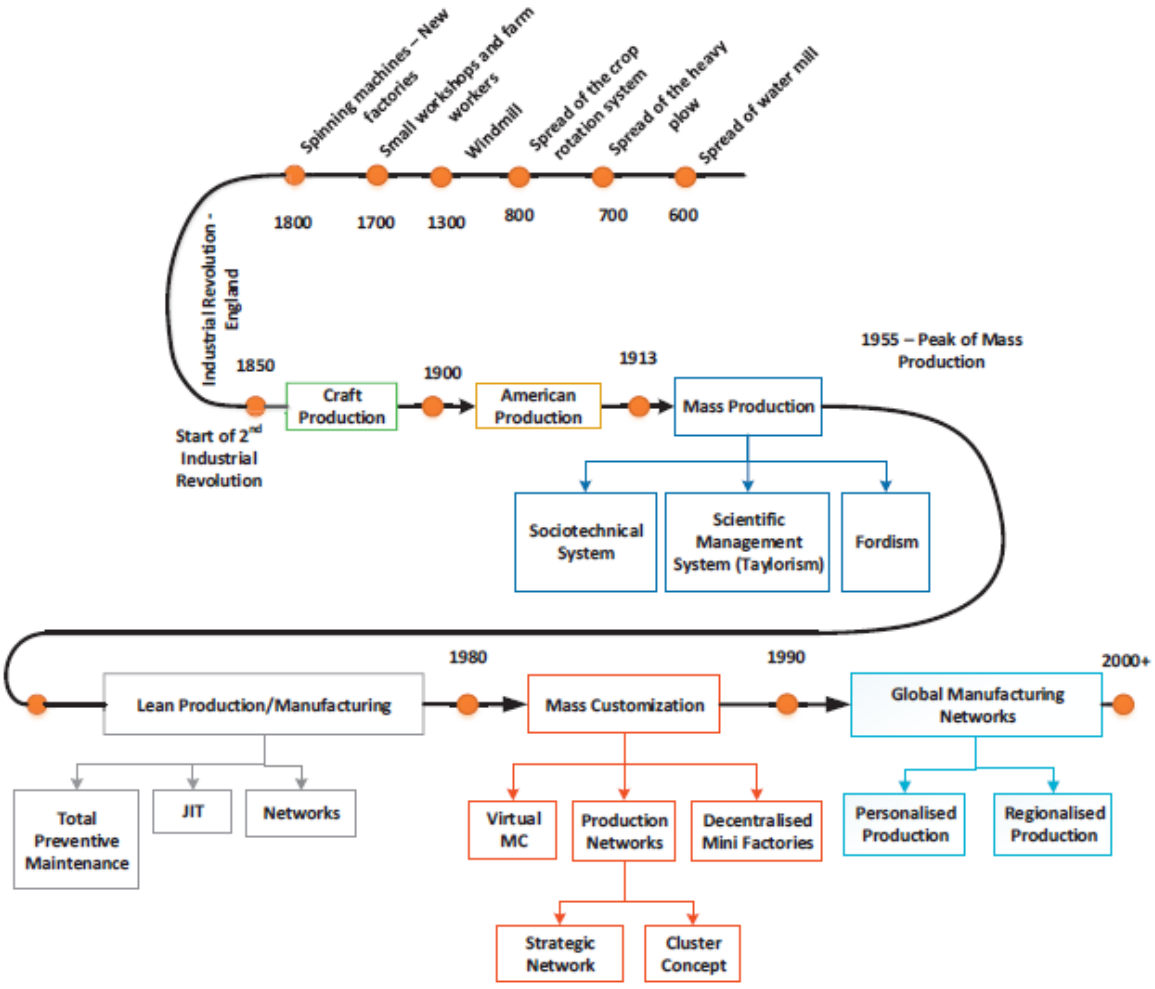

Fig. 1. The evolution of Manufacturing Paradigms (Adapted from [2])

Specific industry types may benefit from a combined implementation of agile and lean practices in their organisation. However, a point in the production procedure should be defined, where these concepts can be easily decoupled according to the incoming demand. This can lead to improved overall performance and profitability of the factory.

Mass customization emerged as a new production paradigm in the late 1980s in order to respond to consumer demands for product variety and appears as an alternative to differentiate companies in a highly competitive and segmented market. This paradigm aims at producing goods and services catering to individual customer's selections with near mass production volume and cost efficiency. The tools of mass customisation can substantially enable product personalisation.

Personalised production aims at the procurement of truly unique products, through the tight integration of the customer in the design process. However, to make personalized production a cost effective reality, several enabling technologies and features must be developed, such as: methods and tools for understanding and capturing consumers' needs and preferences, design by non-designers techniques, cyber-physical systems for collaboration, on demand manufacturing and assembly systems, process, product, volume and production flexibility among other.

Large contract manufacturing companies with plants located in different regions are able to manage higher customer demands. To achieve cost efficiency in production, an appropriate amount of customer orders are required for large capacities. If customers have a low demand in the region, contract manufacturing companies with large capacities might not be able to

fulfil such demands. Low volume customer orders do not foster profitability as high fixed costs exceed planned profit levels. In case of orders with large volumes, productivity may be increased while unity price of purchased components may be decreased at the same time. Stable component prices and efficient capacity utilization becomes possible in an environment where there are long term forecasts and their variations do not cause disturbance in the MRP. There are no simulation systems for planning variations, the robust planning module of the MRP system meets the expectations of the demand and supply chain in addition to high profitability.

Contract manufacturing companies with smaller capacities are able to ensure stable operations with a mix of low volume and high complexity. Flexible organizational structures and resources better suit customer expectations as they are more tailor made. It is essential to build good customer relationship and effective cooperation already in the product design phase. Using operations experience might prove to be cost effective in this phase. Even without long term and reliable forecasts, with this strategy flexibility and proper cost levels could be achieved in the supply chain.

In case of low volume orders, machine utilization might be much lower and production costs may be higher as compared to large manufacturers. Companies with low volumes need to find innovative solutions in production planning and scheduling. The E2E process and other process simulations need to be planned and designed in detail. Learning simulation techniques improves planning skills and enhances precision when it comes to planning purchasing and production processes. These are all required for ensuring on time delivery to the customer.

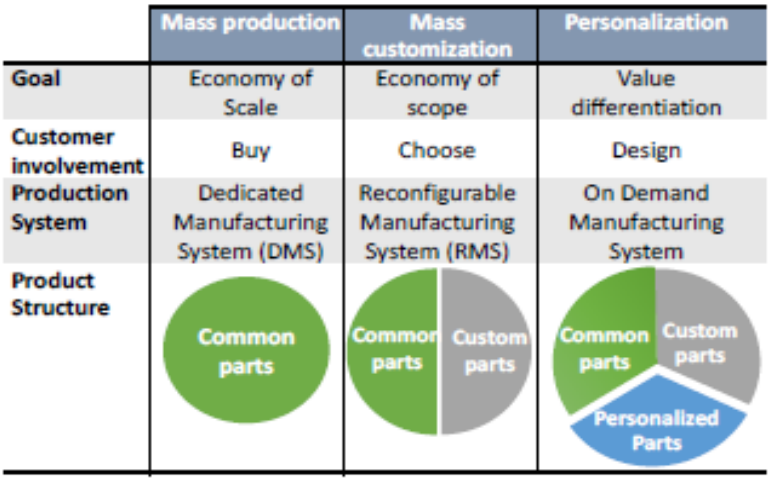

Fig. 2. Different between production paradigms (Adapted from [3])

Role of simulation in manufacturing

A supply chain is the value-adding chain of processes from the initial raw materials to the ultimate consumption of the finished product spanning across multiple supplier-customer links. Robust and flexible system mechanisms are required to realize such inter-enterprise collaboration environments often enabled by the use of simulation technology. Digital Enterprise Technologies (DET) in general, represents an established new synthesis of technologies and systems for product and process development and life-cycle management on an efficient basis. A method to model, simulate and optimize supply chain operations by taking into consideration their end-of-life operations is used to evaluate the capability of OEMs to achieve quantitative performance targets defined by environmental impacts and costs of lifecycle. A method of examining multi objective re-configurability of an Original Equipment Manufacturer supply chain is presented in order to adapt with flexibility dynamically changing environmental restrictions and market situations. A discrete-event simulation model of a capacitated supply chain is developed and a procedure to dynamically adjust the replenishment parameters based on re-optimisation during different parts of the

seasonal demand cycle is explained. A model is implemented in the form of Internet enabled software framework, offering a set of characteristics, including virtual organisation, scheduling and monitoring, in order to support cooperation and flexible planning and monitoring across extended manufacturing enterprise.
Furthermore, the evaluation of the performance of electronics manufacturing networks under highly diversified product demand is succeeded through discrete-event simulation models in with the use of multiple conflicting user-defined criteria such as lead time, final product cost, flexibility, annual production volume and environmental impact due to product transportation.
The historic evolution of simulation is depicted in Fig. 3.

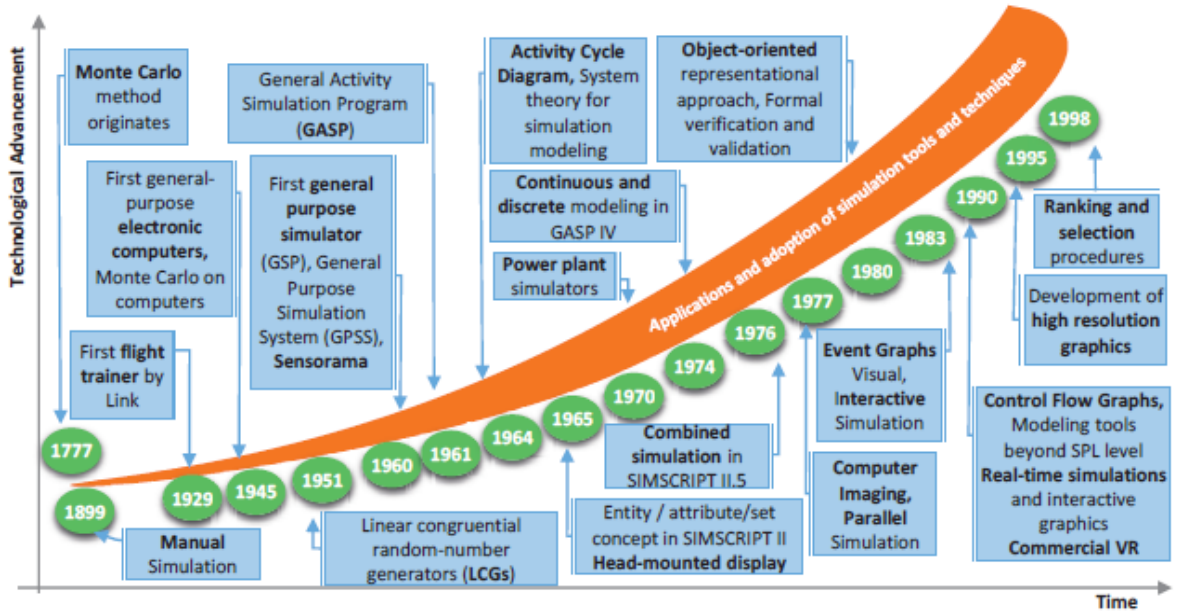

Fig. 3.The evolution of simulation (Adapted from [4])

Although the term "Monte Carlo method" was coined in 1947, at the start of the computer era, stochastic sampling methods were used long before the evolution of computers [5]. It is widely acknowledged that the contemporary meaning of simulation originated with the work of Comte deBuffon in the 18th century, who developed a Monte Carlo-like method and used it to determine the outcome of an experiment consisting of repeatedly tossing a needle onto a ruled sheet of paper. The aim of the experiment was to calculate the probability of the needle crossing one of the lines [6]. About a century later, Gosset used a primitive form of manual simulation to verify an assumption about the exact form of the probability density function for Students t-distribution [7]. In the mid-1940s, simulation makes a significant leap with the contribution of the first general-purpose electronic computers. Ulam, von Neumann and Metropolis use Monte Carlo on computers to solve problems concerning neutron diffusion. Tochter and Owen develop the General Simulation Program in 1960, which is the first general purpose simulator to simulate an industrial plant that consists of a set of machines, each cycling through states as busy, idle, unavailable and tailed [8]. During the period 1960-1961, Gordon introduces the General Purpose Simulation System (GPSS) [7]. Simultaneously, Nygaard and Dahl initiate work on SIMULA and they finally release it in 1963 and Kiviat develops the General Activity Simulation Program (GASP). Although, a significant evolution of simulation is noticed, there are still problems concerning model construction and model analysis which are mentioned and addressed by [9]. Moreover, Bryant initiates parallel simulation [10]. In the beginning of the 1980s, major breakthroughs take place, military flight simulators, naval and submarine simulators are produced and NASA develops relatively low-cost VR equipment [11].

In early 1990s, real-time simulations and interactive graphics become possible due to the increased computer power and commercial VR applications become feasible [12]. In addition, the development of high-resolution graphics focuses on gaming industry surpassing in that way the military industry.

Case study

In the case study, a small electronics manufacturing company is analysed. The company has thirty-five customers and 600 products in its portfolio. Total performance of the E2E process is very poor with significant amount of backlogs and low value of customer on time delivery. Delay was accepted in the organization and improvements were not a priority. This resulted in a low employee motivation due to bad business results. On time delivery of the suppliers shows also very disappointing value and raw material shortage disturb continue operation every day. Rescheduling of production and resource reallocation daily practice. All resource (employee and asset) utilization stay on low level even the big effort of engineering and operators does not change. Company management decided to investigate planning system and found the following result.

OEM customers send EDI message to manufacturer to MRP system. EDI received and stored in SAP system without pre check. Total EDI messages are analysed on weekly level.

Consolidated EDI date transferred to excel environment for further data structure change. This was required to get in order and necessary format of the date for further transformation.

Modified data transferred manually to the PCP (Production Capacity Planning) excel environment, where most of the BOM and master data were stored from SAP. In the PCP system customer order deliveries were traced for further planning purpose.

PCP database also got two input from other excel files where the empty returnable packaging was managed. Returnable packaging came from customer as standard packaging type to deliver them to their manufacturing facility. Expendable packaging was also follow in excel environment which was an alternative packaging material of customer returnable packaging. If the customer could not manage well the returnable packaging deliveries, supplier needed to implement one way (expendable) packaging availability for shipment requirements.

Production planning had two phases, one of them planed the final assembly production process. In this database was the strongest correlation with final assembly result and customer order requirements. This planning was done by manually and managed by one person for whole customer portfolio. Second part of the planning was related with machining (SMD) production planning based on internal Kanban system signal or weekly qty requirements.

Any case of supplier delivery problem or internal quality challenges where the planned qty could not be manufactured excel rescheduled plan information was not uploaded to SAP system. Any modification of the final assy plan had no correlation to machining plan and SAP. That caused inaccuracy in case of raw material planning.

This level of data fragmentation and low efficiency caused customer dissatisfaction and high level of internal inventory value. Both outcome of the process does not support company grow and enough cash to manage business.

Material management team had available SAP data only for purchasing of raw material where lead time was 4-16 weeks and moving planning data just was recognized on weekly level. Customer service team had daily contact with customer and received EDI for further orders. Two teams of supply chain had not too much influence of the changes that result lot of production stop and raw material shortage or inventory excess. Fire-fighting was the type of the way of working and information exchange happened verbally between the teams to inform each other about the changed of any data in planning or purchasing data flow. Data flow showed in Fig.4.

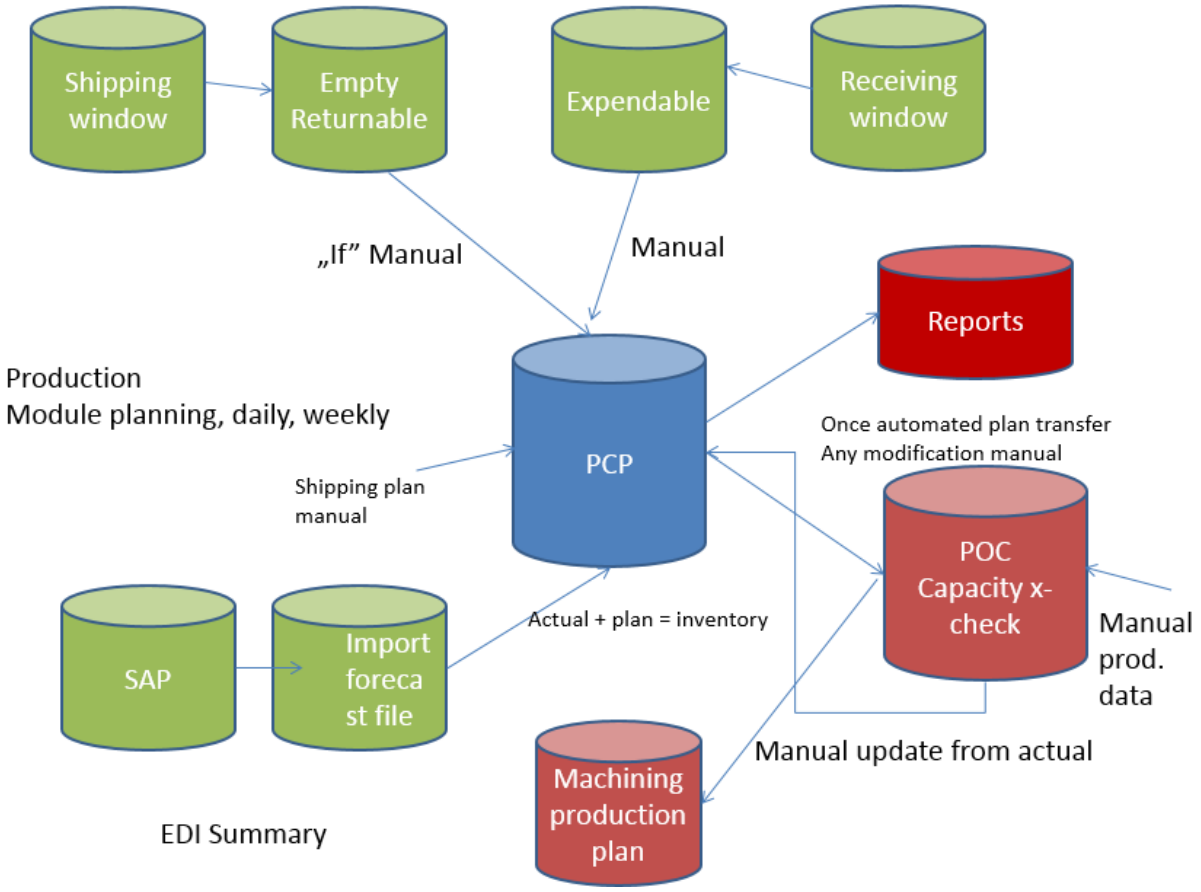

Fig. 4 Supply chain data flow of the investigated company

Management decided to change the process and make sure the complexity and volume increase does not influence efficiency of the planning and purchasing process. Simple model showed in Fig. 5.

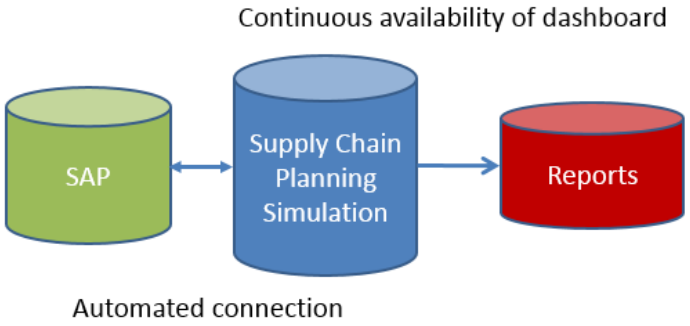

Fig. 5. Simple model

Management concluded that the system optimization shall take place so that business results could increase and that the customers could receive their products.

Based on the production paradigm, the small company had a low volume – high mix production. This was a market segment where it could earn business and profit. Tendering in case of high volume production seemed to be unfeasible as a global production footprint was often times a prerequisite. Being a small company with a small footprint in Europe, large volume production with several regional units is just impossible. Therefore, in such a case, there was no need for technology development mainly due to a lack of financial resources. As opposed to large companies, one of the major advantaged of such small companies is a fast and precise customer service with low volume – high mix production. For that end, accurate supply chain and planning procedures and flexible processes are required. Figure 5 shows

such a system where SAP stores only master data and manages core tasks. Supply chain tasks and other operational tasks are managed by a planning simulation tool in addition to the ERP system. This tool guarantees that data are integrated and based on the input data and having the necessary capacity it re-calculates parameters of all related processes using the available algorithms. The simulation has several advantages: it does not occupy the MRP system and it is also faster.

In case of input data changes e.g. new capacity allocation, the system develops a planning option. After reviewing it, the user is able to make further analyses and develop a new action plan so that customer delivery dates are met. These decisions might include a change in the delivery method of materials, a new allocation of production capacities or requesting overtime. Figure 6 shows the summary of planning data.

The Supply Chain Cockpit enables the planner to grasp the planning situation at a glance and analyze it down to the smallest detail - over several aggregation levels. Individually parameterizable alert functions keep the focus on what is most essential. In addition to the logistical parameters, value and cost aspects of the planning are also evaluated.

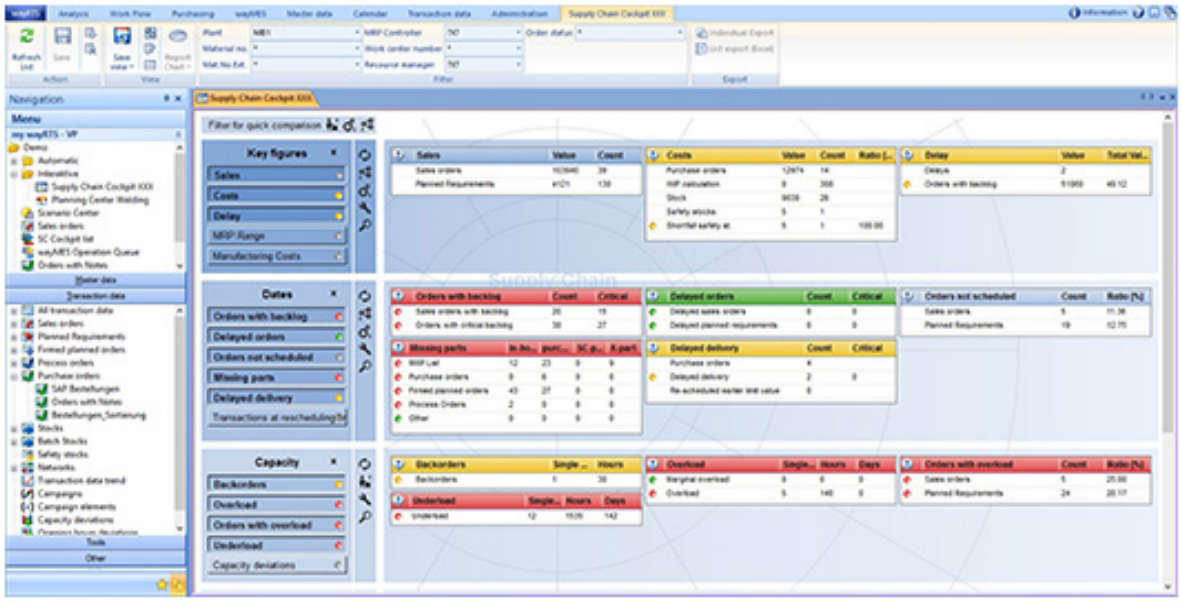

Fig. 6. The planning situation at a glance with the Supply Chain Cockpit

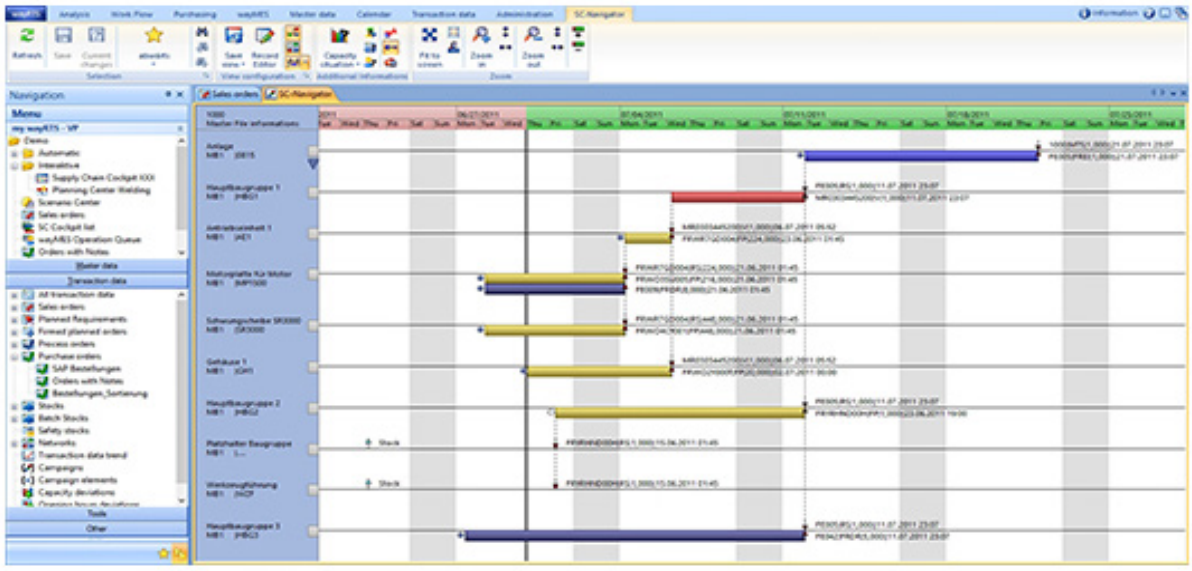

Fig. 7. Analysis and planning of the order network in the Supply Chain Navigator

Thanks to modern visualization and filter possibilities, supply chain simulation offers full transparency across the entire order network starting from the responsive performance of services. The reference to the customer order is retained at all times. Due to excellent graphical preparation and context-sensitive scaling, the planner always has all essential information compact in view. This includes flexible and individually configurable views and dynamic filter functions (e.g. on the critical path). See Fig. 7.

The visualization functions create the basis for interactive planning which can be used to modify the capacities, orders and throughput times using drag & drop. Since Supply Chain simulation is real-time enabled, the effect of the interventions is made directly visible across all production steps and can be easily tracked. Also very important moment all fixed plan parameters are going to uploaded to MRP system. Fig. 8.

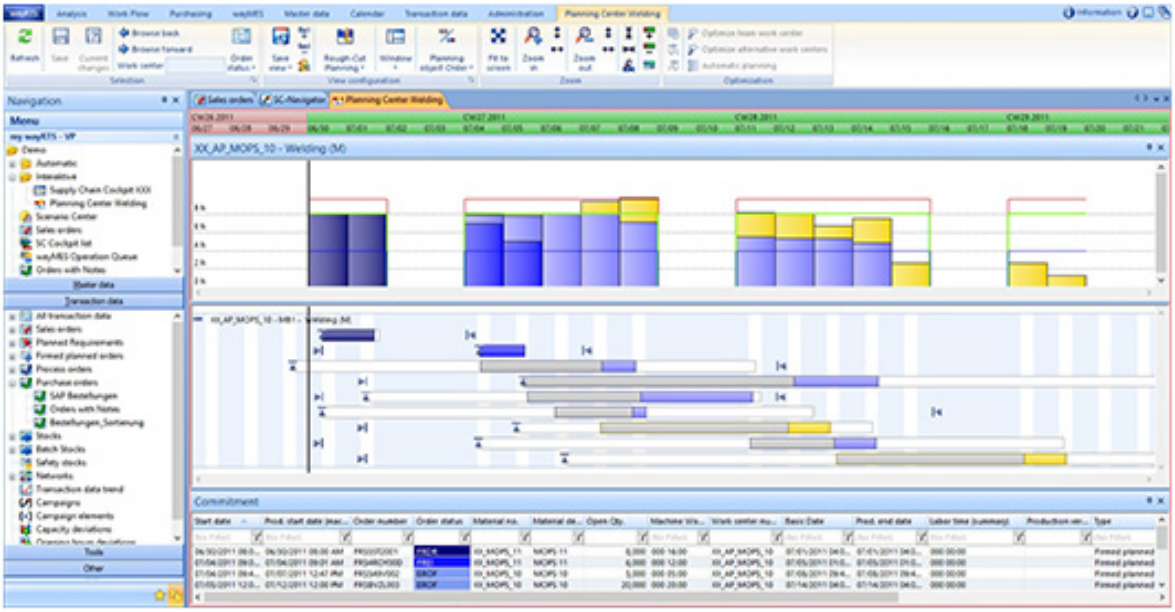

Fig. 8. Visually interactive rough and detailed planning in the Planning Center

Summary

It is essential for companies with smaller capacity and resources to understand their positions in the manufacturing services industry. It is not enough to implement different production models like Lean but it is important to understand flexibility on the market. High volume mass production is critical to all manufacturing companies where large product volumes use available resources and take advantage of price discounts. Small companies may only survive on a competitive market if they work in close cooperation in design issues with the customers and serve them on demand. This requires high flexibility both in terms of planning and production. To achieve such flexibility, small companies need to be creative in technologies and process operations. If flexibility is provided, supplier network operations still need to be effective which means that components are available on time at a low price. Small companies are required to manage an increase in the complexity of product mix. With the development of information technology and mathematics, planning simulation systems have rapidly improved and their implementation is accessible to all on the market and can apply them during planning processed. Both numeric programming and network research has significantly contributed to the implementation of simple but stable computer aided simulations systems. The electronics company described in the case study believed that the related competences available were enough to manage planning procedures. It was only enough until product complexity negatively impacted productivity. Data transfer from one system to another in an Excel environment was manually performed and effects of the changes were not monitored in

the simultaneous systems. In sum, the MRP system was a data provider however, the impact of changes required during planning was not monitored. Running parallel planning systems caused a problem in the entire customer service system as production plan changes were not harmonized with the delivery of raw materials. This resulted in the low utilization of capacities and high stock values. In the long run, the company would use its cash and would make its operations impossible. The top management of the company in the case study recognized the need for change on time and found the simulation tool on the market which best suited it business processes. One of the advantages of the system is that it provided an automatic data connection with the ERP system. In case of any production plan changes, the planner is able to review the impact of changes and make the necessary action before finalizing the plan itself. Modifying the production plan on a daily basis does not jeopardise supplier network planning since being a simulation, these changes are not recorded in the ERP system.

Implementing such a complex supply chain planning system makes customer communication more effective as action plans are easier to define and monitor their execution. In all cases, when the customer is involved in the decision-making process, trust towards the company is enhanced and increased customer orders are provided for.

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ANN (ARTIFICIAL NEURAL NETWORK) APLICABILITY FOR MODELING AL 6061 ALLOY PROPERTIES

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Abstract: In this article, using ANN (Artificial Neural Network), we have analyzed the implications which the chemical composition of Al6061-T6 has over the mechanical properties and elaboration temperature. This correlation between the mechanical properties and chemical composition has a high importance for establishing the right path for a product, without additional costs or wasted time, but also improving certain characteristics of the alloy.
Keywords: Artificial Neural Network , Al6061-T6, mechanical properties

1. Introduction

The majority of newly developed techniques in the aluminum industry are sometimes destined to make special products which require an elaborate investigation of alloy properties, therefore wasted time and additional costs. In the end, the new techniques cannot specify or simulate the required microstructure, optimal parameters, optimal alloy composition in order to improve the new processes which include Al6061. The majority of Al6061 (Al6xxx series) improvements are closely related to their mechanical properties (which also depend on the microstructural characteristics). Therefore, we can use the process-structure-properties simulation methods for the Al6061 alloy, with good results over the physico-mechanical characteristics or in the recycling process.

The thermic treatment has an important role in obtaining the desired alloy, with desired physico-mechanical characteristics. It is important to know the fact that the solutions of the thermic treatments are important in order to establish the characteristics of the alloy but also to optimize the process parameters according to a specific path.

The European Union has a high number of Al alloys, each one of them with specific structure which can undergo ANN simulative – predictive techniques. The idea of ANN applicability is optimizing the process parameters and Al6061 alloy composition in order to obtain a separate combination which can be used on a large scale.

In this article ANN is used to predict the correlation between the mechanical properties of the Al6061-T6 alloy. The objective is developing an ANN method which can provide data related to process parameters and Al-6061-T6 composition influence over the mechanical properties in order to use the alloy for new purposes.

The aluminum is an important element with a complex applicability in several industries, nationally and internationally. Al6061 is used on a large scale for different purposes because of its properties: 2.71g/cm^3 density, Young: 68.9GPa, Poisson: 0.33µL. It is the most commonly used aluminum, although it is split in different categories: 6061, 6061-T4, 6061-T6 (each one having physico-mechanical properties which differ based on elaboration and destination). The maximum resistance is somewhere at 300MPa, 8% elongation, 77^{o}F conductivity at 152W/m·K, endurance limit up to 100MPa.

Al6061 is used in building certain aircraft parts (wings, fuselage), passenger planes, sometimes Al2024 is more resistant, but Al6061 has a better machinability and high corrosion resistance. It is also used for building yachts, boats, engine and wagon parts, bicycle parts, fishing products.

2. ANN modeling

Using ANN requires determining the relationship between the Al6061-T6 properties, alloy composition and process variables. Generally, ANN is characterized by: architecture, activation functions, used algorithms and transfer functions.

In order to describe the ANN model we can consider a black box in which we input data and based on defined criteria it offers us information correlated to the processes-structure-properties line. ANN structure is characterized by the number of inputs and number of neurons in each input (Figure 1). Simplified, ANN consists of: inputs, hidden data (processing) and outputs.

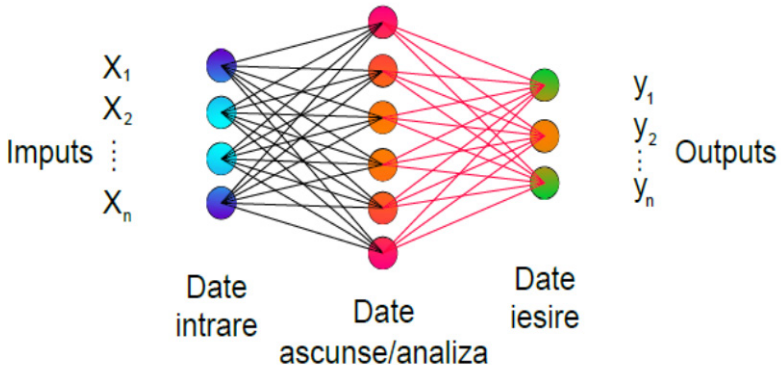

Figure 1. ANN general architecture

Table 1. Al6061 parameters used for ANN

Input Parameters for the 6xxx series

	Major alloying elements			Others					
Alloying element	Mg	Si	Cu	Zn	V	Ti	Fe	Mn	Cr
Number of alloys containing this element	40	30	21	14	0	12	16	13	12
Range, (% weight)	0-1.4	0-1.8	0-1.2	0.0.25	0	0-0.2	0-0.70	0-1.1	0-0.5

Modeling and simulating ANN for Al6061-T6 alloy present the following steps: data collecting, processing, NN training, testing NN training model and predicting simulation used build NN models.

It is also important to limit the errors of approximation and specific input data adjusting, and the whole process repeats until we obtain a criterion or error-free function. Inside ANN a valid function transforms the input data in output values (which have a $y = ax + b$ linear variation).

The input parameters in order to study the processes-structure-properties system for Al6061 are directly related to the chemical composition, quantity, element combination for alloying. For each element of Al6$x_1x_2x_3$ series, the first number indicates the series, x_1 – alloy element modified in a pre-existent alloy, x_2x_3 – special alloy element.

Table 2. Physical and elastic parameters of Al6061-T6

Al6061	**Elastic**			**Physical**							
	E	G	v	T_{sol}	T_{liq}	Cp	a	ρ	ρ_{el}	λ	EC
6061-T6	70000	26300	0.33	580	650	895	23.3	2700	40	166	43

Major alloying elements for Al6061-T6 are Mg and Si, and the chemical composition for the analyzed alloy is presented in Table 1. Physical and elastic characteristics are highlighted in Table 2. They have been taken from specialized articles, analyzed and used in the simulation.

Key to Parameters:		
E	Modulus of elasticity	MPa
G	Modulus of rigidity	MPa
ν	Poisson's ratio	
T_{sol}	Solidus temperature	°C
T_{liq}	Liquidus temperature	°C
C_p	Specific heat capacity	J kg^{-1} K^{-1}
α	Coefficient of thermal expansion	µm m^{-1} K^{-1}
ρ	Density	kg m^{-3}
ρ_{el}	Resistivity	nΩ m
λ	Thermal conductivity	W m^{-1} K^{-1}
EC	Electrical conductivity	%IACS

3. Results and discussions

ANN procedure has been used for predicting the correlation between the processes and the mechanical characteristics of Al6061-T6 alloy. We can analyze the process at different temperatures because the alloy can present different microstructures, therefore it has different mechanical properties.

According to Figure 2 we can analyze the predicted and experimental values of the Al6061-T6 alloy depending on the mechanical resistance properties. The differences are very subtle, approximately 0.214 (statistically, there are no major differences between the two methods).

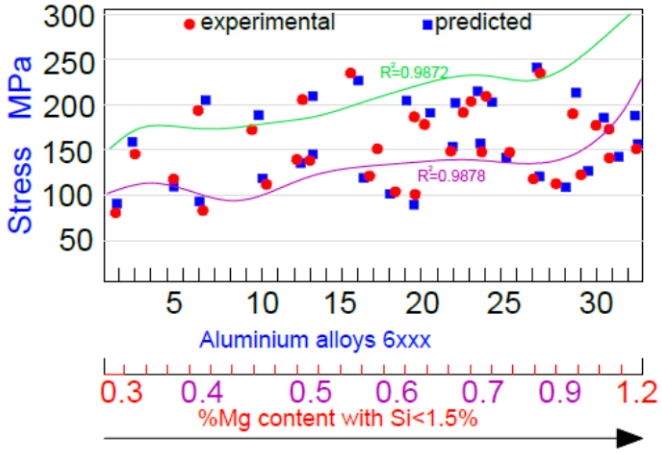

Figure 2. Experimental data variation as opposed to the predicted ones and evolution towards Mg alloying

Figure 3 presents the influence of alloying elements from the chemical composition of the Al6061-T6 alloy over stress distribution. The calculated radius of the graphics R^2_1=0.9872 and R^2_2=0.9878, close to 1, show a high precision of tension and stress values from the graphic. Practically, these curves can be used to approximate the desired chemical composition and to achieve certain mechanical properties. Costs and work time are also very important, therefore they must be minimized. Additionally, Figure 4 presents the area based on ductility evolution depending on alloy composition. The most important areas are rendered for unidirectional and alternative tests.

Figure 5 proves that using ANN for Al6061-T6 we can predict the influence of the chemical composition over the mechanical properties. Maximum values are rendered on the graphic.

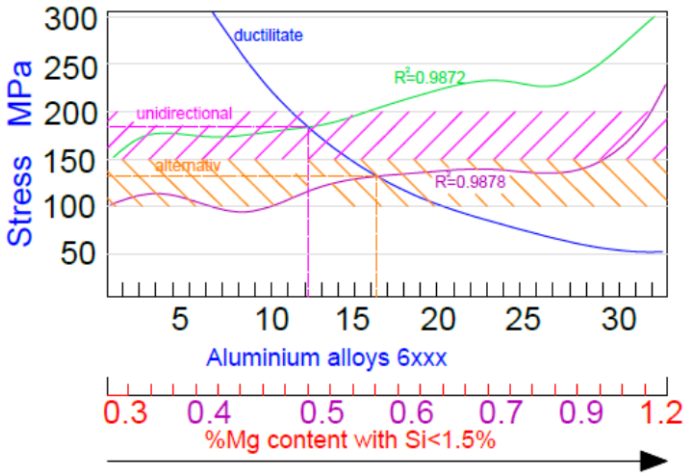

Figure 3. Influence of alloying elements from Al6061-T6 chemical composition.

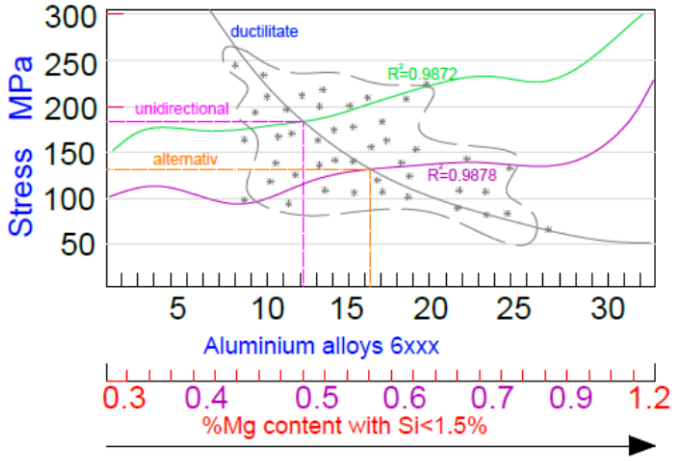

Figure 4. Ductility variation based on alloying elements for Al6061-T6.

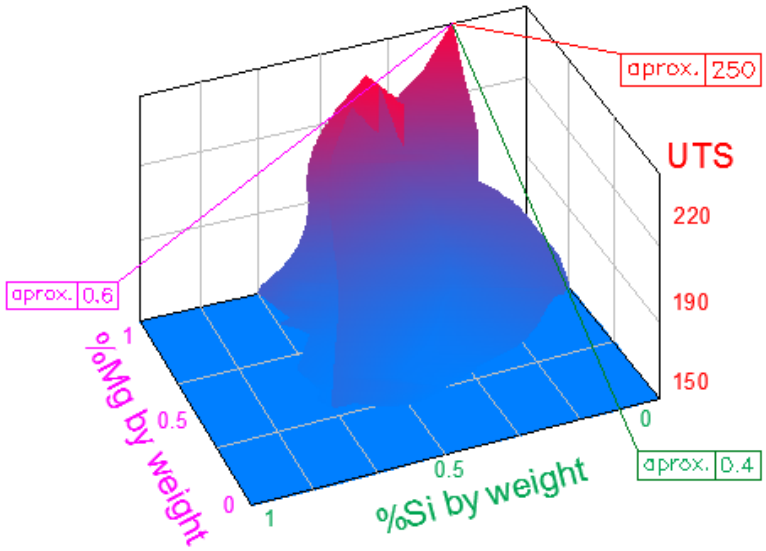

Figure 5. ANN simulation models for chemical composition (alloying elements) influence over mechanical properties.

4. Conclusions

ANN models are used to correlate characteristics such as: structure-processes-properties used for Al6061-T6 material. Therefore, we can remind the following:

- ANN modeling is important for developing pieces and structures made of Al6061-T6 using product mechanical properties information.
- the results of the simulation can be used to determine the optimal composition for Al6061-T6 in accordance with the destination of the final product.
- the ANN method has been used to obtain approximate solutions without additional costs or wasted time.
- ANN predictions, such as the ones in this article, can be used as inspiration source for various design and elaboration projects, reducing production costs to 0.
- the results from this article can be used in different industries for choosing Al6061 alloy domain used based on parameters such as ductility, alloying elements.
- the research in this article can be extended therefore obtaining information related to temperature and chemical composition

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NON-FEROUS METALS RECOVERY

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Abstract: Non-ferrous metals are among the few materials that do not degrade and do not lose their chemical or physical properties in the recycling process. The most frequently recovered metals are: lead, gold, silver, aluminum, copper and platinum. Therefore, studies are being carried out aimed at developing new processes for the separation of metals, mainly from industrial waste by-products. The handling of e-waste including combustion in incinerators, disposing in landfill or exporting overseas is no longer permitted due to environmental pollution and global legislations. Compared to other waste components, such as plastics, wood or textiles, non-ferrous metals exhibit better reusability and higher market values. In future, new strains have to be identified to improve the metal recovery from solid waste.
Key words: non-ferous, recovery, recycling, waste

1. INTRODUCTION

The demand of electrical and electronic equipment (EEE) increased considerably with technological advances. Significant innovations on electric and electronic technologies have their lives shortened, thus increasing generation of waste from electrical and electronic equipment (WEEE) or electronic waste (e-waste). Global production of electrical and electronic equipment is growing rapidly and it is expected to accelerate in the near future. At the global level, latterly there are generated between 20 and 25 million tons of electronic waste per year, with a high share in Europe, USA and Australia. However, it is expected that Eastern Europe, China and Latin America to become a major producer of e-waste in the next ten years [1].

It is expected that, in Europe, electronic waste production to increase by 45% between 1995 and 2020. Therefore, a three-pillar strategy of prevention, recycling and reuse of waste is necessary to minimize environmental impact and to promote the use of wasted resources efficiently [2].

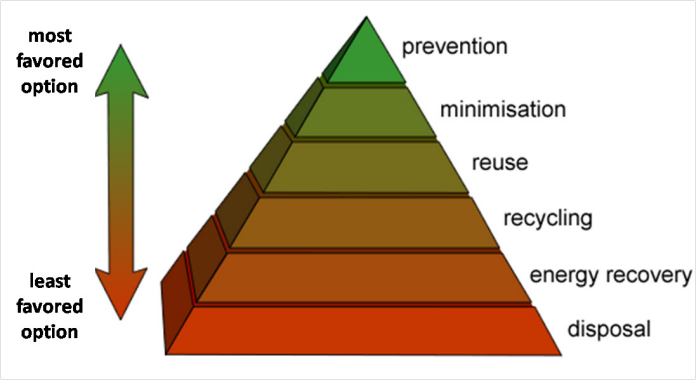

Figure 1. Suggested activities in waste management [3]

2. GUIDE LINES

Considering the Waste Framework Directive (Directive 2008/98 / EC), the treatment of municipal mixed solid waste (MSW) in Europe has become mandatory. Most electronic waste ends up in landfill. According to the US Environmental Protection Agency report on

electronic waste in 2008, 19% of them are burnt and 81% are eliminated through storage [4]. Underground removal of e-waste has several disadvantages, including the contamination of groundwater, soil, and loss of potential sources of valuable metals. In the last decade, many countries have issued legislation on electronic waste. Underground storage of e-waste incinerators or burning is not permitted without isolation of hazardous materials. Moreover, the export of e-waste in underdeveloped countries is not permitted in accordance with international [5].

Underground removal of e-waste has several disadvantages, including the contamination of groundwater, soil, and the loss of potential sources of valuable metals. In the last decade, many countries have issued legislation on electronic waste. Underground storage of electronic waste or incinerators burning is not permitted without isolating hazardous materials. Moreover, the export of e-waste in underdeveloped countries is not permitted in according to international regulations.

Until 2020, it should be prepared for reuse and recycling at least paper, metal, plastic and glass from household waste and possibly from other origins as far as these waste streams are similar to waste coming of household waste to a minimum of 50% of the total weight. Also, by 2020 should be achieved preparing for reuse, recycling and other material recovery, including operations using waste to substitute other materials, non-hazardous construction waste and demolition waste to a minimum of 70% of weight, excluding naturally occurring material.

The treatment methods aimed to reduce the organic carbon content must be in order to meet the final disposal criteria. Unlike storage, the new processing modes allow the recovery of materials contained in solid waste. This focuses on the recovery of non-ferrous metals. Compared to the other used components, such as plastic, wood or textiles, NF metals are easier to recycle with high market values. NF metal production from primary resources is limited and it is a high energy process. Therefore, recycling of metals can contribute greatly to energy saving, reducing carbon dioxide emissions. [6].

Table 1. The energy saved by recycling compared with those of extraction of primary resources [7]

Crt. iss.	Material	Saved energy (%)
1	Aluminium	95
2	Copper	85
3	Iron and Steel	74
4	Lead	65
5	Zinc	60
6	Paper	64
7	Plastic	>80

The overall potential of NF metals from incineration ash and mechanical-biological treatment plants (MBT), depends on the design of the recovery process, employed technologies and efficiency. Many components of the NF concentrate can be extracted by means of eddy current separators, whether incineration ash or during processing in mechanical-biological treatment plants. The separation should be such as to produce metal of sufficient purity to be used as a secondary raw material. The currently used techniques present weaknesses, such as the generation of wastewater and high prices for manual sorting in the European Union. This requires the development of new approaches in accessing resources in waste, while technical requirements depend on the origin of NF concentrate.

Optimised and adapted automated sensor based sorting systems able to identify different nf-metals are considered an applicable solution. However, their application varies considerably

depending on the origin of non-ferrous concentrate. This is due to the different distribution of particle size.

Mostly effective screening can be performed automatically, and staff can be used more effectively for manual quality control. Mineral dust layer covering the debris and various metals contained in incineration ash reduce visual selection mode between minerals and metals at a point where manual sorting is not possible.

E-wastes are classified as hazardous materials, therefore, should be managed properly. However, precious metals (PMS) of e-waste, such as gold, silver, platinum, gallium, palladium, tantalum, tellurium, germanium and selenium make them attractive for recycling. In industry there are various metallurgical processes to extract precious metals from e-waste.

3. ANALYSIS

Metal fractions separated from the e-waste during preprocessing may be further processed by hydrometallurgical, pyrometallurgical, electrometallurgical, biometallurgical methods, and combinations thereof. Hydrometallurgical and pyrometallurgical processes are the most important ways of processing waste electrical and electronic equipment. These routes can be followed by electrometallurgical/ electrochemical processes (eg electrowinning or electrolysis) to a particular metal separation and recovery. Currently, trials for processing electronic waste through biometallurgical pathways are not confined to the laboratory, for example, bioleaching of e-waste. However, this route has potential for further development.

E-waste preprocessing is not always necessary in pyrometallurgical route. For example, complex electronic equipment such as mobile phones and MP3 players can be treated directly during the melting process [8]. However in hydrometallurgical processes, pre-processing is required to separate the metal from other fractions. This increases the efficiency of each step associated with hydrometallurgical processes. Each route has advantages and disadvantages that must be taken into account in selecting a suitable recycling process.

Non-ferrous metals, including aluminum, copper, lead, nickel, tin, zinc and others are among the few materials that do not degrade and do not lose their chemical or physical properties in the recycling process. Consequently, nonferrous metals have the ability to be recycled an infinite number of times. Currently, precious metals are used in a wide range of applications, not only in the electronic and communications equipment, spacecraft, jet aircraft and engines, but also in mobile phones and catalytic converters. The most frequently recovered metals are:

- lead: batteries, nuclear technique, typography, nonferrous metallurgy;
- gold: jewelry, electronics;
- silver: electronics, industrial applications (catalysts, batteries, glass / mirror), jewelry;
- aluminum: nonferrous metallurgy, energy, construction, transport, metallurgy, agriculture etc;
- tin: nonferrous metallurgy (bronze), food, solders, etc;
- copper: energy, electronics, nonferrous metallurgy (brass), food, transportation of electricity and heat;
- chromium and iron alloy (eg stainless steel), nonferrous alloys, superalloys, etc;
- nickel: cast iron and alloy steel (eg stainless steel), super alloys etc;
- niobium: alloy and super alloy high / low resistance;
- manganese cast iron, alloy steel, nonferrous alloys, superalloys, etc.

Recycling for platinum, palladium, rhodium, gold and silver recovery is made from:

- catalytic converters
- catalysts for oil refineries
- industrial catalysts
- nitric acid manufacturing plants
- carbon catalyst
- electronic waste

Considering that precious metals are rare and have a high price, they continue to be recycled at a high rate of recovery. US Geological Survey estimated that 240 tons of gold wastes (new and old) were recycled in 2012 in the United States, which is more than the total domestic consumption of gold reported. In addition, Census Bureau data indicate that about 14,000 tons of scrap precious metals were exported in 2012 worth US $ 5.5 billion. [9].

Gold recovery

Gold is widely used in computer components. Motherboards and the terminal computers are containing precious metals. Although computers and laptops contain more gold, precious metals are found in everything from coffee makers to cars. Gold of older or obsolete devices can be recovered, but if left in landfills is considered dangerous. Obvious gold deposits from technological and household items can be fragmented.

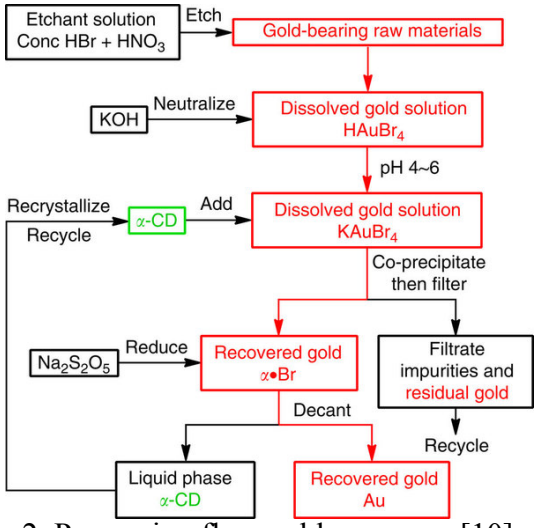

Figure 2. Processing flow gold recovery. [10].

However, gold is very finely layered to be easily removed. CBX solution can be used to extract gold from computer motherboards. CBX underlying material dissolves gold. StripFree is an electrolyte solution using an external source of electricity to remove gold layers with a stainless steel base. StripFree works in the opposite way of galvanization in which electricity is used to cover an object with gold. An old solution for gold recovery is the royal water. A mixture of hydrochloric acid and nitric acid dissolve gold. Gold material is placed in acid and then precipitated using ferrous sulfide.

Platinum recovery

The catalytic converter is a device used to reduce the toxicity of emissions from an internal combustion engine. Widely used for the first time in mass car production on the US market in 1975, to comply with tightening EPA regulations regarding the discharge of gas, catalytic converters are still most commonly used in automotive exhaust systems. A catalytic converter provides an environment for a chemical reaction of combustion and the products are converted to less toxic substances. Opel is the first European producer of catalytic converters mounted on the standard versions of gasoline engines. [11].

The catalytic converter consists of several components:

- The nucleus or core. In modern catalytic converters, the core is often a ceramic honeycomb, but there are also used stainless steel combs. Honeycomb increase the available surface area for catalyst support, and, therefore, is often referred to as a support "catalyst".
- Auxiliary layer. The auxiliary layer is used to make more efficient converters, often with a mixture of silica and alumina. Layer, when added to the nucleus, forming an irregular surface, tough, with a much larger area than the base, which then allows for for multiple places to deposit substances catalysts.

- The catalyst itself is often a precious metal. Platinum is the most active catalyst and it is widely used. This is not suitable for all applications because of unwanted additional and / or costs. Palladium and rhodium are two other used precious metals. Platinum and rhodium are used as a reduction catalyst, platinum and palladium while used as oxidation catalyst. Cerium, iron, manganese and nickel are also used, although each has its own limitations. For example, nickel is not legal for use in the European Union (due to reaction with carbon monoxide), while copper can be used, but its use is illegal in North America due to the formation of dioxin. [12]

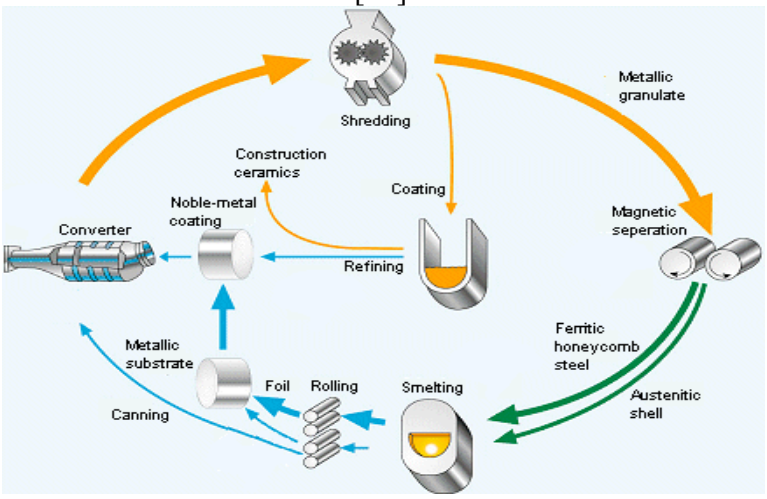

Figure 3. Processing Flow Catalytic converters [13]

While gold is common in electronics because of its superior ability to conduct electricity, platinum is an essential component of catalytic converters. A ceramic honeycomb coated with platinum uses the car engine heat to capture these pollutants. Platinum is the catalyst in a chemical reaction.

A typical catalytic converter contains 1.5 grams of platinum and other metals. The exact amount of platinum depends on the formula used. At the laboratory level, aqua regia dissolution is an excellent way to leach alts of platinum. Salts of platinum can then be further refined to pure platinum. In another technique, sulfuric acid dissolves the ceramic honeycomb, leaving platinum.

Ceramics can be also volatilized and converted to a gas or liquid, a process that may leave behind platinum. Recovery of platinum from catalytic converters and electronic components is much more costly and more difficult than gold recovery. At scrapped, damaged or recovered auto catalysts, from the dismantling car:

- The amount of platinum can range from 1 g to 15 g (or more for high power machines)
- Catalysts for gasoline cars contains about 5 grams of platinum
- Catalytic converters for diesel cars even contain 3 times more platinum than gasoline cars, meaning 15 g or more

Gasoline cars, especially the new generations are equipped with catalysts containing platinum in addition with palladium or rhodium, or both, in different combinations. Diesel engines catalyst contains mainly platinum, palladium and rhodium because they need higher temperatures to become effective or because of chemical reactions that take place. Globally, there is a tendency to remove the platinum catalyst, in particular for gasoline vehicles with new car catalytic converters containing less platinum and palladium becoming more and rhodium. For diesel versions, platinum will be replaced with gold because pollutants will decrease by 40% compared with platinum and especially the lower price of gold. Platinum is not as pure metal, palpable, it is as an alloy (Platinum, Palladium and Rhodium) and it is

dispersed in a kind of ceramic honeycomb (sponge), through which gases are exhausted away. [14].

Lead recovery

The recovery of lead from used batteries is a vast field of research. Lead batteries contain lead alloy, lead sulfate, micro-porous paper and plastic. Every year industry produces about 2.5 mega tonnes of lead worldwide. The most part is used for batteries. The rest is used to cover wiring, plumbing, ammunition and fuel additives. Other uses are as pigments for the paint and plastics from PVC, protection against X-ray, crystal and pesticide production.

Primary lead is produced from sulfide ores containing iron, zinc, copper and other trace elements. The concentrate from the ore and e-waste is treated for the extraction of lead and precious metals. Basically, the process consists in sintering, reduction and refinement. Sintering is carried out to reduce the sulfur content of the material, which is composed of pyrite, limestone, silicon and lead in a high concentration. The reduction is carried out in a blast furnace using the coke in the molten lead by about 85% purity being withdrawn from the bottom of the furnace. The plastic fraction of electronic waste can partially replace coke as a reducing agent during the reduction step and metal fraction reaches the metal phase. In the refining stage, lead dross is processed by adding wood chips, fine coke and sulfur. The sulfur slag produced is separated and transferred into the furnace. The heating of furnace slag separates lead ingots (rich in lead), sulphide copper and other metals.

In the last stage of processing electronic waste by melting method of lead, precious metals and other elements are separated from ingots of lead. The precious metals are separated by Parkes process, in which the zinc forms an intermetallic compound insoluble gold and silver. Other impurities include antimony, tin, arsenic, bismuth, as well as the elements are also separated during the refining step. The end products of the refining stage a concentration of 99.99% lead, precious metals and other elements [15].

Copper recovery

Since the mid-1960s, global demand for refined copper rose by 250% (from 5 million to 18 million tons). Outputs from ores remain vital in order to meet this growing demand. Providing quantity of copper to meet the future society need, means recovery and recycling widespread and substantial investments in the mining industry. Copper is ubiquitous in modern life equipment, high-tech products, electrical installations or engines.

In 2011 the reused amount of copper was 2.1 million tons - an increase of 12% in one year, from end of life products and waste directly recycled manufacturing (direct melting). The increasing percentage of recycling is due to the increasing demand of copper industrial metal worldwide.

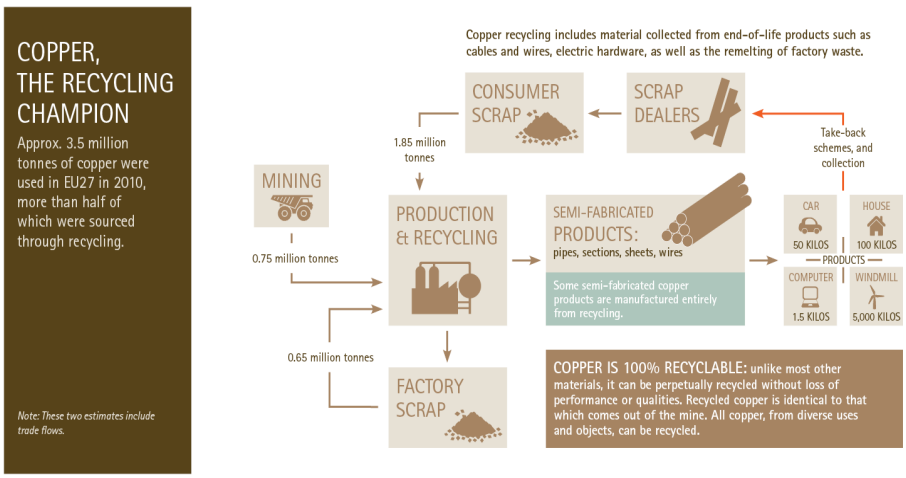

Figure 4. Copper recycling activities [18].

According to the report published by Copper Study Group International (International Copper Study Group - ICSG) 41.5% of the copper used in Europe comes from recycling. This reveals that the requirement of recycling of copper is provided, at a rate gradually. Increasing resources meet the growing demand for this metal (250% more than in 1960), while reducing environmental impact of production and ensuring availability for future generations. A computer contains about 1.5 kg copper, a typical home about 100 kg and a wind turbine 5 tons. As the copper can be recycled and reused infinitely without the loss of performance, we must ensure that products and copper waste are processed correctly when they reach the end of their useful life. [16]

Copper smelting is an environmentally friendly process compared with the melting of lead generating toxic gases.

Copper smelting facilities to minimize transportation costs of e-waste and therefore recycling will be improved, allowing copper smelters to be installed near cities where electronic waste is generated. In these processes, precious metals are recovered through conventional electrowinning process, where they are separated from the sludge. [17].

Silver recovery

Silver recovery from waste solutions such as those produced by conventional processing of medical and industrial X-ray films, photographic films and pictures has been practiced for over 100 years. However, the economic viability of the process has changed radically in recent years. Silver is consumed in various ways, from eyedrops lubricants for jet engines. It is used by each hospital, medical clinic and dentist, and photo department processors, printers and anyone achieves photo processing of a wet solution.

Modern methods of recovery offer the opportunity to earn a quick payback, which means faster profits. Different methods are used to recover silver:

1. Electrolysis – most commonly used. A stainless steel drum with current attracts the silver. The silver is stripped off the drum and the by-product called flake is sent for refining – usually 90% - 95% pure.
2. By adding chemicals, which cause the silver to form sludge – this is then dried and refined. The sludge is usually 30% pure.
3. Silver Traps – are also used to extract silver. This is a container with a cartridge – the fixer filters through the container and the Silver is trapped in the cartridge
4. Researchers have also developed methods for the extraction of silver, using bacteria and enzymes that "eat" the emulsion of gelatin, silver run. This method is not widely used (since 2011).

X-ray films contain an average of 7.5g per kilogram while negatives have 9g / kg and camera film 2g / kg. Fixer varies according to how the film is processed but average at 3.0 grams per liter.

The legislation states that hospitals and clinics to follow certain rules regarding the disposal of X-ray films. X-ray films are considered private information so they must be completely destroyed, while silver and other chemicals in the film are toxic to the environment. Recovery of silver prevents penetration of metal into the environment, but other products used in the process must be carefully withheld or destroyed. [20, 21]

Aluminum recycling

One of the basic characteristics of aluminum is its versatility, allowing the use of the metal and its alloys in a wide range of sectors, from transportation to construction, electronics, packaging, furniture and industrial installations. For these final destinations, aluminum is used in the production of durable goods, excluding packaging. At end of life, it turns into waste products which are either stored or, alternatively, recycled or reused. In market economy a possible recycling is directly related to the recovery of residual value, in the sense that it will be directly proportional to the capability to strive for such a process. In terms of recycling,

aluminum and its alloys are exceptional materials, because as with other non-ferrous metals recycling can be done without significant deterioration of quality.

Almost all of the absorbed energy in the first stage of metal production, namely 95%, is preserved in material and ready to be reused when remelting. As a result, the production of a kilogram of recycled aluminum requires energy equivalent to 5% of the electrolytic production of one kilogram of metal. Secondary aluminum is the equivalent of primary aluminum, even after several cycles of life, so that recycling can:

- recover valuable material without loss of quality;
- save energy compared to primary production;
- reduce emissions and gas producing greenhouse;
- reduce mining activities;
- reduce waste. [22]

4. CONCLUSIONS

Collection of waste from electrical and electronic equipment is a key step for recycling and efficient management of resources. The main options for collecting post-consumer goods are at the municipal level, to retailers, manufacturers and individuals. The economic policies of each country dictate the balance between different ways of collecting. The collection can be improved by raising awareness and increasing investment in well-organized collection facilities.

WEEE contains limited quantities of precious metals; therefore a long-distance transport is unprofitable. Transport is a significant obstacle and overcome this barrier is to develop preprocessing centers near cities. Such centers could perform sorting, dismantling, shredding and metal fractions from the release of other waste material. The conveyance of metal fractions is the only way to minimize transport costs, which can improve the economy of recycling electronic waste.

The lack of the centers for separation the metal from complex e-waste material is one of the barriers in the extraction of precious metals from e-waste, the issuance / separation during mechanical machining. Initial processing and release of metals are essential for recycling electronic waste.

Preprocessing steps, including sorting, dismantling, crushing and isolate the issue metals, alloys and other material values of a complex of e-waste. Some of the technical difficulties during the melting and refining processes can be reduced to a minimum during the delivery stage. Insulating of precious metals from e-waste is a challenge due to interconnections with other metals from computer motherboards.

Another barrier that affects the potential of electronic waste recycling is the incomplete knowledge of methods underlying melting and refining processes. It is crucial to have knowledge about the composition of the feedstock, and its possible side finished product. Recovery of PMS from e-waste using technologies similar to those applied natural ore is a challenge. [23]

However, according to the Belgian company Umicore (one of the largest recyclers in the world, heavy metals from electronic waste and industrial waste), urban mining could result in 200-250 g gold / tonne of integrated circuit cards and 300-350 g / tonne of mobile phones. This contrasts with the concentrations obtained in the mining of gold core, about 5 g / tonne of crude ore.

Output products contains metals in a higher concentration than primary sources, meaning that it takes typically less energy to extract the same amount of metal. The Umicore recycling unit in Hoboken, Belgium, produces, for example, 70,000 tonnes / year of metal and issues with a megaton of CO_2 less than if the amount of metal was made from raw ore.

In Romania, nearly 18,000 tons of electronic waste resulting from the IT, electronics and home appliances were collected in 2008. Using the average of 250-300 g / t, would result

between 62 and 70 tonnes of gold that could be recycled in a single year from this source of waste. For example, in Rosia Montana, the Canadian company RMGC aims to extract 314 tons of gold in 16 years. [24]

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CURRENT CONTROL OF A 3-PHASE ELECTRIC ARC FURNACE USING FUZZY LOGIC

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Abstract: This paper presents a current control for a three-phase electric arc furnace of direct action. In order to do this, a fuzzy control system is proposed. The fuzzy system is a Mamdani fuzzy model and the environment used is Matlab. It has the current deviations as inputs and electrode speeds as outputs. Modifying the position of the electrodes, different arc lengths will be achieved. Also, a simulation of the proposed fuzzy control system is performed in two modes for testing the effectiveness of the proposed fuzzy system. First mode consists of using the fuzzy simulation tool and the second mode consists in implementing of the fuzzy control system in the Simulink/Matlab.
Keywords: electric arc furnace, fuzzy controller, fuzzy logic, electric arc current, electric arc length

INTRODUCTION

Electric arc furnace (EAF) is important equipment and a high energy consumer in metallurgy. EAFs are used in the production of steel and are supplied by a special transformer.
The metal can be heated in the furnace tank directly by the three electrodes which are moving up and down, meanwhile, arc can be generated between every electrode and metal charging [1]. At the considered installation plant, the melting process is performed by direct action i.e. by electric arc that appears between the metal and the graphite electrodes.
EAFs are used in the steel industry in order to melt scrap or other metals into liquid steel. For the metallurgical reactions to take place, it is essential to achieve high temperatures in the furnace [2]. In order to do this, electric arcs are used which consume a lot of power, so, it requires to optimize the power delivered to the furnace. The arc power depends on the current and voltage of the electric arc. These are influenced by the electric arc length, which can be modified by means of the electrode positioning system. Therefore, it is important to control the electrodes movements, so that the desired power to be achieved.
In order to obtain the electric arcs, there are used three graphite electrodes which are supplied by a three-phase power transformer [3]. The three graphite electrodes are used to melt the metals that are loaded in the furnace tank, so different arc lengths exist in the melting stage, these lengths being a result of the random distribution of the metals in the furnace tank.
The electric arc is a nonlinear element, so, if one wants to study the behavior of a system containing an electric arc it must use techniques to model this nonlinearity [4].
Because of the dynamic behavior of the electric arc that appears during melting process of the metals, these furnaces are an important source of disturbances which must not be ignored. Therefore, solutions must be identified through which these disturbances should not be injected in the power supply network. At this network other equipment can be connected which can be influenced by these disturbances.
Due to power system problems attributed to EAFs, there has been an ongoing need for models that can be used to represent this type of nonlinear load in order to better assess the impact to EAF installations, whether existing, up-graded or new. The problem is complicated by the fact that the EAF voltage-current (v-i) characteristic is essentially much nonlinear.

Several known approaches for modeling and predicting the behavior of EAFs include the use of nonlinear resistance, mathematical, stochastic and system identification approaches, as well as methods based on v-i characteristic, power or current/voltage sources and a combination of thereof [5].

METHODOLOGY AND DISCUSSION - SYSTEM DESCRIPTION

EAF requires to be supplied with power in order to take place the chemical reactions. Figure 1 illustrates a block diagram of the electrical system of a typical EAF [6]. The three-phase transformer is the source of power for the furnace. Flexible cables are used for the connection between each phase of the transformer and the electrodes. These electrodes are supported by the electrode arms which are mounted on a hydraulic system that allows obtaining different arc lengths by changing the position of the electrodes. So, it is important to design an efficient control system of the EAF.

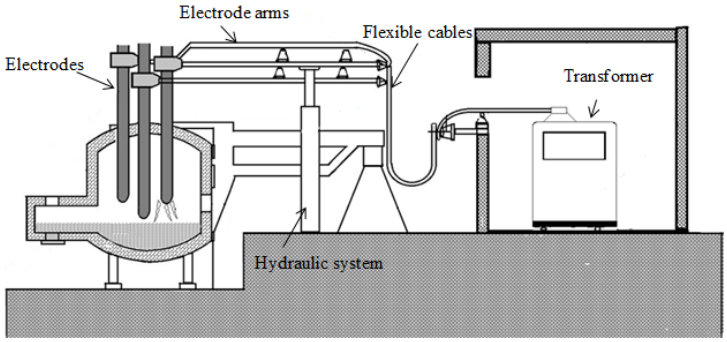

Figure 1. A block diagram of the EAF electrical system

An EAF process cannot function without automatic control of the power, because of the random nature of the electric arc. Automatic control of an EAF should assure a corresponding operating of the EAF from the point of view of metallurgical process and of a high production.

The power level depends by the positions of the electrodes. As a result, the implementation of a competitive control system is very important because it led to reduction of the energy consumption, pollution, and increases the safety of the process [7].

Arc power can be controlled by modifying the power supply or by changing the electrodes position. First control is used for the passing from a technological stage to another, i.e. from the meltdown stage to the refining one. The second control is used to keep constant arc lengths during the same technological stage.

If the position of the electrodes is changed, different arc lengths will be achieved, so, different values for the arc current, arc voltage and arc impedance will be obtained too. Constant arc lengths imply that the electrical power to the arc furnace is stable around the reference value determined by the tap-changer of the furnace transformer.

In this paper, current control is the variable used to maintain a constant arc length. Arc current is mainly used as the control variable in an EAF because of its direct relation with the lengths of the electric arcs. The current controller adjusts the electric arc current, i.e. phase current, by modifying the arc lengths by the means of electrodes position.

If the electrodes are moved up, the arc length is increasing and so, the arc current is decreasing. Similarly, if the electrodes are moved down, it will be obtained a smaller arc length and so, the arc current is increasing.

By the actions that are influencing the arc lengths, so the arc current can be the following:

- The scrap temperature;
- The falling of the scrap that leads to short circuit;
- Shorting of the electrodes;
- Moving the arc because of the electrodynamics forces.

During a technological phase, the voltage of the secondary side of the furnace transformer is modified according to the technological specifications and the current is varying, because it depends by the arc length.

In summary, the process of the EAF involves the following characteristics: complexity, nonlinearity, variation and non-consistency, significant involvement of the human operator, need for expert operational knowledge and very noisy environment. These features justify application of intelligent techniques to EAF process modeling and control [8].

THE IMPLEMENTATION OF THE FUZZY LOGIC CONTROLLER

In this paper is proposed, designed and implemented a fuzzy current controller. Such a controller is important in an arc furnace industry, especially if short circuits occur during the arc furnace operation.

The control variable used in this paper is arc current, this strategy being known as current control. Using this strategy, the disturbances are rejected much faster than in case when other control variables are used. This is very desirable in an arc furnace industry, especially if the electrode tips make connections with the metallic charge and short circuits occur [9].

The structure of a fuzzy controller is composed by the knowledge base, the inference engine and the fuzzification and defuzification units as presented in figure 2.

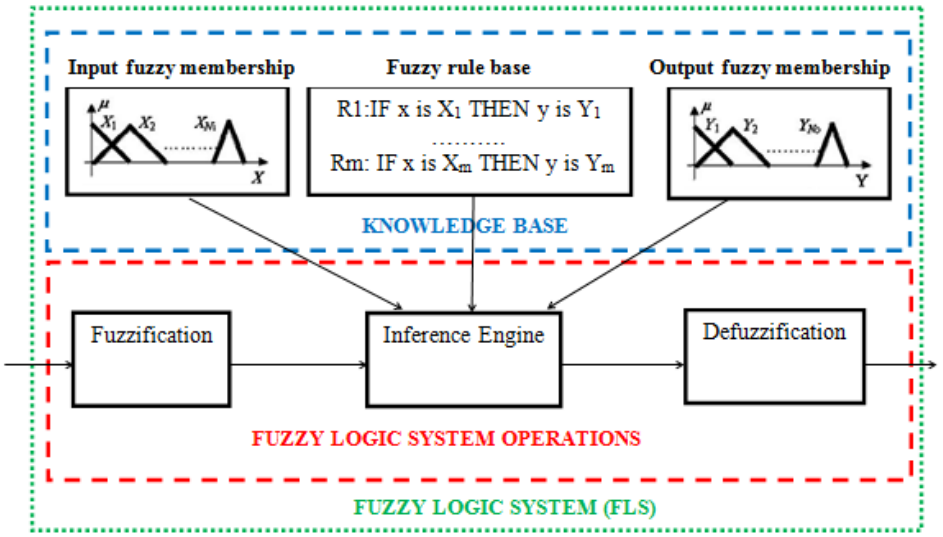

Figure 2. The fuzzy logic controller system

In order to design the fuzzy logic system (FLS) for the current control were chosen three inputs, namely the current deviation for the three phases and three outputs, namely electrode speed for the electrodes movement. In the considered installation plant, the electrodes are moved vertically, up or down, using hydraulic systems.

For the controller output was chosen the electrode speed, because it is easier to give the speed and the direction to which the electrodes should be moved to and not what position should the electrodes have to attend. Using a hydraulic system will be obtained the desired arc length, so desired arc current.

In figure 3 is presented the block diagram of the FLS, this system being designed in an intuitive manner, so, it has three inputs and three outputs, corresponding to the real plant.

Figure 4 presents the membership functions for the input variable, namely arc current deviation. The universe of discourse for this variable is [-1.7, 1.7 KA] and is divided into three fuzzy sets. The membership functions used are trapezoidal. The linguistic variables are negative or positive depending by the current deviation which is the difference between the desired arc current and the measured arc current, obtained during of the EAF functioning. For each of the three input values of the fuzzy system were used the same universe of discourse,

membership functions and linguistic variables. Therefore, in this paper are presented only the membership functions of the current deviation just for a phase of the furnace transformer.

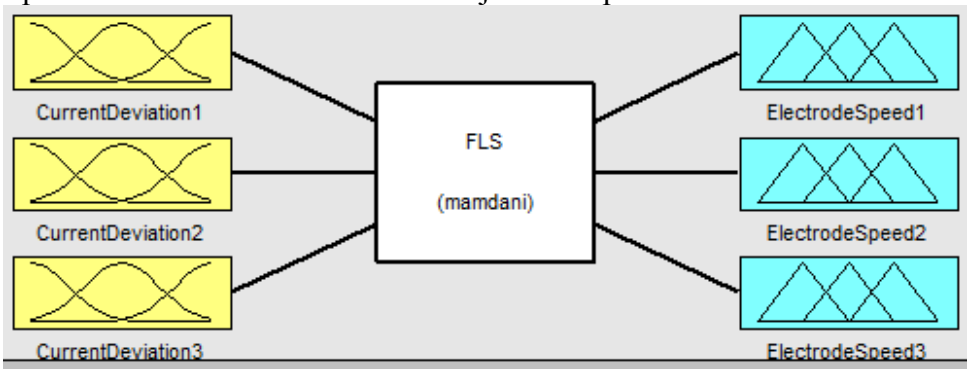

Figure 3. Block diagram of the FLS

Figure 5 presents the membership functions for the output variable, namely electrode speed. The universe of discourse for this variable is [-0.05, 0.05 m/s] and is divided into three fuzzy sets. The membership functions used are trapezoidal. The linguistic variables are negative or positive depending by the movement of the electrodes: down (negative) or up (positive). It was chosen this variable as the output of the fuzzy system because the arc current is influenced by the arc length. For each of the three output values of the fuzzy system were used the same universe of discourse, membership functions and linguistic variables. Therefore, in this paper are presented only the membership functions of the electrode speed needed to obtain only a desired arc current.

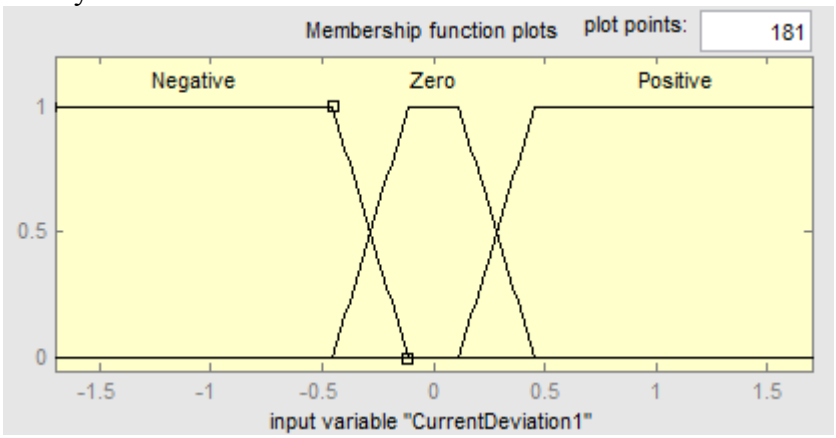

Figure 4. Membership functions for the input variable *Current Deviation*

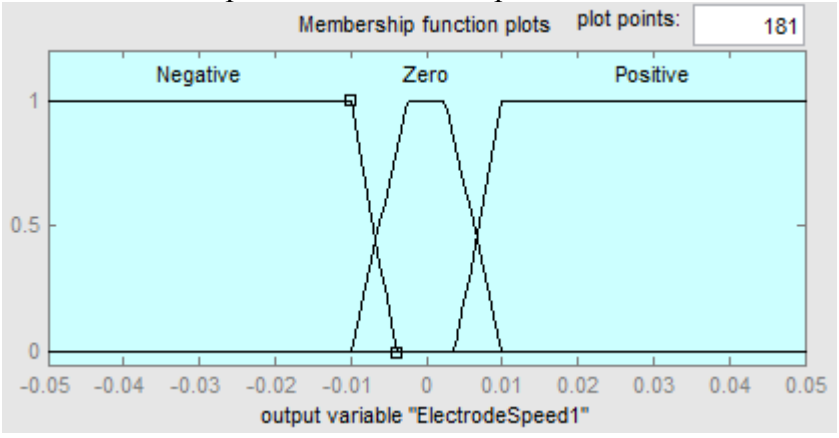

Figure 5. Membership functions for the output variable *Electrode Speed*

A fuzzy knowledge base consists of IF-THEN fuzzy rules and membership functions characterizing the fuzzy sets [2]. In this case, it is known the arc current deviation, as being

the difference between the desired arc current and the obtained arc current. Depending on this value, the controller computes its output, i.e. electrode speed in order to move the electrode up or down with a specific speed.

The electrodes position control is performed taking into account the real conditions that exist on the considered industrial plant. The maximum speed of the electrodes is of 3m/min (0.05 m/s) [10].

Because the fuzzy system has three inputs and three outputs, each with three fuzzy sets, the fuzzy current controller rules base consists of 27 rules that describe how must be moved the electrodes in order to have a desired arc current. In figure 6 are presented the rules base for the fuzzy system.

After the knowledge base is defined, can be applied the fuzzification operation, i.e. transform the numeric inputs into membership values.

The inference engine, infer the output of the controller, so performs all fuzzy logic manipulators. It has as input fuzzy sets that were mapped from numeric values.

The outputs of the fuzzy inference engine are also fuzzy sets so it is necessary to transform these into numeric values. This operation is named defuzzification.

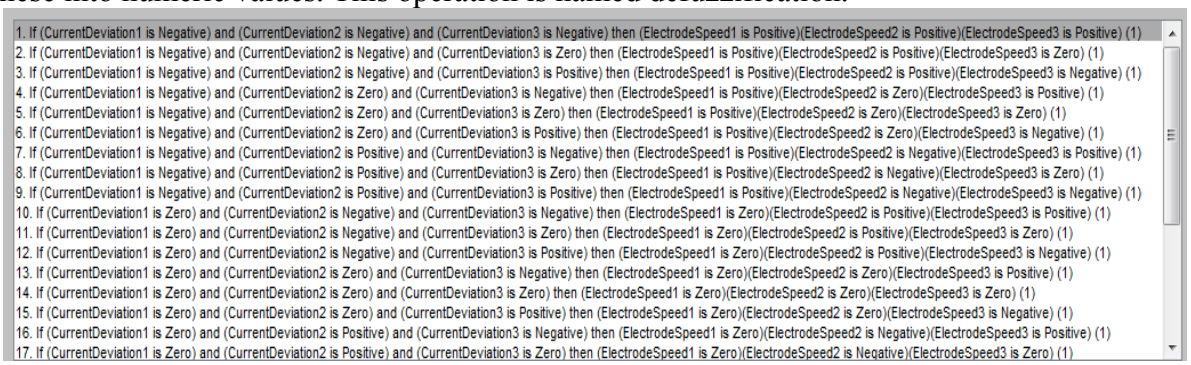

Figure 6. The rules base for the fuzzy system

TESTING OF THE FUZZY SYSTEM

In order to test the effectiveness of the proposed fuzzy system for the current control of a 3-phase EAF, the result obtained during the simulation will be presented in two modes.

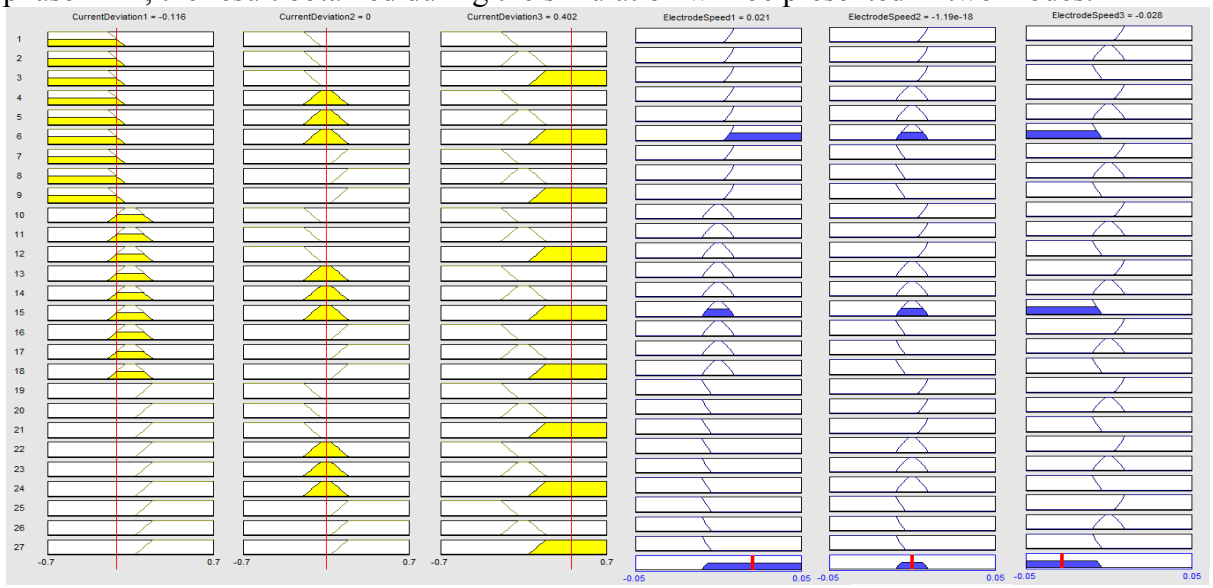

Figure 7. Simulating of the fuzzy system

First one is testing the fuzzy system using simulation tools from Matlab. So, in figure 7 are presented the active rules for a specific value of the inputs and are computed the outputs. The inputs of the FLS are the current deviation for each of the three phases of the furnace

transformer. These deviations are computed as the difference between the desired arc currents and the measured ones. If the current deviation is negative, the measured current is larger than the desired one, so the current on the respective phase should be decreased. If the current deviation is positive, the measured current is smaller than the desired one, so the current should be increased. In order to obtain a larger current, electrode should be moved down and for a smaller current, electrode should be moved up.

Taking into account the information previously presented, active rules from figure 7 can be noticed that:

- The current deviation for phase 1 is negative and zero with different degrees of the membership functions. This means that the measured current is larger than the desired one. Therefore, the electrode for the phase 1 must be moved up, in order to obtain a smaller electric arc current (electrode speed for phase 1 is positive in figure 7);
- The current deviations for phase 2 is approximately in the normal range, so the electrode from phase 2 should be stopped;
- The current deviation for the phase 3 is positive, this meaning that the measured current is smaller than the desired one. Therefore, the electrode for the phase 3 must be moved down, in order to obtain a larger electric arc current (electrode speed for phase 3 is negative in figure 7).

Figure 8 shows the obtained surface with the simulation of the fuzzy system. Because in Matlab can be represented maxim 3D figures, the surface was designed for two inputs and one output. One can noticed that there are not discontinuities in the representation.

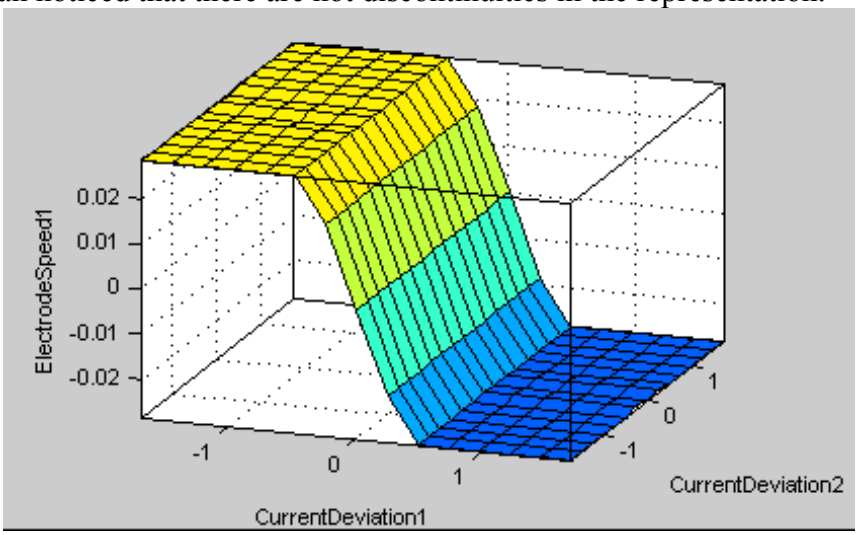

Figure 8. The surface obtained with the fuzzy system for two inputs and one output

The second mode for testing this fuzzy system is to use Matlab-Simulink environment. In figure 9 is presented the implementation in Matlab-Simulink of the fuzzy system. Input variable values are randomly generated using a block that generates random values (random number), in order to simulate all possible cases. Variation of both input variables and output variables can be observed using an adequate block (Scope). Fuzzy Logic Controller block uses the fuzzy system previously presented.

In figure 10 are presented the values of the input variables *Current Deviation* for each of the three phases of the furnace transformer. These values are randomly generated.

In figure 11 are presented the values of the output variables *Electrode Speed* for each of the three phases of the furnace transformer. These values are computed by the fuzzy logic controller taking into account the implemented FLS. One can notice that the output values are in the range of (-0.05, 0.05) and have different speed for the movement of the electrodes.

These variations were obtained using the implementation of the model in Matlab-Simulink.

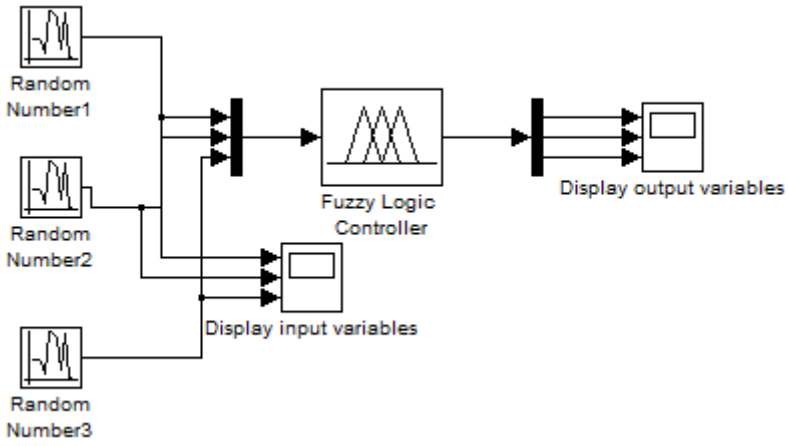

Figure 9. Implementation in Matlab-Simulink of the fuzzy system

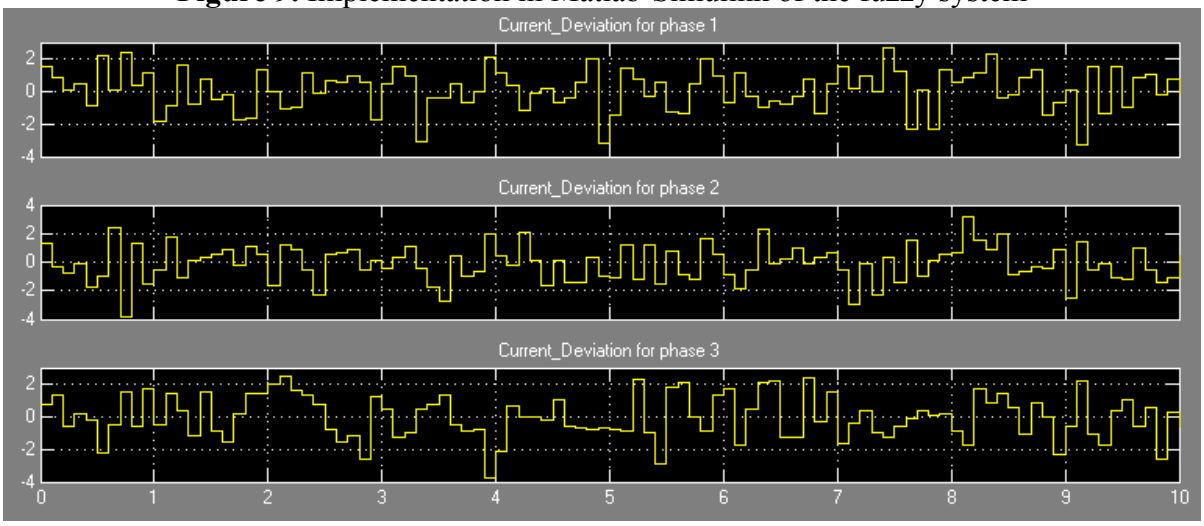

Figure 10. Visualization of the input variables for the fuzzy system

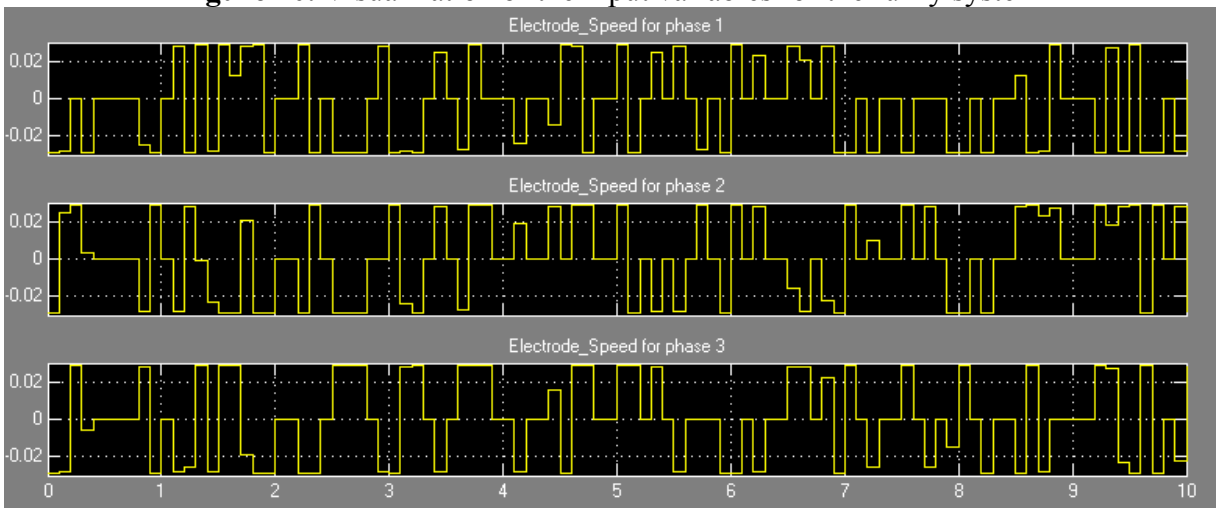

Figure 11. Visualization of the input variables for the fuzzy system

CONCLUSIONS

This paper presents a fuzzy current controller that is used to maintain constant arc lengths of the electric arcs. The purpose of this controller was to maintain the arc lengths as constant as possible by adjusting the vertical displacement of the EAF's electrodes.

In order to maintain a constant electrical power input, so a constant arc length, the phase currents that are the arc currents too, were used as the inputs for the controller.

The simulation results illustrate the effectiveness of the proposed fuzzy system for the current control of a 3-phase electric arc furnace.

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PATTERNS OF ANALYSIS AND RISK INTERPRETATION FOR THE ROLLING STOCK REPAIR PROCESS

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Abstract: Due to increasing competition, reached the romanian companies are being forced to restructure their activity in order to reduce costs. In order to fulfill this objective, and after we have analysed the current situation of a romanian company, we have reached the conclusion that it is extremely useful to implement a maintenance system that, on one hand, it will lead to cost reduction, and on the other hand, it wil contribute to work safety and security, as well as to the enviroment's protection. The implementation of a unique method of analysing potential risks that appear due to equipment attrition and the development of a maintenance plan for the entire company as an integrated plan in the general management plan, constitute a general objective to achieve.

Introduction

Most of the time, the production process presupposes several processes correlated between them in order to attain products. A system such as the one mentioned can be achieved by designing fabrication processes and operation sequence, and emphasizing the risks that pertain to each stage of the process.

In most cases, the production optimization assumes either the minimization of the fabrication cycle, or the cost reduction of the obtained product, or the correlation of the two functions: the dependence between time and cost to be as reduced as possible.

The repair process, or differently said, the maintenance, has been viewed as adjacent to the production processes and their importance was reduced because it affected the final cost of the product. Once company managers understood that the elaboration of a continuous maintenance program can cut costs down, and more, maintenance cost can be lower than repair cost in case of machinery malfunction, the attention given to this integrative part of the production process has increased considerably.

One of the main companies of Cluj, whose main activity consists of the construction, modernization and repair of railway rolling stock is Sc. Remarul 16 Februarie SA, a company that is attested and accredited to perform repair work by international institutions.

Along the tine, the company has well-performed its repair services on the locomotives of Romanian Railway, and because of professionalism has extended its activity to other beneficiaries.

The current document's purpose is to enumerate the main directions that need to be followed in order to set a risk based maintenance system within the repair activity of SC Remarul 16 Februarie SA, and its main objective is time reduction for this activity and implicitly, cost reduction.

Short presentation of SC Remarul 16 Februarie SA

SC Remarul February 16th SA was founded in 1870 with the opening of the rail section Cluj-Oradea, it's the initial concern was the repair of railway wagons and steam locomotives.

The company has experienced rapid growth, and in 1871 has reoriented towards repair and maintenance of diesel-hydraulic locomotives, operations that since 1984 have been oriented to export by signing repair contracts in countries such as Greece, Poland, Serbia and

Montenegro. In this period they concluded export contracts for repairs on some specific equipment for rolling stock equipment repair workshops in Egypt, Mozambique and Nigeria.

Fig. 1. Pictures from SC Remarul 16 Februarie SA

With the development and modernization of locomotives the company has adapted to new requirements to perform repairs and modernization operations on utility wagons of intervention trains that maintained and modernized the railway infrastructure, repair of electric locomotives of 2100 HP Diesel, repair of Duewag railcars, repair railcars of type LVT-LVS series number 79, periodic repair of passenger wagons series 19-47, 20-47, 19-57 and 20-57, modernization of hydraulic Diesel locomotives of 1250 HP for maneuver by featuring remote device, upgrading LDH 1250 CP by featuring generator, diagnosis and control air surveillance, air command controller, LDE 2100 HP modernization, equipped for electric power supply of the travel train, repair with modernization and adapting to traffic on Romanian railways of the electrical frames with French origin, and re-monitoring and modernization LDH 450 HP with Caterpillar engine adapted to traffic in metro tunnel.

Given that the construction of rolling stock occupies a very small share in the company's activities (perhaps nonexistent) attention is required on the repair and maintenance side, seen through the perspective of quality and also the inherent risks

Wear characteristics that must be removed

In the maintenance process of rolling material we face most often whith the wear of the material, wear that must be slown down, for the normal lifespan to be as long as it can.

The wear must be perceived as beeing the deterioration process of physical quality or technological updates of an asset as a results of its use. If obsolescence (the use of asset become unprofitable because the emergence of new fixed assets, more efficient) it can't be controled, even more the advance of technology must be looked as auspicious, physical wear can be controlled and thus the quality of operations performed with the asset to keep for a longer period of time.

The wear as a physical phenomenon involve fine cracks and scratches on working surfaces, changes in shape of the processed parts and sometimes bendings and twistings of those. Also, as it grows the wear, we can have changes in hardness of the processed parts.

The wear curve can be represented as a normal law, either as a gap (j) variation between the conjugated parts, either as a workpiece size variation depending on time.

Analyzing the wear curve by time, (fig.2), we differentiate 3 distinct periods [8]:

First period – initial wear period, also called running-in period and denoted with T_r, phase in which workpiece irregularities is leveled intense under the action of frinction forces; wear in this phase is more accentuated, more intense.

Second period – denoted with T_n, is characteristic to normal operating period and is characterizes by relative constant intensity of the wear; by a lower value. In normal wear operation phase, period T_n, until reaching maximum variation gap allowed it is higher. This period is also know as jointing durability and is calculated according to formula:

$$T_n = \frac{jmax - jmin}{tg\ \alpha}$$, unde tg α = ct

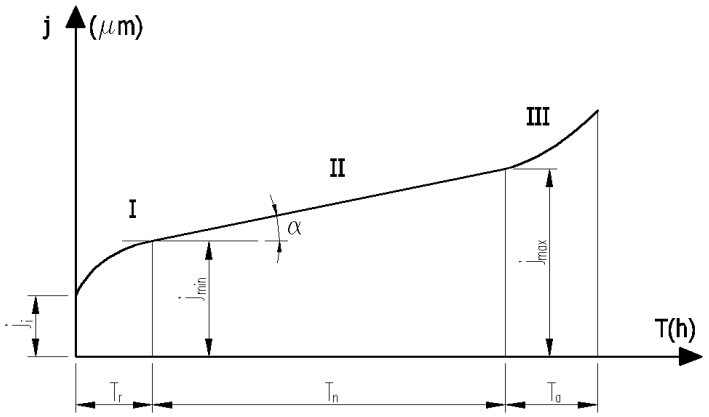

Fig. 2. Wear variation

Third period – also called failure wear T_d, is period further normal function wear. In this phase appears an increase in the variation gap, appears rattling, loud noises, heating and insufficient lubrication, and can lead to destruction of conjugated parts.

During equipment working period to increase the operating time it must be applied measures to decrease the intensity of the wear, and during repairs it must resorted to measures that reduces the gap variation up to a minimum allowable functional value.

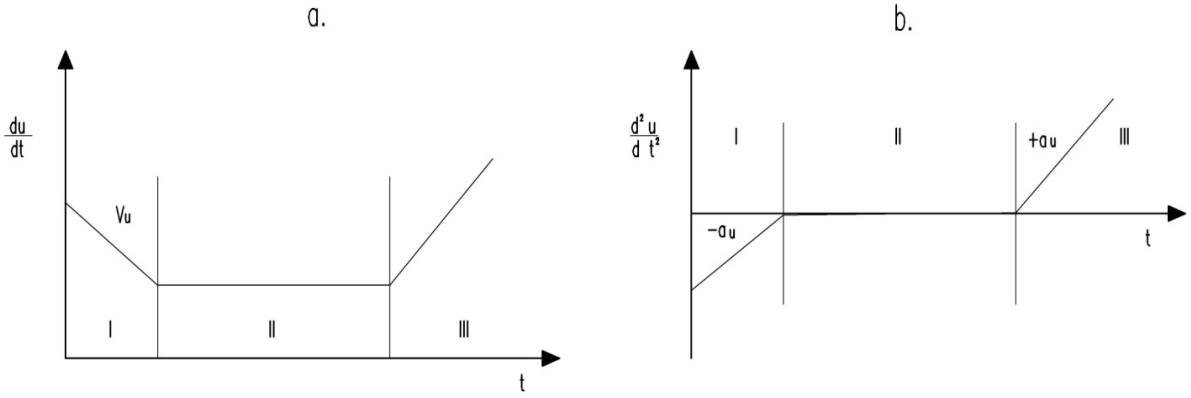

Fig. 3. a. Wear speed for the 3 intervals, b. Variation in wear acceleration in time [8]

Graphic analyzing the wear speed and the accleration, we conclude that the speed value is always positive and wear acceleration is negative or null on the running-in period and normal operating period, taking positive values in the risk failure operating period. Depending on acceleration values, it can be appreciated the normal operating period.

In practice, in the absence of an adequate maintenance system, it can be notice repairs initiations made early or late, thus the importance of technical verifications and establishing technical condition of the equipment is beneficial. Moreover, using the equipment reach his third operating period will lead to possible risks that needs to be analyzed to implement methods to prevent or to eliminate their effects.

The maintenance system at Remarul 16 Februarie SA

In accordance with STAS 8174 / 2-77, the maintenance consists of all technical and organizational actions associated with them, performed in order to maintain or restore technical equipment (machinery, equipment, etc.) in state to perform the specified function.

The maintenance strategies have witnessed a continuous development starting from repairs in cases of emergency and developing based on the need to reduce costs, a maintenance strategy based on measurement and assessment of equipment during operation, in order to prevent adverse events.

The maintenance system consists of technical revisions (R) - Operations undertaken in order to establish the technical condition of equipment, current repairs (Rc) - operations that run periodically in order to process normal wear attenuated or removal of defects that make the machine not operate in optimum design, and overhaul (k) - are undertaken in order to return the original operating equipment parameters and prevention of faults majore. The time between overhauls is the so-called second cycle of repair, and the sequence of operations is repeated periodically. Both technical revisions, current repairs and overhauls run under a maintenance plan, drawn up in advance by a team of specialists from various departments of the company.

The ultimate goals of drafting a maintenance plan are not only related to the reduction of costs incurred in its implementation but, under the new legislation in health and safety, also environmental.

Implementing a risk-based maintenance would make it possible to reduce the exploitation of up to 40% as shown in a study conducted in 2002 in the US.

The risk-based maintenance system has as main pawn, the risk. Based on risk regular analyzes are carried out and a maintenance plan is established. A general model of implementation programs for risk based maintenance is shown in figure 4.

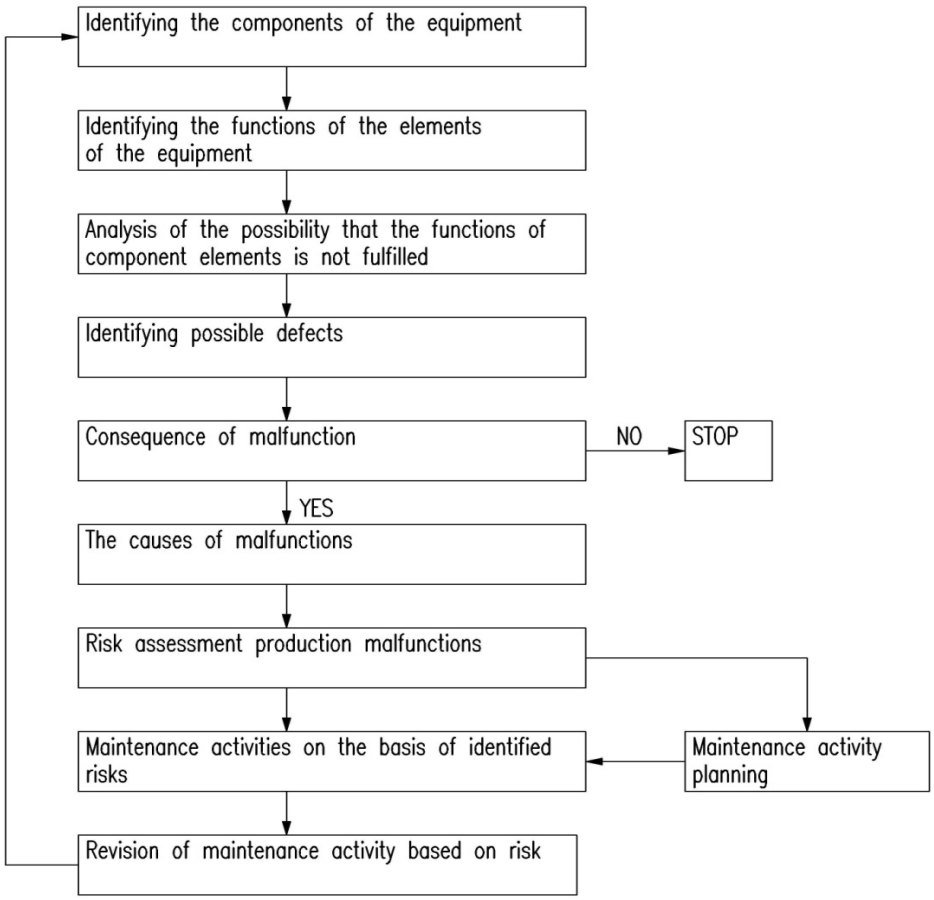

Fig.4. Risk Based Maintenance - general model [2]

An important step in the process, which can be determined step, consists in identifying the possible defects because a premature reorganization of the components would lead to an increase in the consumption of spare parts and consequently the production and use of government spending over the wear limit admissible would lead to an increase in energy consumption, failure technical conditions, prevention and reconditioning opportunities even to an accident affecting the safety and security of personnel work.

Different operational conditions of the equipment, lead to wear of different component parts that can change the life of the equipment. The check to establish the technical condition and possible solutions in order to subsequently restore the equipment in normal operating condition and avoiding risks can be achieved through [8]:

- Checking the technical condition without dismantling - is done according to certain functioning criteria initially established, state of the oil, noises and vibrations, response speed order received, power consumption, processing errors, changes in pressures, etc.
- Checking the technical condition after dismantling - control of the component parts after cleaning and degreasing the equipment. Trace hidden defects, wear and surface defects taking into account the functional factor (size limit no longer providing functional parameters) and economic factors (size limit below which we have a decrease in productivity, increases in losses and consumption);
- The check of hidden defects - can be achieved either hydraulic, pneumatic, magnetic, luminescent, fluoroscopic or ultrasonic, depending on the component which are to be analyzed.

These data obtained when performing the periodic inspections could be sources for the development of maintenance plan based on a risk [7]:

- Qualitative analysis - the risk of occurrence of faults or damage are evaluated considering all likelihood of faults and failures, then using graphical representations for Distinguishing the probability-consequence relationship;
- Semi-quantitative analysis - determine the unique numeric value for each probability of occurrence of a malfunction or failure, and the consequences and effects of each case, based on data obtained from experience or general data specific to the type of malfunction;
- Quantitative analysis - the likelihood and consequences of faults in is determined separately for each part of the distribution scenario variables based on reliability analysis methods equipments and installations.

You can choose for a wide range of risk analysis methods, but the most commonly used as Failure Modes and Effects Analysis - FMEA (Failure Mode Analysis and Effect Analysis). It is one of the methods widely used in engineering to define, identify and eliminate risks, problems, system errors, design, process or service, before the final product reach the client, that is still in the process of planning production. Strict in the maintenance field the method is structured qualitative identifying the immediate effects of malfunctions or accidental stops of each piece of equipment and every risk causing effects on the entire system which includes the equipment.

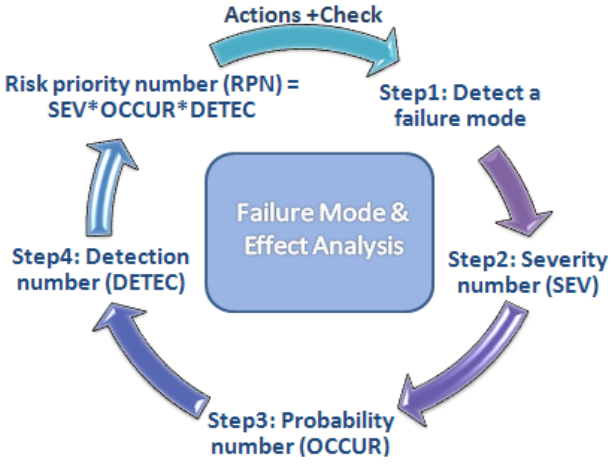

Fig. 5. Steps of the FMEA analysis

In relation to each equipment components are highlighted the potential defects, failure mode the effect and their cause. Considering that risk assessment has a high degree of subjectivity, the analysis of processes will be done in teams of the personnel from different departments of research and development, production, management, quality and sometimes even by customers and suppliers.

Conclusions

Any company, regardless of its size, functions according to an important economical desideratum that is to obtain as large of a profit as possible, while costs are as low as possible. On the first looking, things don't seem as complicated, but we need to keep in mind the health and security of the employees, and the consequences of the activity on the environment. These aspects, corroborated with the objective of obtaining profit (which, of course, means that we have to continue developing quality products) lead us to increasing the efficiency of the processes that are performed within the company, among which, the maintenance process.

The advantage of using a risk based maintenance plan is emphasized in specialty studies. Although, until not long ago, Romanian companies were using a maintenance plan for the equipment, more and more mangers have understood and implemented a new maintenance system that can insure significant cost reductions. Based on cost reductions, there will always be preoccupations in order to improve maintenance methods. However, without an extremely exact risk analysis, the entire maintenance plan is compromised.

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BULGARIEN REGULATION IN THE FIELD OF UTILIZATION OF USED ACCUMULATORS

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Abstract: The end of the life cycle of batteries and accumulators is when they become unusable products. Under the legislation, unfot for usage batteries and accumulators (UFFUBA) is a battery or accumulator which cannot be used for the purposes for which it is produced, i.e. becomes waste. For 2008-2012 were submitted for recovery, including recycling, almost 5% of the hazardous waste, there is a tendency of increase. For the observed trend of increasing quantities of hazardous waste delivered for recovery, including recycling contribution has increased share of the transmitted recovery of hazardous waste generated after pretreatment of spent lead-acid batteries.
Key words: Accumulators and Batteries, UFFUBA, recycling

INTRODUCTION

The end of the life cycle of batteries and accumulators is when they become unusable products. Under the legislation, unfot for usage batteries and accumulators (UFFUBA) is a battery or accumulator which cannot be used for the purposes for which it is produced, i.e. becomes waste. Battery or accumulator is any source of electrical energy generated by direct conversion of chemical energy and consisting of one or more primary cells (non-rechargeable) or of one or more secondary cells (rechargeable).

METHOD OF RECYCLING THE UFFUBA

First of all "What is recycling?"

Recycling is a process to change waste materials into new clean and useful Products without creating pollution and harmful substances. Recycling of the UFFUBA is the most popular and only method of "reusing" the material invested in the batteries and accumulators.

With accordance with the Bulgarian "Ordinance on batteries and accumulators and unfit for usage batteries and accumulators" all manufacturers must require from the dealers to collect all the UFFUBA for recycling at the designated plants.

The Recycling process of the most popular Lead Acid Battery Recycling [1]

The battery is broken apart in a hammer mill; a machine that hammers the battery into pieces. The broken battery pieces are then placed into a vat, where the lead and heavy materials fall to the bottom and the plastic floats. At this point, the polypropylene pieces are scooped away and the liquids are drawn off, leaving the lead and heavy metals. Each of the materials goes into a different recycling "stream".

- Plastic

Polypropylene pieces are washed, blown dry, and sent to a plastic recycler where the pieces are melted together into an almost liquid state. The molten plastic is put through an extruder that produces small plastic pellets of a uniform size. The pellets are sold to a manufacturer of battery cases and the process begins again.

- Lead

Lead grids, lead oxide, and other lead parts are cleaned and heated within smelting furnaces. The molten melted lead is then poured into ingot molds. After a few minutes, the impurities float to the top of the still molten lead in the ingot molds. These impurities are scraped away and the ingots are left to cool. When the ingots are cool, they're removed from the molds and

sent to battery manufacturers, where they're re-melted and used in the production of new batteries.

- Sulfuric Acid

Old battery acid can be handled in two ways: 1) The acid is neutralized with an industrial compound similar to household baking soda. Neutralization turns the acid into water. The water is then treated, cleaned, tested in a waste water treatment plant to be sure it meets clean water standards. 2) The acid is processed and converted to sodium sulfate, an odorless white powder that's used in laundry detergent, glass, and textile manufacturing.

EXPLANATORY

European strategy documents in recent years changed the philosophy and approach to waste, targeted waste management as a factor damaging the environment, a policy of preventing their formation and their effective use as resources.

There is a high probability of changes in European legislation on waste to an even higher level of protection of the environment and human health as well as the transition from waste management to sustainable management and more efficient use of resources [3].

Expectations are focused in several directions, among which a special place is given to the end-of-life vehicles:

- Additional restrictions on the landfill of waste
- Special provisions for reducing the use and waste prevention of polythene bags for single use;
- Restrictions on burning waste that can be recycled;
- Introduction of higher recycling targets for household waste, especially plastic waste
- Introduction of quantitative targets for the prevention of waste, especially plastic, household / grocery and hazardous waste
- Higher targets for preparing for re-use and recycling of packaging waste,

The main legal document concerning the UFFUBA problem in our country is the Law on Waste Management. Which regulates, measures and controls to protect the environment and society preventing or reducing the adverse impacts of the generation and management of waste and by reducing overall impacts of resource use and by increasing the efficiency of such use.

Details are regulated in the Ordinance on the treatment of UFFUBA (2012), which applies to all types of batteries placed on the market, regardless of their purpose, and the UFFUBA

- The ordinance regulates:
- Prevention and reduction of environmental pollution resulting from the treatment and transportation of the UFFUBA;
- the application of any measures of persons placing on the market batteries for the collection, recovery or disposal of spent batteries accumulators with no risk to human health and the environment and achieving the objectives for the recovery and / or recycling and / or recovery ;
- The introduction and operation of environmentally friendly system for management and control of the collection, transportation, storage, recovery or disposal of the UFFUBA;
- To inform the end users about their role in the collection of the UFFUBA and available for collection.

Targets for recycling and recovery of packaging waste from batteries and accumulators are at European level and in Bulgaria are set and implement national targets for waste tires and waste oil and oil products. Targets for recovery and recycling of six groups widespread waste throughout the country successfully implemented through schemes introduced extended producer responsibility. Goals by years are as follows in Table 1.

Table 1.Key targets activities with the UFFUBA in our country for the period 2014-2020 [4]

Waste streams	Year	Purpose		
		Recovery	Recycling	Collection
Batteries and Accumulators		Utilization of not less than:	Regeneration and / or recycling of not less than:	
Portable batteries and accumulators	2014			Min 40% from the released in the market PBA with the exception of the PBA which are already on the market, which have been exported or send outside of the country
	2015 and every next year			Min 45% from the released in the market PBA with the exception of the PBA which are already on the market, which have been exported or send outside of the country
Vehicle Batteries and Accumulators	Each year			The volume of Auto UFFUBA, corresponding to the coefficient of collection, no less than a 100% from the volume released in the market ,the coefficient of collection is calculated according note #3 form the Ordinance on batteries and accumulators and unfit for usage batteries and accumulators
Industrial Batteries and Accumulators	Each Year			The volume of industrial UFFUBA, corresponding to the coefficient of collection, no less than 25% from the volume released in the market ,the coefficient of collection is calculated according note #3 form the Ordinance on batteries and accumulators and unfit for usage batteries and accumulators

To achieve these targets we must overcome a number of problems and weaknesses as:

- There is insufficient capacity to reach the targets for recycling and recovery of the estimated quantities of not only domestic, but also hazardous waste, which include disused accumulators batteries; waste.
- Insufficient activity of citizens and NGOs in the early stages of planning and design of facilities and activities on waste management and enhanced activity in the later stages of the process;

In the still high level of disposal of all types of waste;

- Insufficient level of information support of processes related to making informed management decisions and the preparation of strategic documents.
- Lack of targeted measures and incentives that contribute to waste prevention and a comprehensive policy for information campaigns to inform the public.

Reserves for achieving the goals in the activities of the UFFUBA should be sought, as well as other widespread and hazardous waste in several directions:

- More efficient use of EU financial instruments for solving the problems associated with the effective management of waste;
- Must change public attitudes in favor of environmentally sound and efficient management of waste;
- Expansion of the market for raw materials from recyclable waste, both in the region and within the EU;
- The creation of a single integrated information system for waste management;
- New efficient technologies enabling recovery and recycling of waste;
- Working schemes extended producer responsibility for widespread waste.

CONCLUSION

In Bulgaria was introduced workable scheme extended producer responsibility for the UFFUBA. There is a trend of increasing the quantities of collected and recycled batteries and accumulators. Bulgaria fulfills its objectives in the collection and recycling of UFFUBA.

The achievements of the EU environmental legislation have been transposed into Bulgarian legislation and regulations. Regulations in our country ensure more efficient solving of problems with the the limits of spent batteries accumulators in 2020 under their strict. It is company policy to impose legislation through effective control in the sector.

There are prerequisites that allow for public participation in decision-making related to waste management (procedures for assessing the impact on the environment, public discussions of legislative changes and programs, provision of information through various media and internet). Proposed project for the National Plan for Waste Management 2014-2020, in which, in general objective № 3 is set the framework for the activities of treatment and management of spent batteries accumulators in our country and submitted for comments and suggestions to the public along with the Environmental Assessment Report of the same project plan.

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PRINCIPLES OF MODELLING OF MACHINE AGGREGATES

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Abstract: Modelling of machine aggregates requires systematic approach. There is no general agreement about the definition, structure and classification of subsystems of machine aggregates. In the present paper general principles of modelling of machine aggregates are outlined. Machine aggregate is treated as complete integration of electronic control subsystem, electric driving subsystem and mechanical working subsystem.

1. INTRODUCTION

The machine aggregate in Fig. 1 represents dynamic system to drive a plant and to control the technological process and displays schematics of a modern controlled system. There are three subsystems:

- the (electric) drive, i.e. the (electro)motor and the gear,
- the driven mechanical equipment that represents equipment for electromechanical energy conversion, the actual technological process and the product of the process ,
- the control system performing an optimal control of the machine aggregate.

By the quality of the machine aggregates, i.e. by the static or dynamic characteristics of the subsystems are assigned the productivity of the process, the quality (operational stability, accuracy, speed) of the process and the product as well as the static/dynamic loading of the aggregate mechanical, electrotechnical and electronical units. Also the level and type of mechanical load, accuracy of gears, characteristics of drive and control, overall quality etc. obviously influence the motor and control performance conditions [1], [2].

2. MACHINE AGGREGATE – STATE OF THE ART

A machine aggregate and its intended control functions respecting the mutual energetic interaction of subsystems consisting of

- supply and power converter of some kind,
- electric AC or DC drive with proper kind of electromotor,
- a plant subsystem,
- control electronics (analog or digital, if digital than programmable microcontroller system).

All but the last subsystems are power subsystems. The control subsystem is an information subsystem. Hence, from another point of view, a machine aggregate is an integration of following subsystems:

- power electromechanic system of machine aggregate and plant generating the torques and forces needed by the process, under prescribed speed, position etc.
- energy supplying power electronic system modifying the electrical energy constant parameters of the primary sources to values of the converter postulated by the process,
- information control electronics.

The power electromechanic system together with the energy supplying power electronic system performs an electro-mechanical energy conversion. The goal is an optimal control with respect to the technological process or the dynamics of the aggregate as a whole.

Machine aggregates with controlled drives often need a multi-level hierarchical control. In the basic level of, say a speed system, the angular speed of the motor/drive is controlled by a speed controller, perhaps with the aid of a subsidiary current controller [3].

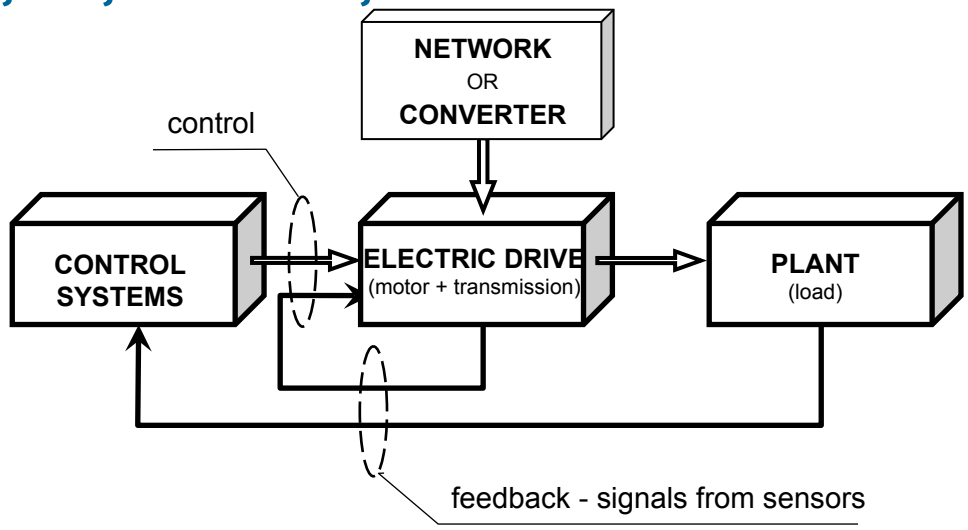

Fig. 1 Block diagram of the machine aggregate.

The control of both current and speed loop controllers can be designed starting with the current controller at the most internal loop in a number of ways. To design the position control systems, the speed control system with speed feedback loop designed above becomes subsidiary to a position control loop. Cascade, parallel and feedback groupings of controllers are available, just to refer to some of the design procedures. In the higher control levels of technology control, operational quantities/parameters are managed, with the goal to keep the conditions of the process optimal. The system approach finds machine aggregate to be merely a subsystem, which is internally controlled part of the whole system, see Fig. 2.

Then the machine aggregate MA is an integrated system consisting of three subsystems: electronic control subsystem ECS, electric driving subsystem EDS and mechanical working subsystem MWS. The integration covers design, construction, operation and maintenance with respect to optimal static as well as dynamic attributes of the MA:

- ECS performs the optimal control of the MA heading the MA objectives: product or/and process,
- EDS is an energy electric-to-mechanic converter,
- MWS executes the final production or process, following the MA objectives.

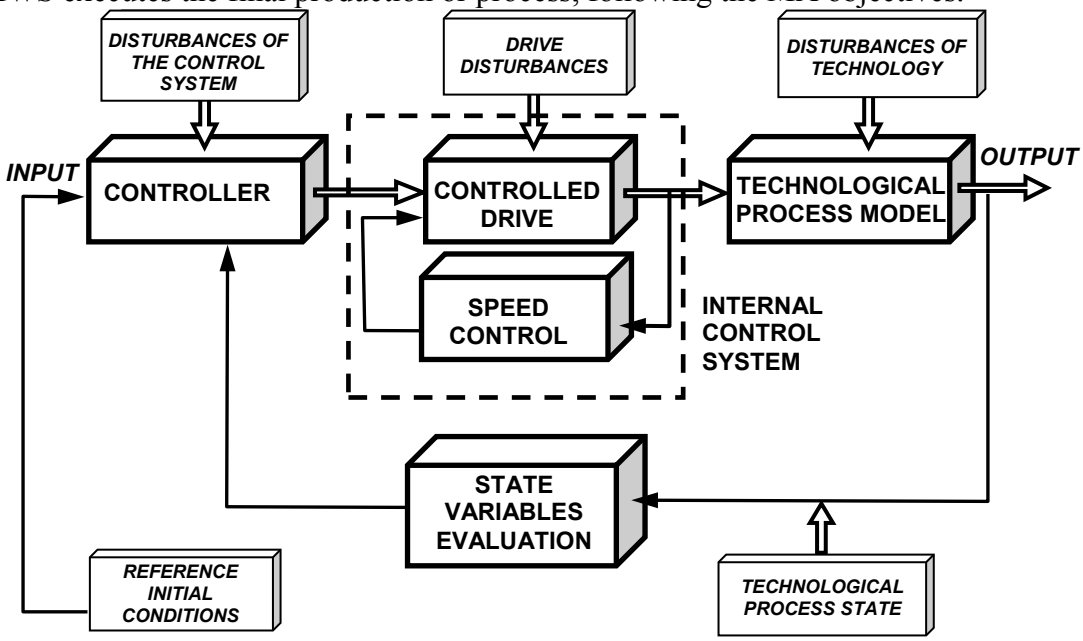

Fig. 2: *Detialed block scheme of machine aggregate*.

3. MODELLING THE MACHINE AGGREGATE

Transition from a real machine aggregate to its model is only possible if ideas on the goal of the system, on the states of the system, on the foregoing analysis, on specification of characteristic features for the designed functions of the system are taken into the consideration. There are lot of cases, when the model and simulation are the only way to get some knowledge. Two main aspects of the approach to the task are:

- creating a proper model (Modelling)
- working properly with the model (Simulation).

Writing the mathematical model in a mathematical form is the first step and is deduced from the proper theory of the investigated subject, namely from known physical laws from all the relevant branches.

The next step is writing the model code as a package of main program and supporting subprograms, using the results of the first step. After the verification of the main program and the whole program package, simulation experiments follow as the step three. The fourth step is verification of the results of the previous steps, probably using some kind of experimentation with physical models, or experimentation with the real object or process modelled.

Synthesis of computational and experimental methods is the basis for modern experimental work and is the most effective method for analysis and synthesis of machine aggregates.

The whole sequence to create a machine aggregate mathematical model as described above has three parts:

1. Modelling of energetic interactions among the subsystems.

- Formulate in natural language and describe mathematically all the individual construction parts of the machine aggregate and interactions among them (Fig. 1).
- Create the main program based on the previous point and the subprograms for the main program.
- Perform identification measurements on the model, i.e. perform the simulation experiments and postprocess them. Make statement, how truly the model substitutes the real object/process. Understand the numbers, tables, graphs etc. generated, describe the results in the natural language.
- Make an expert opinion on the model. The goal is to get the best possible working and simple model of the reality. The quality of the model depends on the quality definition, as an example the quality might be a compromise between the best possible stability of the model, its minimal computational time and accuracy of results.

2. Reducing the model to formulate the control laws.

- Create a linearized model of control, say, for the machine aggregate with working point shifted within a small displacement zone.
- Create a linearized model in the working part of the torque-speed characteristics.
- Create a nonlinear model by the constants assigning method for the nonlinear model using the regression principle.

3. Creating the control law.

Verification within the validity area of the reduced model is based on simulation experiments. Numerical or analytical simulation is optional, depends on the CAMS program (program system, package) in use. The MATLAB can work analytically but perhaps its main domain is the discrete simulation. The MATHEMATICA works analytically. As for the dynamic modelling and simulation, the key view is whether the integration of differential equations describing the machine aggregate is performed by symbolic or numerical integration.

The recent works in the machine dynamics deal mainly with discrete parameters, lumped mechanical system models and also with FEM models. Let us have a look into the recent decades to display what is to be done in next ones. The recent works of experts in drive systems treated in-depth the phenomenon of their own, while the mechanics of the plant was

treated with a reasonable overlap of both branches. The same is valid for the experts in mechanics. As for experts in control, this branch is rich in experts and literature, both in analogue and digital types of control. Even in well done works from electrical (controlled) drives the mechanical subsystem has been assessed and modelled with reduction to single or two rotating bodies, using an ordinary differential equation of the 1st or 2nd order [4].

Some very specific problems emerge due to the above conventional approach to predominantly machine aggregates. One of them is the time constant: The shortest time constants of a common control subsystem may be in units of 10^{-3} sec. The shortest time constant of a electrical part of the drives is within orders 10^{-2} - 10^{-1} sec, while for usual mechanical subsystem may be within orders 10^{0} -10^{1} sec. This difference is the source of compatibility problems even for machine aggregate with the most trivial control subsystems. Future research and models have to develop means to cover the mismatch at time constants of physically different subsystems.

4. CONCLUSION

The structure and principles of modelling of the machine aggregate was analyzed, respecting the interdisciplinary nature of individual steps leading to final global model of machine aggregate as well as respecting the interactions between mechanical and control parts of the drive and the parameters of the plant.

Acknowledgement

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AS-CFD METHOD APPLICABILITY FOR ANALYZING Al 6061 ALLOY POROSITY

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Abstract: In this paper we have analyzed the AS-CFD simulation method applicability for analyzing Al6061 alloy porosity through a pre-established surface. High applicability is encountered when using low diameter particles (required so that the Al6061 alloy passes the ductility test) because in this case the time frame is very high (approximately 30 hours for a standard test).
Keywords: infiltration; modeling; porosity; AS-CFD; Al6061

1. Introduction

Aluminum is an important element with a complex applicability in various industries, nationally and internationally. Aluminum 6061 is widely used because of its properties: 2.71g/cm^3 density, Young: 68.9GPa, Poisson: 0.33µL. It is the most commonly used type of Al used, although it is differentiated in a few categories: 6061, 6061-T4, 6061-T6 (each one having physico-chemical properties which differ based on elaboration and destination). Maximum resistance is at 300MPa, 8% elongation, conductivity 77^{o}F at 152W/m·K, fatigue resistance up to 100MPa.

Aluminum 6061 is used in building certain aircraft parts (wings, fuselage), passenger planes, sometimes Al2024 is more resistant, but Al6061 has a better machinability and high corrosion resistance. It is also used for building yachts, boats, train parts, bicycle parts, fishing ware.

A similar alloy is ASF (synthetic aluminum) and it is used in similar fields, its physico-chemical characteristics being somewhat close to those of Al6061-T6 alloy. In ASF alloy's case, a similar test has been performed by Shizhao Li et all in: "CFD approach for prediction of unintended porosities in aluminum syntactic foam: a preliminary study".

Numerical modeling is widely used in many fields, therefore establishing correlations between properties. In our case, for example, the process and parameters of infiltration, mass parameters modeling, energy equilibriums according to Darcy's equations describe fluid flow in a porous cavity.

In this paper, we have used the numerical modeling based AS-CFD to analyze Al6061 flowing through a porous surface (created in the program) therefore proving the possibility of predicting high porosity areas at the end of the infiltration process.

Using AS-CFD we can improve the infiltration process (with the help of numerical simulation): on the one side analyzing particle interaction and on the other side analyzing the flowing process.

2. Numerical and geometrical modeling

Al6061 flow through a porous surface during the infiltration process is a nonlinear analysis in which two processes dominate: flowing and solidification. According to numerical simulation we have calculated:

a) the interaction between two particles,

b) thermic equations in which Al6061 is considered an incompressible Newtonian fluid.

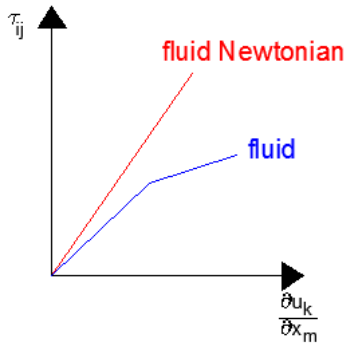

Figure 1. Variation graphic of a Newtonian fluid

As general equations used to express Newtonian flowing process we highlight:

$$\nabla u = 0 \qquad \text{eq1}$$

$$\rho\left(\frac{\partial u}{\partial t} + u \cdot \nabla u\right) = -\nabla p + \mu \nabla^2 u \qquad \text{eq2}$$

where: u – fluid speed, ρ – density, t – time, p – pressure

Though this result is based on another principle:

$\tau_{ij} \approx$ linear function for: effort size (tension) $\equiv$ speed gradient

$$\frac{\partial}{\partial t}\left(\frac{\partial X}{\partial x}\right) = \frac{\partial}{\partial x}\left(\frac{\partial X}{\partial t}\right) = u \qquad \frac{\partial u_k}{\partial x_m} = \alpha_{ijkm} \text{ (approx.81=Newton module)} \qquad \text{eq3}$$

For isotropic fluids the equation is:

$$\tau_{ij} = \mu\left(\frac{\partial u_i}{\partial x_j} + \frac{\partial u_j}{\partial x_i}\right) + \lambda\left(\frac{\partial u_l}{\partial x_l}\right) \rightarrow \nabla \cdot \vec{v} \qquad \text{eq4}$$

where: μ – dynamic viscosity coefficient, λ – elasticity coefficient

For incompressible flow $\left(\frac{\partial u_l}{\partial x_l}\right) = 0$, and for isotropic and incompressible Newtonian fluid τ_{ij} variation is given by:

$$\tau_{ij} = \mu\left(\frac{\partial u_i}{\partial x_j} + \frac{\partial u_j}{\partial x_i}\right) \qquad \text{eq5}$$

Using AS-CFD we have established the model analyzed on a right prismatic surface.

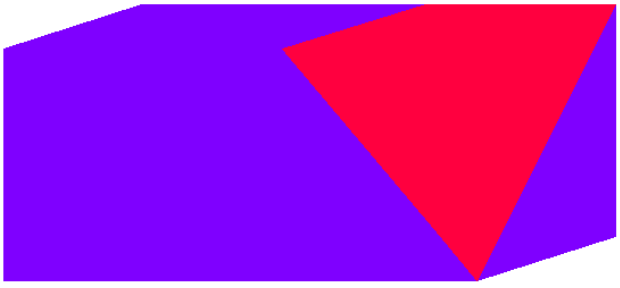

Figure 2. Prismatic surface AS-CFD modeled

Tridimensional geometrical modeling is based on the following characteristics: general surface – regular rectangular prism, spherical particles, fraction volume approximately 33%. The surface can be divided in regular spherical surfaces or cubes in order to reach the 33%. Infiltration process parameters (adopted by Dopler) are important to differentiate the numerical simulation approximations.

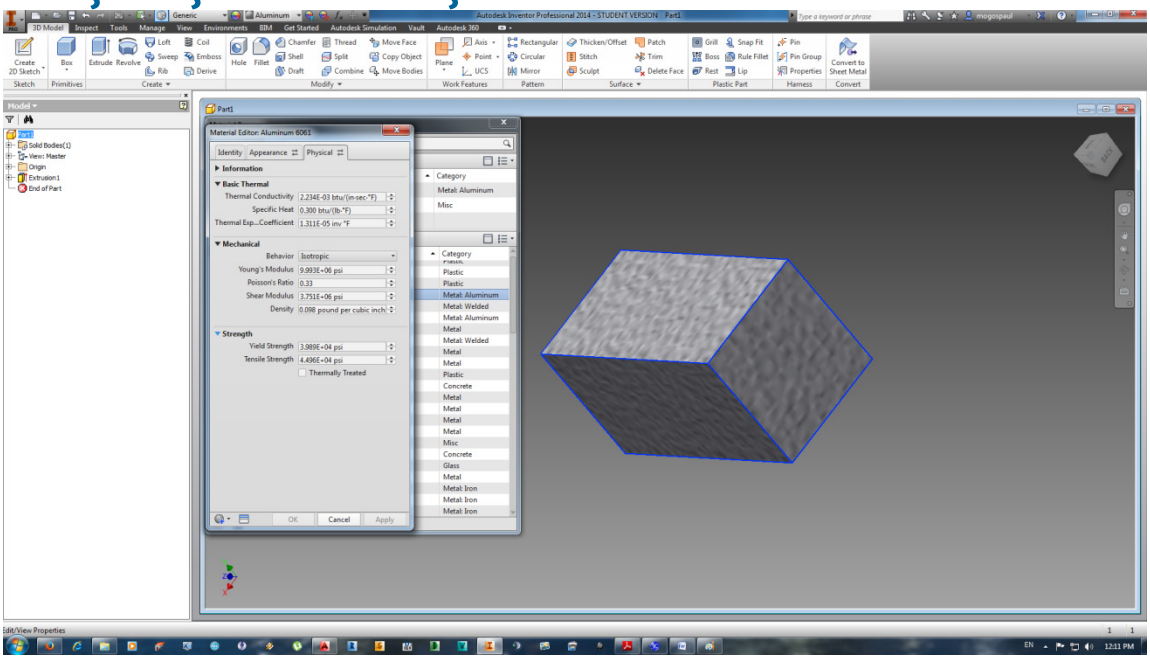

Figure 3. Geometrical modeling of the prismatic surface
using Inventor Professional 2014

AS-CFD modeling consists of creating a regular rectangular prism, with rectangular base L=20cm, l=10cm, h=10cm. The characteristics are presented in Figure 4, pressure 50Pa, external pressure 0.8MPa, all used for the simulation. Al6061 alloy density is 2.71 g/cm^3.

3. Results and discussions

The simulation is presented in Figure 4 and shows variations on different particle diameters (spheres used to simulate): 700µm, 500µm and 300µm. The violet colored area represents Al6061 alloy, blue/green – area that is filled next and grey – area unaffected by flow.

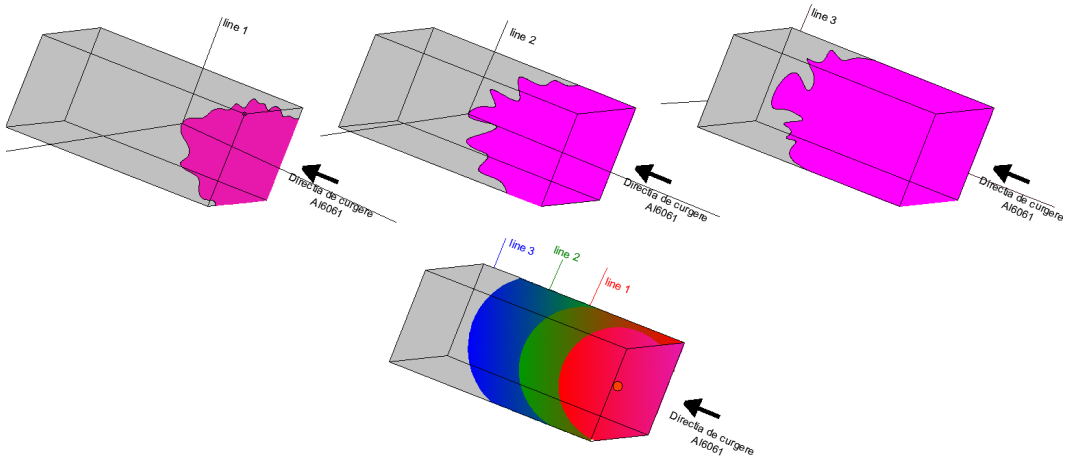

Figure 4. Al6061 alloy flow propagation in the used shape
– simulation on the 3 advancement lines.

The infiltration process is presented using AS-CFD and shows the program capacity of analyzing physical infiltration and propagation characteristics through a pre-established 3D surface (modeled using Inventor) of an Al6061 alloy. Flow symmetry and liquid fraction value are presented in Figure 4 (including air fraction volume) and finally, undetected porosities. These areas can be defined as unsecure areas and are analyzed and highlighted in the simulation.

The relation for Figure 5 is important to establish matches between sphere diameters and time frames, resulting for: 700µm, 500µm, 300µm.

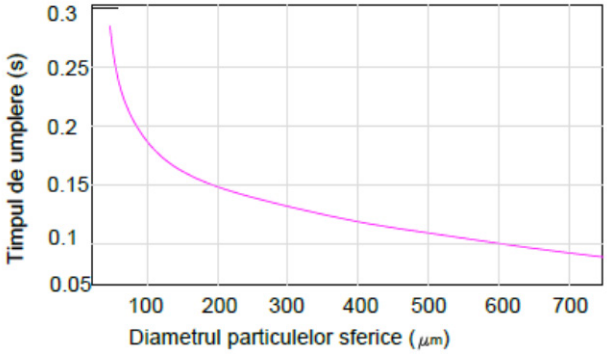

Figure 5. Relation between particle size and porous cavities filling time

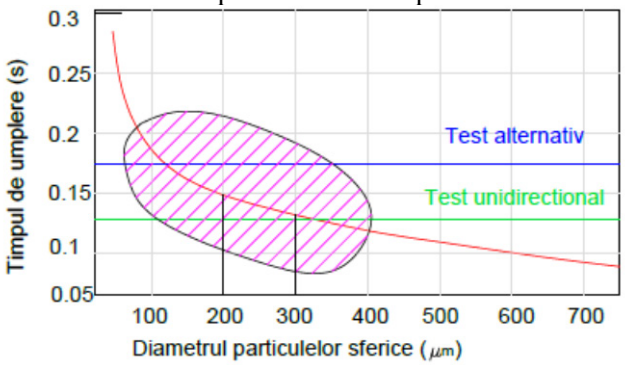

Figure 6. Ration between particle diameter, cavity filling time and ductility (according to alternative and unidirectional tests)

The filling time frame grows with decreasing spherical particle diameter used for simulating, therefore the graphic is a descending parable, such as Figure 5. Spherical particles dimension influences the simulation volume (CFD) which exponentially rises with increasing sphere diameter. Therefore at 700µm, 500µm, 300µm we have a time frame of 5 hours, 10 hours, 30 hours. Because of this it is important to follow the infiltration process for particles with 300µm diameter using AS-CFD because it requires a large time frame.

At the same time, depending on these two parameters: filling time and spherical particles diameter used in the simulation we can characterize the ductility interval of Al6061 alloy, checking the alternative and unidirectional test variation (process highlighted in Figure 6). The graphic suggests that both tests, unidirectional and alternative, should use 200µm-300µm diameter spheres, with a time frame of 0.15s, hence the necessity of using an information simulation solution to analyze the whole process.

4. Conclusions

In this paper we have presented an analysis of the undefined porosity areas in Al6061 alloy using the infiltration process through a surface created using Autodesk Inventor Professional 3D, and for the network nodes we have designed spheres of different dimensions.

1. AS-CFD simulation is similar to the method of approximating permeability on a pre-established surface. In these cases we can calculate undefined porosity areas based on the diameter of the spheres used in the simulation.
2. Decreasing Al6061 sphere diameters involves an exponential growth of the time frame when simulating. This process involves difficulties in analyzing these irregular surfaces (in our case for particles of 300µm because of the very large time frame), but using AS-CFD we can obtain rapid and conclusive results.
3. Using AS-CFD we can also introduce the temperature parameters in correlation with volume and time of the infiltration process. Therefore, we can obtain conclusive information between the experimental data and the numerical simulation.

4. Undetermined or undefined porosity on our model made in AS-CFD influences the ductility of the Al6061 alloy so that not all implicated surfaces can participate in the process, but only the low diameter ones (in our case 300μm) i.e. the ones that require the highest time frame.

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ENERGY EFFICIENCY IN WIRELESS SENSOR NETWORKS

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ABSTRACT: An important problem of the wireless sensor networks is the energy consumption. Each node of the wireless sensor network is equipped with a battery so the entire wireless sensor network has a limited energy. The lifetime of the wireless sensor network strongly depends on how efficiently the energy is distributed to its nodes. The wireless sensor networks nodes use their energy on sending or receiving data from or to their neighbors. The nodes can rout information using long or short paths. Implementing a method which can calculate the shortest path between two nodes can be a solution on efficiently spending the wireless sensor networks energy. In this paper is presented a method consisting in finding the shortest path to rout information between two nodes. This method is in fact a static routing method based on the sink tree methodology.

INTRODUCTION

Wireless sensor networks are based of sensors that are distributed on a large area for monitoring physical or environmental conditions. Nowadays applications require that the sensors should be autonomous. The wireless sensor networks are equipped with sensors which are battery powered, have a radio communication and cooperatively pass their data through the network to a main location. Although the first studies of the wireless sensor networks were made for military purposes, they impose in large ranges of applications: military, industrial, medical, domestic automations, environment monitor, transports because of their reliability, precision, flexibility, low cost materials [1].

The main constrains of wireless sensor networks are:

- nodes distribution: the location of the nodes can be distributed deterministic or stochastic and is strictly depending on the application, the nodes distribution affects directly the networks communication performances. In the deterministic distribution case the nodes are placed manually while in the stochastic distribution case the nodes are placed randomly.
- energy consumption: a very important issue is minimizing the energy consumption without affecting the data accuracy. The nodes have their own limited source of energy that is why we need communication and data processing techniques that minimize the local energy consumption.
- scalability: the number of the nodes placed in the monitoring area is very large. In some application it can reach hundreds or thousands of nodes.
- coverage: a networks sensor obtains and provides some specific information of the monitored environment.
- fault tolerance: sometimes some networks nodes temporary interrupt working because of an energy lack, a physical fault, or because of the environment inferences, but the global functionality of the network doesn't need to suffer.
- connectivity: It is said that a wireless sensor network is strongly interconnected due to the large density of the nodes which prevent nodes to isolate one from another.

- the transmission environment: due to the fact that in the multi-hop wireless sensor networks the communication between two nodes is realized wireless the problems that appear in the wireless communication may affect the functionality of the entire network.
- data aggregation: due to the fact that more sensors are placed in a large area and monitor the same physical parameters, they can provide redundant data [2] .

In case of a forest fire detection system, wireless sensor networks are used for monitoring temperature, humidity, smoke and gas detection. The main advantage of using wireless sensors network in a forest fire detection system is the possibility of maximizing the energy harvested within the environmental, financial and technical limitations:

- Harvard University developed in collaboration with AID Networks and Center for Integration of Medicine and Innovative Technology, a project called CodeBlue, which consists of a wireless sensor network capable of monitoring the medical parameters of the hospitalized patients [3][4].
- Great Barrier Reef Ocean Observing System (GBROOS) is a wireless sensor network for ocean observing, placed on the Davis island area, in the north-east of Australia [5].
- Traceability System for Recirculation Aquaculture (RATS) is a wireless sensor network used for monitoring the water temperature, the salinity, the oxygen concentration and the PH from the aqua culture tanks [6].

The hardware progress and the wireless networks have contributed at the continuous development of the low power, cheap and small sensors.

Wireless sensor networks are reliable, precise, flexible, involve low costs, are easy to develop and that is why they are used in various fields.

More and more applications require wireless connection due to the disadvantages that wired connections have: wired devices can't be placed very close to the monitored phenomenon, limited devices mobility, high maintenance costs because of the large number of sensors that must gather data from large areas. However, in the specialized literature it is state that sending a single bit over radio is at least three orders of magnitude more expensive than executing a single instruction locally, so the wireless communication can have a higher cost in comparison with the local data processing [7].

SIMULATION STUDIES

The wireless sensor network consists of nodes or sensors which are distributed on a large area. The nodes gather information about the environment they are placed in.

The method we propose is a static routing tree introduced by its adjacency matrix.

In our studies we considered that the wireless sensor network can be seen as a routing tree where the first node is the root and all the other nodes of the network are the tree's branches. The wireless sensor networks tree is created by introducing the adjacency matrix, which elements are "0" if there is no edge between two nodes or "1" if there is an edge between the two nodes. The edge is created if there is an exchange of information between the wireless network sensors nodes. Also we can consider that the "0" from the adjacency matrix represent the sleeping mode of the wireless sensor networks nodes and the "1" the active mode of the wireless sensor networks nodes. In Fig.1 is presented the adjacency matrix for a wireless sensor network consisting of 30 nodes. We can see that the routing tree is not symmetric and also it is given the number of the edges of the tree, in this case 42 edges.

In Fig. 2 is presented the routing tree created from the given adjacency matrix of a wireless sensor network consisting of 30 nodes.

This routing tree is a static routing tree because the edges of the information are manually introduced by giving the adjacency matrix.

The main problem of a routing tree is how to find the shortest path between two given nodes so the energy of the nodes should not be wasted. This problem can be solved by using the sink

tree methodology. The sink tree method provides a set of optimal paths from a given node considered to be the starting node to another given node considered to be the stop nod.

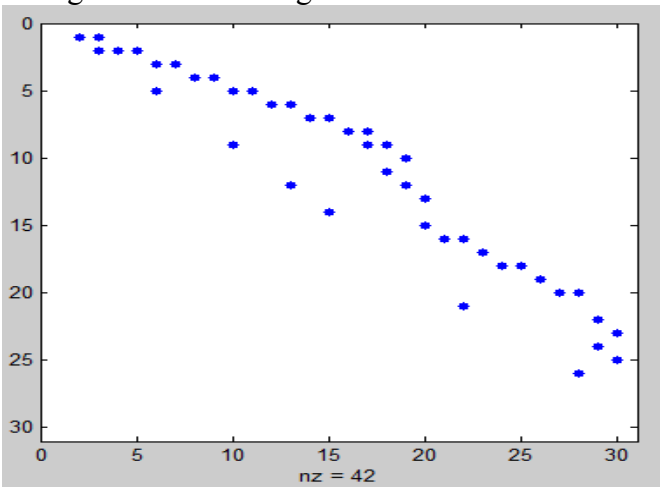

Figure 1. The adjacency matrix for a wireless sensor network of 30 nodes

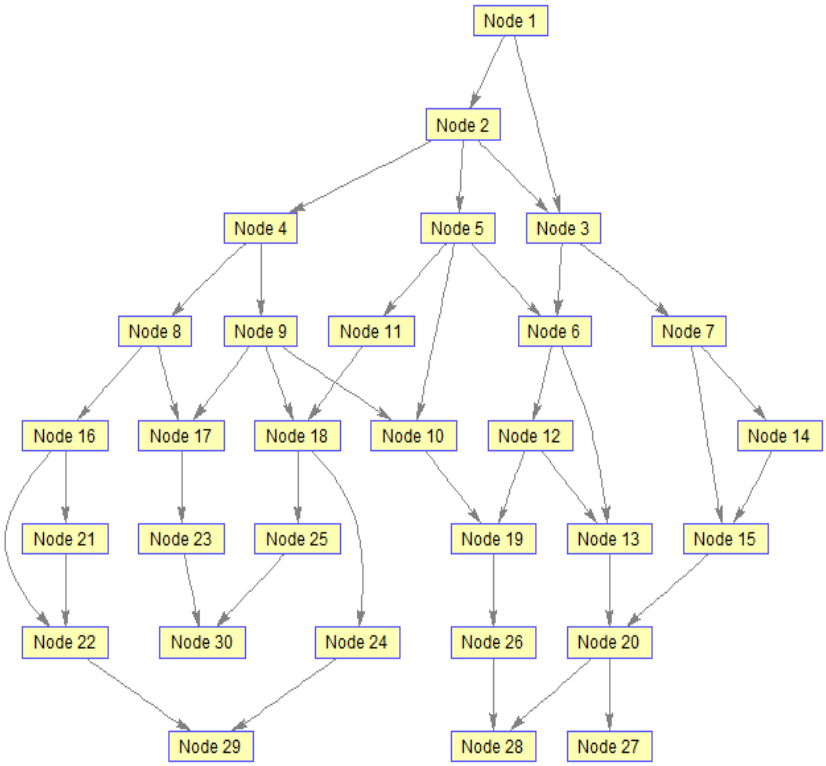

Figure 2. The routing tree for a wireless sensor network of 30 nodes

In our studies we considered the starting node to be "Node 1" and the stopping node to be "Node 29", as it is presented in Fig. 3.

The sink tree method provides all the optimal paths between "Node 1" and "Node 29", but the shortest path between the two nodes is the one who interests us, this path is presented in Fig. 4. The nodes of the tree are in fact the sensors of a wireless sensor network so finding the shortest path between two nodes of the network can optimize the energy consumption. If the path is shorter the information has to travel a short distance between two nodes so the other nodes of the wireless sensor network can be in the sleeping mode while the nodes which create the path are the only active ones. So the nodes which are in sleeping mode only listen to the network without any energy consumption while the nodes which are in the active mode are the only ones which have energy consumption.

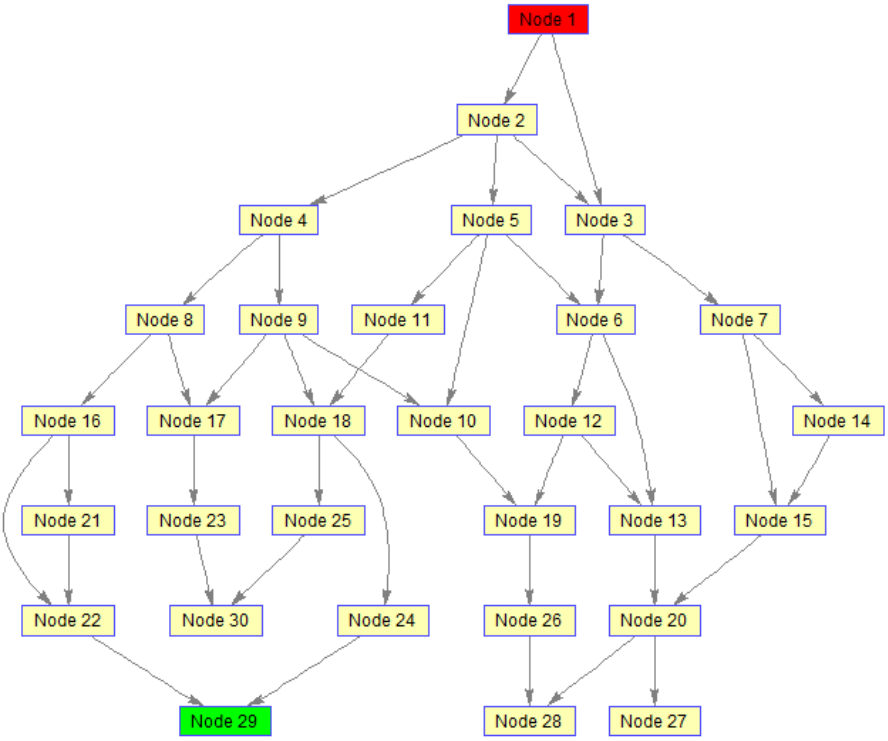

Figure 3. The routing tree for a wireless sensor network of 30 nodes

The number of edges between the two nodes is the one who creates the shortest path. In Fig.4 the number of edges of the shortest path between "Node 1" and "Node 29" is 6.

Using the sink tree method we can also determine the shortest paths from each node to all the other nodes of the wireless sensor network. The shortest paths from each node to all the other wireless sensor network nodes is presented in Fig.5.

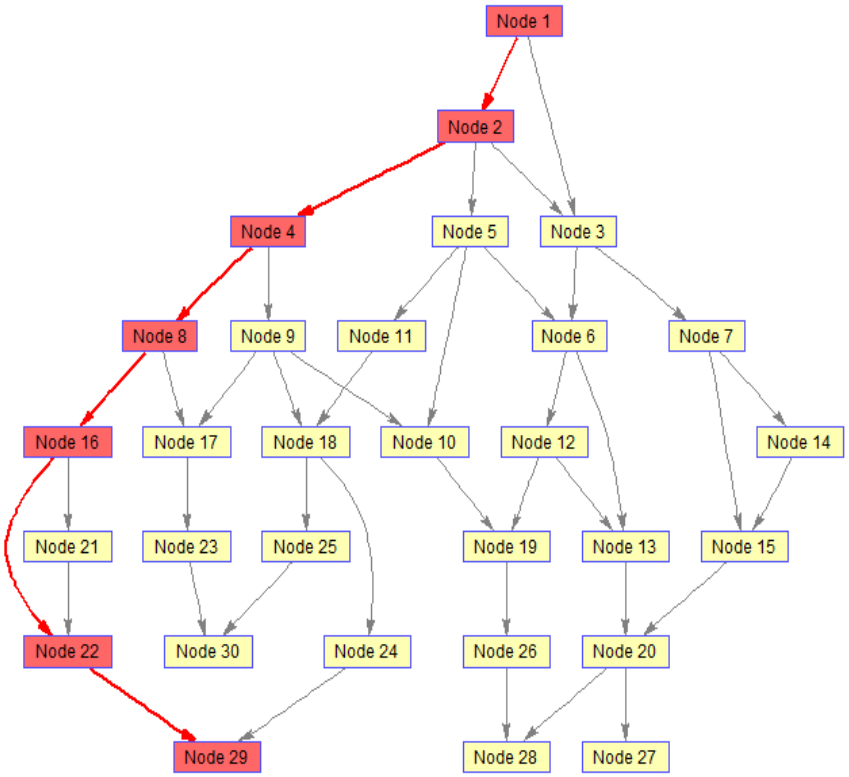

Figure 4. The shortest path between "Node 1" and "Node 29"

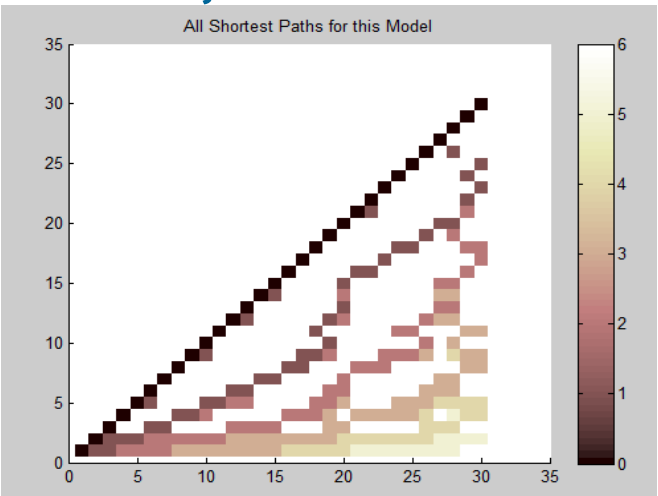

Figure 5. The shortest paths from each node to all the other nodes of the wireless sensor network

The way that the number of the edges between the nodes influences the routing tree is presented in Fig. 6. For the given routing tree was made a scenario to illustrate how a node out of service can influence the entire topology of the routing tree. If a node is out of service the edges which he had with other nodes disappear. For the given adjacency matrix we studied the routing tree without a node, starting from "Node 30" and ending with "Node 15". So the adjacency matrix we used was from a 30 by 30 matrix to a 15 by 15 starting from the given adjacency matrix.

We can see that the number of communications between the wireless sensor nodes decreases.

CONCLUSIONS

An important problem of the wireless sensor networks is the energy consumption. Each node of the wireless sensor network is equipped with a battery so the entire wireless sensor network has a limited energy. The lifetime of the wireless sensor network strongly depends on how efficiently the energy is distributed to its nodes. The wireless sensor networks nodes use their energy on sending or receiving data from or to their neighbors. The nodes can rout information using long or short paths.

Implementing a method which can calculate the shortest path between two nodes can be a solution on efficiently spending the wireless sensor networks energy. In this paper is presented a method consisting in finding the shortest path to rout information between two nodes. This method is in fact a static routing method based on the sink tree methodology.

In our studies we considered that the wireless sensor network can be seen as a routing tree where the first node is the root and all the other nodes of the network are the tree's branches. The wireless sensor networks tree is created by introducing the adjacency matrix, which elements are "0" if there is no edge between two nodes or "1" if there is an edge between the two nodes. The edge is created if there is an exchange of information between the wireless network sensors nodes. Also we can consider that the "0" from the adjacency matrix represent the sleeping mode of the wireless sensor networks nodes and the "1" the active mode of the wireless sensor networks nodes.

The main problem of a routing tree is how to find the shortest path between two given nodes so the energy of the nodes should not be wasted. This problem can be solved by using the sink tree methodology. The sink tree method provides a set of optimal paths from a given node considered to be the starting node to another given node considered to be the stop nod.

The sink tree method is also useful for increasing the lifetime of the entire wireless sensor network because determining the shortest path that an information must cross from a starting node to a stop node is essential in wireless sensor networks. If we can determine the shortest

path between two nodes the information is transmitted on that path, determining to be active only the nodes that compose this path while the other nodes may stay in the sleeping mode. So only the nodes which compose the path will consume energy while the nodes that are in the sleeping mode will not consume energy.

If a node is out of service the edges which he had with other nodes disappear, so he isn't consuming energy any more.

We can see that the number of communications between the wireless sensor nodes decreases.

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OPTIMIZATION OF ENERGY COSTS FOR GAS TRANSPORTATION IN COMPLEX GAS TRANSMISSION SYSTEMS

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ABSTRACT: In this paper the process of gas movement is modeled in the section of the gas transmission system which consists of two branches of the gas main and underground gas storage with its booster compressor station. At the ends of these branches there are three compressor stations. Under the given conditions for the values of pressure and gas volumes at the inlet and the outlet of the system, the dependence of the fuel gas total consumption on coefficients of gas compressibility at the compressor station and on the place of connection of the underground gas storage to the gas main is studied at each compressor station. A method is suggested to determine such operational parameters of the system for which the total amount of fuel gas will be minimal in the case of the satisfaction of the imposed boundary conditions.

Introduction

Underground gas storages (UGS) are used to eliminate the imbalance in the gas transmission system (GTS) in autumn and winter [2-4]. UGS operating is characterized by both the periodicity and the unevenness of processes of gas injection and its withdrawing. Such UGS operating complicates the mathematical model of its functioning in general. In the literature, there are a significant number of works concerning mathematical modeling of individual technological objects (pipes, valves, etc.) as the linear part of the GTS as well as UGS (beds of underground storages, drilling zones, and borehole walls, etc.) [1-8]. The regimes of individual underground gas storage facilities as well as their operating as a part of the gas transmission system are studied less thoroughly. However, in the total, the operating of underground gas storages depends on the gas transportation along the whole GTS. In this regard, there is a need for a detailed study and modeling of joint work of the underground gas storage and the gas transmission system. The movement of gas in the UGS bed should be modeled in non-steady regime, while the process of gas moving in other technological objects of UGS (wells, trails, etc.) is described by stationary models with adequacy sufficient for practice. As for the gas flow in gas mains (GM), it makes sense to study the non-stationary regime of gas movement not within the whole GTS, but in its part where the flow disturbances occur. This choice is due to the fact that non-stationary process quickly damps due to the properties of gas, especially due to its compressibility. The flow disturbance rarely vanishes (emergencies, the necessity to change the volumetric consumptions, etc.). During its main time, the GTS is operating in steady state.

The aim and Object of the study

The aim of this work is to develop a mathematical model of joint operating of the underground gas storage and the gas transmission system to study the effect of the ways of connection of the UGS to GM on energy costs of gas transportation with taking into account hydraulic linking of the system UGS bed-MG.

Object of the study is a mathematical model of gas movement process in a system which consists of the part of GM (Fig. 1) where there are three compressor stations (CS) connected with the I and II pipelines and underground gas storage with its booster CS. The mathematical model of this system is formed of models of technological objects that at the splice points are in compliance with the basis of the relevant laws of physics [1, 2]. Note that the boundary conditions of the corresponding problems of mathematical physics are based on measured data or under conditions of conjugation.

Output relations

1. The equation of the gas filtration process in a complex porous medium has the form [2-4]

$$\frac{\partial}{\partial x}\left(\frac{kh}{\mu z}\frac{\partial p^2}{\partial x}\right)+\frac{\partial}{\partial y}\left(\frac{kh}{\mu z}\frac{\partial p^2}{\partial y}\right)=2mh\left(\frac{\partial}{\partial t}\left(\frac{p}{z}\right)+2qp_{am}\right), \quad (1)$$

where k,m,h are the coefficients of permeability, porosity, the effective gas saturation of the bulk of the bed; p is the pressure at the point of the bed with coordinates (x,y) at the instant of time t; μ,z are the coefficients of dynamic viscosity and compressibility of gas, respectively; q the density of the gas withdrawing.

The solution of Eq. (1) under certain naturally specified conditions is presented in [2, 4].

2. Gas filtration in the medium in the case of violation of the Darcy's law (drilling well) is modeled according to a spherical law of gas inflow, which is described by Eq. [2]

$$\frac{\partial P}{\partial r}=-\frac{\mu}{\kappa}v+\beta^*\rho|v|^2, \quad (2)$$

where $1/\beta^*$ is the coefficient of macro-roughness, v and ρ are filtration rate and gas density.

The solution of Eq. (2) is given in [4].

3. The gas movement in a pipeline under unsteady non-isothermal regime is described by the interrelated system of differential equations in partial derivatives

$$\begin{aligned}
&\frac{\partial(\rho v)}{\partial t}+\frac{\partial}{\partial x}\left(p+\rho v^2\right)=-\rho\left(\frac{\lambda v|v|}{2D}+g\frac{ds}{dx}\right),\\
&\frac{\partial\rho}{\partial t}+\frac{\partial}{\partial x}(\rho v)=0, \quad (3)\\
&\frac{\partial}{\partial t}(\rho E)+\frac{\partial}{\partial x}\rho v\left(E+\frac{p}{\rho}\right)=\frac{4\alpha(T_{zp}-T)}{D}-\rho vg\frac{ds}{dx},
\end{aligned}$$

where α is the coefficient of heat transfer between the pipe and the soil; T_{zp} is the temperature of the soil; s is the curve that describes the relief of the pipeline route; $E=i-P/\rho+v^2/2$ is the total energy of the gas mass unit [1, 5-8].

The third equation in the system (3) defines the balance of the gas thermal energy. It is known [1] that with the lapse of time, the temperature field around the pipeline is determined quickly enough. Assuming that the temperature of the gas in the pipeline does not depend on time, the system (3) breaks up into the interrelated system of two equations and the equation describing the temperature distribution along the pipeline [1, 3]. Note that this approach allows us to solve a number of practically important problems.

4. The work of a compressor station depends on its capacity which is calculated according to the formula [1, 2, 5] $N=\xi zRQT_1\left(\varepsilon^{\vartheta/\eta_{пол}}-1\right)/\vartheta$. Here Q is the gas consumption of CS (m^3/24h), $\vartheta=\left(1-\lg(T_2/T_1)/\lg\varepsilon\right)^{-1}$ is the polytropic index, $\varepsilon=p_2/p_1$ the coefficient of gas compression, p_1 is the gas pressure at the inlet of CS, p_2 the gas pressure at the outlet of CS, T_1 is the gas temperature at the inlet of CS, T_2 is the gas temperature at the outlet of CS, $\eta_{пол}=(\vartheta(\gamma-1))/(\gamma(\vartheta-1))$ is polytropic performance efficiency, γ is the indicator of adiabatic

process, ξ is the dimensional coefficient.

5. The drop of pressure at local resistances is determined according to the formula [1, 2] $\Delta p = \rho v^2 \xi / 2$, ξ is the the coefficient of local resistance. For closure of the system of equations, let us use the equation of gas law $p = \rho z R T$ (R is the gas characteristic). Other parameters of the calculation (coefficients of gas compressibility and hydraulic resistance, Reynolds' numbers) are determined according to formulae known in the literature [1, 2]. In particular, changes in gas temperature along the pipeline in the isothermal case is as follows

$$T(x) = T_{01} + T_{02} e^{-ax}. \tag{4}$$

Here

$$T_{00} = \frac{1}{aL}\left(\Delta p\left(D_i - \frac{1}{C_p \rho_0}\right) + \frac{g\Delta s}{C_p}\right),$$

$$T_{01} = T_z - T_{00},\ T_{02} = T_0 - T_z + T_{00},\ \Delta p = p_0 - p_k;\ a = \frac{\alpha_{gr}\pi D}{C_p M},$$

T_0 is the gas temperature at the inlet of the pipeline; T_z is the temperature of the soil; D_i is the Joule-Lenz's coefficient; p_0 is the gas pressure at the inlet of the pipeline; p_k is the gas pressure at the outlet of the pipeline; ρ_0 is the density of gas under standard conditions (p_{st} = 0,1033 MPa, T_A = 293 K); x is the moving coordinate $x \in [0, L]$, L is the length of the pipeline; D is the internal diameter of the pipeline; α_{gr} is the coefficient of heat transfer between gas and the soil; C_p is the specific heat of gas at constant pressure. In the formula (4), there is taken into account the effect of Joule-Lenz and the temperature change due to friction.

Formulation of the problem

Having formulated mathematical model of the system, to calculate the values of the geometrical and regime parameters of its work, for which the minimum amount of fuel gas consumption is.

The input data

The input data are: the pressure p_{11} and volumetric gas consumption Q_1 at the inlet of the I-st CS; the pressure p_{33} and volumetric gas consumption $Q = Q_1 + Q_2$ at the outlet of the III-d CS; Q_2 is the volume of gas that comes from underground storage and the average pressure of the bed p_n.

Solution problem

We consider two ways to attach UGS to the system. The first one is at the outlet of CS_2 (Fig. 1); The second one is at the inlet of CS_2 at arbitrary point between CS_1 and CS_2 (Fig. 2). Let us introduce the notation

$$\Theta_1(T_1) = \frac{0.02064}{1.16\eta_{emy} Q_n}\left[\frac{3}{4} + 0.025\frac{p_a}{1.033 K_3}\sqrt{\frac{T_1}{288}}\right],\quad \Theta_2(T_1) = \xi\frac{zR}{m}T_1,$$

$$\eta = \vartheta/\eta_{non},\quad \Theta_3(T_1) = \Theta_1\Theta_2,\quad \Theta_4(T_1) = \lambda\, z\frac{RT_1 L}{D}\left(\frac{\rho_0}{S}\right)^2.$$

Parametres Θ_i ($i = 1,2,3$) and η are related to CS, while Θ_4 is related to the linear section between two neighbour CS, K_3 is the coefficient that characterizes the workload of the CS.

The correlations above make it possible to calculate the amount of fuel gas needed to maintain the input and output parameters of the system. If $q_{ni} = \theta_{3i}(T_{si})\left(\varepsilon_i^{\eta} - 1\right)Q_i$ is the value of fuel gas for the i-th CS [2], then the total amount of fuel gas for four CS is the sum of

$$q = q_{n1} + q_{n2} + q_{n3} + q_{n4}.$$

1. Consider the option when from underground storage facilities gas comes into the gas main at the outlet of the second CS (Fig. 1, Problem 1).

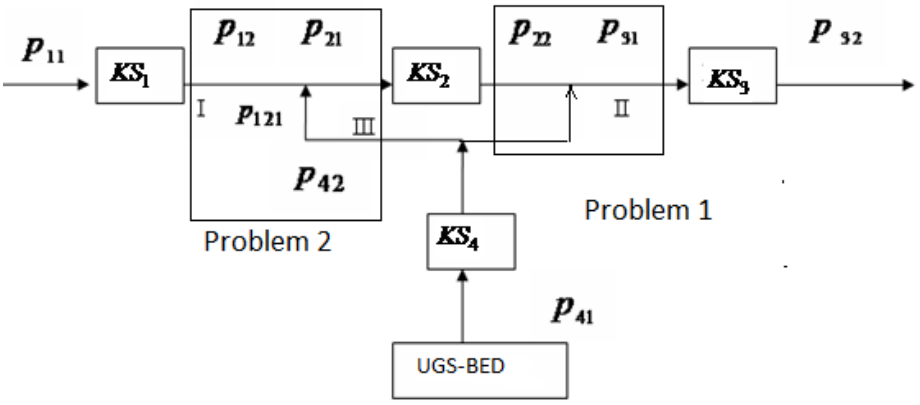

Figure 1. Diagram for calculation of the value of fuel gas for various kinds of connection of UGS to GM.

Using the distributions of gas pressure in technological objects included in the calculation scheme (Fig. 1), for the determination of the fuel gas value we obtain the formula

$$q=\theta_{31}Q_1\varepsilon_1^{\eta_1}+\theta_{32}Q_1\varepsilon_1^{\eta_2}+$$

$$+\theta_{33}(Q_1+Q_2)\left(\frac{p_{32}^2}{\varepsilon_1^2\varepsilon_2^2p_{11}^2-\varepsilon_2^2\theta_{41}(T_1)Q_1^2-\theta_{42}(T_2)Q^2}\right)^{\eta_3/2}+$$

$$+\theta_{34}Q_2\left(\frac{\varepsilon_1^2\varepsilon_2^2p_{11}^2-\varepsilon_2^2Q_1^2\theta_{41}(T_1)}{p_n^2-AQ_2-B_1Q_2^2}\right)^{\eta_4/2}-\theta\,.$$

Here

$$\theta=\theta_{31}Q_1+\theta_{32}Q_1+\theta_{33}(Q_1+Q_2)+\theta_{34}Q_2\,,\quad A=\frac{A_1}{k_{pl}}+\frac{A_2}{k_v}\,,\quad B_1=\frac{B_{11}}{k_{pl}^{3/2}}+\frac{B_{22}}{k_v^{3/2}}+B_{33}+B_{44}\,,\quad A_1=\frac{1}{h\pi}\mu p_s\ \ln\frac{R_k}{R_c},$$

$$A_2=\frac{\mu p_s}{\pi h_x}\ln\frac{2R_ch}{2r_kl_kn_0h_x+\Theta(n_0)\left(r_1^2-r_2^2\right)}\,,\quad B_{11}=12\cdot10^{-5}\frac{\rho_0p_sd^2}{2\pi^2h^2m}\left(\frac{1}{R_c}-\frac{1}{R_k}\right),$$

$$B_{22}=\frac{\rho_0p_sd^2}{\pi^2h_xm}\left(\frac{1}{2r_kl_kn_0h_x+\Theta(n_0)\left(r_1^2-r_2^2\right)}-\frac{1}{2R_ch}\right),\quad B_{33}=\lambda\,z\frac{RT}{D}\left(\frac{\rho_0}{S}\right)^2\frac{1-e^{-b}}{b}L_{sv}\,,$$

$$B_{44}=\lambda_{sh}\,z_{sh}\frac{gRT}{D_{sh}}\left(\frac{\rho_0}{S_{sh}}\right)^2L_{sh}\,,\quad S=\frac{\pi D^2}{4}\,,\qquad b=\frac{2gL_{sv}}{zRT}\,,\quad \lambda=\left(\frac{Y+U+C^{1.5}}{1+76C}\right)^{0.2}\,,\quad U=\frac{k_{uu}}{D}\,,$$

$$Y=\frac{79}{\mathrm{Re}}\,,\quad C=(2Y)^{10}\,,\quad \mathrm{Re}=\frac{Dvp}{\mu_0RT}\frac{T+C}{273+C}\left(\frac{273}{T}\right)^{3/2}\,,\quad z=\frac{1}{1+fp_a}\,,$$

where [2,4] k_{pl}, k_v are the coefficients of permeability of the bed and drilling zone, respectively; R_k is the radius of the surface of the well supply cylinder; R_c is the radius of the surface of the drilling zone cylinder; p_s, q_0, ρ_0 are the values of pressure, well yield and gas density under normal (standard) conditions; d is the diameter of grains of rock; h is the average seam thickness; h_x is the seam thickness in the zone of borehole; r_1, r_2 are radii of boring casing (inner) and collars (outer), respectively; r_k, l_k are the radius and the length of the perforation; n_0 is the density of perforation $f=\left(24-0.21t^{\circ}C\right)\cdot10^{-4}$, $p_a=p_a(x)$ is measured in the atmospheres, the index sh is related to trails, while sv is related to development boreholes of wells.

2. Now let gas from the underground storage comes into the main pipeline at arbitrary point between the first and the second compressor stations (Fig. 1, Problem 2). then

$$q = \theta_{31} Q_1 \varepsilon_1^{\eta_1} + \theta_{32}(Q_1 + Q_2)\varepsilon_2^{\eta_2} + \theta_{33}(Q_1 + Q_2)\varepsilon_3^{\eta_3} + \theta_{34} Q_2 \varepsilon_4^{\eta_4} - \theta_{v2}.$$

In the last equality

$$\theta_{v2} = \theta_{31} Q_1 + \theta_{32}(Q_1 + Q_2) + \theta_{33}(Q_1 + Q_2) + \theta_{34} Q_2.$$

For the given system we obtain the following formula for calculating fuel gas

$$q = \theta_{31} Q_1 \varepsilon_1^{\eta_1} + \theta_{32}(Q_1 + Q_2)\varepsilon_2^{\eta_2} +$$

$$+\theta_{33}(Q_1 + Q_2)\left(\frac{p_{32}^2}{\varepsilon_1^2 \varepsilon_2^2 p_{11}^2 - \varepsilon_2^2 \theta_{4121}(T_{121}) Q_1^2 - \varepsilon_2^2 \theta_{4122}(T_{122}) Q^2 - \theta_{422}(T_{22}) Q^2}\right)^{\eta_3/2} +$$

$$+\theta_{34} Q_2 \left(\frac{\varepsilon_1^2 p_{11}^2 - Q_1^2 \theta_{4121}(T_{121})}{p_n^2 - A Q_2 - B_1 Q_2^2}\right)^{\eta_4/2} - \theta_{v2}.$$

Process control parameters of the gas movement in the system of GM under study are the coefficients of gas compression at the first and second compressor stations, i.e. the total amount of fuel gas q is a function of the arguments ε_1 and ε_2 ($q = f(\varepsilon_1, \varepsilon_2)$). Obtained functional dependences of the fuel gas on ε_1 and on ε_2 allow us to find the global minimum with respect to these parameters and, therefore, to investigate the effect of kinds of connections of UGS to GM on total energy costs. Extrema points are found from the system of equations

$$\frac{\partial q}{\partial \varepsilon_1} = \frac{\partial f(\varepsilon_1, \varepsilon_2)}{\partial \varepsilon_1} = 0, \quad \frac{\partial q}{\partial \varepsilon_2} = \frac{\partial f(\varepsilon_1, \varepsilon_2)}{\partial \varepsilon_2} = 0.$$

For the obtained extrema points ε_{1m} and ε_{2m} we obtain the global minimum of the function $f(\varepsilon_1, \varepsilon_2)$ which determines the minimum value of fuel gas in the subsystem.

Computational experiment

Computational experiment has been conducted for horizontally placed GM for the foolowing input data: pressure at the inlet and outlet of the system p_{11}=55 atm and p_{32}=65 atm respectively, the input volumetric gas consumption Q_1=900 m^3/s and volumetric gas consumption from the storage Q_2=180 m^3/s, the length of the pipeline L_1=90 000 m and L_2=100 000 m, Ø=1.338 m. Other parameters: p_n=50, A=1.02, B_1=0.008, ε_1=1.21, ε_2=1.22, η_{emy1}=0.84, η_{emy2}=0.85, η_{emy3}=0.85, η_{emy4}=0.82, k_1=1.31, k_2=1.32, k_3=1.3, k_4=1.31. The computational experiment was conducted to confirm the theoretical results obtained and the availability of the existence of a global extremum.

The compliance of the curves with different values of the coefficients of compression at the third and the fourth CS are presented in Table 1.

The results of calculations are presented in the form of graphs, where the x-axis represents the values of functions that correspond to

a is the total amount of fuel gas in the case of UGS connection to the inlet of the second CS;

b is the total amount of fuel gas in the case of UGS connection to the outlet of the second CS.

Table 1.

No of curves	ε_1	ε_4
1	1.01	1.151
2	1.19	1.378
3	1.25	1.454
4	1.31	1.529
5	1.39	1.629

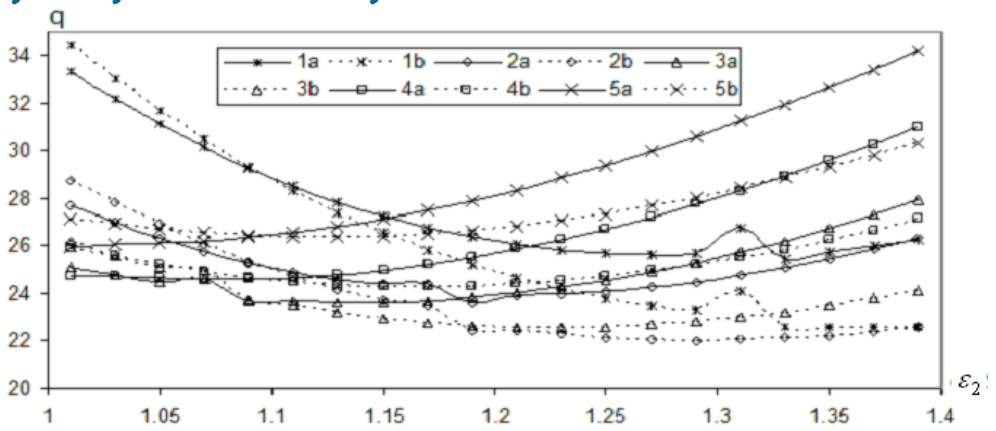

Figure. 2. Dependence of the total fuel gas value q on the coefficient of compression ε_2 at CS_2 for various ways of connection of UGS to GM: to the inlet of CS_2 (with index **a)** and to the outlet (with index **b)**.

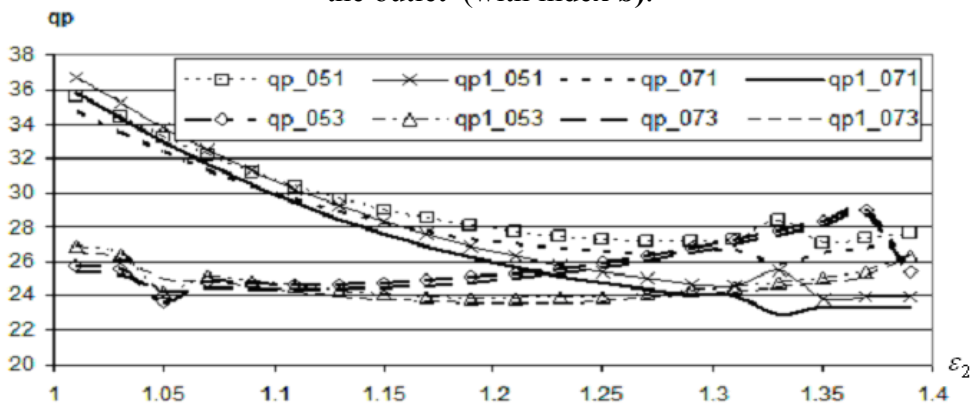

Figure. 3. Dependence of the total fuel gas value on the coefficient of compression at CS_2 ε_2, when UGS is connected to MG in the middle between CS_1 and CS_2 (qp_05i) and at a distance of 63 km from KC_1 (qp_07i).

In Fig. 3, the last digit 1 in the notation of the curves corresponds to ε_1=1,01, ε_4=1,151, and the digit 3 to ε_1=1,25, ε_4=1,45.

Conclusions

In all the cases, there exist such corrrelations among the coefficients of compression at CS that the satisfaction of the given boundary conditions need a minimal amount of fuel gas for both kinds of UGS connection (Fig. 1).

In each case, there exist such values $\varepsilon_{i0}, i=1,2,3,4,$ for which the amount of fuel gas does not depend on the connection of UGS (curves of total amount of fuel gas for various kinds of connections of UGS to GM have points of ntersection).

The place of joint between UGS and GM affects not only the value of total amount of fuel gas, but also the type of its dependence on the coefficients of compression at CS.

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THE PROCESSING OF THE COPPER OXIDIC ASHES USING A MODERN TECHNOLOGY

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Abstract: In this paper, the metal used for the experiments is designed to obtain a brass category, according to STAS CuZn24 brand. Materials are everywhere in our lives, and industrial society has become extremely dependent on resources. Cu-Zn alloys are particularly intended for the casting production. The behaviour of the charge involves quick melting to limitate the slag and the refining to remove impurities like Fe, Mn and Al. For the alloying, we used zinc board brand R1, purity of 99,91%, at a quantity of 117,5 kg. The thermal balance calculated on the total quantity of metal produced was 2400 kg /charge, and the fuel consumption was about 228 kg. The aim of the paper was to study from a technological point a view, the processing of the cooper oxidic ashes, by a modern technological flow relative to the standard, which brings improvements, using a mixing system of the slag which can allow the complete reuse of copper oxidic ashes and to minimize the mechanical losses.

Keywords: cooper, ball-crusher, impurities, brasses

1. Introduction

Materials form the fabric of our present society; materials are everywhere in our lives, and life as we know it would be impossible without them. Industrial society has become extremely dependent on resources, as it produces more, builds an increasingly complex society and accumulates an incredible volume of resources[1]

Brasses are copper based alloys , where the main alloying addition is represented by zinc, and in special situations, in addition to copper and zinc, the brasses may also contain other elements. The spread of the brasses in industrial production, is higher, as compared to other cooper-based alloys. Cu-Zn alloys which contain in our composition, other alloying elements in addition to copper, are called special brasses and to specify their nature, are used designations like: silicon-brasses, manganesse-brasses, tin-brasses, brasses with lead and other categories. These alloys are particularly intended for the casting production. [2] The special brasses ranging, includes all copper and zinc special alloys, where can be added small amounts of silicon, aluminum, tin, lead, which improves their certain physical and chemical properties, especially machinability, hardness, mechanical strength and corrosion resistance.[3]

In recent years, the world is in a tendancy, to elaborate modern hydrometallurgical processes, environmentally friendly, non-conventional, of waste processing cooper alloys, which allow the recovery of the copper in the form of valuable products: cooper-powder, cathode cooper and cooper salts. The other elements presented like Zn,Pb,Sn,Ni,Si,Al and Fe, are separated in the form of recoverable intermediate products.[4]

2. Methodology

The obtained material from the ball-crusher, has the following characteristics:

bulk density: 2300-2400 kg / m^3 ; maximum grain: 75-100.

The general shape of the particles is rounded.

Impurities (%), from the weight of the processed material in the ball-crusher, are: rubber (0.2-0.4%), bricks (0.01-0.05%), iron slag, more than 5% iron and iron oxides (from 1,5 to 3.5%) and iron (2-5%). In table 1, is presented the general chemical composition of the main elements.

Table 1. General chemical composition of the main elements

Cu (%)	Zn (%)	Pb (%)	Sn(%)	Al(%)	Fe(%)	Ni(%)	Si(%)	Bi,Sb, As,Cd,P(%)
63-80	24-17	4-0.6	3-0.6	3-0.8	2-0.3	0,08-0.18	0.07-0.15	0.05

The complete processed material to obtain a 1000 kg/ load, is 1221 kg. The metal is intended to obtain a brass category, according to STAS CuZn24 brand, for the manufacture of radiators sheet, with the chemical composition shows in table 1.

The management of the charge involves three aspects:

- quick melting for the limitation of the generated slag;
- the refining of the metal to remove impurities like Fe, Mn, Al;
- alloying, for bringing in a standard brand, as close as possible to the refined metal.
- the most important technology phase of the elaboration is the metal refiner after the elaborate is complete.

Table 2 shows the composition of metal processing phases.

Table 2. Chemical composition of the metal

Chemical composition	Cu(%)	Pb(%)	Zn(%)	Si(%)	Sn(%)	Fe(%)	Mn(%)	Al(%)	Sb(%)
Processed rough slag	75.8	1.126	22.1	0.001	0.47	0.27	0.001	0.21	1.7
Melted metal	75.6	1.19	19.8	0.001	0.43	0.31	0.001	0.18	1.3
After refining	76.1	1.06	19.1	0.001	0.4	0.11	0.001	0.08	0.34
Alloying	74.5	0.93	23.8	0.001	0.36	0.1	0.001	0.08	0.22
STAS brand CuZn24	72-74	1	22-28	0.01	0.5	0.1	0.05	0.05	0.2

3. Analyses/ Results

This paper aims was to study from a technological point a view, the processing of the cooper oxidic ashes, by a modern technological flow relative to the standard. Experiments were conducted in the graphite crucible furnace and the experimental installation is shown schematically in Figure 1.

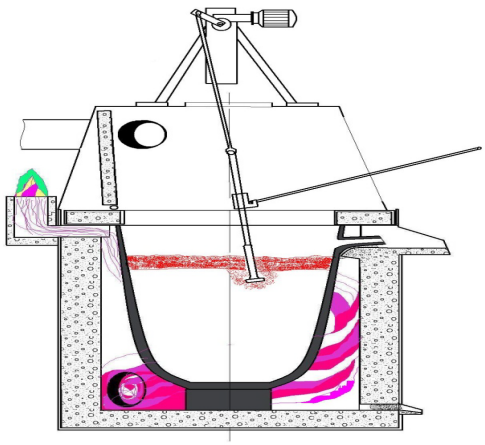

Figure 1. Graphite crucible furnace with a capacity of 2400 kg

The termic balance of the furnace and fuel consumption has the following features: The dimensions of the furnace :

Interior diameter: 1080mm; Outer diameter: 1620mm; Armor thickness: 15mm; Interior space height: 1480mm; Fuel consumption: CLU3 - 50-80kh / h; Wheel of the charge: 3.5 hours; Necessary preparation time: 0.5 hours; Time required for casting: 0.5 hours.

The necessary reagents for each element is:

4% Cu_2O→for →1% Al; 4.5% Cu_2O→for →1% Fe; 3% $CuCl_2$→for →1% Fe;

2,8% NaCl→for →1% Al; 3% Na_2CO_3→for →1% Sb.

The amount of each element to be eliminated is:

$$\Delta Fe = 0.21\% \ ; \ \Delta Al = 0.13\% ; \ \Delta Sb = 1.5\% ; \ \Delta Pb = 0.26\%$$

The necessary reagents for removing the excess impurities from a charge of 2400 kg is:

The quantities of the regeants used are:

$$Cu_2O \cong 28.5Kg; \ C\,uCl_2 \cong 15kg; \ Na_2Co_3 = 100kg; Na_2Cl = 10.5Kg \ .$$

The complete quantity is: 182,38 ≅ 183kg.

The balance of the refining in the metallic liquid get: 23.5kg Cu. From the metallic liquid is eliminated: 34.08 kg. In the slag are passing the combinations of elements considered impurities which can react with the oxygen, Al and $Fe: 4.53kg$ Al_2O_3 and $6.17Kg\ FeO$. The total oxides which are passing into the slag: 10,7kg oxides. In gases, are passing Sb and Pb in the quantity of :4,17kg $PbCl_2$.

The correction of the Zn alloy is only to cover the losses by volatilization. For the alloying , it can be used zinc board brand R1, purity of 99.91%, in a quantity of:117,5kg.

Heat balance calculated on the total quantity of metal produced: 2400kg/charge;

Fuel consumption: $\cong 228kg$; Heat entered:$Q_i = 1808.3 \cdot 10^3\, kcal$; Outgoing heat:$Q_{useful}$–: Heat contained in elaborate brass, where : $Q_{useful} = 1507.2 \cdot 10^3\, kcal$; .

The heat losted with flue gases is $12232 \cdot 10^3\, kcal$. Heat losted with slag: $78.37 \cdot 10^3\, kcal$;q_{dross} =2317kg. The heat losted through the walls of the furnace.

The values are aggreably with figure 2 : $q_s = 51313kcal/m$ and $Q \cong 76 \cdot 10^3$

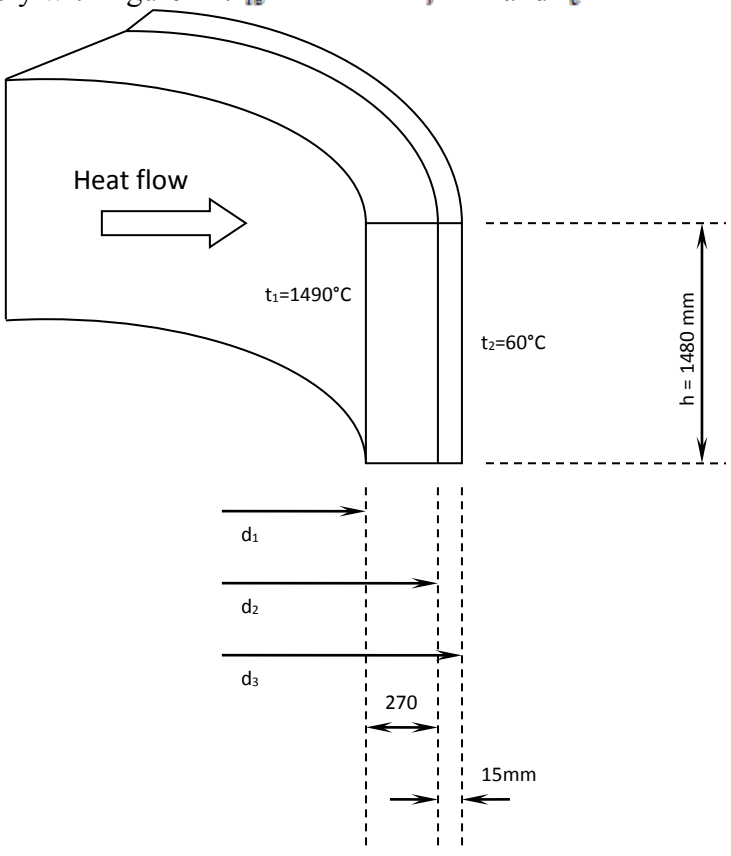

Fig. 2 Sistem heat loss through walls furnace

The configuration of the termic balance of the furnace at the elaboration of the charge of 2400 kg, is shown in table 3.

The difference of the balance it is about 1,3%. The difference occurs due to calculation errors and measuring errors. The share of total useful heat is 83,3 %. the heat efficiency of the furnace balance. Productivity of the furnace : The cycle time of the second castings is

about 4.5 hours. Normally, the furnace elaborates 2 to 3 charges per day, optimum is 3 charges.Technological productivity: 7,2 t/day

Table 3 – The termic balance of the furnace

Heat trapped (kcal)		Outgoing heat (kcal)	
Q from the fuel combustion	$Q_{ica} = 1808.3 \cdot 10^3$	Q useful metal Q flue gas lost Q lost with slag Q lost through the wall	$Q_u = 1507.2 \cdot 10^3$ $Q_{pga} = 122.2 \cdot 10^3$ $Q_{dross} = 78.37 \cdot 10^3$ $Q_{pq} = 76 \cdot 10^3$
Totally	$Q_{ica} = 1808.3 \cdot 10^3$	Totally	$Q = 1783.4 \cdot 10^3$

4. Conclusions

The paper has proposed to study technologically processing copper oxidic ashes, on a flow that upgraded technology compared to standard technology brings the following improvements:

- magnetic separation and processing of the material processed by remelting alloys with an high iron content;
- melting in graphite crucible furnace and mixing system using molten metal slag throughout the elaboration of the charge. This feature allows the reuse of copper oxidic ashes and to minimize the mechanical losses in dross brass alloy. The reduction in specific fuel consumption due to higher thermal efficiency of this type of furnace in comparation with the furnace rotative flame;
- the manual separation of the impurity of tin, aluminum, lead, which allows obtaining alloys with low levels of impurities.

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MODELING OF AMMONIA-WATER BASED ABSORPTION REFRIGERATION SYSTEMS – PROPERTIES OF THE REFRIGERANT

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ABSTRACT: The absorption refrigeration is the cheapest cooling method. That device, with ammonia-water refrigerant pair is able to be used as a heat pump as well. In this article, we show its place among the refrigeration methods, than draw up the base of this method, finally we introduce a mathematical model of this refrigerant system, which works without difficultly available databases and expensive programs background.
KEYWORDS: Absorption, refrigeration, ammonia, water.

1. INTRODUTION

There are many kind of refrigeration methods. Those have versatile domestic, commercial and industrial utilization, some used as a cryotechnic with scientific purpose. (Table 1)

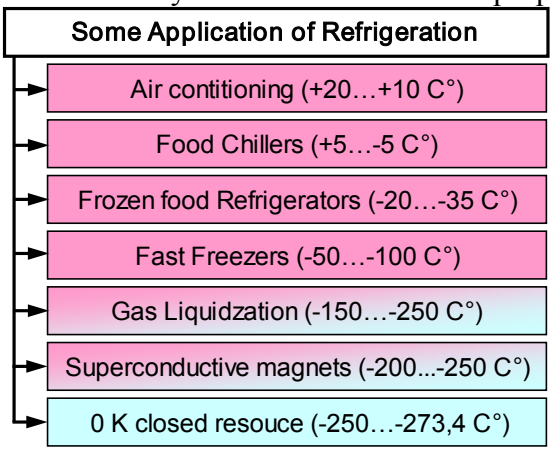

Table 1: Applications of Refrigeration

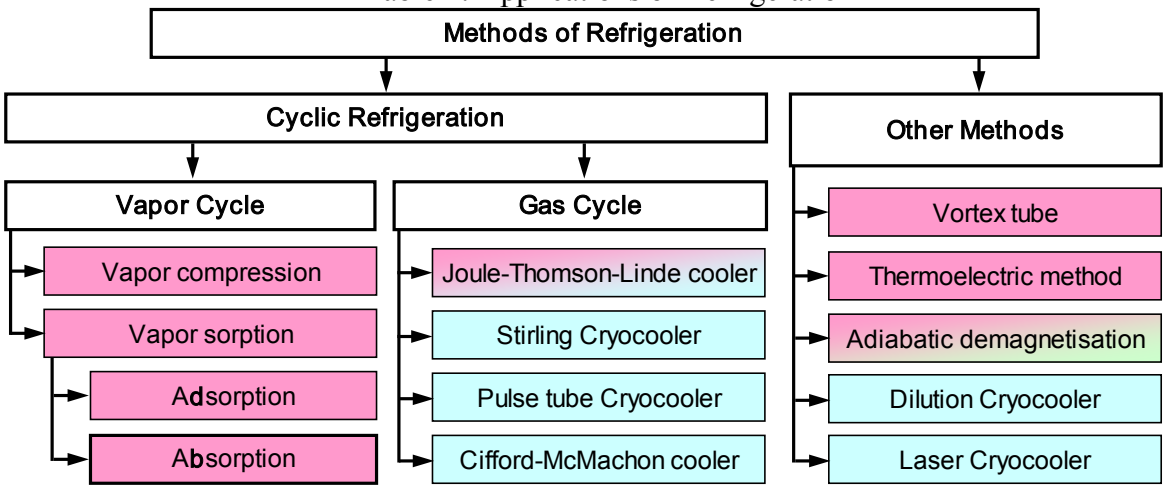

Table 2: Methods of Refrigeration (the scientifically used ones in blue color)

These different purposes cover the temperature scale up to the absolute zero point. So those need different refrigeration methods and devices as well. (Table 2) If the heat source is available, the most effective, energy saver procedure is the vapor sorption refrigeration among those.

This method has huge importance, because when we have junk heat from another industrial procedure (for example a power plant), the work cost of a sorption refrigerator is free. Moreover, the absorption one can be used as a heat pump as well.

2. THE ABSORPTION REFRIGERATION

Everybody knows the vapor compression refrigerator, because that is the so called ordinary cooling method. The difference, between that and the absorption one is the following: There is a generator-absorber pair instead of a high power refrigerant pump. (Figure 1)

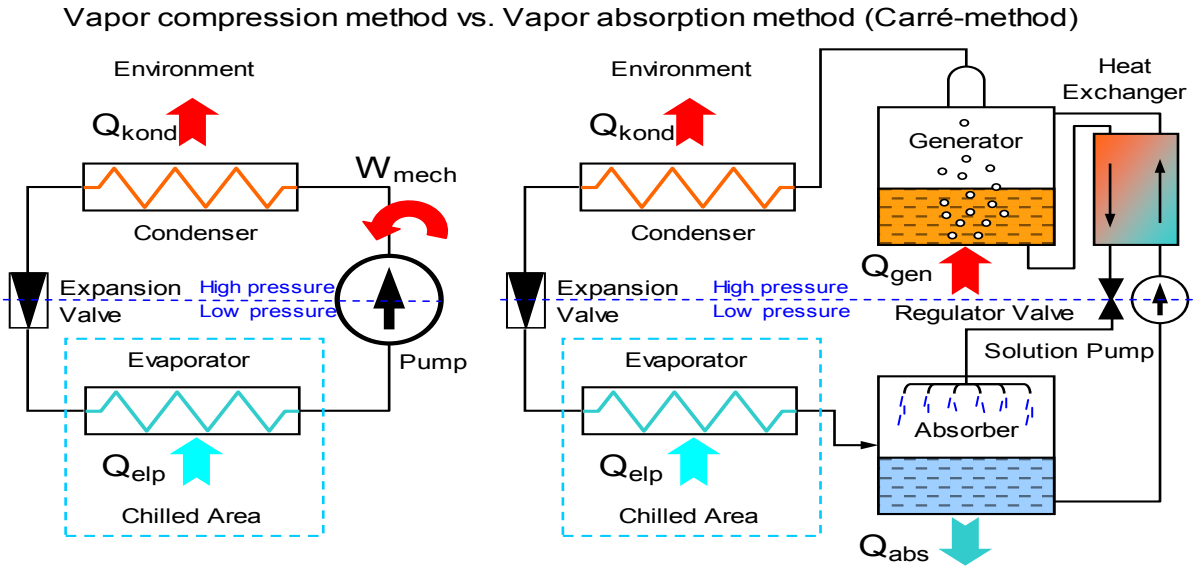

Figure 1: Vapor compression refrigerator versa absorption refrigerator

Working principle of Absorption refrigerator (Carré-method) [1]:

We use not a pure refrigerant, than a refrigerant-solvent pair. We heat up the generator up to 80…100 C°, where the solution has for example 30% of refrigerant. The hot refrigerant leaves the generator as vapor. Than that liquefies in the condenser, passes the expansion valve, and evaporates under low pressure, and extract heat from the chilled area. (like in the ordinary method). Than the cold refrigerant vapor enters into the absorber (which is at for example 30…40 C°), and dissolved in the solution shower. Logically, the absorber gets richer and richer in refrigerant. This is why we need a pump that circulates the solution between the absorber and the generator. I have to mention, that this solution pump needs very small power (just 0,5…2 percent of the entire process) But these two places have different temperatures, so we need a heat exchanger as well. (Unfortunately, there is no perfect exchanger, so that causes a lot of heat loss)

The huge advantage of that method, that it needs power mostly (about 99%) in heat, not in electrical power. Moreover it needs low temperature (80…120 C°) heat that we can get from another process as a junk heat. It is true, that the COP of this procedure is much lower (0,5…0,7, in two stage up to 1,5) that the compressor ones (2…3…even 4,5), but when we have free (junk) power source, that is no matter.

A few words about the other absorption system, the so called Platen-Munters procedure, to avoid the confusion: This has no pressure difference inside, and has no pump at all, however it has a third working component, the hydrogen, as inner atmosphere. This process has very weak COP (0,15…0,3) so that has just domestic use (where electricity is not available, for example in caravans).

3. PHISICAL FEATURES OF THE AMMONIA WATER SYSTEM

The most frequently used refrigerant-solvent pair is the ammonia and the water. (Table 3) It is true, that material is slightly harmful and corrosive, but that is the most useable one, that able to achieve all our goals, such us heat pump function, or low temperature refrigeration.

Refrigera	Solvent	Remark	Use
ammonia	water	Able for heat pump, low temperature available,	yes
water	LiBr	Gives a bit better COP, but just for air conditioning	yes
ammonia	$LiNO_3$	Gives a bit better COP, low temperature available,	experimental
methanol	$LiBr_3$	Gives a bit better COP, low temperature available	experimental
acetone	$ZnBr_2$	Gives a bit better COP, low temperature available	experimental
H_2SO_4	water	Theoretically good, but very harmful and very	not in use
HCl	water	Theoretically good, but very harmful and very	not in use

Table 3: A few refrigerant solvent pairs

If we would like to create a mathematical model, we desperately need the character of the ammonia-water system.

We created easy, well useable, and satisfactorily accurate methods to estimate the wanted physical features. [2] Those are 3D surfaces, depending on the ammonia concentration and on the temperature or pressure.

Which features do we need?

- Vapor pressure curve
- Vapor-liquid equilibrium curve
- Enthalpy of saturated solution,
- Enthalpy of saturated vapor
- Other features (special heat, density, viscosity)

Unfortunately there is no time and place to show all of those, but we introduce the first 2 ones.

4. VAPOR PRESSURE CURVE

We have seen a few expensive software products. Those approached the properties with very complicated high degree polynomials. Let us make that easier!

$$p(t)=e^{A-\frac{B}{t+C}} \quad (1) \qquad p(t,x)=e^{A(x)-\frac{B(x)}{t-C(x)}} \quad (2) \qquad t(p,x)=\frac{B(x)}{A(x)-\ln(p)}-C(x) \quad (3)$$

We know that theoretically the Antoine equation (1) gives that curve. Let us start from that! We know that is good just for ideal matters. Also our material is a mixture, so we need one more variable, (concentration, x) in the function. We have to modify that equation (2). So, this way we can express the temperature with the pressure (3).

We developed Carl G. Almén's earlier work [3] and got for A(x), B(x), C(x) the following: (4)

$$A(x)=11{,}675\cdot\left[1-(0.223-0.155\cdot x)\cdot\sqrt{x}\right]$$
$$B(x)=3840\cdot\left(0.216\cdot x^{2{,}62}+0.1157\cdot x^{1{,}62}-0.62\cdot x^{0{,}62}+1\right) \quad (4)$$
$$C(x)=\left(229+47.7x-20x^2\right)-7\sin(2.8x)-1.5\sin(8.5x)$$

Our diagrams look this way. (Figure 2) Also, as you can see, we could create a really accurate approach.

If we have that we can draw up the so called Dühring diagram (Figure 3), also we can draw up the refrigeration cycle on it as well.

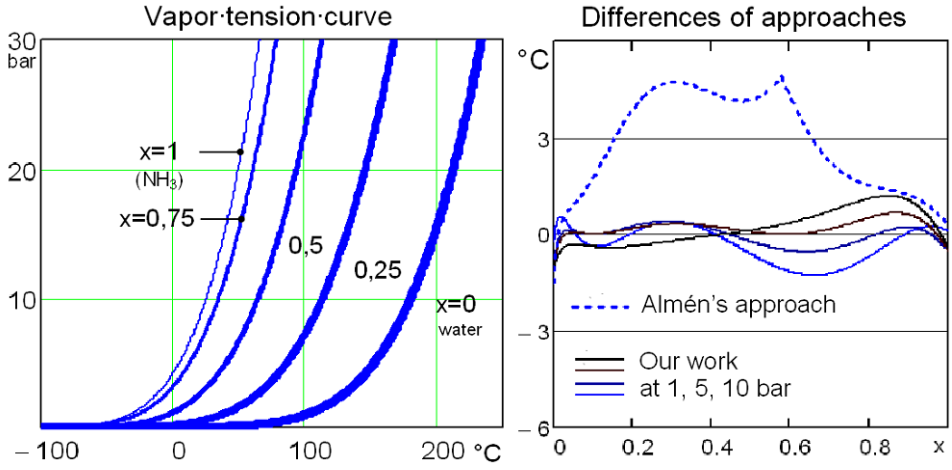

Figure 2: Vapor tension curves, and the difference of approach and measured value.

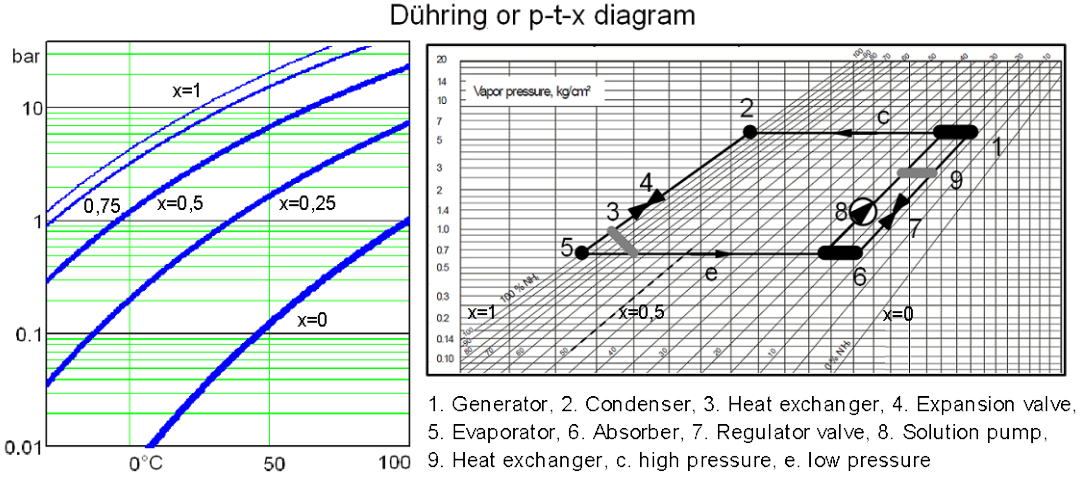

Figure 3: Dühring, or p-t-x diagrams, and the refrigeration cycle [4] on it.

5. VAPOR-LIQUID EQUILIBRIUM CURVE

This curve (in our case this 2D surface) gives that and the liquid phase, with x concentration and what y concentration vapor can hold balance at a given p pressure (or given t temperature). We got the following equation, as acceptable approach (5):

$$y(p,x) = B_y(x) - e^{A_y(p)\cdot x} \qquad \text{Where } A_y(p) \text{ and } B_y(x):$$

$$A_y(p) = 1{,}5413 \cdot e^{-p} + 2{,}5151 \cdot \ln(p) - 14.2715 \qquad (5)$$

$$B_y(x) = 1 - 0{,}0353 \sin\left(\pi \cdot e^{-8x}\right)$$

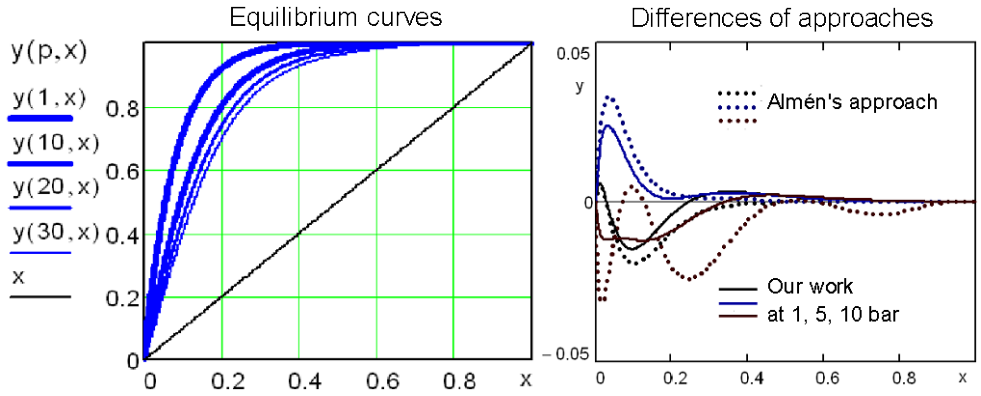

Figure 4: Vapor-liquid equilibrium curves, and the difference of approach and measured value.

Our diagrams look this way. (Figure 4) Also, as you can see, we could create an acceptable approach. Better that the old one anyway. Moreover, that is significantly better at the important concentrations. (between 20-40%, and above 80%)

If we have that we can draw up the bubble point and dew point diagram (Figure 5), at constant pressure and temperature as well.

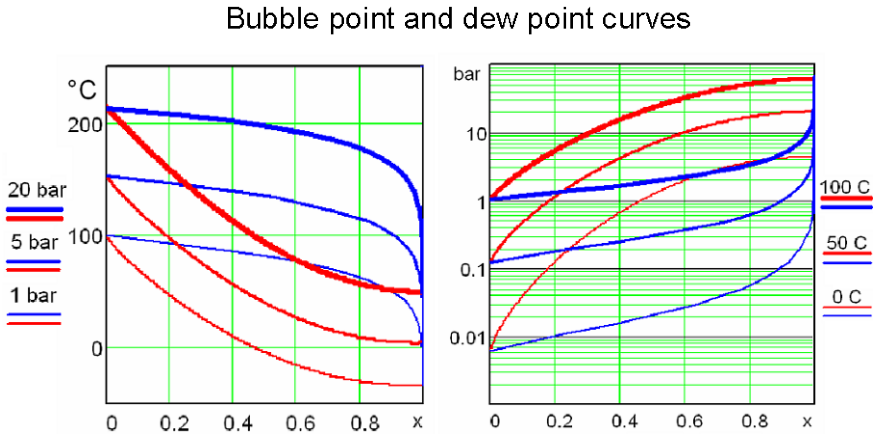

Figure 5: Bubble point (red) and dew point (blue) diagrams at constant pressures (at left) and constant temperatures (at right)

We just know a few estimation formulas, and we could get know so much information about the system.

6. CONCLUSIONS

In this article, we introduced the base of the absorption refrigeration, also introduced two methods that we developed, which are easier and more accurate than the previous ones. One for estimation the vapor pressure and one for the vapor-liquid equilibrium curves in ammonia-water system. Based on this work, in our next article, we introduce how to design an entire refrigeration system how to define its main values and estimate its COP.

ACKNOLEDGEMENT

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NOMENCLATURE

COP	Coefficient of Performance	[-]
x	NH_3 concentration in liquid phase,	[m/m]
y	NH_3 concentration in vapor phase,	[m/m]
p	pressure	[bar]
t	temperature	[C°]

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EXPERIMENTAL RESEARCH LABORATORY FOR THE PURPOSE OF THEIR OWN RECOVERY WITH MAXIMUM ECONOMIC EFFICIENCY OF FINE FERROUS WASTE

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Abstract: The main objective of these investigations was to establish the optimal technological flows of ferrous waste valorisation predominantly with production of ultrafine iron, strategic materials, but at present and in the future. The process is to use a cheap raw materials (iron ore for example or Krivoy-Rog with 60% Fe and average particle size of less than 60 m), fine iron dust and slam , fine ferrous waste generated in steel mills and other businesses including those that are mixed with fine carbonaceous, such as for example dust of blast furnace slam obtaining of blast furnace, converter, and electric furnace. [1,2]
Features of the new manufacturing process of iron powder are in optimal conditions of thermodynamic performance of reduction reactions: 1. using carbon as a reducing what generates the deployment both by direct reactions and indirect what brings the process as close to idealitate, range = 0,08-0,12 at Fe/at a similar reduction processes with tank and inclined tubular furnace; 2. use of ceramic balls with 8-10 mm diameter, heated to 1.200 ° ;. 3. heating and reaction
Keywords: fine ferrous waste, blast furnace**,** dust, ceramic balls.

1. INTRODUCTION

All the instalaţilor used is shown in Figure1. In the vertical furnace (2) equipped with forced heat a quantity of 1.2 kg balls of ceramic (alumina) with average diameter of 8 mm up to 1200 C measured by a thermocouple Cr-Al with ceramic cladding.

Figure1- Experimental research laboratory installation

In response the drum (1), previously heated to 550-600 C, electric or a gas burner with CH4, 1000 grams of ore or waste pulverous with up to 2,5 mm grain, mixed with 200-350 grams electrografit to a maximum grain milled 2,5 mm. insert by using a socket trough lined with refractory, ceramic balls of molten mass. Start rotating the furnace and the gas ignites for protection (carbon monoxide) resulting from the reaction of iron with carbon oxides after being passed through filtration plant (3) and flow meter for measuring (4). Mix by turning the oven for 40 minutes to extinguish the flame of encapsulated o-ring, exhaust shall be considered completed when the reduction reaction. The end point of the reaction is indicated

by a thermocouple that may indicate lower temperatures in the reduction at a speed greater than the limit of 750 c. Cooling load can be insuflând by nitrogen from front cover encapsulated o-ring or by slow cooling of the load at the same time as the natural cooling of the furnace. After the direct reduction with carbon in the experimental facility specially designed and made for this research were analysed after magnetic separation, i.e. products of iron powder and non iron powder.[3,4]

2. PRELIMINARY LABORATORY RESEARCH

Tests were performed on a batch of ore and waste prăfoase as follows: table 1-7

Table 1. Experimental results sample 1 (Brazil iron Ore -Socoimex Galați)

Quantity :iron ore–1000 gr ; electrografit–270 gr Granulated: iron ore < 2,5mm; electrografit < 2,5mm									Chemical composition% sample after reduction, %		Degree of reduction
Chemical composition initial sample, %											
Fe	FeO	SiO_2	CaO	MgO	Al_2O_3	P	S	Mn	Fe	FeO	M %
67,27	-	1,66	0,41	0,15	0,60	0,045	0,012	0,4	48,89	48,69	72,68

Table 2. Experimental results sample 2(Teliuc Hunedoara-iron ore)

Quantity:iron ore 1000 gr; electrografit 200 gr Granulated:iron ore< 1,5mm ; electrografit< 2,5mm									Chemical composition% sample after reduction, %		Degree of reduction
Chemical composition initial sample, %											
Fe	FeO	SiO_2	CaO	MgO	Al_2O_3	P	S	Mn	Fe	FeO	M %
48,28	-	8,95	1,09	3,35	1,89	-	-	2,4	45,96	48,05	95,19

Table 3. Experimental results sample 3(Galați tunder)

Quantity:tunder 1000 gr; electrografit 300 gr Granulated:tunder < 2,5mm ;electrografit< 2,5mm									Chemical composition% sample after reduction, %		Degree of reduction
Chemical composition initial sample, %											
Fe	FeO	SiO_2	CaO	MgO	Al_2O_3	P	S	Mn	Fe	FeO	M %
72,16	-	0,39	1,11	0,79	-	-	-	0,59	56,14	64,85	77,8

Table 4. Experimental results sample 4(Hunedoara tunder)

Quantity:tunder 1000 gr; electrografit 280 gr Granulated:tunder< 1,5mm ; electrografit< 2,5mm									Chemical composition% sample after reduction, %		Degree of reduction
Chemical composition initial sample, %											
Fe	FeO	SiO_2	CaO	MgO	Al_2O_3	P	S	Mn	Fe	FeO	M %
74,02	-	2,22	1,92	1,77	0,59	-	-	0,50	60,92	64,92	82,30

Table 5. Experimental results sample 5(Bataga Hunedoara slam)

Quantity:slam 1000 gr; electrografit 190 gr Granulated:slam < 0,2 – 0,3mm; electrografit< 2,5mm									Chemical composition% sample after reduction, %		Degree of reduction
Chemical composition initial sample, %											
Fe	FeO	SiO_2	CaO	MgO	Al_2O_3	P	S	Mn	Fe	FeO	M %
40,53	-	23,21	2,74	3,15	1,39	-	-	0,55	21,44	24,50	52,90

Table 6. Experimental results sample 6 (Venezuela fine iron ore)

Quantity:iron ore 1000 gr; electrografit 270 gr Granulated:iron ore< 2,5mm; electrografit< 2,5mm									Chemical composition% sample after reduction, %		Degree of reduction
Chemical composition initial sample, %											
Fe	FeO	SiO_2	CaO	MgO	Al_2O_3	P	S	Mn	Fe	FeO	M %
64,6	-	1,11	0,40	0,03	1,04	0,07	0,07	0,059	54,29	13,21	84,04

Table 7. Experimental results sample 7 (Hunedoara tunder and dust)

Quantity:tunder and dust 1000 gr; electrografit 250 gr Granulated:tunder and dust < 0,5mm; electrografit < 2,5mm									Chemical composition% sample after reduction, %		Degree of reduction
Chemical composition initial sample, %											
Fe	FeO	SiO_2	CaO	MgO	Al_2O_3	P	S	Mn	Fe	FeO	M %
58,54	-	10,26	1,64	1,57	1,79	-	-	0,53	33,78	31,75	57,70

3. Discusions OF LABORATORY RESEARCH

In the course of experiments for reducing ore Brazil – Karajos and slam measurements were made of the gas flow and rotate the drum manually stopped. It was observed an increase in the flow of gas to rotate. The mean difference is aprox. 0,5 l/min the amplification reaction of reduction may be seen by the ratio [%], where:-the reading speed of reaction, rotating tail [lCO/min]; -speed of reaction to stationary drum [lCO/min]. Have obtained the value of 110%, 120%, 50%, 30%. Note that large percentages are obtained in the incresing branch of the curve of the exhaust gas flow corresponding to higher degrees of oxidation ore. Descending branch are lower values of the amplification reaction and corresponds to the degrees of oxidation. 2. the average temperature reduction reactions starting with C is 770-790 C. Exceptions are Brazil and Venezuela ores-Karajos rich iron 64.2% respectively for the first 67,4% of gas appeared at 830 C. 3. the quantity of gas phased out during the experiment can be measured and provides useful information on the degree of oxidation (or reduction) of ore at the end of the experiment and the dynamics of his function of various factors: temperature, nature, intensity of ore blending. 4. voltage reducers used in this series of experiments – electrografit – was chosen for the following reasons: to minimize the excess ash in the sample of ore reduced; to represent an alternative use for the production of iron powder with the couple that there are relatively large quantities of such material. 5. quantities of soot filters of gas held in resulting from reactions was averaging 0.27-0.41 grams, which leads to the conclusion that a change can take place of its composition but very low limits; 2CO CO2 + C processing takes place only for 1-3 l of gas produced in the whole process that occur between 140 and 290l of gas. 6. as a result of the determinations of the laboratory was based the need for the use of special ceramic balls and their importance both as a source of heat and mass lenses. Experiments made in the laboratory and small-scale confirms forecast of unconventional possibilities proposed for obtaining technology on iron:

4. CONCLUSIONS

The Romanian metallurgy records nowadays technological inequalities concerning the gathering, the transport, the storing and especially the capitalization of the entire wastes categories. Internationally it capitalizes about 80% from the iron and steel wastes, while in Romania, it capitalizes maximum 48%, the rest being stock-piled.[2,3]

That wastes stock-pile leads at the environment pollution by diffusive emissions of the noxious compounds, and at the top and underground water impurity, on surfaces which exceed the stock-pile areas.

At the ferrous ores agglomeration (inside the integrated traditional flux agglomeration – blast furnaces - steelworks), the pollutant wastes are preponderant represented by the powder collected into the purification installations with electro-filters.

The quantity obtained and used through the classic technologies is about 250.000 tones by year, in the conditions of an actual legal limitation of about 50 mg powder at m^3N evacuated gases into the atmosphere, being estimated at 950.000 tones by year in the conditions of some limits imposition of 25 – 30 mg/ m^3N. A noticeably problem concerning this area is that of this powdery wastes processing before its recycling in order to not be found again into the powder collected at the purification. [4]

As regards the pyrite ashes, sub-product obtained as remnant at the sulphuric acid fabrication, those have totally been stock-piled, angle which constitutes a dominant factor of the environment pollution into the respective areas. The pyrite ashes wastes storing augments a series of problems tided by the agricultural circuit disablement of some important areas, in order to broaden the storing stock-piles, transport and ashes storing expenses and also the stock-piles maintenance. Major negative effects are especially owed to the fact that the ashes are easily taken by the wind and this way it affects very large ground areas which become non productive. The fine powder creates into the area an environment strongly polluted, having the most unwanted effects (including the own industrial platform, by the industrial equipments corrosion and especially on the measure and control equipments).

To fully justify the necessity of the experimental researches development proposed by the present new technology, it has to be mentioned the fact that in Romania the scrap iron became an impercipient raw material, because of the exports liberalization and the acquisition impossibilities by the internal steel producers economic agents because of their financial difficulties.

For those reasons it is necessary the finding of some unconventional technological solutions wherethrough it obtains cast and steel, technologies which allow a flexible and economic functioning way, with investments low expenses. One of those technologies is the sponge iron obtaining by the ore direct reduction with solid reducing agent and its melting in order to obtain cast or steel.

The previous presentation proves the possibility of the capitalization with very low costs of a ferrous sub-products wide range, through an unconventional technology which anticipates, into the technological wave, few technological operations (which implies low costs).

By reason of the fact that the experimental effects, which will be first obtained into the laboratory, it can be extrapolated with perfect similarity at industrial and pilot level.

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METHODOLOGY FOR AN IMPLEMENTATION OF THE DRAWINGLESS MANUFACTORING

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Abstract: In this paper, there are presented the proposal steps to be taken for smart working of the integrated manufacturing system using no drawings. This contribution deals with the activities which are focused on the devices at our institute. These devices are parts of the computer integrated manufacturing. This paper deals also with knowledge about PMI information, and with the smart working with it in drawingless environment.
Key words: iCIM3000, drawingless, CIM, PMI

INTRODUCTION

Modern information technology has opened up new possibilities of flexibilization and cost reduction in production. The development of information technology has brought in mechanical engineering the phenomenon of designing in 3D virtual environment, which enables designers to instantly obtain a far greater insight into the structure and level of detail than is possible when designing in 2D environment. One of these possibilities is the manufacturing using no drawings. Nowadays are drawings only information carriers and they are useful only in their electronic forms. Thereforewill be in this article personated some reasons why we have to choose the manufacturing with no drawing and some manners in wich we should move in. In other, there will be presented why is the PMI good for this implementation,and basic steps how to begin work with this information in effective way.

ICIM SYSTEM

Production with integration of computer support in all phases of the production system, in which all of these phases are connected with each other it is called computer-supported production (Computer Integrated Manufacturing – CIM). It is a network of connected computers includes activities related to the production, starting with the product marketing and ending with expedition to the customer [1, 2].

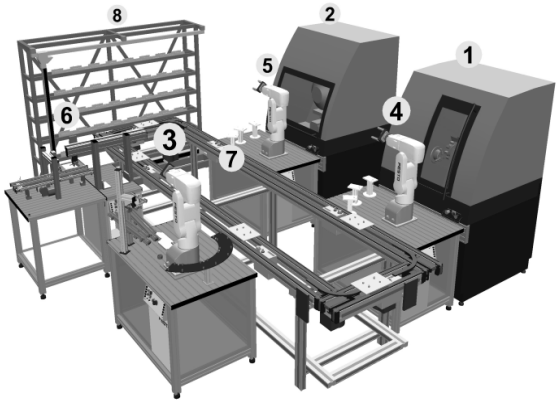

Fig.1. The 3D model of iCIM by FESTO [4, 5]
1-Concept Turn, 2-Concept Mill, 3-Flexible Robot Assembly Cells, 4,5-Service robots of concept machines , 6-Pallet Handling and Quality Station, 7-Pallet Transfer System, 8-Automatic Storage / Retrieval System

CIM - Computer Integrated Manufacturing - is a concept for the structuring of industrial enterprises. Manufacturing technologies demand a CIM concept which can be realized through the capabilities of information processing available today. The idea of integrating different areas of CIM, such as production planning and control (PPC), computer aided design (CAD) and computer aided manufacturing (CAM), is explained through operating chains and put into a CIM architecture based on a hierarchy of EDP systems [3].

If the CIM is a computer controlled production, iCIM is then open system of computer controlled production of CIM. ICIM 3000 is a training and open model system of CIM made by company FESTO. On Fig.1 we can see the 3D model of iCIM by FESTO. This system consists of stations which are marked on fig. 1 by numerical character 1-8.

Transport system

In the whole system, transport system is responsible for the transport of work-pieces which are placed upon special work-piece carriers.

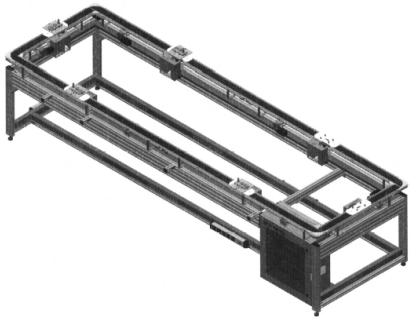

Fig. 2.Transport system[4]

Quality handling station

The quality handling station (fig. 3) is responsible for the work piece (pen holder) testing and the manual feeding of the system with pallets. The pallet handling is done by a linear handling and the testing is executed with an analogue positional transducer and additional camerasystem.[4, 5]

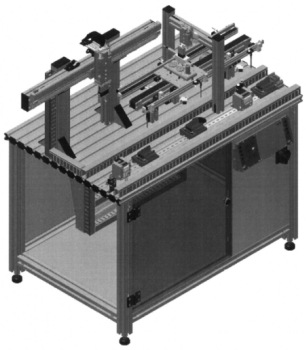

Fig. 3. Quality Handling station [4]

Robot assembly station

The robot assembly station (fig. 4) has the function to assemble desksets, In dependence of the order, the robot assembles the desk set. Once the desk set has been assembled it is moved to the AS/RS station.

Once desk set is to be assembled, the requiered paletts, comtaining the necessary components, are requested for placement onto the palette receptions [4, 5].

CNC feeding turn

The CNC feeding turn (fig. 5) is responsible to production of single parts. The robot takes the raw parts from the magazines to equip the turn machine. There the workpieces are processed coresponding to their order. Before the workpiece is coming on the conveyor systems, the processed workpieces made available on pallets.[4, 5]

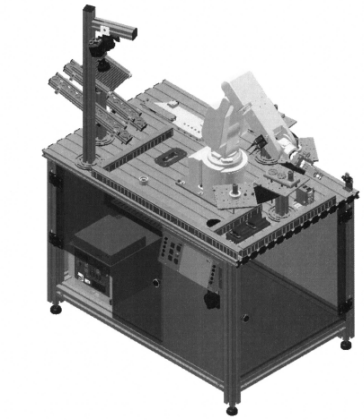

Fig.4. Robot assembly station [4]

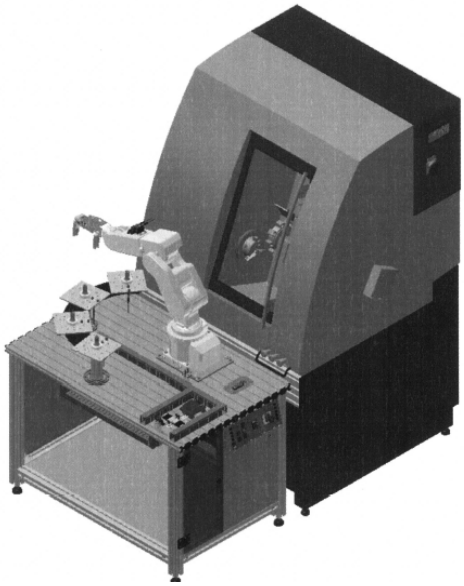

Fig. 5. CNC feeding Turn[4]

CNC feeding mill

The CNC feeding mill (fig. 6) is responsible to production of single parts. The robot takes the raw parts from the magazines to equip the milling machine. There the workpieces are processed corespondin to their order. Before the workpiece are coming on the conveyor systems, the processed workpieces made available on pallets.[4, 5]

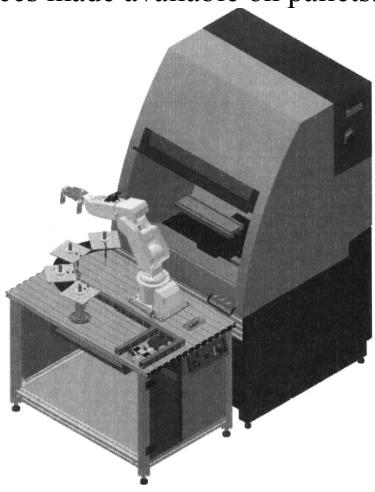

Fig. 6. CNC feeding Mill [4]

AS/RS station

The AS-RS station (fig. 7.) has the function to provide and store the work-pieces and various paletts.[5]

Fig. 7. AS/RS station [4]

Steps for implementation of drawingless manufactoring

For smart implementation of the drawingless manufacturing are there necessary to take some steps. These steps are presented below. In this paper is also presented the usage of the PMI information. This PMI information is necessary during the implementation of the drawingless manufacturing. Therefore we presents the smart way of its usage.

First step will be the analysis of the current state of drawingless production software package suitable for production in drawingless environments. The second step will be the creation of a general methodology for implementing drawingless production into FMS. The next step will be the specification of measures necessary for the implementation of drawingless production in FMS. The last step is the verification and application of established methodology and set the drawingless production into the environment of iCIM system.[3]

We have to in frame of this implementation to prepare analysis of the state of art in field of the drawingless manufacturing. This analysis will focus to necessary hardware and software resources such an organizationally and technical requests for application. On the base of this analysis we will be to create general methodology for application of drawingless manufacturing to the practice. This methodology will be used in the conditions of the flexible manufacturing environment on our institute iCIM3000 presented before.[3]

Use of PMI information

Simple elimination of the risks and the ability to utilize all the information is to concentrate all the information concerning the product in a single source, which should be in my opinion, 3D model of the components. Nowadays the way to set possible manufacturing information into a 3D model, offers use of the PMI, or Product & Manufacturing Information. Possibility of creating PMI information now offer all major CAD systems and PMI information is gradually becoming part of the ISO and ASME standards (ISO 1101:2004, ASME Y14.41-2003).[1, 2]

The aim of the use of PMI is the transfer of a complete set of information necessary to produce the component directly into the 3D model. This information has to be then used in all downstream processes such as CAM, CAE, tolerance analysis, creation of brochures and other visualizations, etc. Finally, the PMI have to use the information to communicate with a supplier or customer in the form of so-called drawingless documentation.[1, 2]

PMI information must to be created and managed using a single module PMI. Tools for creating PMI information provides a comprehensive description of how to use the 3D model

itself PMI size dimensions, which can add the necessary dimensional tolerances, and using geometric tolerances of form and position.Other area used to describe a 3D model with information, are PMI manufacturing information such as surface quality, or welding. Among the tools PMI must also find a wide range of tools to create notes that are otherwise shown on the drawings. Finally, the PMI module have to offer tools for creating 3D models of sections or slices that will allow a detailed description of the product.

Important features of all such generated PMI have to be the associativity of generated information of the objects on which the PMI information is created, so it is possible, for example one mark of quality like finishing assign the entire set of surfaces to be machined with the same quality. At the same time, must to be the logic of the individual instruments controlling derived from the tools, for the creating same information that are on the drawing, which makes the transition from 2D to 3D environment much easier.

Penetration of 3d model with PMI information

3D model have to carry the PMI information, serves as a document of controlled documentation, which is managed by the PLM system, providing full data management and control. Approval Data PLM system must be provided through a defined process so that it have to be traceable in every moment when is something happening with that document and what is his actually status.3D model through containing PMI information have to be the only bearer of comprehensive information about the shape, dimensions and manufacturing requirements of a product among all actors across its life cycle.

Communication of PMI data

The only reason why the drawings through the development process still created is its necessity for communication across the development process. This communication, however, today, in the electronic age becomes slow, error - simply out-dated. This chapter should focus on sharing electronic form PMI information between different actors in the development cycle.

It will start with the simplest model of communication, between the entities. These already have their work available to the appropriate imaging tools. These are CAD systems or other DMU systems - Digital Mock-up. These entities have the ability to share information with the support of PMI's own information system format, or PMI have the opportunity to share information via universal formats, such as JT, or STEP (AP242).

It may be a discrete entity that shares the mere discrete data, or it may be a cooperating entity based on controlled database of data.

Other problem is the shearing data with the subcontractors or partners who do not have access to the database, they are dependent on sharing discrete data, they nor have the tools to enable them to collaborate on the basis of information sharing PMI. Even in this case, now there is a very effective way of sharing data in the form of DMU browsers those companies such as Siemens provides free. These are for example browsers as browser JT2Go designed generally for any data in the JT format and viewer Xpress Review, intended for SW NX and Solid Edge development laboratories of Siemens.

The possibility of sharing data including PMI information is now only a matter of wanting to get away from, in my opinion, the obsolete model sharing information using drawings and embark on a new phase of electronic data sharing.

With the current state of computer technology, we are able not only to share this data, but also thanks to PLM systems to manage and control, which is fully completed the process refunds 2D documentation for 3D documentation.[2,4]

The formation rate of PMI information

The formation rate of PMI information is one of the cons of using PMI information. The next step I will show some principles which can the work with PMI information make easier and

achieve clearly faster formation, against the creation using combination of the model with the drawing.

The first principle is to simplify. This means it is not necessary at all to create the 3D model information, as in the drawing, but only those which are important for the production, respectively to achieve the desired quality of the components, i.e. only tolerated and check dimensions, geometric tolerances, notes, and other surface quality. Then the number of PMI information decrease.

The second principle is the formation of PMI information already in the actual construction. PMI information is possible (and recommended) already defined in the design work, when designer has already had a clear idea of what requirements must be designed product accomplish. This enables to capture the information immediately at the time of the request. This prevents the complex procedure of inventing and re-thinking all dependencies when creating drawings.

The third method is the conversion of existing parameters. Acceleration of opportunities arises from the conversion of the existing parameters of the components. For example in system NX I will mark only the parameters that I want to convert then with the help of the context menu I will create the PMI information only from chosen parameters.

Conclusion

The aim of this paper is the description of iCIM3000 system, which is situated on our institute, and the further drawingless production methodology steps for its implementation.Categorization of these machines, which are presented in this paper, is the first step in the process.

The possibility of sharing data including PMI information is now only a matter of wanting to get away from, in my opinion, the obsolete model sharing information using drawings and embark on a new phase of electronic data sharing.

With the current state of computer technology, we are able not only to share this data, but also thanks to PLM systems to manage and control, which is fully completed by the process refunds 2D documentation for 3D documentation.

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EVOLUTION OF MATERIALS FOR MOTOR VEHICLES BRAKE DISCS

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Summary: At the end of the 19th century appearance of the first automotive assembly required development of different components of their braking systems. Historically, the first material used in the production of automotive brake discs were gray cast iron with the following properties: good diffusivity and thermal conductivity, corrosion resistance, abrasion stability, low weight, low noise, durability, operational and low price. From a technological standpoint, over time, they have been made a large number of experiments, especially with the beginning of the Second World War. Therefore, for more than one hundred years, have seen more materials intended to meet all these features, but until now the most used material in large scale production of brake discs was still the gray iron. The paper presents the evolution of materials used in making brake discs and order research in the composite material and the positive implications of their use in the automotive industry.

1. Introduction

The automotive industry is an economic sector that uses products obtained in all other industries (metallurgy, chemistry, electronics, textiles, etc.) and the main consumer for most of them. On the other hand, during the operation, the vehicle is a major consumer of petroleum products and industrial fluids. Because of this, the automotive industry is the largest consumer of materials in economy.

However, competition in this area and the requirements imposed on motor vehicles requires mastering the properties of materials, development of new materials and technologies processing, in order to increase performance and operational safety, adapted to market requirements.

In order to meet the demands manifested in the quality, cost and performance vehicles, current concerns are directed towards the recovery of the latest research in materials and modern technology in all areas which contribute to achieving vehicle.

By using new materials and the application of modern technologies in the design, manufacture and testing of motor vehicles shall ensure:

- improving the efficiency of engines and transmissions;
- reduction of pollutants in the exhaust gas components;
- obtaining parts as small weight, rigidity and high resistance to wear;

2. THE STUDY OF THE PROBLEM

The main function of brake systems is to reduce vehicle speed to a desired value or to stop it. This is accomplished by converting kinetic energy into heat by friction process and dissipation him effectively by the braking system components.

Many parts of the composition of vehicle actively or passively contribute to increasing their required performance. Safety is closely linked to the effectiveness of the braking system, which is one of the most important component of a vehicle. The correct operation of braking systems is essential, both for the safe of transports and passengers. During operation the vehicles, brake system components require brake discs that are constantly undergo thermal and mechanical deformations relatively high, which in time can lead to intense wear, formal changes or deterioration of this. Also, the braking torque is influenced by a number of random

factors, such as: weather conditions and type of surface which the vehicle runs. The vehicles braking system consists of several components, fig.1,[1].

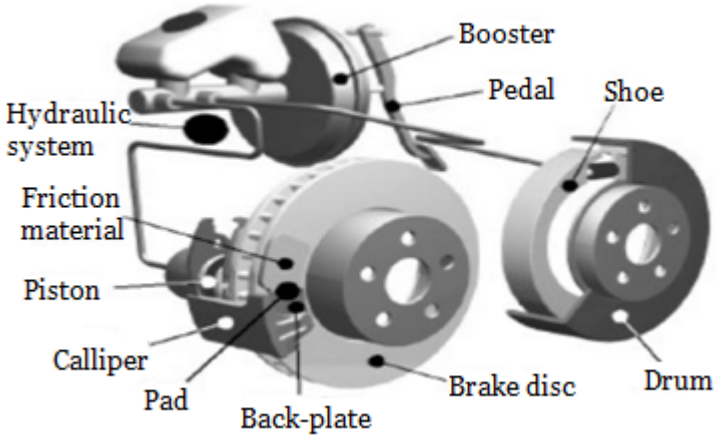
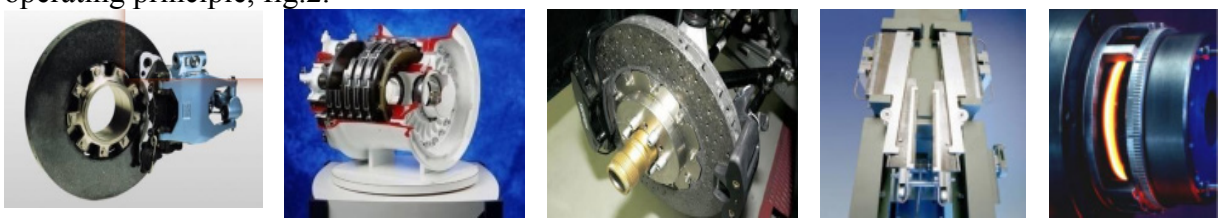


Fig. 1 Components of the braking system of vehicles,[1]

Braking systems are not only found in all vehicles, but also embedded in other machinery, which serving various technological processes specific to several industries. Regarding construction brake discs, there are several constructive forms, but all are similar in terms of operating principle, fig.2.



train plane vehicle elevator slide bridge

Fig. 2 Brake discs used in the braking systems, [1]

The most importatnt component in the braking system is the brake disc. The main functions of the brake discs are sending a considerable mechanical force and heat dissipation obtained during the operation, fig.3, [2].

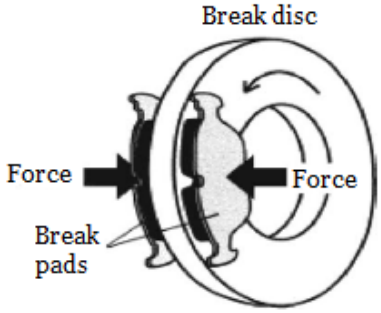


Fig.3 The principle of operation of the brake discs, [2]

During deceleration the brake disc temperature and brake pad assembly can reach values close to 650^0C, it depends on the severity and the number of brakings. Overheating disk-plate assembly can have serious consequences, reducing braking safety systems, [2].

For this reason, the materials used in the making of the brake disc should present a high heat capacity and diffusivity, as well as a low density. They also must provide a good coefficient of friction, stable mechanical characteristics at high temperatures in humity and high wear resistance. In the selection of materials for brake discs the most importatnt is the thermal diffusivity and thermal conductivity because the discs must perform simultaneously transfer and heat dissipation by converting the kinetic energy into thermal energy, [3]. Thus, the brake disc is created in temperature gradients which can lead to the phenomenon of thermal

fatigue. In addition, during braking, the brake disk is exposed to a mechanical load cyclically applied by the brake pads, which leads to wear of the two components (disc plate). Therefore in normal conditions disc is exposed to fatigue loads, [4].

The brake disc can be subjected to three types of fatigue: thermal (where component is subject to abrupt temperature changes only without load), isothermal (where the temperature and load are stable) and thermo (temperature and load are variable) [5] . Most importantly to represent the best condition during braking disc is thermomechanical fatigue where maximum load is applied when the temperature is the lowest possible, and variable. Sudden changes in temperature may cause localized heating or can lead to thermal shock, which causes behavior change brake disk material due to structural changes. They either may cause occurrence of cracks on the surface of the disc, or the occurrence of residual internal stress upon cooling, fig.4, [2].

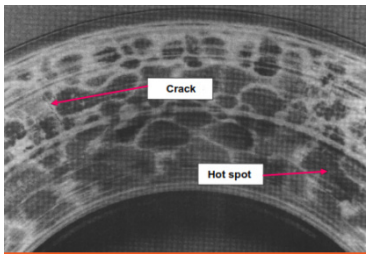


Fig.4 Thermal fatigue cracks on the surface of a disc brake made of grey cast iron, [2]

All of them require analyzes, studies and research on materials and technologies used in the manufacture of brake discs.

3. ANALYSIS, DISCUSSION, APPROACHES, INTERPRETATIONS

Automobile history began in 1700 when Nicholas Cugnot convinced the King of France to finance his project, a vehicle of 10 tonnes for towing cannons. The vehicle run with 10 km / h and was powered by a steam boiler. On the first trip, the inventor realized that did not provide a solution to stop it, which is why his vehicle hit a wall, so the first accident took place. However merit inventor could not be ignorant, [6].

Around 1886, Gottlieb Daimler and Carl Benz changed history, inventing, independently of one another, the first prototypes of cars with internal combustion engines, which were produced only effective after ten years, [6].

At the end of the 19th century, thanks to the appearance of many automobiles, components development has imposed them, both in terms of materials used and in terms of their geometrical shape.

The inventor of the first material embedded in the brake lining was Herbert Frood in 1897. The material was made of cotton impregnated with a solution of bitumen was used both to train wheel and the wheels of the first car. This invention led to the establishment of the foundation of Ferodo Company, which produces materials for braking until today, [6].

The first disc brake was created in 1902 by an english engineer, Frederick William Lanchester. It describes the rotor as a metal plate rigidly connected to the rear wheels of the vehicle, having claws pressed against the edges [6]. This period highlights a major development of new technologies for the production of brake discs. The first companies who introduce these new technologies was Mercedes and Renault, [7]. Table 1 presents chronologically, the evolution of the materials used to build the brake discs, [6].

During the twentieth century-the first brake disc created in 1902 has been continuously improved, both in terms of material and in terms of performance.

The evolution of automotive brake discs was marked by Dunlop Gridlingand Lockhed Corporation, whose products are similar to those records today, [6]. The first material of which were made brake discs was gray iron that meets all requirements in terms of: thermal conductivity, thermal diffusivity, corrosion resistance, durability in operation, low noise,

stability friction, low wear, price low cost. Over more than 100 years we have developed numerous materials that were created in order to improve brake performance. However, many of these have proved to be ineffective, the only material which has been preserved to these days was gray cast iron.

Table 1. Evolution chronological used to build materials from the brake discs,[6]

Material description	Application(s)	Approximate year
Cast iron on steel	used in blocks and other components of railroad car brakes	1870
Cotton or hair (straps)	cart wheel and the first automobiles	1897
Asbestos tissue and other wires to increase strength and performance	trucks and automobiles	1908
Bronze particles with low ash content bituminous coal, produced with internal reinforcement of short fiber	trucks and automobiles	1926
Material molded from a dry mixture of post-metallic to replace the fragile cast iron brake pad on electric trains	London subway	1930
Flexible resin developed with agglutinant elements more intricately formulated	drum brake reinforcement	1930
Metal alloyed with resin	for aeronautic industry use	1950
Glass, mineral, metallic, carbon, and synthetic fibers to give semi-metals better performance than amianthus (beginning of the discussion aboutamianthus safety)	automobiles and trucks	1960
Compounds without amianthus	drum brakes and car equipment	1980
Suggestion of carbon fiber use	automotive brakes	1991

Cast iron is a traditional metal material containing 2 <C <4.5%, shows high resistance to high temperatures, a relatively low manufacturing cost, but because of its large weight increases brake discs, which implies consumption of large quantities of fuel in the operation of vehicles due to large inertia. Discs made of cast iron is obtained in foundries which must be strictly controlled as the chemical composition and cooling process to route the shape, distribution and excess carbon precipitation [6]. They ensure minimizing distortions of processing, good wear characteristics, low vibration and high resistance to cracking, the subsequent use.

Irons provide excellent thermal conductivity, which facilitates dissipation of heat generated by friction brake pads during braking and good vibration damping capacity. One is how to make heat transfer capacity is to increase the thermal diffusivity, which is fundamental to the design parameter brakes. Thermal diffusivity may be used to calculate the thermal conductivity, which is a measure of the transfer of heat is made. Brake discs with improved thermal conductivity have a considerable increase in the resistance to thermal fatigue, which makes it possible to increase their lifespan, [8]. Currently, gray cast remained the most used material in the manufacture of brake discs as it presents the best price / quality ratio.

In general, materials used to build the brake discs must have the following properties: good thermal diffusivity, high thermal conductivity, corrosion resistance, abrasion stability, low weight, low noise operation and sustainability as a low cost price. The chemical composition and geometry of the brake discs influence their sustainability because they have influence over brake on the transmission of heat flow implications on the ability of vibration attenuation, noise and produce sharp wear.

To have these properties was considered appropriate combination of several materials with different properties in different proportions; thus the composite materials [9]. The initial goal of achieving composites was less competitive classic material whose properties of strength and stiffness could not be improved by other means, this being achieved by the introduction in their structure some form of reinforcement fibers, [9].

In recent decades much attention was given to improving performative brake discs on their behavior when friction brake pads. This effort has led to the development of materials such as ferrous copper alloys, aluminum matrix composites, carbon composites, [9].

The composite material is a combination of two or more constituents of the same type, or different, from physical and chemical point of view. The materials retain their separate identity in the final composite. Their combination offering its properties and characteristics different from those of constituents, fig.5, [8].

Composite materials are designed to meet the requirements in terms of [9]: resistant to chemical agents, resistance to corrosion, mechanical strength and rigidity, resistance to varying loads, shock resistance and wear resistance, dimensional stability, and not lastly low weight. Their main advantage is the high ratio between strength and weight density [8]. These features not only ensured the widespread use of these materials, but have stimulated research for discovery of new types of materials with improved properties.

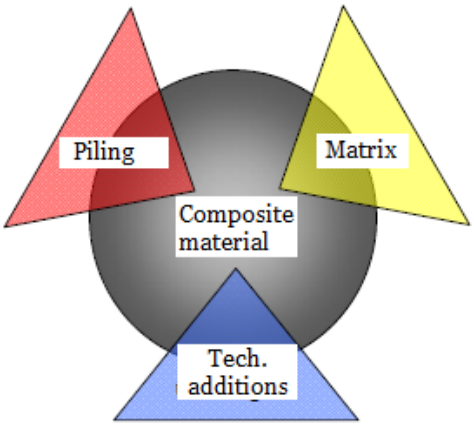


Fig.5 The structure of composite materials, [8]

Materials that can enter to the structure of composites are plastics, synthetic fibers, glass fibers, carbon, boron, wood fiber, metal, cellulose, etc. metals such as Ni, Co, Al, Cr, Ti, W, Ta, Zr, Mo, [9].

Research conducted to date shows that titanium alloys provides a lower weight brake discs, approximately 37% lower than those of the same size made of cast iron and also good resistance to high temperatures, but the price manufacturing is high, [5].

The literature discloses that aluminum matrix alloys do not dissipate heat as well as gray cast irons, leading to construction of the brake disk with a larger surface, losing the advantage of low weight,[6].

With regard to composites of aluminum-metal matrix reinforced with ceramic particles, which have a low-density, high thermal conductivity, low weight, approximately 50-60% as compared to gray cast iron, due to the low density of aluminum, [9].

Nowadays there are over 2 000 types of materials used in the production of brake discs. In the automotive industry, these materials increase the reAl-Cu matrix composites reinforced with SiC have a hardness and superior wear resistance of cast irons. Due to the low density they have a major advantage in producing brake discs, ensuring fuel efficiency during braking due to relatively low inertia, but their price of manufacturing is high, [6].

The literature includes studies about possibility of producing truck discs with a cheaper cast iron alloy with high thermal fatigue strength. They used prototypes of different alloys with variable quantities of elements and some of them had nichel and cerium inoculated. They verified the connection between the material thermal fatigue strength, its physical and mechanical properties, and its corresponding microstructure. They noticed that the higher graphite quantity is distributed on a matrix with refined grains, the lower the crack

propagation rate is, and that the number of graphite flakes increases with nickel addition and some cerium inoculation. They also observed that the thermal fatigue limit is not severely affected by the number of cycles before the beginning of the crack, but after it. From this survey, a low cost brake discs alloy was developed, equivalent to the one used nowadays, [2].
The goal of research in composite materials is to achieve the following objectives:

1. Investigation of the basic characteristics of the components and composite materials as a whole;
2. Optimizing materials for specific operating conditions;
3. The development of manufacturing technologies and study their influence on the material properties;
4. Development of analytical procedures for the determination of material properties and behavior prediction parts during operation;
5. Development of experimental assistance of parts and decline in vehicle weight, which translates into lower fuel consumption and increase performance. Fig.6 shows different embodiments of the brake disc of composite.
6. Nondestructive material integrity and operational safety;
7. Findings sustainability, life cycle and how the occurrence of defects.

- disc brake type DRL | -brake disc type Schunk Kohlenstofftechnic | - disc brake type SGL | - disc brake type Brembo

Fig.6 Ventilated brake discs made of composite materials,[7]

Overriding concerns and achievements of the high-performance composite materials in all developed countries, due to the desire to continue the process of technological development through the use of higher quality materials and made possible through the efficient and clean processes and technologies, [6].
Figure 7 illustrates composite materials consumption by 2010 worldwide, compared with traditional materials or natural products [2].

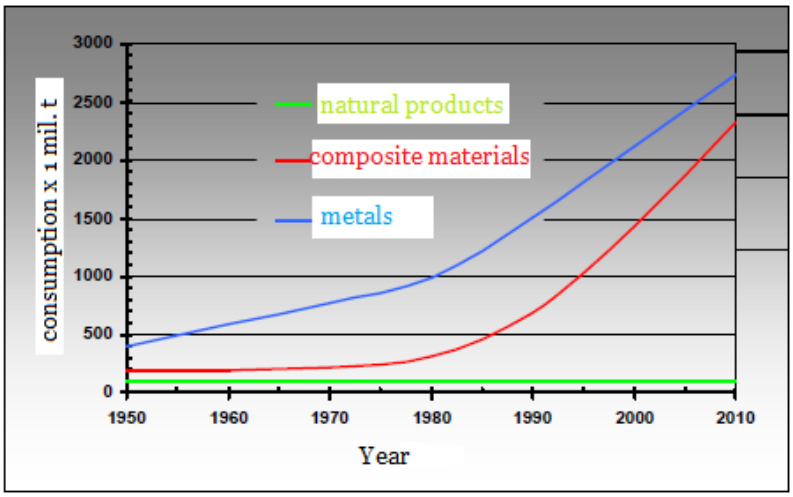


Fig.7 Composite materials consumption in worldwide, [2]

Traditional materials used in vehicle design have been studied in time, so today we know their characteristics, advantages and disadvantages. Technological problems that can not be adequately resolved by using these materials as resources issues, how to achieve economic aspects have led researchers in the field of road vehicles to seek special materials to replace those classics. A study by experts at the request of a Japanese car manufacturing companies main conclusion that: "companies that do not take measures to replace traditional materials with new ones will not be able to compete" [8].

The selection process for achieving brake disc material is difficult due to the large number of parameters that must be met simultaneously.

4. CONCLUSION

Following the study conducted on the development of materials technologies in the automotive industry following conclusions:

- Competitiveness in the automotive industry, requires obtaining new products that provide high parameters in operation, resulting in achieving a more efficient and reliable vehicle;
- Automotive industry development generates a impulse for other industries;
- In the automotive industry, the use of composite materials leading to increased resistance, while decreasing their weight, this translating to reducing fuel consumption and increasing performance;
- Composite materials do not occur naturally, but are artificially created to respond to well-defined requirements;
- Through an appropriate choice, both qualitatively and quantitatively constituent materials can be made of composite materials with superior properties of traditional materials;
- Share in the automotive industry have metallic materials, but forecasts show that these materials will be replaced by composite materials;
- Car brake discs shipments are still gray cast iron products that offer the best price / performance ratio even after receiving additional alloying elements.

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SPECIFICATION IN THE PRACTICE OF LAW ENFORCEMENT (APPLICATION OF BIOMETRY)

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Abstract—After the accession of Hungary to the Schengen region on 21 December 2007, the border control at internal borders was abolished. By the removal of this essential law enforcement measure some Member States experienced an internal security deficit that requires more intensive and efficient police and law enforcement activity and controls, well targeted and reliable identification methods. For the citizens of the European Union (hereinafter referred to as EU) the privilege of safe life has become a priority issue. In order to establish the area of "security, freedom and justice" it is indispensable to establish a person's identity conclusively and beyond any doubt. The application of biometric identification provides a quick, efficient and reliable method of identification for authorities excluding the possibility of errors arising from subjectivity. The only question is what methods and control mechanisms can guarantee the reliable execution of identification performed by police.
Keywords—security, biometry, identification, biometric identification for enforcement purposes

SECURITY AND FREEDOM (BASICS OF NATIONAL AND INTERNATIONAL APPLICATION OF BIOMETRY)

Abolition of borders, harmonisation of legislation, globalisation, integration, acceptance of individuals, surrender of cultural individuality on a certain level result in a number of legal and socio-political aspects. On the one hand, some adherence of national cultures to the grand European ideas, on the other hand shocking effects of cultural elements that must be handled on national level. Public security can be considered a variable of this kind. Open borders resulted not only in free movement of positive services and people respecting law between the member states of the European Union. Perpetrators to justice, criminal organisations and the crimes committed by them started to spread as well with the same intensity.[1][1] It is not entirely a coincidence that the objectives of the gradual abolition of checks at common borders of five countries were set out in Schengen Agreement signed on 14 June 1985 in Luxemburg.[2][2] After the definition of these goals the other element influencing the national public safety and life of the EU citizens was the Treaty of Amsterdam on the creation of an "area of freedom, security and justice" [3] that was declared on 2 October 1997 and entered into force on 1 May 1999. As it was defined: "Freedom, security and justice are core values which constitute key components of the European model of society."[3][4]

1 Based on Unified Investigation Prosecution Court Statistics: regarding the number of committed crimes 1989. 185.000, 1998. 600.000, 2011. 432.000, 2012. 451.512 crimes were detected In: http://crimestat.b-m.hu/Default.aspx;

2Szabó J: Az Európai Ideától a Schengeni Egyezményen át, Magyarország teljes jogú schengeni csatlakozásáig vezető út - benne hazánk határrendészeti szerepvállalása, határrendészeti Tanulmányok V. Évfolyam 1. szám, 2008/1, Budapest, 2008. ISSN: 1786-2345, - p. 25.(Title in English: The Road from the Idea of Europe to Accession of Hungary to Schengen Zone – Role of Hungary, Border Protection Studies,)

3 Neither Maastricht Treaty nor the Treaty of Amsterdam defined the meaning of freedom, security and justice.

4 Rapcan, J-Rapcanova, M: The Context of Citizenship in the European Union and Freedom, Security and Justice, Pécsi Határőr Tudományos Közlemények XI, Pécs 2010, HU ISSN 1589-1674, - p. 1.

Actual measures were defined by Tampere European Council on 15-16 October 1999 that reaffirmed its resolve to create an area of freedom, security and justice. Crime prevention, combating organised crime and the cooperation of police forces were emphasised.

The European Council of 5 November 2004 adopted the Hague Programme, where biometry was defined as the most objective form of identification and as possible means of the establishment of public safety.[5] The passports including biometric data – namely fingerprints - were introduced by the Member States in 2006. Following the harmonisation of legislation and the establishment of legal framework, the development of the second generation Schengen Information System (SIS) [4][6] and Eurodac System [5][7] was launched.

Joining this initiative Hungary – similar to other EU Member States – has been issuing e-passports with a photograph (first generation medium) since 29 August 2006. The passports issued since 28 June 2009 include the fingerprint of the owner as well (second generation).

Public safety is in direct cause-effect relationship with the efficiency of the police, which can be considered to be the crucial dimension of security. Quick, reliable and effective identification has a major importance in this structure.

An important issue is the way the identification of biometric data stored in data bases and documents is realised during enforcement controls. What means are required to ensure the possibility of identification carried out at different control points (for instance public area, motorway parking area or roads) in a short time? During the completion of police controls the same question arises: is the person whose documents are examined identical with the person indicated in the documents shown by them? Exclusion of subjective factors from this process will lead to increased security. As it is believed, the application of identification for enforcement reasons based on biometric parameters will result in high objectivity, which will make it possible to eliminate the negative effects of subjective factors influencing the completion of identification carried out in a traditional way based on anatomic features.[8]

BIOMETRIC IDENTIFICATION

Biometric identification methods make it possible to identify the person itself who provides the sample, with the help of guarantee elements, such as live sample, it is possible to exclude even the possibility of deception. On the other hand, subjectivity of the person carrying out control that is considered to be another source of error can be practically eliminated.

Another major benefit is the decrease of control time, which can be measured in seconds in the case of biometric data even if high number of samples should be taken into account.

As for biometric identification systems, the technologies based on physiological features of the person are considered to be the most reliable option, for instance fingerprint recognition, iris scan, retinal scan, facial recognition[9], hand geometry, vein identification, voice recognition and DNA analysis.

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5 This program regards the application of biometry as a method to manage migration waves.

6 Regulation of the European Parliament and of the Council 1987/2006/EK (December 20, 2006.) on the establishment, operation and use of the second generation Schengen Information System (SISII) In: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:381:0004:0023:H U: PDF, downloaded 10.06.2012.

7 Regulation of the Council 2725/2000/EK (December 11, 2000) establishment of Eurodac for the comparison of fingerprints for the effective application of Dublin Convention, L316/L 22 Hague Programme: Strengthening Freedom, Security and Justice in the European Union (2005/C 53/01), Article 1.7.2.

8 In the practice of the Hungarian Police biometric identification is not applied in every case, it can only supplement the traditional means of identification based on anatomical features. In case of doubt, identification based on biometric data can be performed if required.

9 This biometric identification system would serve as optimal and the most secure means during the entrance to the police object, movement between police units performing different service related

Biometric identification techniques using physiological characteristics are the following: fingerprint recognition, voice recognition, facial recognition in 2D, 3D, hand geometry, veins, iris recognition, retina scan and DNA. [6][10]

Similarly to other generally applied systems it is important to declare the aspects of operation security and reliability and establish a set of operation parameters. Basic elements are formulated in „Handbook of Biometrics" [7][11] and publications of Applied Biometrics Institute – ABI [8][12], which enumerate eight biometric factors that can be used when assessing the suitability of the identification methods and tools.

The eight principles of biometric identification are the following: 1. universality (generality), 2.uniqueness, 3.permanence, 4.availability, 5.productivity (performance), 6.acceptability, 7.circumvention, 8.measurability (collectability).

1. Universality of biometric data can be assured by two elements: on the one hand, every individual possesses a trait, and the percentage of probability that it passes into unauthorised hands is extremely low.
2. On the other hand this trait is unique and specific to the individual, and as such it can be related to an only person.[13] Reliability is well-established since this data cannot be lost, stolen or handed over.
3. It is indispensable that this data show permanence during different phases of an individual's life.
4. It is important that they are protected against attainment by a third party, they are safe so that they could be inalienable from the owner and it would be difficult to reproduce.
5. Two factors of the performance of the system is the speed and accuracy.
6. Acceptability means the positive attitude of the society towards the mass application of biometric identification.
7. Circumvention eliminates the successful manipulation of metric data by an unauthorised person.
8. Measurability declares that data taken and registered is accurate and exact and the measuring instruments are certified and verified.

The issue of the reliability of the operation must be emphasised, and three indicators can characterise the systems from this point of view: [9][14]

1. FAR (False Acceptance Rate): false acceptance rate shows the instance of a security system incorrectly identifying and verifying an unauthorised user.
2. FRR (False Rejection Rate): false rejection rate shows the instance of a security system rejecting an authorised user.
3. FTER (Failure To Enrol Rate): data entry error – the rate at which the attempts to sample input is unsuccessful. [10][15]

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tasks, information flow or sphere of activity of police forces with special covered tasks. However, due to the ontogenetic changes of users it weakens the principle of statics. The possible changes of facial proportions it includes the possibility of getting false results.

10 Kovács T: A biometrikus azonosítás alapjai:, Óbuda University Bánki Donát Faculty on Mechanical and Security Sciences Engineering Applied Biometrics Institute (ABI) Digital lecture notes 2014. (Title in English: Basics of Biometric Identification)

11 Jain-Flynn-Ross: Handbook of Biometrics Springer Science & Business Media, LLC. 2008.

12 Kovács T: A biometrikus azonosítás alapjai, Óbuda University Bánki Donát Faculty on Mechanical and Security Sciences Engineering Applied Biometrics Institute (ABI) Digital lecture notes 2014. (Title in English: Basics of Biometric Identification)

13 Disregard the least reliable behaviour based biometric identification, for instance analysis of signature sample or key presses, analysis of way of walking.

14 Nadort, A: The Hand Vein Pattern Used as a Biometric Feature. Vrije Universiteit , Amsterdam 2007.

Based on the metrics described above FAR of some biometric system is the following: [11][16]

- Voice recognition: 500 : 1
- Facial recognition: 2000 : 1
- Fingerprint recognition: 1 000 000 : 1
- Iris recognition: 10 000 000 : 1
- Retina scan: 10 000 000 : 1

Besides classical elements other, practical elements are taken into consideration as well. For instance easy access to the sample: the unique pattern of the skin on a person's sole is suitable for individual identification, however, this biometric data will never serve as a basic element for an access system due to health and other application reasons.

The primary element of applicability is the ability to produce quick reaction from the side of a population of any size. It means that it should perform the identification or negative recognition in a split second.

As for cost effectiveness, the launch of the operation requires higher costs compared to the traditional, token-based identification systems. On the other hand, when operating a token-based system, continuous replacement is required due to the movement of people, fluctuation, entrance cards and the depreciation of other equipment and as a result of this, the application of biometric identifiers will result in a more economical way of working after a while.

APPLICATION OF BIOMETRIC IDENTIFICATION IN THE FIELD OF LAW ENFORCEMENT

Special factors are to be taken in consideration in the course of the application of biometric identification in the field of law enforcement. There is a lack of fundamental literature in the topic, the area is developing its own methodology and application literature. Balla József police lieutenant colonel [12][17] has defined basic premises when introducing a unified system of requirements into the field of methods and means employed, which is considered to be a really thorough professional factor for the police.

A. Method specific set of parameters

- in the course of which it must be ensured that the identification is –

1. Universal - applied for everybody
2. Independent of the spot - it can be performed at different spots with the same efficiency, stable and mobile, it is reliable in road, air and railway circumstances.
3. Independent of circumstances - it produces reliable results in different, extreme weather and temperature circumstances during different parts of the day
4. Incorporated into regime measures - it can be fit into the control process
5. It cannot be appropriated - performed via internal biometric identification
6. Contact free - as for hygienic considerations, there is not a need for personal contact between the person and the instrument
7. Time limit - it does not increase the basic control time significantly

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15 Bunyita A: A ma és a holnap beléptető rendszereinek automatikus személyazonosító eljárásai biztonságtechnikai szempontból, Hadmérnök VI. / 1. pp. 24-25. In: http://hadmernok.hu/2011_1_bunyitai.pdf, Downloaded: 20.10.2014 (Title in English: Automatic Personal Identification Processes of Access Control System of Today and Tomorrow from Aspects of Security Technology),

16 Dr. Kovács T: A személyazonosítási módszerek általában , Digital Lecture Notes 2014., - p. 1-2., Óbuda University Bánki Donát Faculty on Mechanical and Security Sciences Engineering Applied Biometrics Institute (ABI) (Title in English: General Methods of Identification)

17 Balla J: Biometrikus adatok az azonosításban In: http://www.pecshor.hu/periodika/XIV/ballaj.pdf downloaded: 20.10. 2014. (Title in English: Applying Biometric Data for Personal Identification)

8. The result is categorical - possible only between two outputs: accept - refuse (GO-NO GO)

B. Equipment specific set of parameters

- the equipment shall be able to perform the check on persons -

1. Task-oriented structure - focus on the task to be solved, goal oriented, without applications
2. Operational stability - operation should be reliable in extreme weather conditions and in the case of a large number of sample taking
3. User-friendly - easy to use, it should not require specific knowledge from the user

INTEGRATION OF THE BIOMETRY INTO BASIC POLICE TASKS

Public security is in immediate cause-effect relationship with the operational efficiency of the police, which is regarded a definitive factor of security. In order to provide this, quick, reliable and efficient identification has a crucial role.

Due to its geostrategic situation, Hungary has not only internal [13][18] but also external borders [14][19] functioning as a transit country for illegal migrants. There are certain views that consider illegal migration to be the major source of threat.[15][20] This approach emphasises the direct and significant responsibility of border control body in establishing the public security in member states as well, [16][21] making clear the relevance of the reliable identification.

It is acknowledged that managing migration is a real and significant law enforcement task and problem, however, the criminal threat arising from free movement of organised criminal structures must be considered to have the same significant importance. Open borders provide possibility not only for free flow of goods and services but also for criminal acts, crime and criminals. We must mention here terrorist threats, organised crime, escort networks, brothels, crime organisations specialised in making harm to the elderly, or simple "travelling crime" as well.

Work and border control activity of police bodies can be secure if it prevents and detects infringements and it prevents free movement of persons who may be a danger to the public security of the Union or Hungary. [17][22] Primary police measures in realising this is the control

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18 Member States of EU with common land borders (including lake or river borders as well), their airports for internal flights, sea, river or lake ports with regular ferry. Article of Regulation No 562/2006 EK of European Parliament and Council (15 March 2006.) establishing a Community Code on the rules governing the movement of persons across borders (Schengen Borders Code February 23, 2015)

19 Land borders of EU Member States including lake or river borders, sea borders, airports, river, lake or sea ports in case they are not internal borders. Procedures for refusing entry at the border: Regulation No 810/2009/EK [Official Journal L 243, 2009.9.15.]

20 Balla J: A biometrikus adatokat tartalmazó úti és személyazonosító okmányok biztonságnövelő hatása a határ- es közbiztonság alakulására Doktori (PhD) értekezés), National University of Public Service, Doctoral School on Military Sciences, 2013. (Title in English: Security Increasing Effects of Travel and Personal Identity Documents Containing Biometric Data on Border and Public Security; PhD Dissertation)

21 Dr. Ritecz Gy: A magyar Határőrség szerepe az európai biztonságban, Pécsi Határőr Tudományos Közlemények III., Pécs 2004. HU ISSN 1589-1674, - p. 1. (Title in English: The Role of Hungarian Immigration Office regarding European security)

22 "With the help of the control of border traffic on external Schengen borders and the performance of internal security strategy resulting from the cease of internal borders not only the security of Hungary but also the security of the whole Schengen area is provided" Balla J: A biometrikus adatokat tartalmazó úti- és személyazonosító okmányok biztonságnövelő hatása a határ- és közbiztonság alakulására Doktori (PhD) értekezés National University of Public Services Doctorial School on Military Sciences 2013. (Title in English: Security Increasing Effects of Travel and Personal Identity Documents Containing Biometric Data on Border and Public Security; PhD Dissertation)

of documents that is quick and reliable identification of persons moving in the area. Apart from filtering out undesirable elements, free and undisturbed movement for the rest of EU citizens must be assured.

This is the reason why the identification methods of police play a crucial role in establishing the security of the area, Hungarian public security and internal security of Schengen region. The guarantee of security means the respect of free movement of individuals besides the reliable identification of persons by authorities.

SET OF CRITERIA FOR BIOMETRIC IDENTIFICATION FOR LAW ENFORCEMENT PURPOSES

As it has been made clear above, the application of biometric identification for law enforcement purposes has specific criteria. It must be universal, which means applicable for everybody, in different spots and control conditions, inserted into the control process of strict methodology of regime measures. Speed and reliability is a must, so it is essential to guarantee immediate results without loss of time. The identification needs to be performed via biometric identifier without contact. Only a part of biometric identifiers can meet the strict requirements from all respect. As for its application in public areas, the raison d'être of fingerprint recognition, facial recognition, vein identification or iris scan technique is unquestionable.

During the performance of tasks in public places, the policemen can control documents based on authorisation provided by national law [18][23] They can control the documents of a person whose identity shall be established in the interest of public security, crime prevention, or law enforcement purposes, in order to establish the lawfulness of their stay, during traffic police control procedures, and to protect the interests of natural, legal personalities or legal organisations. The law makes a difference between the citizens of Hungary and of other nationalities from the point of view of identity control. In the case of Hungarian citizens identity card, passport and driving licence of card format is acceptable as personal document for identification purposes [19][24]. The same Article stipulates that "fingerprinting or photographing of every person whose identity cannot be established with certainty on the basis of valid documents is allowed, their external corporal features can be recorded based on perception or measurement".[25]

Practical order of the identification of a person is realised primarily on the basis of anatomical properties. The given person is compared to his photograph included in his document used for identification, taking his age and other features into consideration. [20][26]. The efficiency of the method depends basically on the personal competencies of the police officer performing the action. Besides professional knowledge, external circumstances, weather, part of the day, the effects of environmental redundancy and time factor, the most crucial factor of the document control is the acting officer himself. The possible interference and distortion of subjectivity can influence efficiency, it is considered to be an element with the highest failure rate in the workflow. With the application of biometric identification process this subjectivity can be significantly decreased.

Public area activity is an emphasised part of police activity and due to special circumstances it demands extraordinary ability to react to the given situation in every case. Whether it is about

23 Police Act No 1994. XXXIV. tv. 29. §.

24 This is a document issued by authority that authentically justifies the identity of citizen based on the Law No LXVI 1992 on the protection of individuals with regard to the record of personal data and address.

25 Police Act 1994. XXXIV. tv. 29.§.(4)

26 Lakatos G: Nyomozástan II. A kriminalisztika alapjai 1. Nemzeti Szakképzési és Felnőttképzési Intézet Budapest 2013. (Title in English: Methodology of Investigation II. Basics of Criminalistics)

patrolling or performing identification checks at control points (EÁ-p[27]), the factors influencing the activity must be taken into consideration every time.

It is believed that certain elements of the system need rethinking. Regarding the person performing identification, objective elements shall be completed with the degree of workload of the controller, which defines the quality, the length and accuracy of the control itself. It is also of utmost importance to examine the state of equipment used during the examination since it guarantees the quality and reliability. One of the primary objective elements regarding the person being controlled is the examination of clothing. The assessment of non-verbal signals must be continuous, and the extent of control and stress absorbing capacity must be taken into account since these factors can modify the control process in different ways. On the one hand it can be a warning sign so that the police officer shall deal with the person more thoroughly or on the contrary, the person controlled can suffer from neurodegenerative disease and he needs help to manage this control or stress situation.[28]

	OBJECTIVE ELEMENTS	SUBJECTIVE ELEMENTS
FACTORS ARISING FROM PERSONALITY OF CONTROLLER	Physical state (organs of sense) Place of service Weather conditions Parameters depending on the part of the day and season Time spent on the control Workload State of instruments used for control	experience- professional skill Professional competencies Ability to identify a person Mental state Service time Experience in control activity
FACTORS ARISING FROM THE PERSONALITY OF THE IDENTIFIED	Age related features Illnesses Physical state Non-verbal signs Intention to cover face (eg. sunglasses, scarf) Pretending sleeping Clothing	Behaviour Absorbing attention of controller Degree of control tolerance Distracting techniques (eg. Initiating conversation) Degree of stress tolerance Intensive discussion with others
FACTORS ARISING FROM OTHER CIRCUMSTANCES	Lighting of the control place Brightness required for the control Quality of the photo Time elapsed since the photo was taken Human background of the control place (composition of inhabitants) Traffic conditions of the control place Weather conditions at the time of control	

Fig. 1 Factors influencing identification[29]

27 Police activity of identification of persons at control points – grantor points.

28 Based on the experience gained during police controls in the area of Fejér County Police Department, when the police officer misidentified the person with mental disorder to be under the influence of alcohol – the person had limited ability to speak and walk due to a stroke – a Strokon Átesettek Érdekvédelmi Szervezete (Mutual Defence Organisation for people who had stroke) and Értelmi Sérültek Fejér Megyei Egyesülete (Fejér County Association for Mentally Disabled) worked out a leaflet including the most essential information about the disease and when there is a police control the patients can give it to the police officer in order to clarify the situation. Apart from this a training was held for police staff of Fejér County Police Department in 2013-14 in order to make them aware of the way the mentally handicapped people should be handled.

29 Prepared by Krisztina Földesi

As the analysis of the results of previous police actions, regarding current social processes it is indispensable to carry out an analysis of the human composition of the areas involved, which has a significant influence on the result of police controls. [21][30]

The following table will summarise the factors influencing identification process supplemented with the elements listed above. It includes objective and subjective elements of police control performed in public area regarding the characteristics of the parties involved. As basic premises, the set of parameters collected by Balla József police lieutenant colonel was accepted and later supplemented with further important elements that influence identification. The workload of the officers performing controls is emphasized since it has a significant effect on their mental state and performance as well. As for the identified person, the evaluation of non-verbal signs, his tolerance to stress and to control, and physical state play an important role in the process. Regarding other factors, the human background of the place of control cannot be neglected as it has already been mentioned.

One of the basic elements of the formation relating to police service should be the support of practical activities. A number of initiatives and recommendation for supporting police forces performing on-the-spot identification checks have appeared so far including their provision with the necessary equipment. [22][31] On the basis of the current practice the acting patrol performs primary control of checked person's data in the central data base via radio. Based on the information given by the patrol the data is checked in the electronic database by the contact person working in the centre. In the meantime personal and qualified data is transferred orally and openly, which raises concerns regarding data protection. This is the reason why it is justified to provide police units with mobile equipment that can eliminate these sources of failure. The application of mobile fingerprint and document reader has already been proposed. [23][32] However, it has not been realized yet, the new measure to support objectivity was launched in October 2014. In order to support measures taken in public places the so called TIR-MOBIL system, a computer aided application was installed into patrol cars. This system makes it possible to realize screening of documents, cars or wanted persons. Although the system does not have fingerprint recognition or facial recognition functions, the opportunity of the introduction of this application is given. [24][33]

ACKNOWLEDGMENT

Biometric procedures can be inserted into the methodology of law enforcement control and they can assure identification conforming the level of the security risk. Evaluation of particular biometric identification methods based on law enforcement parameters is required to perform according to special internal measures adapting to special legislation and regime measures.

30 After the infamous case that is known as „Olaszliszka syndrome" many similar cases occurred. In: http://www.szon.hu/218jabb-soforveres-gyerekel252tes-utan-sajohidvegen/news-20080501-08022533 downloaded 03.03.2015.

31 Report on the research results carried out on modernization of IT system of police and border control activities in the framework of Check-net defined by the European Union. Based on a project accomplished in cooperation of ZMNE Faculty of Border Control and Council of Police Research Society, ZMNE 2006., Dr. László Zsigovits lieutenant colonel and Dr.Gábor Kovács lieutenant colonel

32 Project DSVII-PA 2006 carried out by József Balla police lieutenant colonel: A biometrikus adatokat tartalmazó úti- és személyazonosító okmányok biztonságnövelő hatása a határ- és közbiztonság alakulására Doktori (PhD) értekezés. National University of Public Services Doctorial School on Military Sciences 2013. 69. (Title in English: Effects of Identification Documents Containing Biometric Data on the Status of Border and Public Security; PhD Dissertation)

33 ORFK report of 2014/2 on Directive No 57/2013. (XII. 21.) on uniform way of operation for centers providing general police activities, duty of police and centers receiving distress calls.

The scope of biometric identification methods that can be applied for enforcement purposes, namely for identification purposes, is much tighter than the full scope of available biometric means. The set of criteria for the application is defined not only by the group of general elements but also by law enforcement equipment and method specification described above. False Acceptance Rate (FAR) shall be highlighted among them since currently it is the main risk factor from the point of view of identification and security. In this case the system transfers unauthorised persons and such cases bring risk during police controls since wanted persons remain at large, runaway children cannot be found by authorities, cars or persons involved in criminal actions can slip through control points. Based on the above mentioned fact FAR value of particular control methods used in enforcement applications can be accepted only if they show low possibility of errors.

False Rejection Rate (FRR) cannot be tolerated either since an authorised person is rejected; in this case security risk does not appear, however, it means inconvenience for the controlled person. The clarification of the problem shall happen on the spot due to personality, legal and naturally financial and resources related issues.

The third element is data entry failure in the case of which exact and accurate measurements were carried out. According to the results it can be stated that the increased usage time of equipment results in a higher percentage of failure. As for fingerprints it can result in a FRR value of 60-80% based on 3500-piece measurement series. This percentage of failure cannot be tolerated in the field of police operations performed in public places. The total value of working hours for public places service of Fejér County Police Department reached 31 708 hours in 2013, with the number of 70.714 identified persons.[34] It means that in every case the identity of the persons was also checked. On country level about 1.500.000 people were affected.

The study of application of biometric identification methods and its compliance in law enforcement, more closely in police practice, is continuous. Based on four basic sets of criteria - reliability, evaluation time, permanence, circumvention – a comparative study [25][35] identifies three outstanding sets of identification measurement systems. At the same time, the most reliable biometric identification method, DNS identification shall be excluded from this set of measurements since it cannot meet the requirements of immediate feedback or evaluation. As a result of examinations and surveys performed it can be stated that if suitable conditions are provided, four different biometric identification methods seem to be applicable in the practice of police: facial recognition, fingerprint recognition, iris scan and vein identification.

Identification based on iris scan can be primarily applied, supported by a special software. The second method applicable in law enforcement is identification based on fingerprint recognition and vein identification. However, identification based on facial recognition is particularly suitable for executing special searches for missing persons or warrants. In these cases identification based on facial recognition is appropriate – in case of optimal arrangement of surveillance cameras - and it must be managed by human resources.

It is obvious that identification techniques via biometric data cannot be applied in every field of police work or in every control spot, and there are occasions when they cannot substitute the identification work based on traditional anatomic features. However, it is indispensable for the future generation of police officers who can make use of this reliable tool in the fulfilment of their tasks.

34 FMRFK internal statistic data

35 Tajti B: A biometrikus ujjnyomat azonosítás alkalmazásának új lehetőségei, Hadmérnök VII./ 1. , p 52. In: http://hadmernok.hu/2012_1_tajti.php , Downloaded: 29.06.2012. (Title in English: New Perspectives in Application of Biometric Fingerprint Identification)

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[14.] Land borders of EU Member States including lake or river borders, sea borders, airports, river, lake or sea ports in case they are not internal borders. Procedures for refusing entry at the border: Regulation No. 810/2009/EK [Official Journal L 243., 15.09.2009.]

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MODERN METHODS OF RESEARCH THROUGH OPTICAL AND ELECTRONIC MICROSCOPY OF SPECIAL METALIC MATERIALS STRUCTURE

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Abstract: In this paper we present the results of experimental research performed using a Philips XL 30 ESEM TMP scanning electronic microscope, owned by UPB-CEMS, on a number of 6 samples taken from an iron-nickel-chromium special material, used for making high voltage overhead power lines, which were disc-shaped, with a diameter of 7mm and a height of 0,5 – 1,2 mm, electrically eroded.[1],[2]. Inside a vacuum environment, using a 30 kV voltage for accelerating the electron beam, a spot dimension on the sample surface equal to 3 and a distance between the polar piece of the microscope and the surface of the sample of 10 mm, there have been obtained images of secondary electrons, which have helped morphologically characterize all the samples, at magnifications between 100x and 25.000x.

Keywords: electronic microscope, vacuum environment, secondary electrons, morphologically characterize

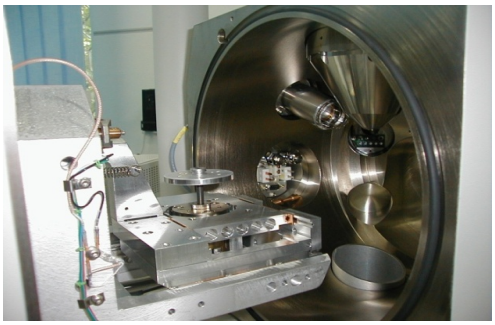
1. Introduction

Results of the compositional analyzes have been obtained using a energy dispersion EDAX – Sapphire spectrometer, at acceleration voltages of 30 kV, dimension of electron beam spot equal to 5,5, distance between the polar piece and the surface of the sample of 10 mm, at an angle of 35º between the sample surface and the X-ray detector. [3].Compositional analyzes have been achieved at magnifications of 100x, on five fields, the results presented in this report being an average of the individual quantitative results. It must be taken into account during data interpretation that the microanalysis is a compositional characterization method of micro volumes, determining chemical composition of nonhomogeneous substance volumes requires performing atomic spectrometric or mass determinations.[4].

2. Methodology

Within this study six samples (Sample 1 – Sample 6) have been examined through SEM / EDS method using a XL 30 ESEM (3,5 nm resolution) electronic scanning microscope, coupled with an energy dispersion EDAX Sapphire spectrometer (128eV resolution). (Picture 1a and 1b). Results are objectified by using morpho-compositional images (secondary and re-dispersed electrons) and EDS spectra with adjacent quantitative results.

Picture 1a



Picture 1b

Sample 1

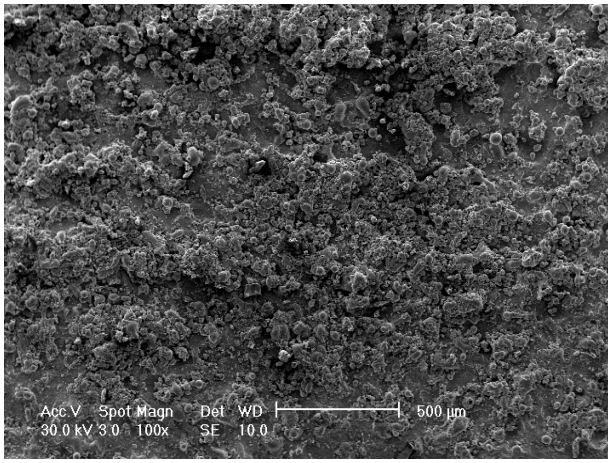


Figure 1.1 Secondary electrons image – surface morphology at 100x magnification.

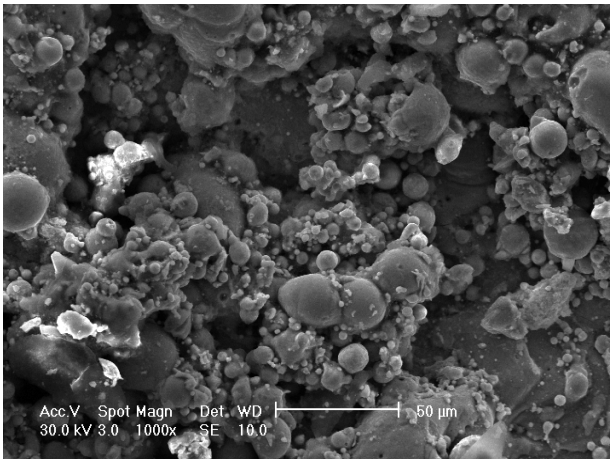


Figure 1.2. Secondary electrons image – surface morphology at 1.000x magnification.

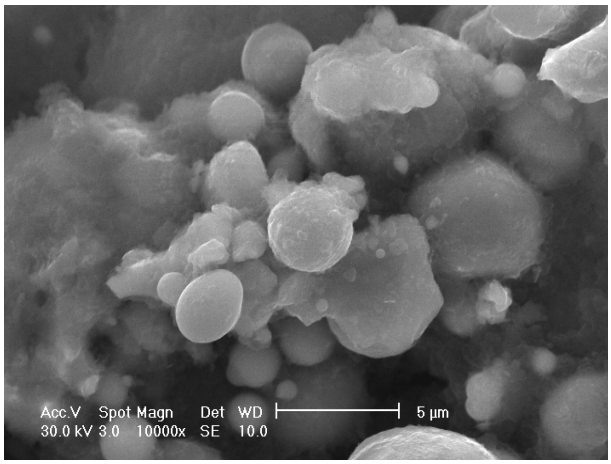


Figure 1.3. Secondary electrons image – surface morphology at 10.000x magnification.

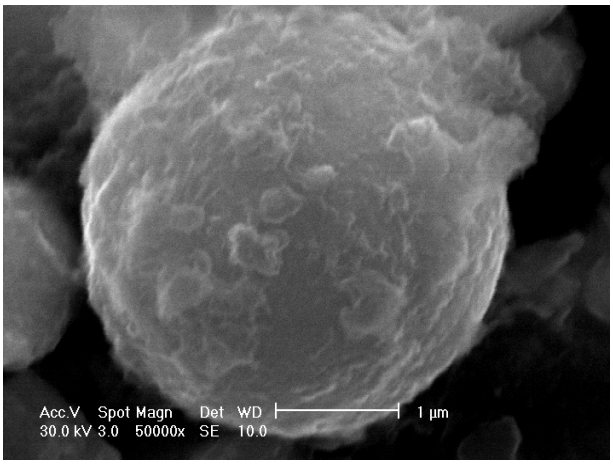


Figure 1.4. Secondary electrons image – surface morphology at 50.000x magnification.

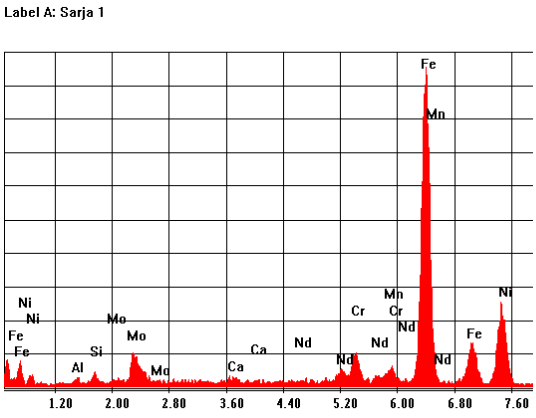


Figure 1.5. Characteristic X-ray emission specter, corresponding to sample 1 compositional analysis.

Element	*Wt %*	*At %*
AlK	*1.49*	*3.18*
SiK	*1.81*	*3.72*
MoL	*8.14*	*4.89*
CaK	*0.52*	*0.75*
NdL	*4.23*	*1.69*
CrK	*3.75*	*4.16*
MnK	*2.05*	*2.15*
FeK	*55.39*	*57.21*
NiK	*22.64*	*22.24*
Total	*100.000*	*100.000*

Table 1. Quantitative compositional results corresponding to sample 1.

Sample 2

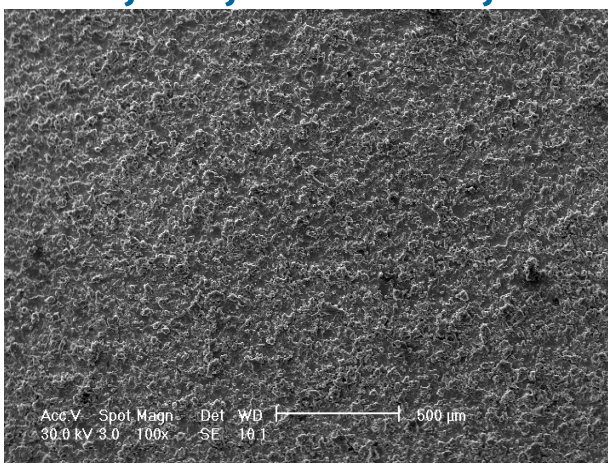


Figure 2.1. Secondary electrons image – surface morphology at 100x magnification.

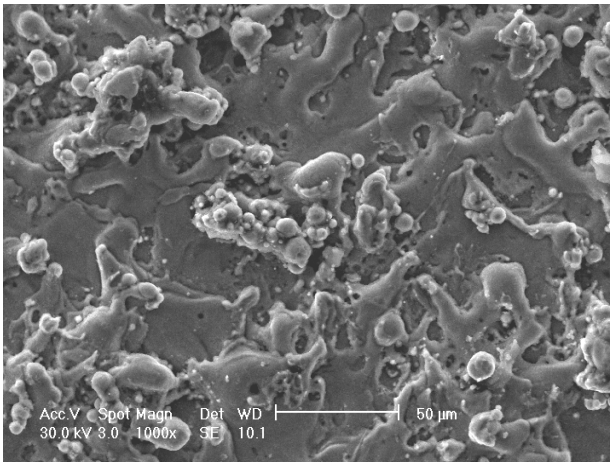


Figure 2.2. Secondary electrons image – surface morphology at 1.000x magnification.

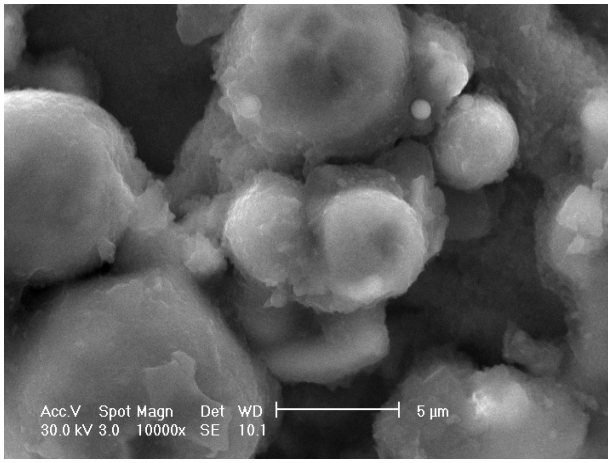


Figure 2.3. Secondary electrons image – surface morphology at 10.000x magnification.

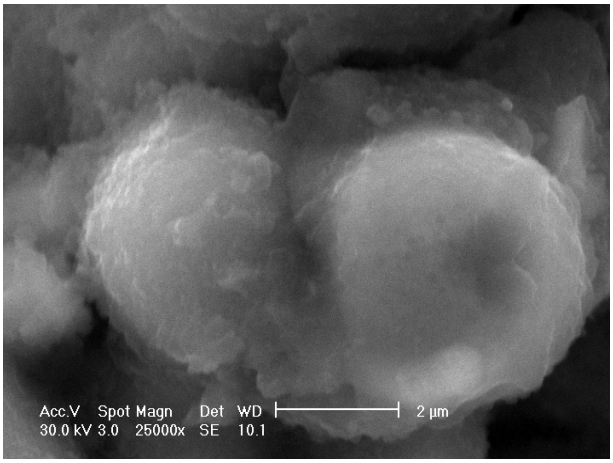


Figure 2.4. Secondary electrons image – surface morphology at 50.000x magnification.

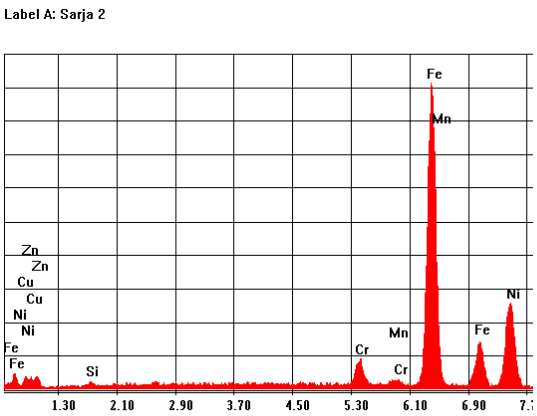


Figure 2.5. Characteristic X-ray emission specter, corresponding to sample 2 compositional analysis.

Element	Wt %	At %
SiK	1.02	2.07
CrK	3.31	3.61
MnK	0.68	0.70
FeK	55.02	55.97
NiK	27.00	26.12
CuK	10.20	9.12
ZnK	2.77	2.40
Total	100.000	100.000

Table 2. Quantitative compositional results corresponding to sample 2.

Sample 3

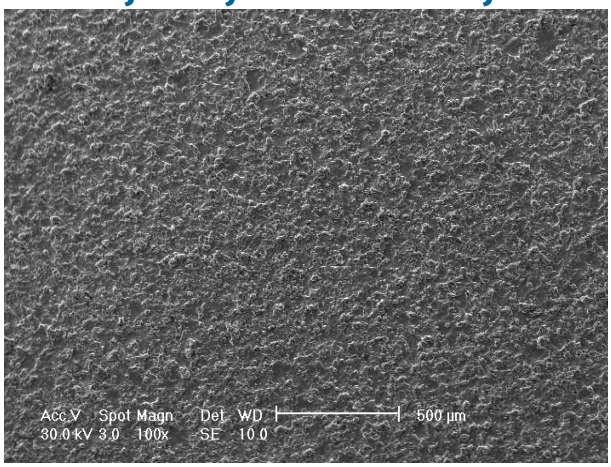


Figure 3.1. Secondary electrons image – surface morphology at 100x magnification.

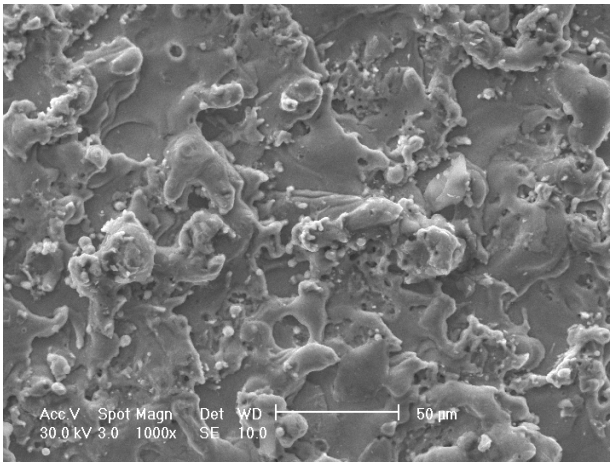


Figure 3.2. Secondary electrons image – surface morphology at 1.000x magnification.

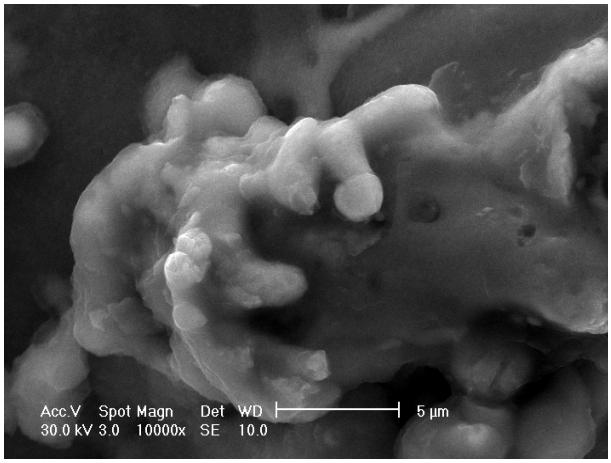


Figure 3.3. Secondary electrons image – surface morphology at 10.000x magnification.

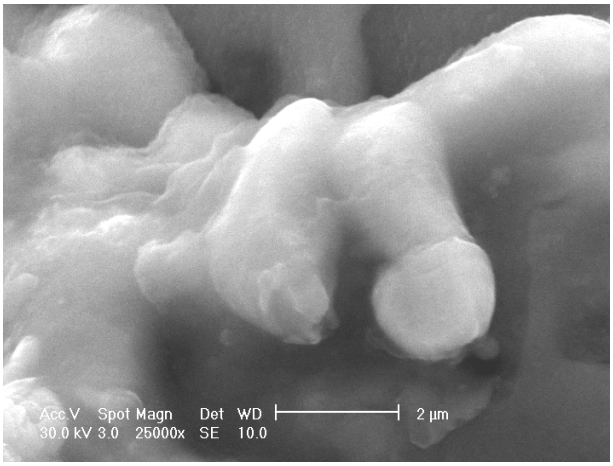


Figure 3.4. Secondary electrons image – surface morphology at 25.000x magnification.

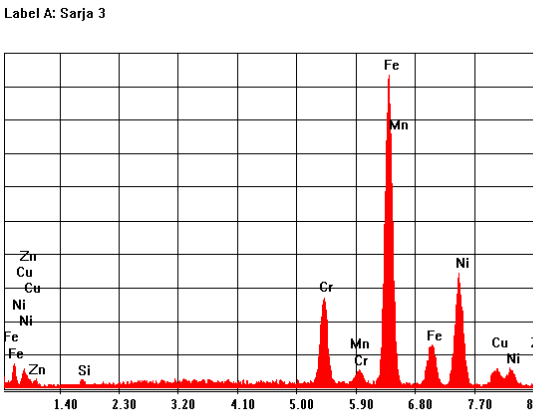


Figure 3.5. Characteristic X-ray emission specter, corresponding to sample 3 compositional analysis.

Element	Wt %	At %
SiK	1.05	2.09
CrK	10.51	11.35
MnK	0.51	0.52
FeK	50.78	51.07
NiK	29.68	28.39
CuK	5.88	5.20
ZnK	1.59	1.37
Total	100.000	100.000

Table 3. Quantitative compositional results corresponding to sample 3.

Sample 4

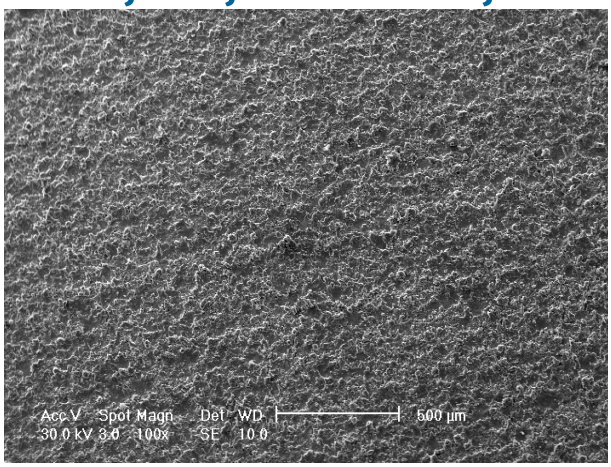


Figure 4.1. Secondary electrons image – surface morphology at 100x magnification.

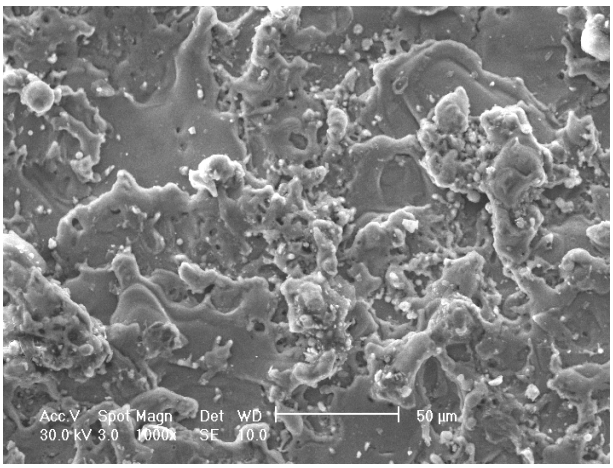


Figure 4.2. Secondary electrons image – surface morphology at 1.000x magnification.

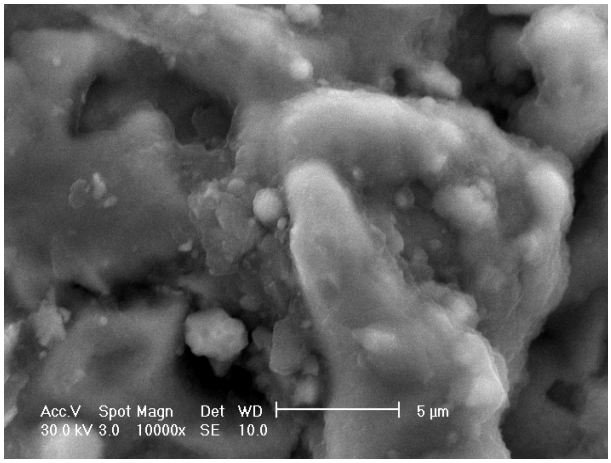


Figure 4.3. Secondary electrons image – surface morphology at 10.000x magnification.

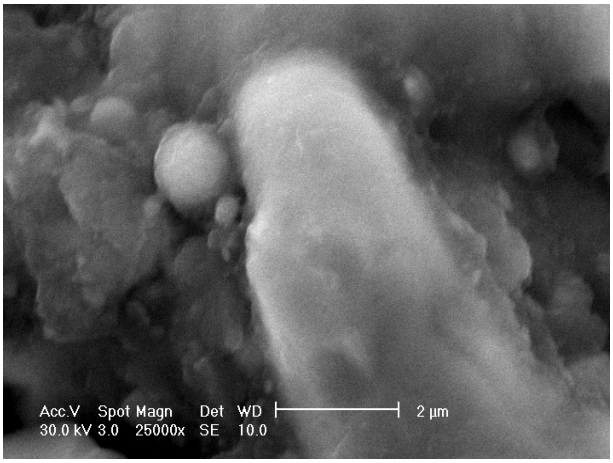


Figure 4.4. Secondary electrons image – surface morphology at 25.000x magnification.

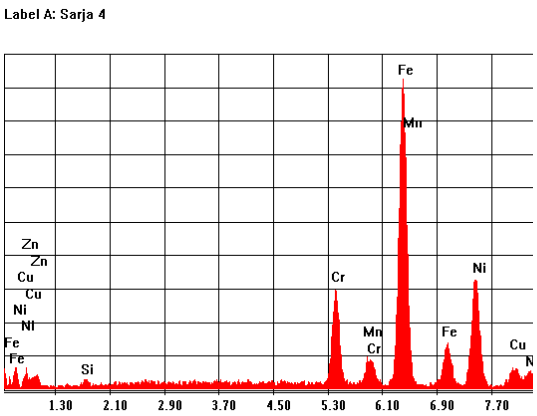


Figure 4.5. Characteristic X-ray emission specter, corresponding to sample 4 compositional analysis.

Element	Wt %	At %
SiK	1.14	2.28
CrK	10.67	11.53
MnK	3.10	3.17
FeK	47.42	47.70
NiK	28.71	27.47
CuK	6.48	5.73
ZnK	2.47	2.12
Total	100.000	100.000

Table 4. Quantitative compositional results corresponding to sample 4.

Sample 5

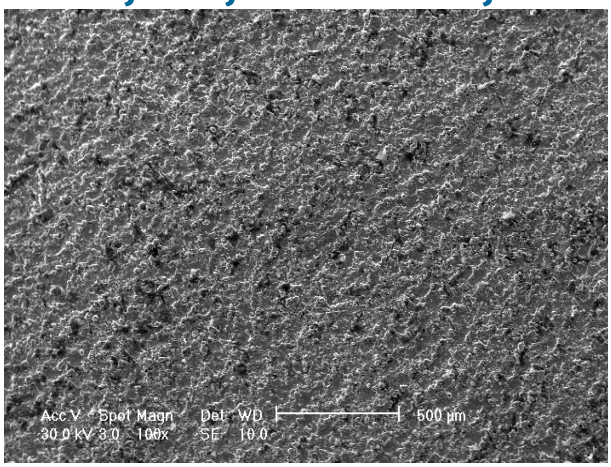


Figure 5.1. Secondary electrons image – surface morphology at 100x magnification.

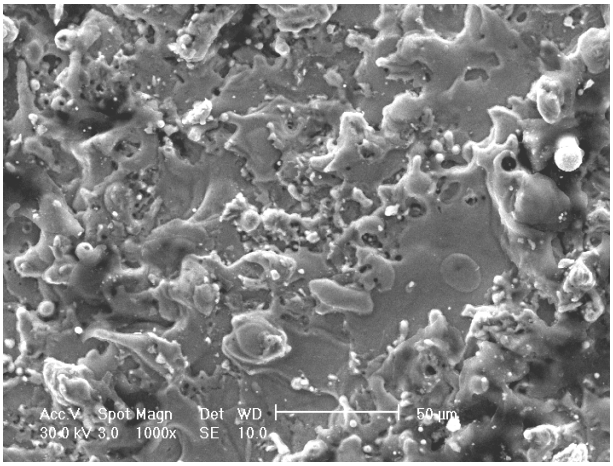


Figure 5.2. Secondary electrons image – surface morphology at 1.000x magnification.

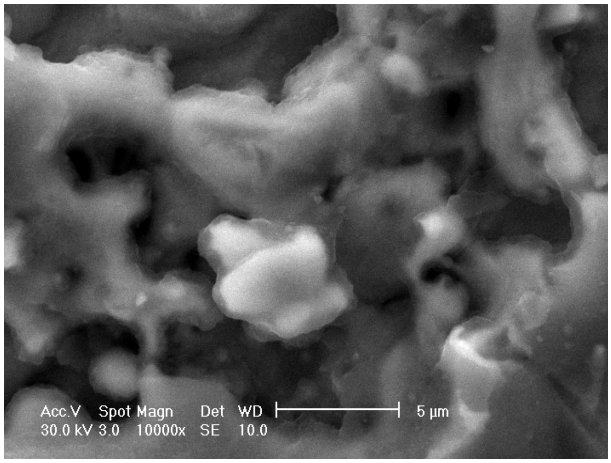


Figure 5.3. Secondary electrons image – surface morphology at 10.000x magnification.

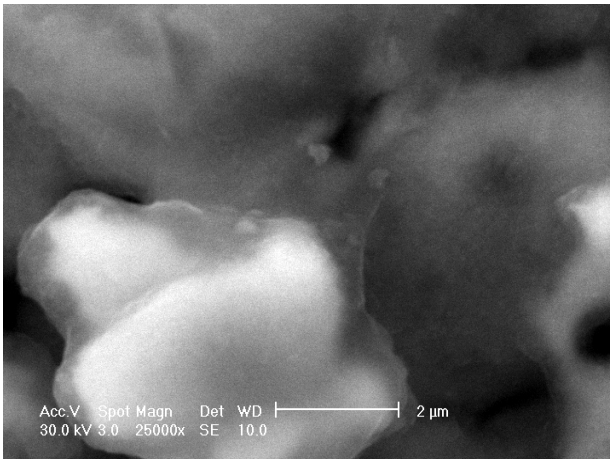


Figure 5.4. Secondary electrons image – surface morphology at 25.000x magnification.

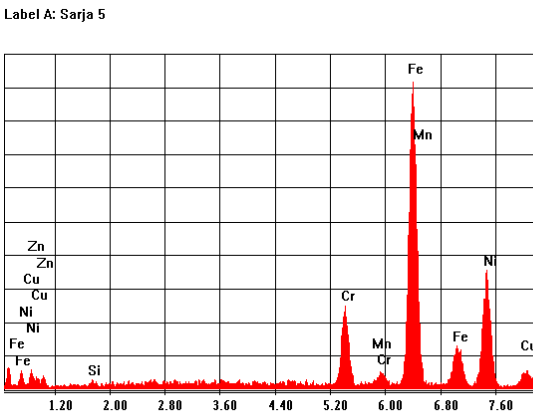


Figure 5.5. Characteristic X-ray emission specter, corresponding to sample 5 compositional analysis.

Element	Wt %	At %
SiK	0.58	1.17
CrK	9.42	10.24
MnK	0.92	0.94
FeK	50.68	51.29
NiK	30.63	29.49
CuK	5.91	5.25
ZnK	1.86	1.61
Total	100.000	100.000

Table 5. Quantitative compositional results corresponding to sample 5.

Sample 6

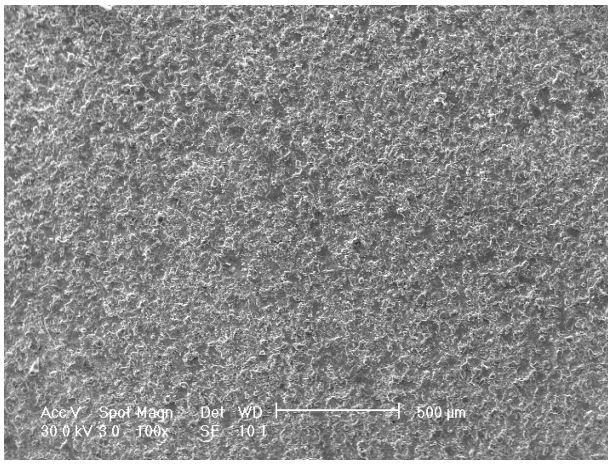


Figure 6.1. Secondary electrons image – surface morphology at 100x magnification.

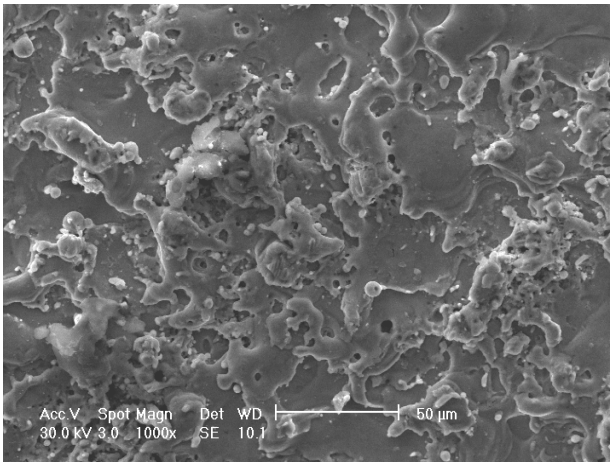


Figure 6.2. Secondary electrons image – surface morphology at 1.000x magnification.

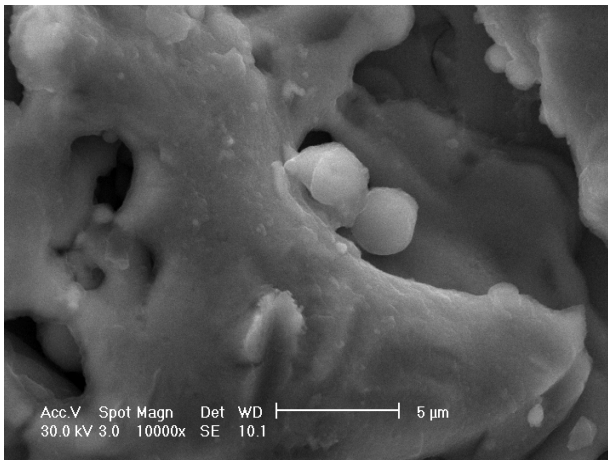


Figure 6.3. Secondary electrons image – surface morphology at 10.000x magnification.

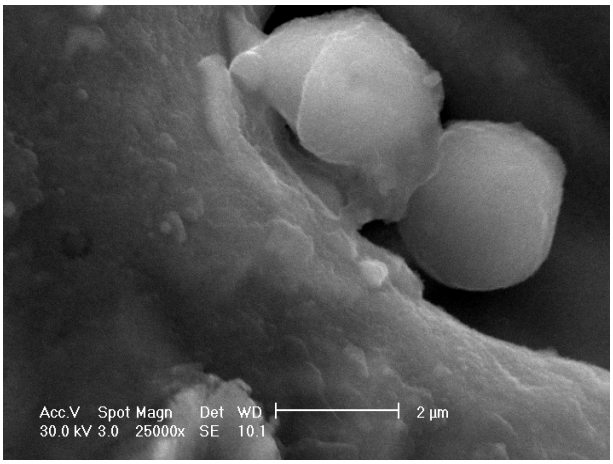


Figure 6.4. Secondary electrons image – surface morphology at 25.000x magnification.

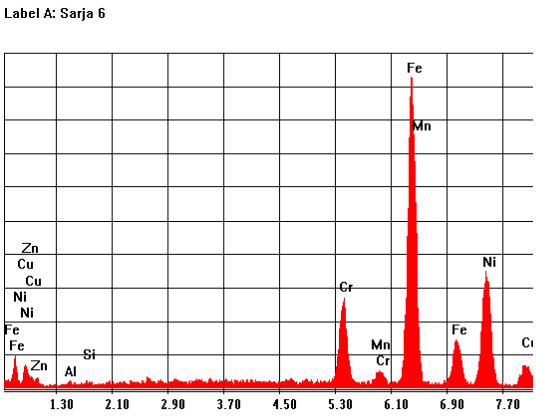


Figure 6.5. Characteristic X-ray emission specter, corresponding to sample 6 compositional analysis.

Element	Wt %	At %
AlK	0.91	1.88
SiK	0.65	1.29
CrK	9.68	10.42
MnK	0.52	0.53
FeK	49.57	49.66
NiK	30.55	29.11
CuK	6.69	5.89
ZnK	1.43	1.22
Total	100.000	100.000

Table 6. Quantitative compositional results corresponding to sample 6.

4. CONCLUSIONS

This report highlights the possibilities offered by this investigation method and allows drawing important conclusions over the structure of the investigated materials from analyzing the results.

Examining the samples using this method allows collecting information over:

- The morphology of analyzed surfaces – characteristics of object surface or, also known as, details regarding their textures, the link between material characteristics and properties (ductility, resistance, reactivity, etc.);
- Chemical composition of the samples – data regarding elements and compounds they are made of, but also quantitative ratio
- Crystalline structure – atom distribution in the crystal; the direct correlation between atom arrangement in the crystal network and material properties (conductivity, electric properties, resistance, etc.).

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PROBLEMS IN THE PYROLYSIS OF THE DISCARDED TIRES

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Abstract: The main element used for the production of tires is rubber. It is not subject to corrosion under natural conditions, leading to accumulation of large quantities discarded tires in landfills. Large cluster of them in landfills can cause atmospheric pollution when there is a fire. In the article we can see the problems associated with implementation of pyrolysis in our country. They are a consequence of the fact that European legislation does not distinguish between the use of UAG to burn as fuel in furnaces and pyrolysis. This Is an obstacle to the use of this technology for the recovery of waste tires as serious.
Key words: End-of-life tires (EOLT); environmental pollution; Pyrolysis; treatment of EOLT; Thermal decomposition

Introduction

End-of-life tires (EOLT) are a source of serious environmental pollution. They are not subject to natural decomposition, and with their accumulationmay be converted to a convenient location for the propagation of rodents, insects or other vermin, which makes them a potential source of various infections.

The tires are also flammable, In case of ignition, the fire is difficult to extinguish and often burn for days. At the same time significant growth in the vehicle park leads to continuous increase in the quantities of the thrown tires.

In connection with the serious environmental risk that is created by tires. At the end of 2012 entered into force and ordinance the requirements for treatment of discarded tire. This ordinance defines the requirements for collection, transport, storage, recovery or disposal of discarded tires, including targets for the regeneration and / or recycling and / of or recovered of them.

The ordinance prohibits the abandonment; illegal disposal or other form of uncontrolled disposal; burning with the exception of those in her case; landfilling of whole and cut tires, with certain exceptions.

Only in Bulgaria annually are generated about 60 000 tons of waste from used tires. This type of waste is extremely harmful to the environment, because it is not self-degradation, and then a heavy rain becomes an outbreak of infectious contamination.

In most part, these wastes contain hydrocarbons, oils, phosphatides, sugars and many other ingredients t, derived in an appropriate manner are very valuable raw materials for the preparation of biofuels.

Methods of processing EOLT

Permissible methods for recovery of discarded tires are specified according to the ordinance: regeneration, recycling, use as material in the construction and incineration for energy production [1].

Although the worn out tires contain valuable raw materials such as rubber, metal cord,and textiles have been developed and continue to develop technologies for their processing and recovery, the data show that only a small part of discarded tires are reprocessed.

Currently, the found practical application technologies suggest the use of whole tiresor shredded into small particles. Theworn out tires typically is used as a fencing to create artificial reefs to protect the slopes from erosion, etc. This method is one of the easiest for the

application, since it does not require tires to be subjected to special treatment. The tires can be used to produce energy through their combustion. Most commonly whole tires are burned in the enterprises of the cement industry.

Advantage of using whole tires is that the costs are mostly limited to the purchase of tires and drop these for the complementary their grinding. The tires are with a lower fire hazard. On the other hand, their transport, storage and management create certain difficulties. [6]

Often, the preferred option is the cutting of the tires into smaller pieces and usually with square form in different sizes. They can be stored in the open piles of. Submitting them to the furnace can be through a conveyor belt. The use sliced tires have several advantages. Submitting speed of the furnace can be adjusted, also in comparison with the use of whole tires, here necessity for manual labor is much smaller. As a disadvantage is the higher costs associated with the cutting of the tires and the difficulties created by the contained metal cord tire that is cutunevenly and may be submitted by the rubber layer.

Burning is not recommended. From an environmental point of view, burning tires in order to obtain energy is not assessed uniquely. Above all, this is due to the release of harmful substances into the atmosphere as zinc and sulfur oxides.Thefumes contain carcinogenic substances and certain quantities dioxin. However, it is good to note that burning tires does not always lead to pollution. From a technical point of view the safe combustion is entirely possible in providing of appropriate filter systems [2, 4].

The main problem is the need for significant investment in purification systems. According to some experts the burning of tires is not particularly efficient from an energy point of view.

Some predictions indicates that the use of tires as fuel for the cement industry can reduce fossil fuels by about 25% and to reduce levels of environmental pollution.

Fragmentation of tires is considered one of the most attractive methods for processing, since it allows maximally preserving the physical properties of rubber in the final product obtained from the processing. The method of milling is often divided into grinding in positive temperatures and cryogenic grinding. One of the applications of the resulting pieces of rubber is their use as an additive to the asphalt.

Pyrolysis as a method for the treatment of EOLT

Pyrolysis is process of thermal degradation of the solid waste in an inert atmosphere. This is a process of decomposing ofa complex chemical compounds into simpler substances, at high temperature and absence of oxygen. Furthermore, decomposition to smaller fragments, pyrolysis may include isomerization and the formation of more complex high-molecular compounds. By pyrolysis of methane can be obtained and pure carbon and hydrogen [3].

Pyrolysis is a sequence of several processes: drying, dry distillation, gasification, combustion of coke waste.Thermal decomposition of the starting waste and subsequent decomposition of intermediate compounds as well as condensation and polymerization of the molecules, resulting from the destruction of the starting material. Depending on the temperature of the flow are three types of pyrolysis:

- Low temperature (450-5500 C) - evolution of gas is minimum
- Medium - (over 8000 C) Quantitative product gas is maximum and the residues at the end of the process are in smaller amounts.
- High temperature - up to 11000 C.

At a temperature of 14000 the slag is liquid.

Resins and coal waste are obtainedin pyrolysis, which are used in the manufacture of plastics, as fillers in the manufacture of tires, instead of graphite in metallurgy. Pyrolysis is used most often for processing of old tires [2].

In Bulgaria the process of pyrolysis is based and the facility for pyrolysis of whole tires on company Eco process Piroteks and installation, offered by the company Enerkemikal.

Processing of old automobile tires is achieved via vacuum pyrolysis. During this process, with oxygen-free and at a high temperature, the complex hydrocarbon compounds are decomposed to simpler ones.

The process is extremely low energy intensive because of using their own energy (gas evolved) produced by the process itself.

Energy efficiency, expressed as the difference between the amount of processing of pyrolysis perton of tires energy, amounting to 35,700 MJ, and the extended energy for the process from MJ 2628, amounting to 33,072 MJ / ton, which is equal to 9187 KWh per ton tires.

The production process is uninterrupted. It ensures the environmental waste-free process of unfit tires and recovery of valuable materials from them, including the rational use of energy dissipation.

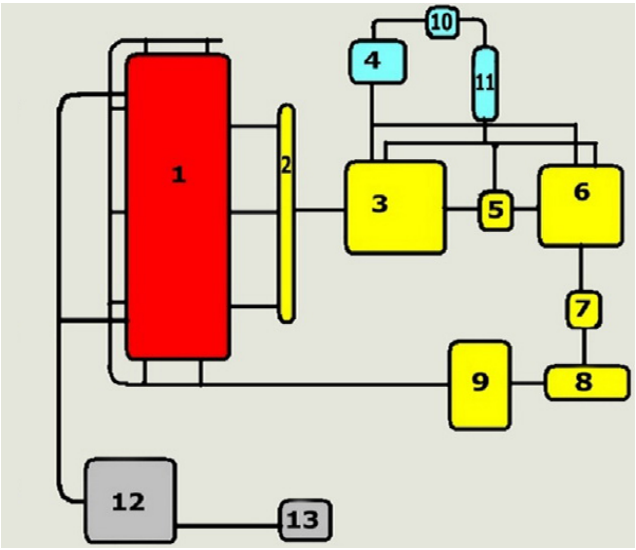

Fig. 1. Schematic of pyrolysis installation

1. Furnace pyrolysis – with three chambers, 2. Gas collector; 3. Scrubberfor wet scrubbing; 4. Pre collection of pyrolysis fuel; 5. Venturi. 6. Absorber for wet scrubbing 7. Centrifugal separator drop. 8. Fan for pyrolysis gases; 9. Receiver - gas. 10. Circulation pump. 11. Cooler. 12. Compartment for preheating. 13. Flue liners with smoke ventilators)

Fig. 1 shows the general scheme of the installation for processing and utilization of ENERKEMIKAL Ltd. - Bulgaria. Processing of old automobile tires is achieved via vacuum pyrolysis. The production process is continuous; it ensures the environmental waste-free process of unfit tires and recovery of valuable materials from them, including the rational use of energy dissipation [5]. At the base of the processing of EOLT is used the process of thermal decomposition. The process takes place at a temperature of 400 – 600C^0 in the absence of oxygen. During this process, with oxygen-free and at a high temperature, the complex hydrocarbon compounds are decomposed to simpler ones. The process is extremely low energy intensive because of using their own energy (gas evolved) produced by the process itself.

As a result of this process are given high carbon residue, liquid fraction and burn my non-condensable gases. The quantity of the liquid fraction is between 40 and 42% of the rubber content of the tire and that contains about 52% diesel fuel. From one ton raw material (EOLT) are obtained 400 kg liquid fraction (heavy fuel oil), 70 kg gas and 100 kg metal cord. Table 1provides information from testing the liquid fraction (heavy fuel oil) obtained by pyrolysis of EOLT [6].

Energy efficiency, expressed as the difference between the amount of processing of pyrolysis per ton of tires energy, amounting to 35,700 MJ, and the extended energy for the process from MJ 2628, amounting to 33,072 MJ / ton, which is equal to 9187 KWh per ton tires.

Table 1. Heavy fuel

№	Indicator	Testing results	№	Indicator	Testing results
1	Ash content	0.03%	6	density	0.9988 g/cm^3
2	Specific heat of combustion	39.84 MJ/ kg	7	Water-soluble acids and alkalis	-
3	kinematic viscosity	1.2 mm^2/s	8	Flash point	66^{0}C
4	Sulfur content	0.49%	9	Water content and sludge	0.2%
5	freezing temperature	-20^{0}C	10	total moisture	1.8 %

Table 2. The measured concentrations in burning (mg/Nm3)

№	substance	heavy fuel	pyrolysis gas
1	CO	163	21
2	SO_x(expressed as SO_2)	0.00	0.00
3	NO_xexpressed as NO_2)	20	0.00
4	CO_2 (%)	1.7%	0.1%

The resulting liquid fraction is used to preheat the installation and as fuel for boilers of fuel oil. The gas is used to maintain the technological process of combustion in the gas burner. High carbon residue is used for a solid fuel and as a raw material in the chemical industry in the form of activated carbon. It could be used in sewage treatment plants and various kinds of filters and dryers.

The metal cord contains steel as raw material for subsequent remelting.

The total content of dioxins and furans, obtained by the process is 0,012 ng / m3, which is proven by measuring with gas chromatography, with mass spectrometer Agilent 6890 Series II Plus GC / MSD Thermo Finnigan MAT 95XL, MID - mode. The total concentration of these substances in the waste gas is defined as the sum of the product of the concentrations of certain compounds and their toxic equivalency factors.

In our country, 16 installations for pyrolysis of EOLT are working.

The main problems facing these enterprises are connected with the inability to register the resulting products in the market as raw materials. According to the current legislation they are classified as a waste and thus cannot easily be represented on the market. This somewhat renders impracticable the production process.

It is not completely solved the problem with the collection of EOLT and making control on the stations for pyrolysis.

Conclusion

In descriptions and used the method of pyrolysis in Bulgaria, it does not release harmful substances into the environment and especially the carbon dioxide, which is a major greenhouse gas. Also, an advantage of this method is extremely low content of polychlorinated dibenzodioxins and dibenzofurans (PCDDs / PCDFs). This makes pyrolysis one of the most promising methods for treating EOLT.

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A REVIEW OF THE STATE-OF-ART FOR THE COPPER INDUSTRY

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Abstract: Copper has outstanding electrical and thermal conductivity, brought about in both cases by electron transfer. The recycling of copper is, for example, in Europe, well-functioning with established business for collection, treatment and processing of highgrade scrap. Copper is a versatile metal with a variety of industrial and residential applications, such as in electronic products, construction, industrial machinery, transportation and as alloying element inbrass and bronze. This is shown in the rather large proportion of the copper produced originating from secondary sources. Various secondary sources and wastes containing copper-based alloys are generated in industries such as brass scrap, waste residue of electric arc furnace, automobile shredder scrap, rayon industry sludge, and the alkaline batteries. Materials form the fabric of our present society and are everywhere in our lives. Many gold producers are today processing gold ores containing significant amount of cyanide soluble copper. There are many studies about the separating and recovering or hydrometallurgical process.
Keywords: resources, scrap, copper, recycling

Introduction

It can be assumed that there will continue to be a demand for copper also for future generations, as it has properties that are difficult to compete with in certain applications. The recycling rates for copper are good, some challenges can be foreseen, such as a scarcity of pure and high-grade scrap and an increased amount of products containing a mixture of materials and with low copper concentrations, which means that the processing industry must deal with more impurities.[1]

In recent years, there is a gaining considerable interest to recover metals, such as zinc, copper, iron etc., from the secondary sources and wastes. Separating and recovery of these metals is important and necessary both from view of economic point and the increased requirement of environmental protection.[2] Copper has outstanding electrical and thermal conductivity, brought about in both cases by electron transfer; many of its alloys have a very useful level of corrosion resistance.

In the galvanic series, their corrosion resistance is below that of noble metals, graphite, titanium, silver, passive stainless steel, and certain nickel alloys, but above that of active nickel, stainless steels, tin, lead, cast irons, carbon steels, and aluminum, zinc, and magnesium systems.[3]

The challenge of sustainability is rooted in the way that we now process resources to make materials and products, which are often discarded at the end of life. This linear economy is now running into its limits given the large demand for materials and resources of an increasing (and increasingly affluent) global population. Industrial society has become extremely dependent on resources, as it produces more, builds an increasingly complex society and accumulates an incredible volume of resources. Mankind now dominates the global flows of many elements of the periodic table (Howard and Klee, 2004).

The materials are drawn from natural resources. However, the Earth's resources are not infinite, but until recently, they have seemed to be: the demands made on them by manufacturing throughout the industrialization of society appeared infinitesimal, the rate of new discoveries outpacing the rate of consumption. Increasingly we realize that our society

may be approaching certain fundamental limits. This has made access to materials an issue of national security of many nations, especially also to ensure that emerging new "sustainable" technologies can be supplied with metals and materials. [4]

The study of the issue

Many different approaches have been taken to quantify the rates at which metals are recycled. Inevitably, recycling rates have been defined in different ways, and this has made it difficult to determine how effectively recycling is occurring. [5]

Copper is an essential trace element found in all organs and cells. The redox chemistry of this element makes copper highly suitable as a catalytic co factor in oxidative enzymes. The absorption is dependent on the amount ingested, its chemical form, and the composition of other dietary components such as zinc. [6] Typically, cyanide destruction is used to prevent the discharge of copper cyanide into tailings storage facilities. This imposes a significant financial cost to producers from the additional cyanide used to solubilise the copper and the cost of cyanide destruction reagents. This includes enabling the treatment of gold ores with even higher soluble copper. Over the years, a variety of processes have been developed or proposed to recover the copper and/or cyanide including acidification based technologies such as AVR and SART, direct electrowinning, activated carbon, ion exchange resins, solvent extraction, polychelating polymers, and membrane technologies.

In the paper, „A review of copper cyanide recovery technologies for the cyanidation of copper containing gold ores**"** , these processes are critically reviewed and compared, with particular focus on the advantages and limitations, and the separation of copper from cyanide. Ultimately, there is no universal process solution and the choice is highly dependent on the nature of the stream to be treated and integration with the whole processing plant Due to the dwindling resources of simple cyanide extractable gold deposits, a large proportion of the gold processed in the 21st century will be recovered from complex gold ores, many of which will contain soluble copper mineralsVarious processes have been developed or proposed which all require a clarified feed solution.[7]

„A review of the genesis, geochronology, and geological significance ofhydrothermal copper and associated metals deposits in the great xing'an range", provides informations about the Great Xing'an Range, which is situated NE China, and hosts many hydrothermal Cu and other base and precious metal mineral deposits and mineralization. Is an important part of the giant Central Asian metallogenic belt, and has been the focus of many recent studies (Chen et al., 2011; Liu et al., 2004; Liu et al., 2012; Rui et al., 1994; Zeng et al., 2009, 2010, 2011; Zhao et al., 1997). Mineral exploration in this area resulted in the discovery of numerous large-,middle-, and small-sized Pb–Zn, Cu, andMo deposits, including the Errentaolegai and Jiawula Pb–Zn deposits, the Duobaoshan and Wunugetushan Cu–Mo deposits, the Lianhuashan and Naoniushan Cu–Ag deposits, and the Maodeng and Aonaodaba Cu–Sn deposits, and recent studies have increased our understanding of the processes that formed these deposits (Chen et al., 2011; Chu et al., 2012; Li et al., 2007; Liu et al., 2012). The hydrothermal copper and associated metals deposits in this area can be divided into three genetic types based on their geology and geochronology: porphyry Cu–Mo, high-sulfidation Cu–Ag and Cu–Sn epithermal, and Cu–Fe skarn.

All of these mineral deposits, barring the Cu–Sm epithermal deposits, are closely related to high-K calc-alkaline I-type graniticmagmatism. The geodynamic setting of the region during these mineralizing events is consistent with Early Paleozoic collision between the Xing'an Massif and the Songnen Terrane, Late Permian collision between the North China Craton (NCC) and the Heilongjiang Plate, Middle Jurassic collision between the Siberian Plate and the NCC epicontinental aggradational belt, and crustal extension and thinning during an Early Cretaceous collisional orogenic event. This indicates that the mineral deposits formed in an intracontinental transitional orogenic or post-orogenic extensional tectonic setting. [8] The

work, **"**A critical review of the thermodynamics of hydrogen cyanide and copper-cyanide complexes in aqueous solution", brings the available thermodynamic data for the hydrogen/ cyanide and copper/cyanide systems in aqueous solution with special emphasis on measurements made at elevated ionic strengths and as a function of temperature.

The copper/cyanide system is of particular importance in gold hydrometallurgy as gold is often associated with copper sulfide minerals such as chalcopyrite, chalcocite, covellite and bornite, all of which except chalcopyrite are reasonably soluble in cyanide solutions due to the formation of copper/cyanide complexes. It has been found that,while reliable data are available at 25 °C and very low ionic strengths, the data for higher ionic strengths and temperatures are limited. An attempt has been made to rationalize the available data, and to point out areas where further careful measurements are desirable. At low cyanide concentrations, Cu will be mostly present as the sparingly soluble white cuprous cyanide solid, CuCN(s). The solubility product for CuCN(s) at 25°C and infinite dilution was determined after an extensive study by Vladimirova and Kakovskii (1950).

In aqueous HCN solutions, the solubility of CuCN(s) varies with the square root of the HCN concentration. When copper minerals are present in gold cyanidation systems, especially those where remnant gold is recovered from copper sulfide flotation tailings, the cyanide-soluble copper is generally present in much higher concentrations than the gold, and can therefore compete with the gold for both available cyanide and for adsorption sites on activated carbon. This can cause significant processing problems both from excessive cyanide consumption and reduced gold adsorption into carbon, thereby increasing overall treatment costs and reducing recoveries. The equilibria between Cu and CN, in aqueous solutions are thus of critical importance in the study and modelling of real copper–gold–cyanide processes. The formation constants for Cu–CN− complexes, except for the difficult-to-detect CuCN0(aq), are well documented at 25 °C and at low ionic strengths.

However, there is limited systematic knowledge on how these formation constants vary with ionic strength, solution composition and temperature. Further careful measurements of these effects are highly desirable because such constants are essential for modelling a variety of observed effects under actual hydrometallurgical conditions. A similar case can be made with regard to the corresponding enthalpies and entropies of reaction. [9]

Analysis and discussion

An important realization regarding metal recycling is that it is a sequence of steps. If any one step is done poorly, the efficiency of the entire sequence suffers. Attention needs to be paid to each of the steps, because one step may be the most inefficient for some types of products, other steps for others. The key questions, of course, are whether overall recycling efficiencies can be improved and, if so, by how much. That is, can materials cycles be transformed from open (without comprehensive recycling) to closed (completely reusable and reused), or at least to less open than they are at present.

These are issues that turn out to be quite complex, to involve everything from product designers to policies for pickup of discarded electronics.[10] The use and degradation of refractory linings in copper furnaces are discussed, thereby describing the main steps taken at the research, developmentand industrial level to minimize refractory wear. Which combination of chemical, thermal and mechanical degradation mechanisms is dominantdepends on many factors such as the furnace type, the lining design, including the selection of the refractory type, and the process conditions.

Magnesia-chrome bricks are widely used to line copper furnaces, despite the potential risk for the formation of hexavalent Cr under specificconditions, typically in the presence of alkali or alkaline earth oxides. This review concludes with refractory selection and use on the industrial level, including the waste and recycling management of spent refractories.The pyrometallurgical processing of copper from ores or recycled scrap, may comprise either

batch, semi-continuous, or fully continuous processes, thereby involving smelting, converting and/or refining furnaces. The reliable and profitable operation of these furnaces strongly depends on the integrity of the vessel, which is often subjected to turbu-lent and aggressive process conditions.
It is however not the only driving force for the refrac-tory companies to develop new bricks and procedures. Although the most appropriate material to line the furnaces of the copper industry so far is considered to be the magnesia-chrome type due to its high resistance against slags with different basic, the possible formation of Cr6+, above all when working with calcium ferrite slags in converting processes or sodium carbonate/hydroxide slags in refining processes, has increased the interest in magnesia and alumina bricks as alternatives. To the best of our knowledge, the use of the latter brick types is still mainly in the research and development phase, and their future evolution will depend amongst others on how the use of Cr containing bricks in the steel industry will evolve.
Finally, with respect to the recent evolutions in the copper production, two trends that will affect further brick development should be mentioned. Firstly, the input material of the primary copper production is changing as concentrates with low levels of impurity elements are becoming more scarce. These increased level of impurity elements can change the refractory degradation behavior, either directly or through a change in operation conditions. Secondly,secondary copper production is gaining importance, there by introducing new flow sheets, operating conditions and input material compared to the primary production processes. Prior to this work, multiple interesting review papers on refractory for use in the copper production can be found. Schlesinger provides an overview of the copper production units and their factors influencing the refractory behavior, the history of refractory material types, the use of magnesia-chrome refractories for copper production and the prospects for chrome-free refractories. For a summary of the main chemical, thermal and mechanical degradation mechanisms, the work by Barthel, Taschler and Rigby can be recommended. The paper by Barthel describes the factors influencing the refractory lining in copper smelting furnaces and how chrome-magnesia and magnesia-chrome bricks behave under these conditions. Besides the wear mechanisms, the review work by Taschler, for refractory use in the copper and lead industry, describes the main slag properties, the evolution in brick development and the quality requirements.
The paper by Köffel and Taschler, has similar content as the review paper by Taschler. The review paper by Rigby is in particular interesting for the refractory linings of converters and anode furnaces in the copper industry. The main wear mechanisms, the operational factors influencing there fractory life-span and the effect of lining installation practice and brick quality for these furnaces are summarized.[11] The pyrometallurgical recovery of copper-based alloys with zinc from secondary resources had been studied under different conditions. The equipment used in the pyrometallurgical process always includes blast furnace, reverberatory furnace, and converter et al. Zinc existed in scrap copper-based alloys is widely distributed in various parts of the process, which not only result in some trouble in recovery of zinc but also reduces the recovery rate of other metals. For example, when copper-based alloys with zinc are smelted in the blast furnace, 12% w 15% by weight of zinc exists in black copper, 45% w 55% volatilizes into smelter flue dusts in the form of ZnO, and 30% w 35% remains in slag, which causes the melting point of slag to rise and viscosity to magnify, thus, copper is prone to be mixed in slag, which reduces the recovery rate of copper.
In the hydrometallurgical process, different leaching agents, including sulfuric acid, hydrochloric acid, acetic acid, cyanide and ammonia, were used, which were studied or developed by many authors. However, the hydrometallurgical methods have draw backs such as complex process flows, high consumption of chemical reagents, high cost in operation and secondary environmental pollution. Therefore, it is necessary to research a progressive

process for the recycling scrap copper-based alloy containing zinc for a complex system in the form of piece or block. Treatment of zinc based on conventional pyrometallurgical process Separation and recovery process of zinc from scrap copper-based alloy was carried out under vacuum condition in a sublimation reactor. [12]

In the study, „Effect of accumulative roll bonding process on the electrochemical behavior of pure copper" the effect of accumulative roll bonding (ARB) process on the electrochemical behavior of pure copper in 0.01 M borax solution has been investigated. The microhardness tests showed that by implementing the ARB process the values of microhardness improve with increasing the number of ARB cycles. Copper are extensively used in industrial applications, corrosion prevention, power generation, and heat exchanger tubes. So, there is an interest in studying the corrosion and electrochemical behavior of this metal in different conditions, particularly in alkaline environments.

The passivation behavior of copper in the alkaline solutions is very important because of the scientific importance of this phenomenon. Indeed, the passive film provides an efficient barrier against the metal dissolution. This behavior has been studied in correlation to the protective nature and the electrochemical behavior of the copper passive film. [13] The authors Graham Llong ,Yongjun Peng, Dee Bradshaw, in their work, related that the arsenic is a toxic and volatile element that has little commercial use. This is causing some concern to copper smelters as they are obliged to dispose of arsenic materials produced as a by-product to the smelting process in accordance with ever tightening environmental guidelines. The onus is to move back to concentrate producers to remove toxic elements, such as arsenic, earlier in the concentrate supply chain.

The common copper–arsenic bearing minerals in copper ores, enargite (Cu_3AsS_4) and tennantite ($Cu_{12}As_4S_{13}$), contain significant amounts of copper; 48.4% and 51.6% respectively. Removal of these minerals from the concentrate removes valuable metal, hence income. There is a dearth of literature concerning the selective removal of enargite and tennantite from sulphide ores, but there are reports on some success using either chemical oxidation or potential control. These methodologies have been applied to ores from mines as they deepen where arsenic levels in concentrate are becoming prohibitive. In copper ores, arsenic is often contained within tennantite ($Cu_{12}As_4S_{13}$) or enargite (Cu_3AsS_4). These copper–arsenic minerals contain 51.6% and 48.4% copper respectively, so they tend to float similarly to other copper sulphide minerals, reporting to the concentrate.

With smelters having to dispose of arsenic products in accordance with environmental regulations, they are becoming more selective in the concentrates they buy, and imposing financial penalties for excessive arsenic levels on concentrates when appropriate.[14]

Conclusions

Materials will play a key role in the transition of our society toward sustainability. Today, China produces half of all the cement, steel and other commodities in the world. Recyclable wastes are often collected by cities and municipalities, selling them into a market of traders and secondary processors who reprocess the materials to eventually sell them to manufacturers. In the recycling market, prices fluctuate according to the balance of supply and demand, the prices of materials made from primary resources, as well as the behavior and organization of markets and its stakeholders (the role of increased market power concentration, and speculation of silver and copper). This couples the price of the recycled material to that of the primary or virgin material. The markets are also affected by economic or policy interventions.[15]

There are few studies of exposure levels in the work environment of copper-producing plants or plants using copper in their production in the scientific literature. Even fewer reported studies have used sampling techniques that take into account health-related aerosol fractions by sampling particles according to size. [16] Therefore, the recovery of copper as a valuable

by-product and the recycle of cyanide to the leach circuit have the potential for significant economic and environmental benefits. It has been estimated that about 20% of all gold deposits have significant copper mineralization commonly associated with chalcopyrite, tetrahedrite, tennantite, as well as bornite and chalcocite in certain ores (Muir et al., 1989).

It has also been found that the majority of copper minerals including copper oxides, carbonates, sulfides (with the exception of chalcopyrite) and native copper are highly soluble in cyanide solutions (Marsden and House, 2006). [17] There is limited systematic knowledge on how these formation constants vary with ionic strength, solution composition and temperature.

Further careful measurements of these effects are highly desirable because such constants are essential for modelling a variety of observed effects under actual hydrometallurgical conditions. A similar case can be made with regard to the corresponding enthalpies and entropies of reaction.[18] The factors affecting the evaporation ratio of copper-based alloy and the separation efficiency of zinc, such as heating temperature, residual gas pressure, vacuum evaporation time and the amount of scrap copper-based alloy were separately investigated. The experimental results revealed that zinc was successfully separated from the scrap copper-based alloy, where the evaporation ratio of copper-based alloy reached 18.43%.

Namely, 96.09% by weight of zinc could be removed under the condition: residual gas pressure of 50 Pa, heating temperature of 1323 K and vacuum evaporation time of 90 min. If corresponding to the residual gas pressure 500 Pa, the evaporation ratio reached 18.17%, and 94.73% by weight of zinc could be removed under the following experimental conditions: temperature 1323 K, vacuum evaporation time 180 min. Meanwhile, the thermodynamics of vacuum sublimation and refining to recover zinc was analyzed and calculated.[19] Copper are extensively used in industrial applications, corrosion prevention, power generation, and heat exchanger tubes. So, there is an interest in studying the corrosion and electrochemical behavior of this metal in different conditions, particularly in alkaline environments.

The passivation behavior of copper in the alkaline solutions is very important because of the scientific importance of this phenomenon. Indeed, the passive film provides an efficient barrier against the metal dissolution. This behavior has been studied in correlation to the protective nature and the electrochemical behavior of the copper passive film.[20] The authors Graham Llong, Yongjun Peng, Dee Bradshaw, in their work, related that the development of an economical method of removing arsenic bearing minerals earlier in the beneficiation stream is becoming increasingly more important. Magnetic separation of copper and copper–arsenic sulphides present a low chance of separation, so little work to progress this treatment option appears to have been conducted. Roasting was also used to reduce the arsenic content of copper concentrates at the El Indio mine, Chile.

A high arsenic–copper flotation concentrate was produced that contained 10.5% arsenic, contained within enargite and tennantite. Kappes et al. (2007) investigated an unnamed gold–copper deposit that contained elevated levels of tennantite. Product specifications required a copper concentrate below 2000 ppm arsenic.[21]

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OVERVIEW OF THE INFORMATION SECURITY STANDARDIZATION

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Abstract—There are different kinds of standards, treated by different organizations. In the article below they are presented to the standardisation bodies, which European and the Hungarian economy has big a impact. We do all this in order to find your way to the right so that the client can compare a multitude of information security.
Keywords—standardization; organizations of standardization; information security, information security standards

THE NEED FOR INFORMATION SECURITY STANDARDS

The information is an important value in the economic and social world. The information is the resource of the organizations. This is the basis for the efficient operation of the Organization's assets, and often also the status of your product.

The successful economic, social behaviour is now not only the high quality of carried out activity, a well-functioning organization, should be subject to competitive products and services, but also related to data and information management and protection, as well.

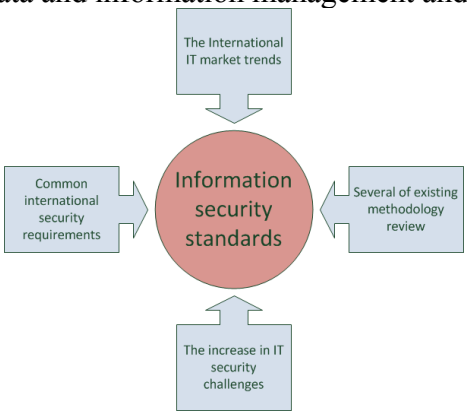

Fig. 1. The main factors of the information security standards (by the authors)

Basically, the reliability and safety of the information affects the body's functioning, as well as the operational, logistic, financial and other processes. And this is in addition to the productivity and legal compliance and profit-making capability, and the market image, and much more.

So, therefore it is essential that a sufficient level of protection of the information. The information security processes and activities of standardization could be applied by a single form. Compliance with the standards and certification audits, offer guarantees of the economic operators and public organizations as well. A number of government standards or recommendations developed along its own information security strategy, as the Government of Hungary did this, too.

THE STANDARDIZATION

A. The standard

A standard is a document that provides requirements, specifications, guidelines or characteristics that can be used consistently to ensure that materials, products, processes and services are fit for their purpose. [1]

B. Short history of the standardisation

The standardization is an activity that can be used again and gives solutions to general existing or anticipated problems, with a view to the effect that organizes the most favourable conditions possible.

The standardization is nothing more than the pursuit of harmonisation. The history of standardization – if not in the today's form–, the instinctive standardization began when the languages and number systems, ensuring consistent communication within groups. The development of a system of units of measurement was a conscious tool of standardization, trade, manufacture, levy made this necessary.

The unification demands raised earlier but only in the 1790's made on a proposal French Bishop Talleyrand, the definition of the meter and prefixes.

Organized by the national standardization bodies delegated to standardization began in the 20th century, when the Engineering Standards Committee was formed for the first time in London in 1901. In Hungary, two decades later, in 1921, has been converted into the corresponding Hungarian Institute for Industrial Standards. The standardization is the latest generation of the international standardisation, which was followed by the level of national standardization only a slight delay. The IEC[1] has been founded in 1906, and ISA[2] has been founded in 1928.

There are several levels of standardization, which are among the highest of international standardization, in this is participate the competent bodies of the countries. There are standards bodies on international level, as well as the ISO[3] since 1947, our country has been the member of it. And there is the IEC[4] and the ITU[5], which are the United Nations specialized agencies.

The regional standardization is such a standardization, which is the world's only in a specific geographical, political, or economic area countries can participate in the relevant bodies. There are regional standards bodies, such as the European Committee for Standardization (CEN[6]), and the European Committee for Electrotechnical Standardization (CENELEC[7]) and the European Telecommunications Standards Institute ETSI[8].

The national standardization is a specific country level current standardization. For example, our national standardization bodies are the Hungarian Standardization Institution (MSZT[9]), the BSI[10], the German Standards Institution (DIN[11]) and the ANSI[12].

We can talk about the enterprise standardization when the company is valid within its organisation, usually mandatory, mostly related to prepare and apply technical specifications,

[1] The International Electrotechnical Commission
[2] National Standards Bodies International Association
[3] International Organization for Standardization
[4] International Electrotechnical Commission
[5] International Telecommunication Union
[6] Comité Européen de Normalisation
[7] Comité Européen de Normalisation Electrotechnique
[8] European Telecommunications Standards Institute
[9] Magyar Szabványügyi Testület
[10] British Standards Institution
[11] Deutsches Institut für Normung e.V.
[12] American National Standards Institute

ensures enterprise-wide implementation of the national standard. The supplier is also demanding the corporate standards. [2]

ORGANIZATIONS OF INTERNATIONAL STANDARDIZATION

A. The International Organization for Standardization - ISO

The ISO story began in 1946 when delegates from 25 countries met at the Institute of Civil Engineers in London and decided to create a new international organization 'to facilitate the international coordination and unification of industrial standards'. In February 1947 the new organization, ISO, officially began operations.

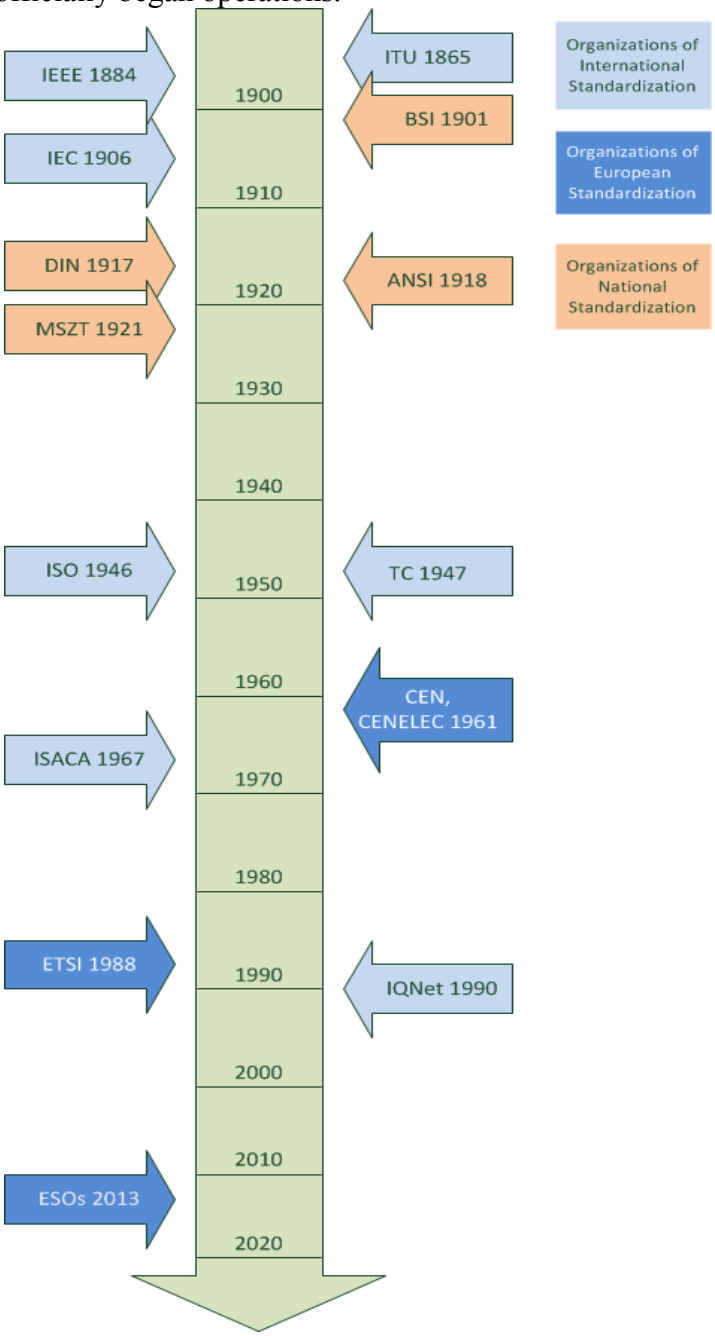

Fig. 2. Formation of the organizations of standardization (by the authors)

Since then, they have published over 19 500 International Standards covering almost all aspects of technology and manufacturing.

Today they have members from 163 countries and 3 368 technical bodies to take care of standard development. More than 150 people work full time for ISO's Central Secretariat in Geneva, Switzerland.

Their name is ISO, because 'International Organization for Standardization' would have different acronyms in different languages (IOS in English, OIN in French for Organisation Internationale de Normalisation), their founders decided to give it the short form ISO. ISO is derived from the Greek *isos*, meaning equal. Whatever the country, whatever the language, they are always ISO.

ISO is an independent, non-governmental organization made up of members from the national standards bodies of 163 countries. Their members play a vital role in how they operate, meeting once a year for a General Assembly that decides on their strategic objectives.

They have a Central Secretariat in Geneva, Switzerland, that coordinates the system. Operations at the Central Secretariat are directed by the Secretary General.

The ISO Council takes care of most governance issues. It meets twice a year and is made up of 20 member bodies, the ISO Officers and the Chairs of Policy Development Committees (CASCO, COPOLCO, DEVCO). Membership to the Council is open to all member bodies and rotates to make sure it is representative of the member community.

Under the Council there are a number of bodies that provide guidance and management on specific issues.

The President's advise the Committee Council and oversee the implementation of the decisions taken by the Council and the General Assembly.

- CASCO[13] - provides a guidance on conformity assessments
- COPOLCO[14] - provides a guidance on consumer issues
- DEVCO[15] - provides a guidance on matters related to developing countries
- Council Standing Committees - advise on financial and strategic matters
- Ad hoc Advisory Committees - can be established to advance the goals and strategic objectives of the organization

The management of the technical work is taken care of by the Technical Management Board. This body is also responsible for the technical committees that lead standard development and any strategic advisory boards created on technical matters.

They work closely with two other international standards development organizations, the International Electrotechnical Commission (IEC) and International Telecommunication Union (ITU). In 2001, ISO, IEC and ITU formed the WSC[16] in order to strengthen the standards systems of the three organisations. The WSC also promotes the adoption and implementation of international consensus-based standards worldwide.

In addition, they also have a close relationship with the WTO[17] which particularly appreciates the contribution of International Standards to reducing technical barriers to trade.

ISO also works with the United Nations partners. For example, they liaise with UN specialized agencies that do technical harmonization or technical assistance, including the ECOSOC[18].

In total, ISO collaborates with over 700 international, regional and national organisations. These organisations take part in the standard development process as well as sharing expertise and best practices. [3]

They have been developed by the family of chief information security standard, ISO/IEC 27000, which we use today.

[13] Committee on conformity assessment
[14] Committee on Consumer Policy
[15] Committee on developing country matters
[16] World Standards Cooperation
[17] World Trade Organization
[18] UN Economic and Social Council

B. The Technical Committee - TC

The list of ISO technical committees provides basic information for each technical committee (TC). The TCs are listed in numerical order, following the order in which they were established. For example, TC 1 focusing on screw threads was created in 1947 and TC 269 on railway applications was created in 2012.

JTC1[19] is the Joint ISO/IEC TC that was created in 1987.

Project Committees are established when there is a need for an International Standard on a specific topic that does not fall into the scope of an existing TC. Project Committees are disbanded once the standard has been published. [4]

C. The International Electrotechnical Commission - IEC

Millions of devices that contain electronics, and use or produce electricity, rely on IEC International Standards and Conformity Assessment Systems to perform, fit and work safely together.

Founded in 1906, the IEC (International Electrotechnical Commission) is the world's leading organization for the preparation and publication of International Standards for all electrical, electronic and related technologies. These are known collectively as "electrotechnology".

IEC provides a platform to companies, industries and governments for meeting, discussing and developing the International Standards they require.

All IEC International Standards are fully consensus-based and represent the needs of key stakeholders of every nation participating in IEC work. Each member country, no matter how large or small, has one vote and a say in what goes into an IEC International Standard. [5]

The International Electrotechnical Commission is the leading global organization that publishes consensus-based International Standards and manages conformity assessment systems for electric and electronic products, systems and services, collectively known as electrotechnology.

IEC publications serve as a basis for national standardization and as references when drafting international tenders and contracts.

The IEC Statutes and Rules of Procedure is the governing document of the IEC. It details the rights and obligations of the member National Committees, the IEC Officers and the different IEC management boards.

The Directives outline the procedures of the IEC's technical work, including the rules for the structure and drafting of International Standards. [6]

D. The International Telecommunication Union - ITU

ITU (International Telecommunication Union) is the United Nations specialized agency for information and communication technologies – ICTs.

For a century and a half since 1865, the International Telecommunication Union (ITU) has been at the centre of advances in communications – from telegraphy through to the modern world of satellites, mobile phones and the Internet.

The story of ITU is one of international cooperation, among governments, private companies and other stakeholders. The continuing mission is to achieve the best practical solutions for integrating new technologies as they develop, and to spread their benefits to all. [7]

They allocate global radio spectrum and satellite orbits, develop the technical standards that ensure networks and technologies seamlessly interconnect, and strive to improve access to ICTs to underserved communities worldwide.

ITU is committed to connecting the entire world's people – wherever they live and whatever their means. Through their work, they protect and support everyone's fundamental right to communicate.

[19] Joint Technical Committee 1

Today, ICTs underpin everything they do. They help manage and control emergency services, water supplies, power networks and food distribution chains. They support health care, education, government services, financial markets, transportation systems and environmental management. And they allow people to communicate with colleagues, friends and family anytime, and almost anywhere.

With the help of their membership, ITU brings the benefits of modern communication technologies to people everywhere in an efficient, safe, easy and affordable manner.

ITU membership reads like a Who's Who of the ICT sector. They are unique among UN agencies in having both public and private sector membership. So in addition to their 193 Member States, ITU membership includes ICT regulators, leading academic institutions and some 700 private companies.

In an increasingly interconnected world, ITU is the single global organization embracing all players in this dynamic and fast-growing sector.

ITU is headquartered in Geneva, Switzerland, and has twelve regional and area offices around the world.

ITU membership represents a cross-section of the global ICT sector, from the world's largest manufacturers and carriers to small, innovative players working with new and emerging technologies, along with leading R&D[20] institutions and academia. [8]

E. The Institute of Electrical and Electronics Engineers - IEEE

IEEE[21], an association dedicated to advancing innovation and technological excellence for the benefit of humanity, is the world's largest technical professional society. It is designed to serve professionals involved in all aspects of the electrical, electronic, and computing fields and related areas of science and technology that underlie modern civilization.

IEEE's roots go back to 1884 when electricity began to become a major influence in society. There was one major established electrical industry, the telegraph, which since the 1840s had come to connect the world with a data communications system faster than the speed of transportation. The telephone and electric power and light industries had just gotten underway.

IEEE, pronounced "Eye-triple-E," stands for the Institute of Electrical and Electronics Engineers. The association is chartered under this name and it is the full legal name.

However, as the world's largest technical professional association, IEEE's membership has long been composed of engineers, scientists, and allied professionals. These include computer scientists, software developers, information technology professionals, physicists, medical doctors, and many others in addition to IEEE's electrical and electronics engineering core. For this reason the organization no longer goes by the full name, except on legal business documents, and is referred to simply as IEEE. [9]

IEEE is a leading developer of international standards that underpin many of today's telecommunications, information technology, and power generation products and services.

Often the central source for standardization in a broad range of emerging technologies, the IEEE Standards Association has a portfolio of more than 1,671 standards and projects under development. This includes the prominent IEEE 802® standards for wireless networking. [10]

1) The IEEE standards association

The IEEE-SA[22] is a leading consensus building organization that nurtures, develops and advances global technologies, through IEEE external link. They bring together a broad range of individuals and organizations from a wide range of technical and geographic points of origin to facilitate standards development and standards related collaboration. With collaborative thought leaders in more than 160 countries, they promote innovation, enable the creation and

[20] Research and development

[21] Institute of Electrical and Electronics Engineers

[22] IEEE Standards Association

expansion of international markets and help protect health and public safety. Collectively, their work drives the functionality, capabilities and interoperability of a wide range of products and services that transform the way people live, work and communicate.

The IEEE-SA is governed by the BOG[23] who are elected by IEEE-SA Members. The Board of Governors oversees number of committees that are dedicated to manage key operational aspects of the IEEE-SA. The IEEE-SA Standards Board reports directly to the BOG, and oversees the IEEE standards development process. Standards Board members are elected by IEEE-SA members as a privilege of membership, and all Board Members and Committee members must be IEEE-SA members in good standing.

The IEEE-SA standards development process is open to IEEE-SA Members and non-members, alike. However, IEEE-SA Membership enables standards development participants to engage in the standards development process at a deeper and more meaningful level, by providing additional balloting and participation opportunities. IEEE-SA members are the driving force behind the development of standards, providing technical expertise and innovation, driving global participation, and pursuing the ongoing advancement and promotion of new concepts. [11]

F. The Information Systems Audit and Control Association - ISACA

As an independent, non-profit, global association, ISACA[24] engages in the development, adoption and use of globally accepted, industry-leading knowledge and practices for information systems. Previously known as the Information Systems Audit and Control Association, ISACA now goes by its acronym only, to reflect the broad range of IT governance professionals it serves.

ISACA was incorporated by individuals who recognized a need for a centralized source of information and guidance in the growing field of auditing controls for computer systems. Today, ISACA has more than 115,000 constituents worldwide. [12]

ISACA got its start in 1967, when a small group of individuals with similar jobs—auditing controls in the computer systems that were becoming increasingly critical to the operations of their organizations—sat down to discuss the need for a centralized source of information and guidance in the field. In 1976 the association formed an education foundation to undertake large-scale research efforts to expand the knowledge and value of the IT governance and control field. Previously known as the Information Systems Audit and Control Association, ISACA now goes by its acronym only, to reflect the broad range of IT governance professionals it serves.

Today, ISACA's constituency is characterized by its diversity. Constituents live and work in more than 180 countries and cover a variety of professional IT-related positions—to name just a few, IS auditor, consultant, educator, IS security professional, regulator, chief information officer and internal auditor. Some are new to the field, others are at middle management levels and still others are in the most senior ranks. They work in nearly all industry categories, including financial and banking, public accounting, government and the public sector, utilities and manufacturing. This diversity enables members to learn from each other, and exchange widely divergent viewpoints on a variety of professional topics. It has long been considered one of ISACA's strengths.

Since its inception, ISACA has become a pace-setting global organization for information governance, control, security and audit professionals. Its IS auditing and IS control standards are followed by practitioners worldwide. Its research pinpoints professional issues challenging its constituents.

[23] Board of Governors
[24] Information Systems Audit and Control Association

Its CISA[25] certification is recognized globally and has been earned by more than 109,000 professionals since inception. The CISM[26] certification uniquely targets the information security management audience and has been earned by more than 25,000 professionals. The CGEIT[27] designation promotes the advancement of professionals who wish to be recognized for their IT governance-related experience and knowledge and has been earned by more than 6,000 professionals. The CRISC[28] designation for those who identify and manage risks through the development, implementation and maintenance of information systems controls have been earned by more than 17,000 professionals. [13]

G. The International Certification Network - IQNet

IQNet - The International Certification Network has been active since 1990, and has almost 40 Partner certification bodies with more than 200 subsidiaries worldwide. Each of them IQNet Partners is a leader in their region; and collectively through IQNet, this represents the most extensive and reputable network of certification bodies worldwide. IQNet headquarters are based in Bern, Switzerland. IQNet supports the work of international organizations by its membership and involvement in for example IAF[29], and EA[30].

A common database of certified/registered companies has been established since 2005. Certificates/registrations contained in this database are issued by IQNet partners. Certificates are mainly third-party certification/registration of management systems in accordance with international standards such as ISO 9001, ISO 14001, sector specific standards, or national standards.

The objectives of this database are to promote valid certificates issued by IQNet partners, and to act as a point of verification for all conformity assessment stakeholders; including procurement bodies.

IQNet partners are regularly updating and entering their data. With more than 250.000 entries, the IQNet database is one of the largest public listings on certified/registered companies worldwide. [14]

ORGANIZATIONS OF EUROPEAN STANDARDIZATION

A. The European Standardization Organizations - ESOs

The three European Standardization Organizations, CEN, CENELEC and ETSI are officially recognized as competent in the area of voluntary technical standardization. The European Union (EU) Regulation (1025/2012) which settles the legal framework for standardization, has been adopted by the European Parliament and by the Council of the EU[31], and entered into force on 1 January 2013.

Although they deal with different fields of activity, CEN, CENELEC, and ETSI cooperate in a number of areas of common interest, such as the machinery sector or information and communication technologies (ICTs). They also share common policies on issues where there is a mutual agreement.

An EN (European Standard) “carries with it the obligation to be implemented at national level by being given the status of a national standard and by withdrawal of any conflicting national standard". Therefore, a European Standard (EN) automatically becomes a national standard in each of the 33 CEN-CENELEC member countries.

[25] Certified Information Systems Auditor
[26] Certified Information Security Manager
[27] Certified in the Governance of Enterprise IT
[28] Certified in Risk and Information Systems Control
[29] International Accreditation Forum
[30] European cooperation for Accreditation
[31] European Union

Standards are voluntary which means that there is no automatic legal obligation to apply them. However, laws and regulations may refer to standards and even make compliance with them compulsory. [15]

B. The European Committee for Standardization - CEN

CEN, the European Committee for Standardization, is an association that brings together the National Standardization Bodies of 33 European countries.

The core business of CEN is to develop and publish European Standards and technical specifications that meet the evolving needs of European businesses and other organizations. This important work brings concrete benefits, such as: improving safety, quality and reliability of products, services, processes; reinforcing the Single Market and supporting the economic growth and the spread of new technologies and innovation.

In order to prepare and produce state-of-the-art standards, CEN relies on the knowledge of some 50.000 experts, who participate in various technical activities through a network of 50 National Standards Bodies (33 Members plus 17 Affiliates) and continuous cooperation with organizations representing different stakeholders, including consumers, workers, environmental interests and SMEs[32].

The CEN/BT[33] is responsible for co-ordinating and managing the standards development work that is being carried out in more than 320 Technical Committees. In addition to overseeing these activities, as well as their related processes, the CEN Technical Board is also responsible for evaluating and addressing requests for standardization on new subjects.

The Vienna Agreement provides a framework for technical cooperation between CEN and the International Organization for Standardization (ISO). It provides provisions relating to the exchange of information between ISO and CEN, mutual representation at meetings, and parallel approval of standards.

CEN provides a European platform for the standardization of products, services, processes and systems across a wide range of sectors.

A growing number of sectors are being addressed by both CEN and the European Committee for Electrotechnical Standardization (CENELEC) in the framework of their joint activities. These include among others: Accessibility, Defence and Security, Energy Efficiency, Energy Labelling, Ecodesign and Energy Management, Health and Safety. [16]

C. The European Committee for Electrotechnical Standardization - CENELEC

CENELEC is the European Committee for Electrotechnical Standardization and is responsible for standardization in the electrotechnical engineering field. CENELEC prepares voluntary standards, which help facilitate trade between countries, create new markets, cut compliance costs and support the development of a Single European Market.

CENELEC creates market access at European level but also at international level, adopting international standards wherever possible, through its close collaboration with the International Electrotechnical Commission (IEC), under the Dresden Agreement.

In an ever more global economy, CENELEC fosters innovation and competitiveness, making technology available industry-wide through the production of voluntary standards.

Through the work of its members together with it's the experts, the industry federations and consumers, European Standards are created in order to encourage technological development, to ensure interoperability and to guarantee the safety and health of consumers and provide environmental protection.

Designated as a European Standards Organization by the European Commission, CENELEC is a non-profit technical organization set up under Belgian law. It was created in 1973 as a result of the merger of two previous European organizations: CENELCOM and CENEL. [17]

[32] Small and Medium-sized Enterprises
[33] CEN Technical Board

D. The European Telecommunications Standards Institute - ETSI

ETSI[34] produces globally-applicable standards for ICT[35], including fixed, mobile, radio, converged, broadcast and internet technologies.

They are officially recognized by the European Union as a European Standards Organization. The high quality of their work and their open approach to standardization has helped us evolve into a European roots - global branches operation with a solid reputation for technical excellence.

ETSI is a not-for-profit organization with over 750 ETSI member organizations drawn from 64 countries across 5 continents world-wide. More information concerning ETSI member organizations is available in the membership section. [18]

1) Openness

'Openess' goes much further than simple access to a standard once it has been published. At ETSI, 'openess' is a question of culture.

They pride ourselves on being 'open', not only in creating their standards via consensus but via the direct input of their members. It is they who ultimately make and set ETSI standards.

'Openness', in ETSI terms, also means that almost any organization or person, from any part of the world, can become a member.

But having a truly 'open approach to business' does not stop there.

They believe one of the best ways to encourage market growth and innovation is to allow 'open' access to standards, which is why anyone in the world can download ETSI standards free-of-charge, via their web site.

Standardization is high on the strategic agenda of any company with international ambitions.

The 'openness' and knowledge accessibility within standardization is also a key driver in adding value to expensive research and development programmes.

Indeed, at the very core of standardization is the 'mutualisation' of technical development with the aim of enabling markets to grow, and industry to compete, with a minimum of interoperability and inter-working required.

For such a system to work most efficiently, it must be 'open' to all who wish to contribute and remain 'open' all along the standards production process, including delivery. [19]

ORGANISATIONS OF NATIONAL STANDARDIZATION

A. The American National Standards Institute - ANSI

The American National Standards Institute (ANSI) has served in its capacity as administrator and coordinator of the United States private sector voluntary standardization system for more than 90 years. Founded in 1918 by five engineering societies and three government agencies, the Institute remains a private, nonprofit membership organization supported by a diverse constituency of private and public sector organizations.

Throughout its history, ANSI has maintained as its primary goal the enhancement of global competitiveness of U.S. business and the American quality of life by promoting and facilitating voluntary consensus standards and conformity assessment systems and promoting their integrity. The Institute represents the interests of its nearly 1,000 companies, organization, government agency, institutional and international members through its office in New York City, and its headquarters in Washington, D.C.

ANSI facilitates the development of American National Standards (ANS) by accrediting the procedures of SDOs[36]. These groups work cooperatively to develop voluntary national consensus standards. Accreditation by ANSI signifies that the procedures used by the standards

[34] European Telecommunications Standards Institute

[35] Information and Communications Technologies

[36] Standards Developing Organizations

body in connection with the development of American National Standards meet the Institute's essential requirements for openness, balance, consensus and due process.
ANSI is often asked about the total number of standards (and standards setting bodies) in the United States. It is estimated that in the U.S. today there are hundreds of "traditional" standards developing organizations - with the 20 largest SDOs producing 90% of the standards - and hundreds more "non-traditional" standards development bodies, such as consortia. This means that the level of U.S. participation is quite expansive as the groups themselves are comprised of individual committees made up of experts addressing the technical requirements of standards within their specific area of expertise. [20]

B. The British Standards Institution - BSI

Sir John Wolfe Barry - the man who designed London's Tower Bridge - instigated the Council of the Institution of Civil Engineers to form a committee to consider standardizing iron and steel sections on 22 January 1901.
In World War 1, British Standards were used by the Admiralty, the War Office, the Boad of Trade, Lloyd's Register, the Home Office, the Road Board, the London County Council and a lot of colonial governments.
During the 1920s standardization spread to Canada, Australia, South Africa and New Zealand. Interest was also developing in the USA and Germany.
On 22 April 1929, the Engineering Standards Committee, (since 1918 the British Engineering Standards Association) was granted a Royal Charter. A supplemental Charter was granted in 1931 changing the name, finally, to The British Standards Institution.
Between 1939 and 1945 over 400 war emergency standards were produced.
1946 saw the first ever Commonwealth Standards Conference, held in London and organized by BSI, which led to the establishment of the International Organization for Standardization (ISO).
The UK's[37] first management systems quality standard, BS 5750, was published by BSI in 1979. In 1987, it was superseded by the ISO 9000 series of international standards which BS 5750 inspired.
Revised in 1994, 2000 and then in 2008, the international quality management systems standard has proved a global success with more than 1 million ISO 9001 certificates (2000 and 2008 combined) issued in 178 countries and economies by the end of 2009. [21]
They are the UK's National Standards Body (NSB) and were the first national standards body. They represent UK economic and social interests across all European and international standards organizations and in the development of business information solutions for British organizations of all sizes and sectors. [22]
BSI is recognized as the UK NSB[38] by the UK Government. This status is formally codified in the MoU[39] between the United Kingdom Government and the British Standards Institution in respect of its activities as the United Kingdom's National Standards Body.
The MoU recognizes BSI's status as the UK member of the international standards organizations, ISO and IEC; the European standards organizations, CEN and CENELEC; and as the NSO[40] participating on behalf of the UK in ETSI.
The MoU defines a number of key responsibilities for BSI as the NSB. Its membership of the international and European standards bodies also entails a number of specific responsibilities.

[37] United Kingdom
[38] National Standards Body
[39] Memorandum of Understanding
[40] National Standards Organization

In addition, there are certain aspects of BSI's work that are further defined through the World Trade Organization's TBT[41], to which the UK Government is a signatory.

Most of BSI's responsibilities are undertaken on a day-to-day basis by BSI Standards Ltd., a wholly owned subsidiary company of BSI Group. A Supply of Services Agreement sets the framework by which this can be systematically monitored.

The NSB has the responsibility of the Director of Standards and is administered within the External Policy team. It receives some funding from the UK Government in recognition of work undertaken in the public interest.

The exact scope of the activities regarded as belonging to the NSB is listed in the BSI Code of Conduct. [23]

C. The German Institute for Standardization - DIN

The remit of DIN German Institute for Standardization is to encourage, organize, steer and moderate standardization and specification activities in systematic and transparent procedures for the benefit of society as a whole, while safeguarding the public interest. The results of DIN's work serve to advance innovation, safety and communication among industry, research organizations, the public sector and society as a whole, and to support quality assurance, rationalization, occupational health and safety, and environmental and consumer protection. DIN publishes its work results and promotes the implementation of these results. Some 30,000 experts contribute their skills and experience to the standardization process which is managed and coordinated by the DIN staff of around 400. By agreement with the German Federal Government, DIN is the acknowledged national standards body that represents German interests in European and international standards organizations. Ninety percent of the standards work now carried out by DIN are international in nature. A registered non-profit association, DIN has been based in Berlin since 1917. [24]

D. The Hungarian Standards Institution - MSZT

The Hungarian Standards Institution was founded in1921.

This legal status is non-profit body of public interest, according to Law XXVIII of 1995 on national standardization and its amendment by Law CXII of 2001; self-governed and registered in accordance with the provision of the Civil Code.

By virtue of the Law, the Hungarian Standards Institution (MSZT) is the national standards body of the Republic of Hungary.

Hungary is represented by MSZT, via its membership, in the following international and European standards organizations:

- International Organization for Standardization (ISO) membership of MSZT: since the foundation of ISO - 1947
- International Electrotechnical Commission (IEC) membership of MSZT: since the foundation of IEC - 1906
- European Committee for Standardization (CEN) national membership of MSZT: from 1st of January 2003
- European Committee for Electrotechnical Standardization (CENELEC) national membership of MSZT: from 1st of June 2002
- European Telecommunication Standards Institute (ETSI) full membership of MSZT: from 1996

[41] Technical Barriers to Trade Agreement

The Officials of MSZT	Activity
President	▪ simultaneously the Chairman of the Standards Council ▪ elected by the General Assembly ▪ responsible for his activities to the General Assembly ▪ performs activities as defined in the Statutes
Vice-President	▪ elected by the General Assembly ▪ also a member of the Standards Council
Members of the Standards Council	▪ elected by the General Assembly and delegated by central administrative bodies ▪ gives guidance for the activities of MSZT
Members of the Financial Control Committee	▪ elected by the General Assembly
Chairmen of the national technical committees for standardization	▪ elected by the relevant committee from its own members
Managing Director	▪ Manages the Executive Organization

[a.] Officials of MSZT (by the authors)

1) *Members of MSZT*

- Any legal entity as well as economic organization other than legal entity can become member of MSZT members of MSZT are registered;
- current number of MSZT members: 320 (this membership covers more than 85% of the Hungarian economy)
- MSZT members have delegated more than 3500 experts (representatives) to the 184 national technical committees for standardization;

2) *Conditions of membership in MSZT:*

- acceptance of the Statutes;
- applying for membership;
- payment of membership fee.

The Bodies of MSZT	Activity
The General Assembly	▪ chaired by the President ▪ approves the Statutes ▪ decides about the acceptance of the yearly report ▪ elects and discharges the President and vice-president of MSZT ▪ elects and discharges the eligible members of the Standards Council and the Financial Control Committee ▪ approves the accounts of the Standards Council and the Financial Control Committee ▪ approves the yearly budget ▪ responsible for any action referred to it by legislation or by the Statutes
The Standards Council	▪ chaired by the President ▪ determines the membership fees ▪ defines the basic policy for the functioning of MSZT ▪ approves the long-term and yearly programmes of national standardization
The Financial Control Committee	▪ inspects the conformity of the economic activities of MSZT to the rules
The Technical Committees for National Standardization	▪ carry out the professional work in each particular sector in an operative way
The Executive Organization	▪ provides continuous activities necessary for the functioning of MSZT

[b.] Bodies of MSZT (by the authors)

3) *The main responsibilities of MSZT, in accordance with the Law, are:*
- development of national standards or provision for their development, their approval and publication, withdrawal and amendment as well as the preparation of the respective methodology and rules of procedure;
- participation in the work of the international and European standards organizations and the coordination of the participation by stakeholders;
- preparation of guidance and advice in national standardization issues;
- preparation and publication of studies related to standardization;
- determination of the use of the national standards mark as well as implementation and management of the rules for the application of international and European marks related to standardization;
- development and management of a certification system to assess conformity of products and services to national standards;
- participation in the development of rules for the certification of conformity with legal rules or other specifications;
- establishment of a system for the certification of quality assurance systems against standards;
- participation, on request, in the preparation of Hungarian legislation based on directives of the European Union;
- provisioning of information and dissemination of knowledge related to standardization and certification;
- management and development of trainings related to national standardization and certification of personnel;
- technical documentation and other services.

4) *Sources for the functioning of MSZT:*
- membership fees;
- sale of standards and publications;
- certification;
- training;
- information services;
- other services;
- mandates from Government;
- support from interested parties. [25]

ACKNOWLEDGMENT

This article has been summarized in the structured organizations of standardization of information security, which International, European and national have been collected for the purposes of grouping. The organizations of standardization discussed in this article are all great impact in Europe and the Hungarian economy's life. [26, 27,28]

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COST EFFICIENCY OF ELABORATING IRON BY USING PULVERIZED COAL AS A REPLACEMENT FOR COKE IN BLAST FURNACES

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Abstract: Currently the world is tending towards a dramatic specific consumption of coke per ton of pig iron by injection of coal dust in blast furnace tuyeres. The purpose of injecting pulverized coal in the furnace is to reduce coke consumption, to replace the liquid fuels and natural gas, to ensure a steady running, increase economic efficiency and improve environmental conditions. The injection of pulverized coal technology in the furnace is justified by: increase furnace productivity, expressed as the amount of iron produced per day in the furnace; reducing the consumption of more expensive coking coal and metallurgical coke, through replacing of coke with energetic coal; maintaining the stability of the furnace; improving the quality and reducing the silica content in iron cast without disturbance of the thermal regime of the furnace; reducing emissions of greenhouse gases.
Keywords: pulverized coal injection, coke, iron, blast furnace, cost efficiency.

Introduction

Coal injection helped the steel industry to reduce operating costs, to extend the life of the coke furnace and reduce greenhouse emissions. Once the increasing understanding of the impact of quality of pulverized coal, there was a shift from highly volatile thermal coal to less volatile semianthracite. A heat and mass model was used to investigate the impact of injected coal properties on coke replacement ratio and operating costs under two sets of operating conditions corresponding European and Japanese practices. The pattern was also used to investigate the impact of the injection of ash from coal probable cost of operating a furnace [1,2].

Today the world is tending towards a dramatic decrease of the specific consumption of coke per ton of iron by injection of pulverized coal in the blast furnace tuyeres.

Injection of pulverized coal as a replacement of coke in the blast furnace is applied currently in over 100 furnaces worldwide, amongst which 44 are in Western Europe.

The progress made in the past years, with the injection of pulverized coal in the blast furnaces, is related to the safety of equipment as well as to the ratio of injection achieved, at a present stage a specific consumption of 300 [kg/t iron] of coke is accepted. Currently, efforts are being made to inject 250 kg of coal/t iron in large furnaces, which could lead to o coke consumption of 250 [kg/ t iron].

Impact of using coal dust injection in blast furnace.

The need for coal dust injection in the blast furnace was originally imposed by high oil prices, but now the increased use of coal dust injection is determined by the need to reduce raw material costs, pollution and also the need to extend life of coke ovens.

The injection of coal in the furnace has shown that it increases the productivity of the furnace, the amount of iron produced per day by the furnace; reduces coking coal that is more expensive, by replacing coke with cheaper thermal coal; ensures furnace stability; it improves the quality of iron and a lower content of silica in iron;-reduces emissions of greenhouse gases, life-cycle analysis conducted by Tata Steel showed a 6.2% decrease in CO_2 emissions when coal dust blowing ratio increased from 16 kg/thm to 116 kg/thm.

In addition to the above benefits, the injection of coal has been shown to be a powerful tool in the hands of the operator from blast furnaces for adjusting the thermal state much more quickly than it would be possible by adjusting the load from the top.

In general, Europeans intend to decrease fuel quantity in order to increase productivity, while Japanese objective is to have a higher ratio of fuel in order to meet the gas demand of the integrated steelworks [4].

The development of coal injection systems led to improvement of systems for storage and distribution technologies. The critical goal in the design of the distribution system is to ensure a uniform batch of coal for every tuyeres without fluctuations. Constant development continues to improve through lance model and oxygen injection.

British Steel has developed an alternative method for coal injection. Granular Coal Injection (ICG). ICG technology and coal injection (CPI) were assessed at Bethlehem Steel Burns Harbor steel mills corporations in a project funded by the U.S. DOE. Hill and others (2001) reported that the only differences between the PCI and ICG injection proportions of up to 140 kg/t pig iron are those that the ICG had lower requirements, providing savings both in capital costs and in operating ones.

Types of coal for blast furnace injection

World market is divided into sectors: coking coal, semi-coking and thermal coal after different properties. Coking coal demand hardly needs a special price due to its unique plastic hard coke and limited supply. Semi-soft coking coal has some plastic properties and can be used in mixtures of coke. Thermal coals are generally considered to have good combustibility in coal power plants and fuel ratio (fixed carbon/volatile matter-free) around 2 or less. Low volatile coals may also be regarded as being used for igniting the coal thermal kiln and fluidized bed boilers.

The relative importance of the different aspects of the quality of the coal PCI, varied, while the injection technology has improved and increased injection rate. In the late 1970s, triggered by the oil crisis, interest in coal injection coal reappeared and was considered as an economical replacement for fuel oil. Combustibility was considered important for PCI, thermal coal were used. At that time, thermal coal was available and had a much lower cost than hard coking and semi-soft coking coal. While understanding the impact of coal quality on the performance of the furnace increased, the demand for less volatile coal also increased in the last five years.

Replacement Ratio

For coal, coke substitution ratio was set to three injections ratios of 100, 150 and 200 kg/t pig iron. This allowed for a rate of injection of coal coke hypothetical zero, as shown in figure 2, for the operation of the high rate of fuel. The maximum rate of coke was tested for two other coal using two PCI rates and then used to calculate the expected replacement rate of the others coals. While the model gave lower ratios of European operations for fuel substitution lower than those estimated by Brouwer and his relationship Toxopeus (1991) [6], which were based on data from furnaces Hoogovens.

Injected coal gasification

Goto and others (2002) investigated the maximum rate of pulverized coal in a furnace using the carbon balance of material and heat balance model. Unburned coal that is not consumed by the reaction of loss of solution will be trapped in the furnace or will come in the form of dust. Shen and others [7] estimated the maximum rate 230 kg/t pig iron from the combustion efficiency of 75%.

To estimate the likely economic impact of the blast furnace operations Fukushima's model was used to determine differences in the demand for coke for two combustion efficiency (> 80% and 60% <) for a coal with high volatility and a volatility Scout 150 kg/t pig iron. For high volatile coal, there was no difference in the need for coke. For low volatile coal

combustion efficiency at low coke demand grew by only 1%. Coking coal requirements for low volatility at low combustion efficiency was still lower than for coal with high volatility. Babich (2002) and Kochura (the productivity in 2002) summarized the measures enhances combustion of coal as follows [8]:

Other influences on the operation of other PCI of the furnace

These calculations do not take into account the possible impact of ash on furnace operations, can affect the productivity and costs. The injection volumes larger than 160 kg/t pig iron, it was observed that changes occur in the operation of the furnace.

All changes are interrelated and are influenced by the properties and quantities of coal and combustion conditions. At higher proportions of 180 kg/t pig iron permeability around the combustion zone is of concern. Ichidai et al (2002) have analyzed the main causes of low permeability caused by injection of coal. These causes are related to unburned coal and slag composition.

Injection of coal will continue to be a means to show the steel industry needs. Highest proportion of replacing coal with low volatile PCI coal makes them prefer the proportions of injection of 170 kg/t pig iron. The high combustion efficiency path is important to achieve higher proportions of 190 kg/iron. To determine the optimal or mixed coal injection on a large scale requires thorough research of various coal combustion kinetics and mixtures under different conditions of the combustion zone.

Injection of pulverized coal as a replacement of coke in the blast furnace is applied currently in over 100 furnaces worldwide, amongst which 44 are in Western Europe.

Table 1: Average operating parameters of blast furnaces with injection of pulverized coal in Europe and Arcelor Mittal Galati

Description	UM	F 5-ARCELOR MITTAL Galaţi	F9-Thyssen Hamborn	F4-Sidmar Gent	F4-Sollac Dunk.
		Romania	Germany	Belgium	France
Crucible diameter	m	11,6	10,2	10,0	14,0
net volume	m^3	2560	1833	1776	3648
I_u –use index	$t/m^3 24h$	1,777	2,68	2,77	2,40
Load					
- sinter	%	78,71	70,87	91,45	80,48
- pelett	%	12,64	18,50	6,87	-
- ore	%	8,65	5,29	1,62	19,52
- others	%	-	5,34	0,06	-
Coke sp. consum.	kg/thm	461	338	303	316
Cole sp. consum.	kg/thm	102	141	181	174
M.V. of coal	%	~ 35	25,7	26,6	20,6
Oxygen in air	%	23,19	23,7	24,5	23,6
Air temperature	°C	1050	1132	1209	1210
Flame temperature	°C	2210	2155	2187	2114
Pig iron:					
- siliciu	%	0,77	0,408	0,38	0,338
- sulf	%	0,025	0,038	0,018	0,026
- pig iron temp.	°C	1494	1503	1488	1491

Table 2 compares the operating parameters of the F5 Arcelor Mittal Galati S.A. furnace with the ones operating in UE. It is noted that both national average parameters and the average parameters of some furnaces, ranks these aggregates amongst the furnaces with high performance through both specific fuel consumption and productivity. By comparison the parameters of F5 blast furnace from Arcelor Mittal Galati indicate an average coke specific

consumption of 461 kg/t iron and 102 kg pulverized coal/t iron, therefore a total fuel consumption higher by 60–75 kg/t iron, this difference is found at all levels of injection practiced which helps limit the quantities of pulverized coal injected efficiently.

Table 2**:** Arcelor Mittal Galati, F5 indicators for the proposed options, in comparison with the real values of blast furnace

Indicator	Composition	Usual reference option	First proposed option	Second proposed option
Load [Kg/t iron]	sinter	1327.5	1327.5	1341.9
	pellet	484.4	484.4	484.4
	Mn ore	7.6	7.6	7.6
	TOTAL	1819.5	1819.5	1833.9
[Kg/t] [Nm^3/t] [Kg/t]	coke	508.7	455	430
	CH_4	53.9	50	-
	coal anh.	-	50	125
	TOTAL	562.6	555	555
Air parameters	flow [Nm^3/t]	1336.5	1168.21	1202.1
	humidity [%]	1	1	1
	O_2 [%]	22	24	23.5
	temp.[°C]	970	1200	1200
Activity indicator	Iu[thm/m^3day]	1.165	1.805	1.8
	Ia [tk/ m^3day]	0.59	0.8213	0.778
Reduction degree	Rd/Ri	42/58	40/60	40/60
Furnace gas composition	[Nm^3/t]	1888	1749.33	1760.7
	CO_2[%]	18.35	19.76	20
	CO[%]	22.64	23.18	23.3
	H_2[%]	4.01	5.96	4.5
Pig iron quality	Si[%]	0.84	0.84	0.84
	Mn[%]	0.88	0.88	0.88
	S[%]	0.023	0.023	0.023
	C[%]	4.55	4.55	4.55
Slag quality	[Kg/t hm]	451.9	451.6	466
	CaO/SiO2	1.25	1.25	1.32
	(CaO+MgO)/ SiO_2	1.33	1.33	1.419
Heat resources	CO[10^3Kcal/t]	79	76.7	77
	H_2.[10^3Kcal/t]	4	4.7	4
	Air[10^3Kcal/t]	17	18.6	18.8
Thermic Balance	ht[%]	87.1	87.52	87.63
	hC[%]	61	62.13	69.94
	dif.[10^3Kcal/t]/ [%]	192.1/7.6	194/7.5	196/7.5
The temperature in the combustion area of the crucible	[°C]	1809	1947	1996

Presenting the worldwide situation of the pulverized coal injection will highlight the importance to Arcelor Mittal Galati SA as a prerequisite for improving the PCI, the performance boost of technology in the classic version. This feature is found in all the furnaces using the injection of pulverized coal across Europe.

Technical and economic calculations for proving the Arcelor Mittal Galati F5 blast furnace functionality using the pulverized coal injection

Calculation premises: the use of pulverized coal from Valea Jiului (PALD type) will be taken into account, unsintered, particularly washed (PALD type for semicoke), at 9-10% ash.

Coke composition, determined by the technical analysis: A^{anh}=9,2%; V^{anh}=36,2%; S_t^{anh}=1,01; H_2O=1,1%; $P_{calorific}$=6700[Kcal].

Composition of the volatile matter: CH_4=5%; H_2=6%; CO=37%; CO_2=35%; N_2=17%.

The analysis performed on F5 furnace at ARCELOR MITTAL Galati, was accepted as a starting point for technological calculations, so that in the end the operating intensity index to be adjusted to normal.

Fuel consumption: Coke (k_t) = 478.93 [kg/t]; methane gas = 0 [Nm^3/t]

A replacement ratio of 0.96 [kg coke/kg coal] was used.

The first proposed option: auxiliary fuel methane gas = 50 [Nm3/t]; coal (anh) = 50 [kg/t].

The *second proposed option*: it is injected only pulverized coal,125 [kg/t], in the tuyeres.

The results of all calculations performed for the proposed variants are recorded in table 2, showing these results compared to real values of operating the blast furnace during the reference period.

Conclusions

The result of the performed analysis is a satisfactory development of the reduction processes and the accomplishment of great efficiency at indirect reductions of CO and H_2. An insufficient temperature was used to pre-heat the air, which lead to decrease in the replacement ratio of the coke through methane gas, evaluated at 0.9.

Economic advantages can be observed by lowering the specific consumption of technical coke from 508.7 kg/t iron (the furnace operating at the reference option) to 455.0 kg/t iron (for the second option). The total quantity of fuels dropped from 562.6 to 555.

The efficiency of CO (η_{CO}) increased from 44.6 to 46.77 and the efficiency of H_2 had dropped in the first option. From here the conclusion that we obtained performances comparable to the ones obtained at furnaces in Germany, USA, Japan, etc. According to these performances a ratio was obtained between the direct and indirect reductions from FeO to Fe of approximately 40/60.

The quality of the iron remained the same with the one from the reference option, the quantity of cinder had a slight increase in the option with 100% coal. The cokes replacement ratio from the auxiliary fuels was able to increase from 0 to 1.01 and 0.97 (for the first option), including to 0.98 (for the second option).

From that mentioned above, the most plausible, for the furnaces in Arcelor Mittal Galati, is considered the first option, although the second option could be used as well form the economic points of view. This is the reason the injection equipment was made based on the option with 100% coal.

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ECONOMIC VALUATION OF BLACK LOCUST AND TREE OF HEAVEN

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Abstract - The spreading of invasive species causes serious economic and environmental problems nowadays. The recognition of these negative effects, understanding, and protection against them are based on estimates, assessing the size of the damage. Black locust (Robinia pseudoacacia L.) and tree of heaven (Ailanthus altissima Mill.) are widespread and extremely dangerous woody-stemmed plant species in Hungary. In our research we analyzed economic potential and cost of repel of the above mentioned species and items of these. During the data collection we sent thematically compiled questionnaire to the relevant state institutions (national park directorates and state forest companies). In addition, other publicly available background information was collected and telephone interviews were carried out as complement of data. Questionnaires concerned items of income and expense (15 items) in aspect of the analyzed species for the 2009-2013 period. A significant number of incoming data came from national park directorates, but vast majority of the state forest companies did not give information despite of multiple requests. During evaluation of data, we found that costs of black locust reduction were so high (sometimes hundreds of millions of HUF) that those could not be compensated by revenue from the sale. However, in the case of the state forest companies, incomes were several times bigger than costs in each year. Judgment of tree of heaven was negative in all areas. They could not be sold, so no revenue was derived from their presence, but reduction was very expensive.
Keywords: bioeconomic study, invasive plant, black locust, tree of heaven

INTRODUCTION

Nature conservation is getting more and more emphatic nowadays, and so the problems related to invasive species.

The European Union council of ministers is currently working on a list that is about invasive species to exclude or repel.

Abroad have been quite a few studies have dealt with the economic implications of invasive species issues.

The study of PIMENTEL et al (2005) was based on economic analyzes related to invasive species on the US territory. They found that the non-native, aggressively spreading species caused significant environmental damage and losses, which amounted to nearly $ 120 billion a year.

Another research was also carried out in the territory of the United States (DITOMASO 2000), which had the subject of pasture-infectious invasive plant species. DiTomaso estimated the field weed related annual losses of $ 2 billion in the States.

Another group presented a quantitative bio-economic framework model, which they can use to carry out a comprehensive risk assessment of invasive species, and methods of protection against them in relation to the environment (Leung et al., 2002).

Similar researches can help to uncover and understand the ecological and economic consequences of the spread of these species. In our country does not currently have a comprehensive data that would lead to the conclusion about the spread and injury cash value

of invasive species (HARASZTHY 2013). There wasn't a similar research in this topic in Hungary.
Black locust and tree of heaven are common invasive species in Hungary. The former got a lot of media attention in last year and now - as a result of the acacia coalition' action – it is declared Hungaricum (http1). This was due to its expansion and its forest- and apiary-related economic benefits. However its expansion is unwanted in many areas, and prevention consumes significant amounts of money.
Today, black locust has the largest area of tree species in Hungary. Reforestation of the country – starting in 1949 - gave a big boost to its expansion. Its 1-2 % area ratio went up to more than 22 % in just 100 years. The national success of black locust are due to its resilience and good usability. It is an excellent plantation species, which is easy to install and be grown. It grows so fast it becomes mature in 30-35 years, therefore it can be sold relatively soon. Through its vegetative recurring capability it requires minimal care and financial investment. (BARTHA *et al.* 2006).
In addition, it can tolerate chewing damage of wild animals relatively well, so its install can be more succesfull than other tree species (REMÉNYFY 2014).
The black locust wood is valuable, because it is hard and durable. It can be used for many things like pillar, parquet production or supporting structures, but is is also suitable for chipboard- and fiberboard production. Due to its density and high calorific value it is perfect for firewood too (BARTHA *et al.* 2006).
Its expanded root-system can absorb also weak-structured soils, and it can live on poor, drier areas. Because of this characteristics, black locust is suitable for re-cultivating raw soils, and for reforesting landfills and waste dumps (BARTHA *et al.* 2006).
Its presence is important for not just the forestry but also for another industry. Due to its excellent honey quality and great area, this species gives the base of the national honey production. Half of the sold honey is acacia (BARTHA *et al.* 2006).
According to Attila Borovics - director of Forest Research Institute of National Agricultural Research and Innovation Centre - the total value of the hungarian black locust stocks is approximately Ft 500 billion (VEREB 2014).
Black locust can be grown on more than 100 types of habitat in Hungary, which illustrates well the ability to find its life conditions widely. Its sprouting ability, strong vegetative reproduction and 50 years viable seed bank make it almost unable to be eradicated from those places where it already was settled once. Currently it has stock on more than 380 thousands hectares, but in addition it has presence in also other places like in smaller forestations, tree groups, and beside of roads and railways. This means it can get to almost anywhere or has already gotten (BARTHA *et al.* 2006).
According to Landscape Ecological Vegetation Database & Map of Hungary today 200 000 hectares semi-natural vegetation is infected, and from this, 33 000 hectares is damaged by black locust. In addition, it is spreading in the 60 % of our specially valuable oak-steppe (SZMORAD & TÍMÁR 2014).
It occupies more and more places also in our Central Mountains, since its original habitat extends up to the height of 1500 m above sea level. So the seeds of black locust already got to the significant part of the country. Phisical soil disturbance – like agricultural machine use – can bring them up to the soil surface, transport the seeds, or – as direct or indirect ground-fires – can destruct their hard husk, which helps them germinate.
Black locust largly transforms its habitat, thus reducing species diversity of the area. With its powerful evaporation and nitrogen enrichment effect, it can displace less tolerant plant species with the connected animal species from their original habitat (BARTHA *et al.* 2006).
Tree of heaven is a similarly agressive species, that appears mostly on opened, disturbed soil surfaces, and its continuous expansion can be observed in our country.

From the presence of this species – unlike to black locust - no profit is realized, because its wood are not useful, generally classified as worthless.

Ailanthus altissima (Mill.) spreads mostly from populated areas along the roads in Hungary. It can settle more easily on disturbed soil surfaces thus endangering also valuable plant communities (e.g. on sand of Kiskunság, on Torna-karst, or on Szársomlyó) (UDVARDY 2004).

On those areas where tree of heaven appears and proliferates, the original vegetation deteriorates and transforms. This occurs first because of dissolvent allelopathic compounds of the roots, later increasing shield effect, than the big amount of fallen and degraded leaves causes nitrogen enrichment in the soil. Nitrofil, disturbance-tolerant, shade-loving plant species appear mostly in those populations (UDVARDY 2004).

So tree of heaven is subject to negative conservation perceptions, as it can displace our valuable plant species, damage our natural- and semi-natural plant communities, and can decrease biodiversity.

Due to its nature and strong sprouting ability it is one of our hardest to eradicate in Hungary.

Fast-absorb herbicide injection to the vascular tissues is proved to be a good solution.

In order to increase the efficiency and for the protection of other species, must close the wounds of the treated plants when using strong chemicals.

Planting of native tree species to the place of exterminated Ailanthus stock can be a good solution in longer term, as the closed plant-stock already can prevent the re-strenghtening of tree of heaven (UDVARDY 2004).

Due to actuality of the previously discussed negative effects, we thought it useful to choose a research topic that deals with the mentioned species.

Our goals were, collecting and evaluating data from what we can conclude Hungarian territorial distribution, economic benefits, area size, economic value, suppression costs – where it is needed – and elements of the latter, related to black locust and tree of heaven. In addition, we planned to do national economic benefit and suppression cost estimate of the studied species.

Materials and methods

Data collection

We wanted to get the necessary data from mostly national park directorates and state forest companies counting on their objective attitude and accurate documentation. Although a significant portion of the forest land is owned by private forest owners, is was not possible to ask them due to their big number and in default of their contact.

We needed information from what we could conclude economic value, spread, judgment and suppression cost of this two invasive species. Accordingly, we compiled an Excel-based questionnaire, including different sources of income and expenses itemized regarding the last 5 years. Data of several years may give a better overview of the processes direction and extent of the changes. The questionnaires were sent via email as an attachment to the 10 national park services, and the 22 state forest companies. Finally we did not get considerable feedback, and appropriate amounts of information for over several months either. Because of this, we sent a simplified questionnaire to the competents, hoping they will fill it out with more pleasure.

As a result of the second request, we got more response, and our dataset expanded.

The need for expansion of datasets with regional values became clear with the received data.

With these informations we can calculate economic benefits and suppression costs of the studied species per hectare. Therefore we tried to get these regional informations - about the relevant species – from the helpful national park directorates and state forest companies via email for first, and than by phone.

Beside correspondence, data found on internet were also collected. National park directorates

For national park directorates mostly utilization of tender sources – especially Environment and Energy Operational Programme -, and for state forest companies mainly regional and species ratio data could be found on their webpages.

Data processing

Received and collected data were stored and processed in Microsoft Excel, and the two species were always treated separately.

First we summerized reactions of national park directorates and state forest companies to our request separately. These reactions were classified to these simplified categories :

- ≡ table filled ot
- ≡ given textual information
- ≡ or did not provide data

The number of responses to the above mentioned categories was compared to the number of addressees receiving their % of the distribution. It was done in respect of national park directorates and state forest companies separately. The gotten values of % were also represented on diagram.

To show the results, we used also bar charts, and data – like incomes and costs - were shown mostly with the related periods. Calculating the incomes and costs per unit area seemed to be useful, but with the exception of National Park Directorate of Hortobágy, we did not get the sent questionnaire-related values about any region.

However we got informations of eradicational costs – what were financed by Environment and Energy Operational Programme tender sources – from several national park directorates. With these data, we could calculate costs – unlikely the incomes - per area unit.

Related to the spreading area of black locust we received almost no data. In case of the tree of heaven we got no data at all.

The earlier mentioned data were to be found exclusively on the web page of the state forest companies.

Results

As you can see, at the diagrams, most of the National Park Directorates replied. Moreover they provided us with useful information. On the other hand, most of the state forest companies did not react to our request. Our first, more detailed chart, unfortunatelly in despite of the helpful answers, was filled out by none of them totally. That is why the usable data was uncomplete. Out of the responding national park directorates, the National Park Directorate of Kiskunság was outstanding, where from a significant amount of useful data arrived. A diagram was made out of this data, which shows us the extermination of the invasive species located at national park directorates, financed by the tender sources, and the destribution of cost (figure 2), in a period of 5 years.

The directorate spent most of the money on the eradication of Black Locust (figure 2). In the Environment and Energy Operational Programme, the chemical eradication of the species is made by Ft 456,3 million in the period of 2010-2015, with the affected area of 346,45 hectares. According to the report - made by the national park direcotrate -, the amount of money is 42 % of the total source of the Environment and Energy Operational Programme. Looking at the costs, at the second place is milkweed, followed by our other studied species the tree of heaven. Latter is eradicated by Environment and Energy Operational Programme and Public Works Programme by the expense of Ft 142,1 million from the area of 249,48 hectares in 2009-2015. According to the earlier mentioned riport this amount takes 13% of the total source provided by the Environment and Energy Operational Programme. The other eradicated species, in decreasing order of the cost: desert false indigo, green ash and box elder, silver berry and European goldenrod.

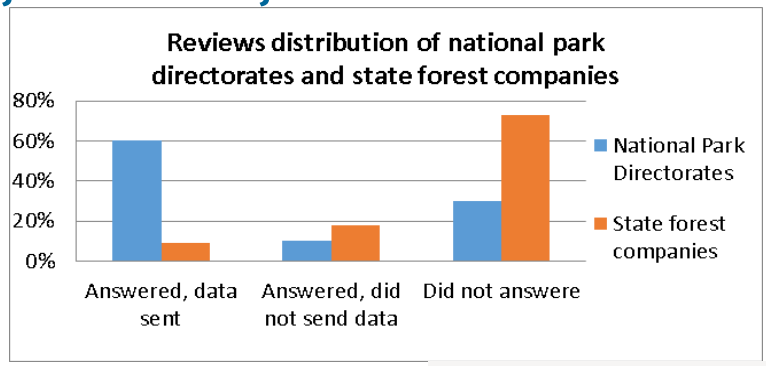

Figure 1. Reviews distribution of national park directorates and state forest companies

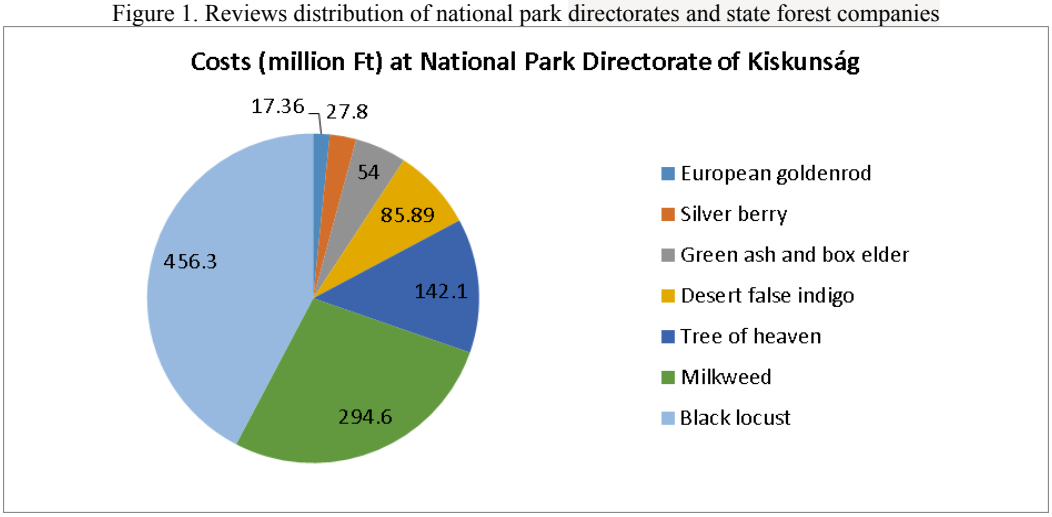

Figure 2. Distribution of eradicationed plant species and costs in Kiskunsági National Park Directorate (2009-2013)

Therefore, the National Park Directorate requested support for the suppression of 8 invasive plant species, being the most dangerous the black locust, milkweed and tree of heaven, according to the costs.

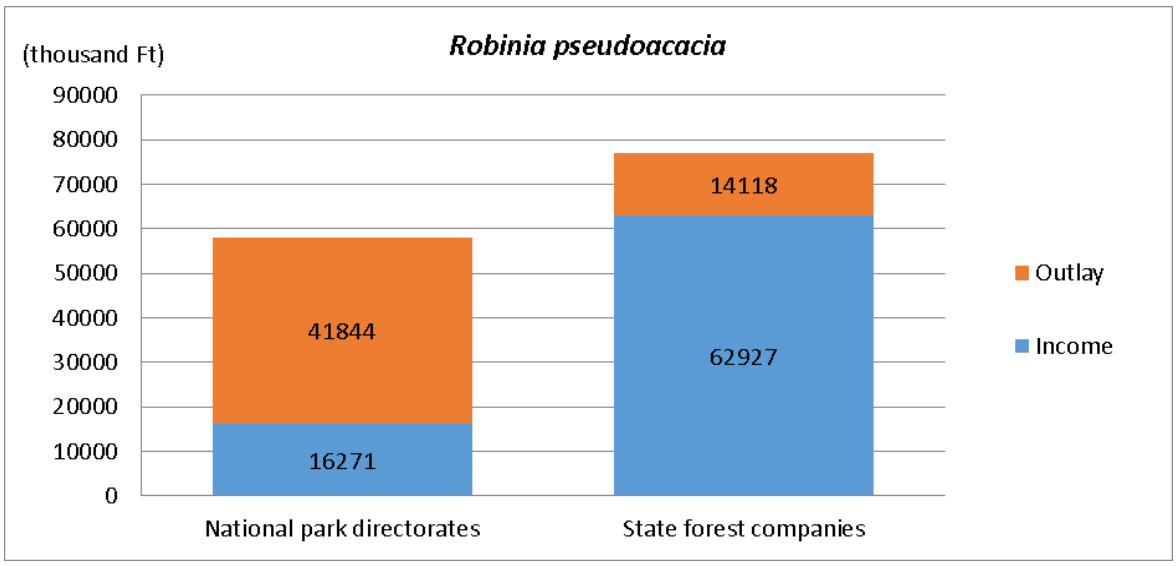

Figure 3. Overall black locust related average income and outlay in the national park directorates and state forest companies between 2009 and 2013

Looking at the incomes, the state forest companies were in much better financial status. With 4 times bigger values compared to the national park directorates (figure 3.) However the expenses of the latter were almost 3 times bigger than the state forest companies. This result is

not so surprising, since the state forest companies usually have closed forest stocks, where it is harder for invasive species to get in and get stronger. However, the black locust is installed on many areas, and instead of its expensive eradication it is lumbered in age of mature, what gives the state forest companies great financial advantage. Opposed to this, the national park directorates manage less with this species. They cannot wait the black locust to get mature giving them bigger profit, because it can endanger the protected areas and ecological systems. That is why instead of the greatly refundable lumbering they have to do the more complex and expensive supression.

The main difference comes basically from that how wanted the species is, and how it can be kept under control on the area. It is not included on the earlier shown diagram, but needs to be noticed that the National Park Directorate of Kiskunság spent Ft 450 million on the supression of black locust on its own in the last 5 years.

Because of insufficient data, the value of income/outlay could be added by regional data only in case of National Park Directorate of Hortobágy so incomes/hectares could be calculated only from this. As conclusion of the received informations we got Ft 840 081income per hectares.

There was insufficient data providied by the other national park directorates and state forest companies to calculate this value. Only National Park Directorate of Körös-Maros alone mentioned that their income did not exceed Ft 1,5 million per hectares.

The outlay per hectares and eradication costs could be calculated from more type of data. The chart - filled out by the National Park Directorate of Hortobágy -, and costs of suppression – came from Natonal Park Directorates of Kiskunság and Bükk – and regional data were available for this calculation.

As summarization of the data we calculated Ft 1 215 480 outlay per hectares, that more than exceeds the income per hectares mentioned in the previous thread.

According to the answers, tree of heaven was negatively judged on every area. Its large-scale spreading causes problems on almost every area.

The state forest companies – partly because of the quality of its wood - can not sell it, but its eradication means plus expanses during the cleaning work.

The appearance in opened plant association and aggressive spreading of this species cause bigger and bigger damages at national park directorates. According to the received data, the suppression of this species is the most expensive at National Park Directorate of Kiskunság, as they spent more than Ft 140 million for this reason. Their expenses per hectares - as regards this species – were approximately Ft 569 584 .

Discussion

Our data collection was based on questionnaire survey sent to the hungarian national park directorates and state forest companies (a total of 32 institutions). Three months elapsed between the detailed and simplified questionnaire were sent. However, more than half of the surveyed institutions did not answer in any form. The small number of and incomplete questionnaires provided a few appreciable and well comparable data for the black locust. We received even less information about tree of heaven.

For this reason, we tried to get more information on websites of the relevant institutions, but most of them had not transparent, systematic data.

Therefore, comparison and evaluate of the values proved to be difficult.

The received and collected data were usually summarized in the form of charts and diagrams.

Due to the complexity of these data, we could come only to partial conclusion, and usually could not compare them.

The results seem to prove that suppression of black locust costs a huge sum of money on those areas where it is unwanted (e.g. the National Park Directorate of Kiskunság spent more than Ft 450 million just for suppression of this species in the studied period. At the areas

treated by national park directorates outlay is usually bigger than income. As a contrast, at state forest companies income is more significant. Tree of heaven is negatively judged on each areas, its suppression costs Ft 100 millions.

Spontaneous emergence and expansion of the studied species can be expected. To avoid this and for planning and ending of a potent intervention estimated data on regional level would be needed. Transparent budget elicitation of state forest companies and national park directorates would also be important in unified and comprehensible form to support further researces.

Our research can be a base of a national-scale, realistic data-based, reliable cost estimate for suppression of invasive species, which already exists in many countries. In the future similar, complex researches can help to explore and understand negative – nature conservational – and for some species positive – financial - effects of invasive species. During the collection of data we were warned of other, dangerously spreading plant species. Those invasive species mentioned in the report of Environment and Energy Operational Programme sent by National Park Directorate of Kiskunság are the remarkable ones, since their suppression cost millions. Continuing of similar researches on a larger scale with in regards of the previously mentioned species would also be useful.

Acknowledgement

Hereby we thank the competent associates of national park directorates and state forest companies for the provided data. The research was supported by the Research Centre of Excellence- 17586-4/2013/TUDPOL.

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REFINING STEEL IN AN INDUCTION LADLE FURNACE

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Abstract: This paper depicts the results of experimental research concerning the synthetic cinders used in the steel industry, cinders obtained from waste powder. The widespread introduction of refining liquid steel by synthetic slag pot is conditioned by the high costs and the lack of technical alumina obtained from bauxite, a component of the synthetic slag. The possibility of improving the purity of steel through refining and with the help of synthetic slag has been analyzed: while mixing steel with slag we focused on the achievement of a contact and interaction surface 300 times larger than in the electric arc furnace, the physical–chemical .properties of slag suitable for the reduction of sulfur and oxides inclusions, to meet these conditions, knowing the physical chemical reactions, the metal–slag system is binding when the two fazes are intensely mixed. These cinders can be added in the ladle of liquid or solid steel. For the industrial experiments solid steel was the choice because the furnace for melting synthetic slag was not available on the working platform.
Keywords: wastes, synthetic slag, steel, siderurgy, refining.

INTRODUCTION

The steel processes underlying the production of iron, ferroalloys, refineries and even casting (especially the continuous one) of the iron are happening due to the involvement of slag. Its chemical and physical characteristics must be consistent with the essence of the project and with its purpose. In the development of the iron, the slag must be in a fluid state, must have a reducing nature, and have the ability to embed larger loads of ore, tailings and some impurities. At the development of steel it must be oxidant to ensure the refining of the metal bath or reducing the deoxidation and desulphurization character to facilitate the removal of oxygen and sulfur in steel. At the electric melting of steel under slag, the latter must have reducing character, must be fluid and with retention and high capacity of retaining the impurities (sulfur and nonmetallic inclusions), and at the continuous casting of steel it must also have reducing character, be fluid to lubricate the walls crystallizer and to have protective action against gas ingress into steel.

Ordinary steel developed in furnaces without special technological measures for quality improvement, contains waste, excessive quantities of impurities, especially non–metallic inclusions of oxides and sulfides. With the increasing content of such inclusions, and worsen of heterogeneity the mechanical and technological characteristics of steel increase.

The refining of liquid steel with clay powder or with various mixtures of synthetic slag has increased based on shift unwanted impurities (sulfur, suspended minerals, oxygen) of liquid steel in the slag, mainly by diffusion, or partly by involving the suspension of clay particles in the synthetic pond thus being subject to the treatment inside the bath of steel.

The summary of the process using synthetic slag is to achieve a lasting contact on a greater surface between the processed metal and slag, whose composition is chosen so as to provide an advanced desulphurization and deoxidation of the metal.

In the processing of steel with synthetic slag, when, after shooting at high altitude, the steel crosses the slag as a multitude of drops, the interphase surface area S takes values thousands of times higher than in the case of the deoxidation of the metallic bath with white or Carbide slag, inside the electric arc furnace.

As well as the deoxidation effect, synthetic slag due to their basic character and high fluidity, to their high capacity and increased dispersion surface; provide very favorable conditions for desulphurization. In the case of treatment with $CaO–Al_2O_3$ slag system $L_S = (S)/[S] = 100...200$ [4] reports were obtained.

Synthetic slag used in the treatment of steel slag systems $CaO–Al_2O_3$, $CaO–Al_2O_3 –CaF_2$, $CaO–TiO_2$, $CaO – CaF_2$ are presented in patented works, the best results being obtained with soda lime–alumina slag [1] [2], [3], [5], whose equilibrium diagram is shown in Figure 1.

EXPERIMENTAL

The secondary treatment of steel with the synthetic slag takes place in the pouring ladle. With increasing of the height of fall of the jet, the medium–range of emulsified slag particles in steel drop (Fig. 2). Contact area increases significantly up to a certain amount of drop height of the jet and then remains practically constant [4]. These data have great practical significance, since the tendency to increase the effectiveness of steel refining, favors an excessive increase in drop height of the jet, because over a certain amount of it takes place in a slag crusher so that small particles remain in steel slag, leading to the formation of slag inclusions. Typically, the drop height is 5–7 m.

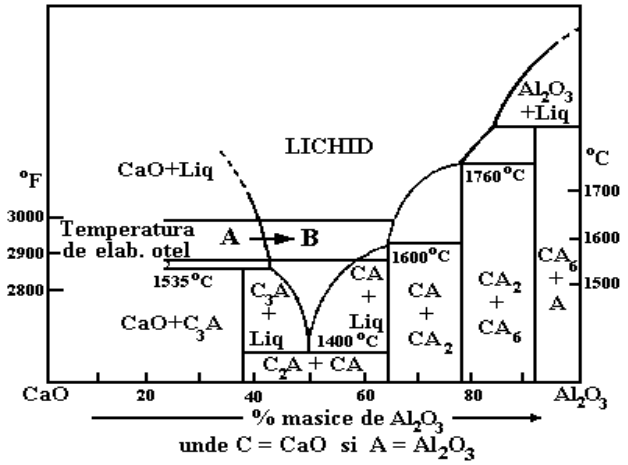


Fig. 1. Binary equilibrium diagram $CaO–Al_2O_3$

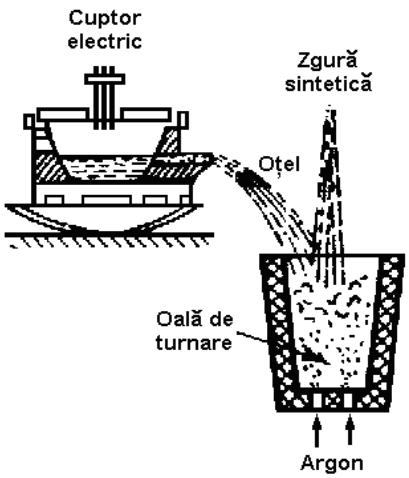


Fig. 2. Steel's treatment in synthetic slag ladle

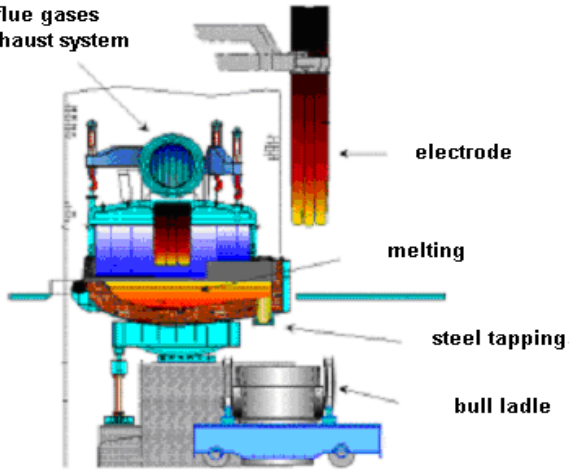


Fig. 3. Steel electric melting furnace (type EBT)

Experiments in Electric Steelwork 2 were conducted on 16 batches of steel (four batches / recipe) developed in electric arc furnace of 100 tons – UHP, steel pipe for production (Fig. 3). In this case given the fact that the removal of steel from the furnace is made in one pot, a comparison was made with other batches of the same brand of steel produced under similar conditions.

To obtain reducing slag, 30min before removal from the oven, a mix in an amount of from 4 to 14,5 kg / t steel was placed on the bottom of the ladle for pouring steel, consisting of: lime (68 – 75% by weight of the mixture and grain in 40 mm), calcium fluoride (in amounts of 14–17% and grain in 35 mm) and alumina slag (11–15% with a particle sized less than 25mm). Also, in this case (Table 1), to offset the heat loss resulting from melting the mixture, the exhaust temperature was 20 – 40 ^{0}C higher than normal. The chemical composition of formed synthetic slag is shown in Table 2.

Table 1. The chemical composition of the materials used

Elements	Chemical composition, [%]							
	CaO	SiO_2	MgO	Al_2O_3	Fe_2O_3	Al	CaF_2	H_2O
Lime	92,5	2,40	3,10	0,2	0,8	–	–	–
Slag	9,95	4,04	2,75	51,88	3,06	10,2	–	1,20
Calcium fluoride	4,30	1,20	0,45	0,65	0,90	–	90,82	–

Table 2. Chemical composition of synthetic slag

Chemical composition of formed slag: lime 70%; 20% alumina slag and 10% calcium fluorine	Chemical composition, [%]						
	CaO	SiO_2	MgO	Al_2O_3	Fe_2O_3	Al	CaF_2
	66,81	2,53	2,72	10,56	1,28	2,07	9,11

In all variants steel samples as well as slag samples were tested from the exhaust stream and ladle at 15min after its filling and, immediately after filling the casting ladle. Based on evidence analyzed, it was determined the chemical composition of steel and slag, and consequently, the way to calculate the degree of deoxidation and desulphurization (Table 3).

Table 3. The yield desulphurisation

Crt. No.	Sulfur content, [%]			Degree of desulphurization [%]	
	S_{topire}	$S_{oală}$	S_{final}	$\eta_{S\ zgs}$	$\eta_{S\ total}$
1.	0,044	0,027	0,016	40,74	63,64
2.	0.043	0,023	0,014	42,74	64,66
3.	0,040	0,024	0,014	50,00	70,00
4.	0,046	0,023	0,014	53,00	66,01
5.	0,050	0,026	0,014	46,15	72,00
6.	0,052	0,026	0,014	46,15	74,00
7.	0,054	0,026	0,014	46,15	74,07
8.	0,045	0,028	0,016	42,86	64,44
9.	0,054	0,025	0,012	52,00	77,78
10.	0,050	0,022	0,014	36,32	72,02
11.	0,050	0,024	0,014	36,36	72,00
12	0,050	0,026	0,012	34,32	70,01
13	0,050	0,030	0,013	56,67	74,00
14.	0,048	0,028	0,015	46,43	68,75
15.	0,052	0,025	0,017	32,00	67,31
16.	0,052	0,024	0,016	31,02	66,31

To calculate the degree of desulphurization from treatment with synthetic slag in the pot ($\eta_{S\ zgs}$), we used the relationship:

$$\eta_{S\ zgs} = \frac{S_{oală} - S_{final}}{S_{oală}} * 100, \quad [\%] \qquad (1)$$

The total degree of desulphurization treatment with synthetic slag in the pot ($\eta_{S\ total}$) is calculated with:

$$\eta_{S\ total} = \frac{S_{topire} - S_{final}}{S_{topire}} * 100, \quad [\%] \qquad (2)$$

RESULTS AND DISCUSSIONS

The data from the experiments were processed in Excel spreadsheets program and the variation degree of desulphurization in the ladle with synthetic slag and the total variation of the degree of desulphurization experimental work loads were obtained (Fig.4).

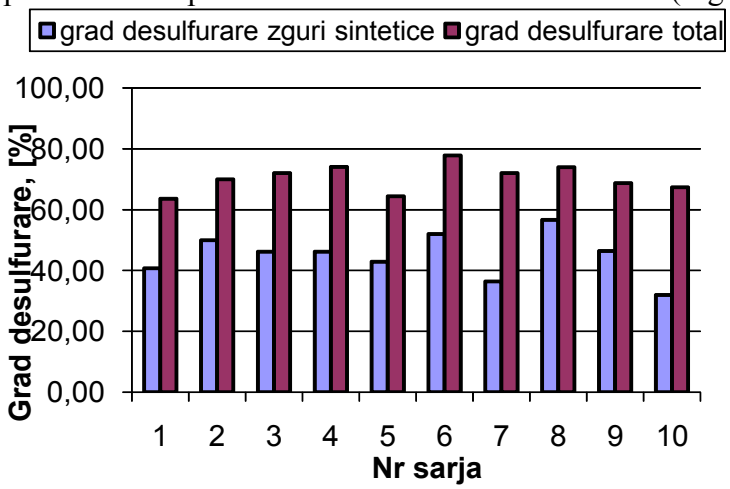


Fig. 4. Variation of partial and total degree of desulphurization at steel's treatment with synthetic slag in the pot

From the chart analysis is noted that the degree of desulphurization from synthetic clay pot varied within 30–60% and the total degree of desulphurization varied within 60–80%, resulting in sulfur content at the end of treatment on average of 0,015% S.

The data from MATLAB processing are presented in Figure 5…8.

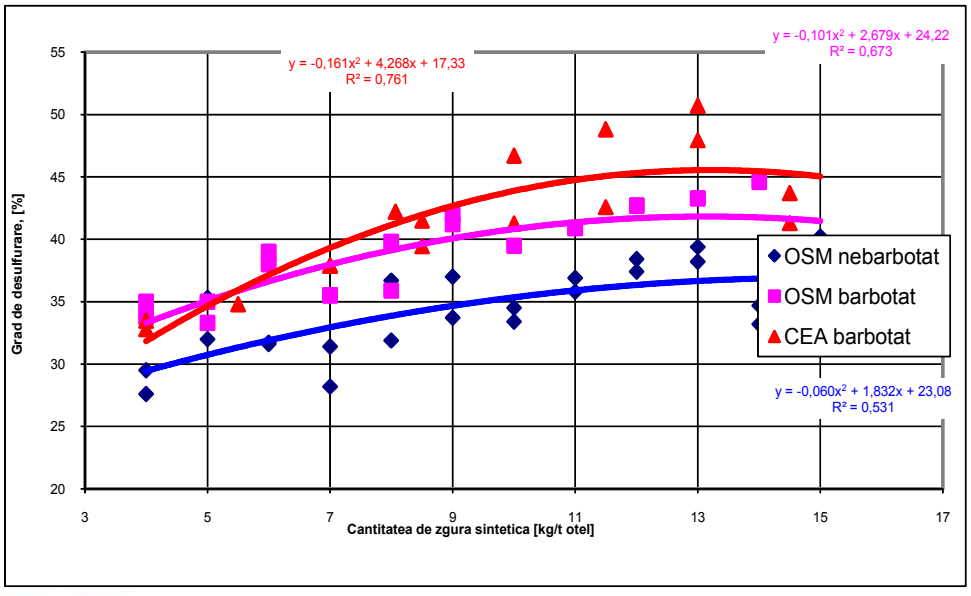
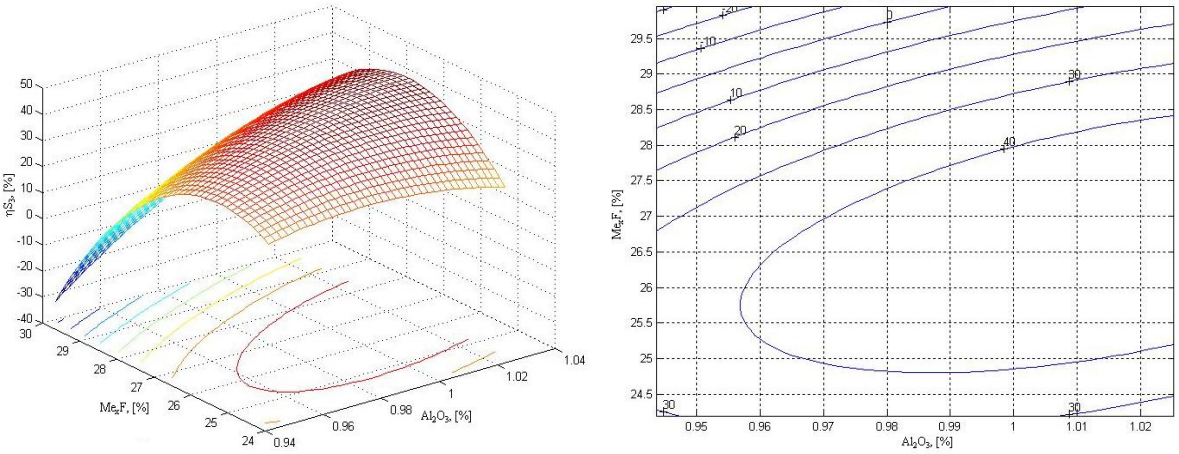


Fig. 5. Variation of degree of desulphurization function of the synthetic slag amount

It has been used the following notes for the desulphurization degree:

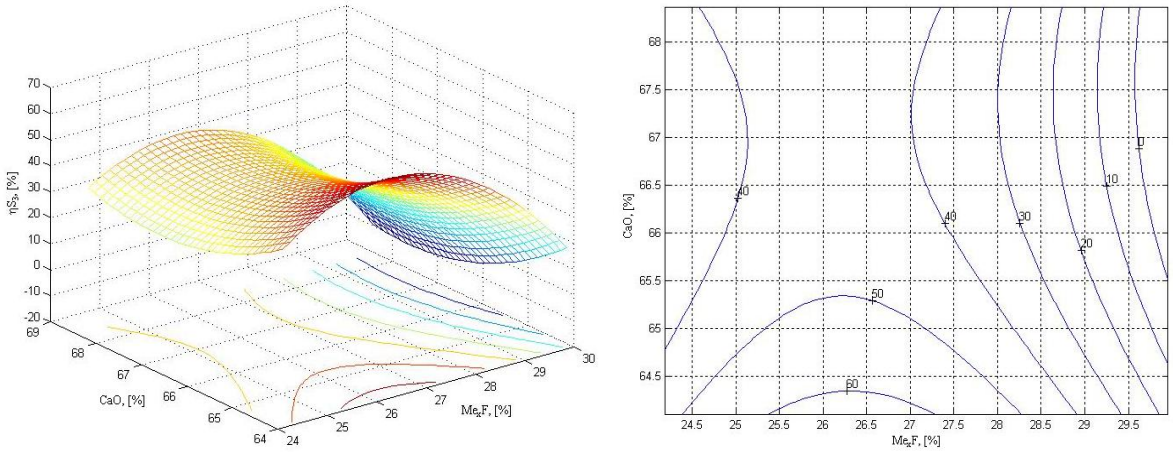
ηS_1 – Electric arc furnace steel made and without steering

ηS_2 – Electric arc furnace steel made and with steering



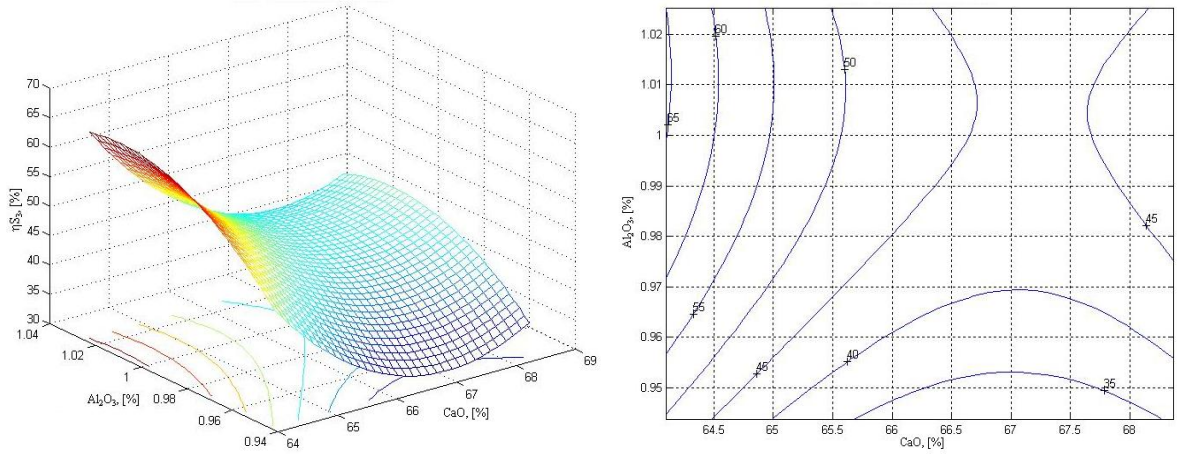
a) b)

Fig. 6. Regression surface (a) and level curves (b) for $\eta S_{2(CaO\ med)}=f(Al_2O_3, Me_xF)$



a) b)

Fig. 7. Regression surface (a) and level curves (b) for $\eta S_{2(Al2O3\ med)}= f(Me_xF, CaO)$



a) b)

Fig. 8. Regression surface (a) and level curves (b) for $\eta S_{2(MexFmed)}= f(CaO)$

CONCLUSIONS

After studying the process of desulphurization of the steel ladle with synthetic slag obtained by melting desulphurization mixture, the following conclusions arise:

- additions used for deoxidizing the steel will produce a high power slag desulphurization fluoride having an important role, ensuring a good fluidity, an important parameter for the ability of slag deoxidation;
- desulphurization with synthetic slag is effective when used as appropriate slag ternary system $CaO – Al_2O_3 – Me_xF$ and the binary: $CaO – Me_xF$;
- steel with argon bubbling during treatment with synthetic slag will increase the degree of deoxidation / desulphurization by 6% – 10%;
- the amount of slag positively affects the deoxidation degree, so from 4 kg/t to 15 kg/t leads to an increasing degree of desulphurization with 6–9% of steel produced in electric arc furnace (with bubbling with argon in the ladle)
- we established multiple correlations, and in particular, the graphical representation of hyper surfaces regression, of particular interest for practice because they allow determination of chemical composition of the slag areas (areas likely to be achieved in practice), which provides higher values for degree of desulphurization;
- using alumina slag (as a result of aluminum manufacturing technological flow) in synthetic mixture desulphurization slag formation, we ensured economic recovery and we managed to put in circulation a waste deposited in a landfill and play the natural storage space occupied by slag.

Acknowledgement

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SAFETY CONSIDERATIONS FOR ROBOTS FUNCTIONING IN DIVIDED WORKSPACE

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Abstract: Owing to the continuous large-scale development of robots predictive statistics suggest that by 2020 there is going to be on average one robot per household. Due to its physical size and power it could be a potential source of serious threat for people in the same space, be they an operator, a person being served, or a patient waiting for surgery. Rapidly developing devices are not always accompanied by the adequate safety regulations. However, in the future these regulations are going to be indispensable for without them the developments are going to be uncoordinated and during the implementing the financial interests are going to overtake safety interests and risk reduction. However, contrary to an industrial robot that is only threatened by economic and moral disadvantages, we, humans are threatened by away bigger risk: the loss of life. Therefore several regulations should be created to reduce risk and to keep the developments within the confines of security. For this, the creation of forward-looking international standardization and moderation are necessary and should be applied by each developer, manufacturer and user in the severest way.
Key words: medical robot, divided workspace, secure human-machine relationship, sensors

Introduction

During the development of the world there has always been a need for production equipment and production methods. After the emergence of guilds and manufactories the increment of human factors appeared on every field. The steam engine created by James Watt is a highlighted milestone on the path to the Industrial Revolution of the 18th century, being the first device ever to generate kinetic energy several times higher than human force can. A new unit of measurement, the watt has simultaneously been introduced to the SI, as the unit of performance. From then on more and more efficient ways to apply this generated kinetic energy have started rapidly developing. The fact that the primary field of utilization had become the industrial production has led to the outburst of the Industrial Revolution. From then on the development of industrial machine tools and processing units has begun at a pace never before seen. The development of production equipment reached the point in the 19th century where the kinetic energy generated by steam machines was insufficient. This caused the appearance of several developments using a different propellant, such as Nikolas August Otto's Otto engine patented in 1876, being the first internal combustion four-stroke engine. The appearance of this new form on energy caused the development to skyrocket, for the Otto engine was able to produce a significantly bigger amount of energy than the steam engine. The demand for the dynamo, the device to generate electrical energy appeared simultaneously. Several experiments regarding this device have already been conducted at that time. Ányos Jedlik was able to transform kinetic energy to electrical energy in 1861but this technology was patented by Ernst Werner von Siemens in 1866. Electrical energy has the advantage over any other kind of energy of being easily regulable and economically transportable from the producer to the user. This advantage was quickly recognized in the field of industrial applications. Long term and extensive developments conducted by John von Neumann followed in 1952 and the first computer was created that could utilize electrical energy to store data. The working principle of this computer, called von Neumann's principle is still used to date. The developments of the last 60 years prove that regulation, control, production, processing, and data storage require electrical energy.

Robots gained special attention during the developments since electrical energy has been usable as kinetic energy or for data storage. They are considered the realization of artificial intelligence and the way to overcome the disadvantages of the human factors and the electromechanical machines used to increase energy. This increased energy used to cause severe accidents in the early days for there had not been elaborate safety standards or directives regarding the application of robots. Currently robots are primarily used in an industrial environment with the most modern safety regulations that during standard operation exclude the possibility of even the smallest injuries. Robots are currently able to execute industrial operations alone or under surveillance of operators, so there is no need for them to come in contact with humans. By the exclusion of divided workspace the possibility of personal injury can be reduced to the absolute minimum. This act can prevent human injury, an economically inexpressible damage. However, there still is a possibility of the robot damaging itself, but this can only be deducted as an economic damage. But the further development of automation becomes limited if the workspace can't be divided by humans and robots. Several researches regarding medical and service robots have been conducted for nearly 30 years. These researches include the application of divided workspace, for in the case of a medical robot there is no way to avoid coming in physical contact with a patient or an operator. Researches dedicated to making divided workspace as secure as it possibly can be have consequently become more frequent.

In this paper the security issues of a complex robot cell is going to be presented from an electronic and mechanical point of view, and also from the point of view of its software. Security regulations and their application regarding robots used in the industry, dangers of the divided workspace, and the risks of the human factors are also going to be presented.

Security analysis

Due to the development and the accidents that had occurred in the past security analysis is getting a bigger attention, especially risk analysis. It was recognized, that applying risk analysis from the very beginnings can prevent a number of accidents, be it personal injury or economical or moral damage. However the task of risk analysis has to be taken into consideration from the elaboration of the process to during the designing, the production, the set-up to the usage itself. Owing to this, several risk assessment procedures that apply mainly mathematical probability theory and statistical calculations have been worked out. We can safely say that risk can never be reduced to zero but we have to take every possible step to reduce the chance of accidents to the absolute minimum.

We have to set up a model during risk analysis that presents the actual machine, the situation, the environment and the relation with the staff in the most realistic possible way.

Applied modeling methods

Preliminary danger analysis

This method is expedient when the developments regard a machine or an environment about which there's not much experimental information available. This occurs mostly during the designing of experimental or developmental machines, and gets a highlighted role during the creation of the concept and designing. The possible risky situations, sources of danger and the extent to which these dangers are damaging to the health can usually be presented on a tree graph. Then the risky situations are evaluated based on the extent of their dangerousness. A method is created for every single risky situation to presumably reduce the extent of danger.

Error tree analysis

The goal of the analysis is to examine every possible accident in depth and to explore every single step that can lead to that accident. During this process all circumstances, and environmental and human factors are taken into consideration and the process is completely traced back to the smallest of initial problems. On every level where risk can occur it is evaluated and reduced to the smallest extent the possibilities allow. It is known that the

occurrence of an accident is almost never triggered by a single factor but rather consecutive errors. Primarily because these singular events can be foreseen and therefore prevented. Risk is generally caused by a sequence of related and unplanned happenings. The error tree analysis seeks to solve the problem as early as possible to decrease to risk of occurrence.

"What if…" analysis

This method is useful in the case of low complexity systems that have only two levels of error. It's also useful to determine trivial risks in the case of more complex systems. Already developed security systems can be revised for possible errors using this analysis. E.g. "What if a wire in the security electrical circuit breaks?" This way every subtask is analyzable. In case the analysis is unsuccessful or the criteria of the occurrence too complex a different risk analysis method is recommended.

HAZOP (Hazard and Operability Studies) analysis

The HAZOP analysis is a particularly complex method that applies experts for every field involved. The links between these fields are defined and used as starting points for further exploration of possible accidents and risks. The extent to which these fields are linked to the risk is defined and the possible errors are explored. In case the probability of the occurrence can't be reduced to almost zero, the experts will suggest a measure together to increase safety.

Event tree analysis

This method is similar to the error tree analysis as it explores consecutive events. Only this time the starting point is the trigger event and every process started by a new event is recorded and presented to show the interdependence in an obvious way. This way the possible consequences of the occurrence of an initially neglected small event become apparent. The chain of events that can lead to a severe accident can this way be revealed.

Failure mode and effects analysis

During this analysis the each element's frequency of failure and the probable consequences are collected. Analyses of this type are regularly reviewed considering the experiences. The other name for these analyses is FMEA (failure mode and effects analysis). The FMEA reveals the ideal frequency of maintenance and replacement of components. In the case of this analysis every error is managed independently.

MOSAR (Method Organised for Systematic Analysis for Risk) analysis

The MOSAR analysis involves the review of the effectiveness of the existing risk reducing analyses. The interaction between subsystems is explored. After the analysis of risks the acceptability of risks is evaluated and then suggestions are made to better the prevention.

System design methodology

A number of researches and developments were conducted to create a methodology that could be a guide during the development of a robot from the conception to the manufacturing and the maintenance. The most advanced system methodology to date is hazard identification and safety insurance control (HISIC). HISIC proposes that during the development of a robot a team of experts of several fields should work together keeping the basic principles in mind. HISIC has seven basic principles. By the application of these principles the development, the design, the employment and the maintenance of the robot will get enough attention from every aspect.

The seven basic principles are the following:

- Definitions and requirements
- Hazard identification (HI)
- Safety insurance control (SIC)
- Safety critical limits
- Monitoring and control
- Verification and validation

≡ System log and documentation

The adequate application of these basic principles allows the risks occurring during the employment of robots to be reduced. Risk can be reduced to the absolute minimum if the operator recognizes the hazard and reacts in time. The role of robots does not just stop at the operation they were meant to execute. They help the operator recognize and prevent the stochastically and deterministically occurring dangers at once. If the monitoring system's sampling time and reaction time are making it capable of preventing hazards or reducing the damage to the absolute minimum, reaction time can be reduced to its fraction. HISIC provides a method to realize this process in an adequate quality and time.

Complex robot cell

A complex robot cell, be it industrial, surgical or service robot, is composed of several principal components isolated from each other from the point of view of safety. For this and to create the most reliable and hazard free product many different experts are required during the process of development. The three main fields are electronics, mechanics and software. These fields have very small intersections with each other when it comes to safety. In the following the way to reduce the intersections and to reduce the hazard of accident will be presented.

Naturally, these separate fields are cooperating because it's required to execute the desired operation. The lack of cooperation can also be a source of hazard.

Electronics

Since the appearance of electricity the presence of electrical signal has always been essential in automated processes. Software is able to manage the properties of an electrical signal as data and actuators are able to create kinetic and other kinds of energies in a regulated way based on data transported by electrical signal. Earlier, production equipment functioning solely by mechanical principles did exist, e.g. punch cards used to store data mechanically. But today we could not imagine executive equipment that is not software controlled or that is not electrical.

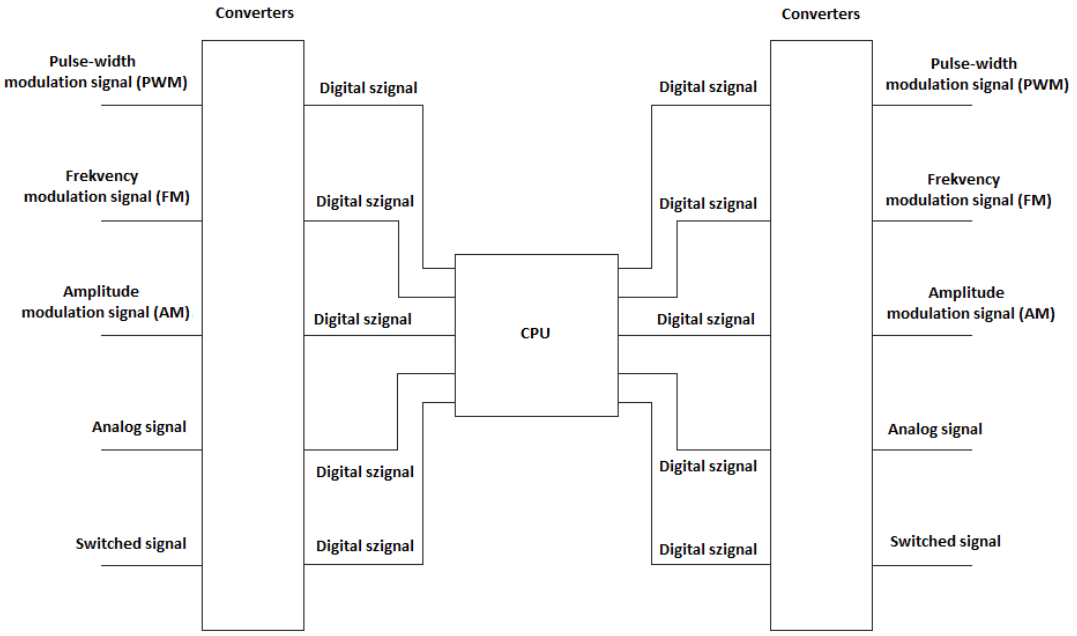

Fig. 1.

The existence of a homogeneous system requires data received from environmental and internal characteristics to be transformed into electrical signal. Naturally, as a consequence of the development electrical signal can be split into different modifications, because analog amplitude modulated and frequency modulated signals and digital PWM (Pulse Width

Modulation) signal are electrical signals too. Nonetheless computers with an operating principle based on von Neumann's principle can only manage and binary signals (Fig. 1.) and forward binary data.

The central processing unit, depending on how advanced or complex is it, can be a 4-8-16-32-64 bit CPU. This is of top importance from the point of view of the management of inputs and outputs. But the majority of detectors (Fig. 2.) transform the measured signal into analog signal and actuators transform analog signal into kinetic and other kinds of energies.

Type of detector	Measured property	Working principle, output signal
PT 100, PT 1000 thermometers	Temperature	Voltage change triggered by change in resistance depending on temperature. Tension measured between output points appears in the form of analog signal.
Incremental encoder	Position	The displacing dial generates a series of impulses with the help of photo electronics. The extent of the displacement can be calculated by the amount of impulses. The output signal appears in the form of square wave where the number of rising edges is relevant.
Incremental encoder	Angular velocity	The displacing dial generates a frequency modulated signal with the help of photo electronics. The frequency of the signal is directly proportional to the angular velocity in every instant.
Inductive-, capacitive- and mechanical switch	Presence	Depending of the measuring principle output voltage will appear in the output of the single switches. The output signal of the switches is called switched voltage.

Fig. 2: Types of detectors and their working principle

Electronics are responsible for transforming communication into a homogenous system. It provides computers and actuators with authentic data in real time.

Thus the first small intersection is the communication on the adequate level. Every single signal conversion will inevitably cause a minimal loss of data and time delay. Thus it is of tom importance to make the least amount of conversions between the occurring environmental property and the data reaching the software. During the design the conversions have to be reviewed to find the omittable or replaceable ones.

The particularities of the detectors part of the subtasks of electronics. A number of environmental and internal characteristics exist that can influence the safe operation of a robot. These characteristics can be:

- temperature
- humidity
- light
- presence
- position
- direction of displacement
- velocity
- pressure

There are a number of detectors with different working principles to measure the single characteristics. Optical systems/sensors are the latest sensors. These sensors perform complex measurements in real time, therefore the time delay is minimal. We are able to measure temperature, light, presence, position, direction of displacement and velocity with optical systems if the sampling time is sufficient. However, every property requires a specific detector to maintain a safe data collection. But the most effective way of preventing the malfunction of a detector is by redundant sensors with different working principles. The electrical signals they emit are evaluated by a software program, as a decision-making unit.

To sum it up, from an electrical point of view the intersection is the establishment of a homogenous system and the detectors. To resolve this intersection and reduce the hazard, simplification and redundancy are the answer.

Mechanics

The reason why the raison d'être of robots cannot be questioned is because they are able to resolve the disadvantages of the human factors and increase the human-made energy to sufficient level for the execution of a process. An industrial robot is able to displace several tons of mass if necessary, unlike people. Furthermore, a surgical robot is able to perform the most precise incisions without a shaky hand, or reach places unreachable for the human hand. Also, a robot is able to work in a dangerous environment that is potentially hazardous for the human health. However, during the designing process the selection of the adequate actuator and adequate scaling of the mechanical loading require special attention.

Actuators primarily apply precision DC electric to move robots, or in some cases hydraulic motors, but the latter is not characteristic for surgical or service robots for their controllability is insufficient. In the case of surgical robots precision is critical. Thus, when choosing the actuator the application of a special servo motor is required. The majority of servo motors are PWM operated and are also detectors, so they are able to provide data of their position in real time.

Another small intersection of mechanics is stability. Therefore robotic arms have to be designed to be able to execute twice the physical operation they have to operate. Furthermore, in a divided workspace robots are exposed to external stochastic impacts. It's impermissible for the robot to be moved out of its operational position because of such effects. Therefore, the body of the robot has to be designed in a way that it can resist possible external physical impacts and manage to stay stable.

Thus, risk originating from the mechanical unit can only be reduced if the prescribed maintenance, the selection of actuators and mechanical design are made to perform twice as well at carrying capacity and operating time as they will have to. Unfortunately, redundancy is not feasible in the case of mechanical risk reduction.

Software

With the advanced technology of today computers are indispensable when using any kind of electrical device. Be it detectors, actuators, or communication. Actually, every electrical device that contains a programmable microcontroller or microprocessor is a computer. Accordingly, these devices execute a targeted task but they have a program memory and they run a machine code. In addition, every complex robot system has a central controlling computer that makes decisions and regulates actuators based on data from the detectors' electrical signals. Its task is to synchronize their operation and perform controls that reduce risk. Thus software is the part of the robot that assumes that mechanics, electronics and commination works adequately and error-free, and if it detects an error, it instructs risk reducing measures. If the software program can't eliminate a problem sufficiently, it will have to decide about shutting the robot down. The software program running in every programmable component of a robot has to be completely stable, run time errors are not permissible. Thus, a robot has to go through several tests before set-up, and the methods

presented earlier have to be applied to reduce hazard. One very important property a software program has to possess is the ability to override or correct obviously irregular orders from the operators. [10] Creating this ability is of top importance during the development of the software program. However, operators have to be able to intervene in case of an error. The most trivial way of doing so is by pushing the emergency button that stops the functioning of the robot.

Software is responsible for the adequate management of communicational protocols. Usually such complex systems use system buses between components, but direst connections also exist. During the selection of the system bus two characteristics that depend on the distance applied, have to be considered: data transfer rate and reliability. The number of devices the system bus can maintain commutation between is among the criteria of the systems. The following comparison presents the characteristics of the most frequently used system buses (Fig. 3.).

Fig. 3.: Characteristics in the case of twisted pair cables

Name	Data transfer rate (kbit/s)	Maximum number of communication devices (pcs)	Maximum length of wire (m)
CAN Bus	50-1000	64	40-1000
Profi Bus	9,6-12000	32	100-1200
LIN Bus	20	16	40
LonWorks	78-1250	32385 (127)	125-2200
Inter Bus	500	4096	200-13000
P-Net Bus	76,8	125	1200

Summary

This paper concludes that risk analysis is of top importance during the development of each system. Risk factors have to be taken into consideration from the creation of the concept and solutions for risk factor have to be sought from the very beginnings. The more complex a system is, the bigger the hazard of health damage or economical disadvantages. The necessity of components in the robots desired to be developed, such as the central control device, the adequate communication, actuators, and sensors can be concluded. These components pose many risks and from the point of view of safety, a number of small intersections can be found and have to be resolved to reduce risk. Following the risk reduction of the single components, the expected level of cooperation of the components on connection points is necessary. Next to minimal hazards, complex robot sells have to operate with an expected level of safety. Divided workspace becomes riskier than isolated workspace due to the human factors. As long as a robot operates in an isolated space, human injury cannot occur next to normal operating mode, thus, due to safety regulations, robots immediately stop if a strange object or person enters the workspace, so personal injury is impossible. However, in divided workspace the human-machine physical contact, accidental or intended, is inevitable. Thus risk reduction has to be done taking stochastic and deterministic physical contact into consideration to prevent permanent injuries, or injuries harmful to health of the operators or served people.

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ANALYSIS OF THE EAF METAL CHARGE STRUCTURE OF REMOVAL OF LIQUID STEEL TO ELECTRIC OVENS EBT TYPE

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ABSTRACT: Homework work deals with a matter of great topical interest in the production of steel namely optimization to obtain steel using the electric arc furnaces with an alternating current, having regard to that, in the present, world–wide, over 40% of the steel weight is obtained in the electric arc furnaces, a fact that leads to a high consumption of electrical energy and produce powerful quality disturbances to electrical energy delivery to customers in the vicinity of these ovens. The paper presents the results of analyzing the structure of the charge intended for ultra–high power EAFs, with eccentric bottom tapping (E.B.T.), 100 tonnes capacity. In the cases we have studied, the charge consisted of scrap (types: E1, E2, E5, and E100), internal & purchased ferrous skulls, and ferrous materials from internal recycling & disposal. We monitored 96 heats, analysing the structure of the metal charge, the additives introduced directly in the metal charge throughout the steelmaking process, the propellant materials and the oxygen blown into the metal bath. The results are shown in graphical form, based on which we made a technological analysis, presented in this paper.

INTRODUCTION

Metal load of the furnace with electric arc consists primarily of scrap iron. In many steelworks is used and the foam of iron. In the framework of such experiments carried out in an oven EBT type 100 tonnes was used only scrap iron of different kinds [1].

It has been an analysis of raw materials necessary for the production of steel. For economic reasons is justified the need maximize amount of steel products from scrap metal, the constraints related to the environment is also important, the production of steel waste allows significant reductions in air pollution (about 86%), in the volume of water used (40%), water pollution (76%) and of mining waste results (97%).[2] Directive on eco–design makes it possible to identify the requirements for recycling capacity and stripping of the products cost–effective way which will ensure a better access to the pieces of metal. [3]

It is intended to identify some technology upgrades and the possibility for their implementation in the production units which are aimed at reducing energy costs, the costs of raw materials used in the production of the hotel. Steel industry is one of the biggest sources of CO2 emissions (it is estimated that in the EU–27, between 4% and 7% of anthropogenic emissions of CO2 from this industry, which has generated an average 252,5 tons of CO2 emissions during the period – 2008).[4] Technical Development has determined, however, the increase in so far as much of the sources of "scrap iron", by taking out of operation of machinery, plant, plant, metal buildings, means of transport, etc., worn physical and moral category and by larger quantities of scrap manufacturing (as a result of the increase in production), with the result that steel is drawn up to a large extent from the "scrap iron". By reintroduction into the productive of iron, recirculate not only iron, but also alloying elements and the harmful. For this reason, in stainless steel, in addition to the factors prescribed, aimed to ensure quality steel requested by requirements on the use, I get up there and foreign elements, also known as a rule that "waste". [5,6,7].

In these new technological conditions particular importance has structure and quality metal load both chemical composition, its origin, the degree of preparation of the load.

STUDY OF THE PROBLEM

Given the above, for the analysis of the charge structure we monitored 98 steel heats made at an electric furnace steel plant equipped with an electric arc furnace of EBT type and a continuous casting plant with 5 strands, the semi–finished products obtained being blooms, billets and round profiles.

The parameters monitored at those 98 steel heats, intended to produce steel tubes, were:

- components of the metal charge: scrap (types: E1, E2, E5, E100), internal and purchased ferrous skulls, scrap from internal recycling or disposal;
- auxiliary materials for slag formation: dolomite, foaming material, coke, Topex Ca, Topex;
- additives for the refining process: lime, graphite, carbon (injectors), oxygen (injectors), oxygen (lance), gas (injectors);
- additives for the deoxidation process: ferro–manganese, ferro–silicon and ferro–silico–manganese;
- duration of the technological stages until tapping (included);
- electrical energy consumption;
- limits of variation and average values for the monitored parameters;
- content of trace elements unusable as alloying elements at the end of the melting stage;
- content of trace elements that can be used as alloying elements at the end of the melting stage;

During the steelmaking process, the charge structure was carefully monitored, along with its dimensional appearance and slag content, either concerning the internal steel skulls (collected from the slag dumps) or purchased. Also, we visually appreciated the quality of the prepared scrap (E1, E2, E5, and E100) and the scrap originated from disposals, concerning the content of rust, nonferrous metals, soil, sand, etc.

Below, we graphically presented the obtained results, based on which we performed a technological analysis of the conducted research.

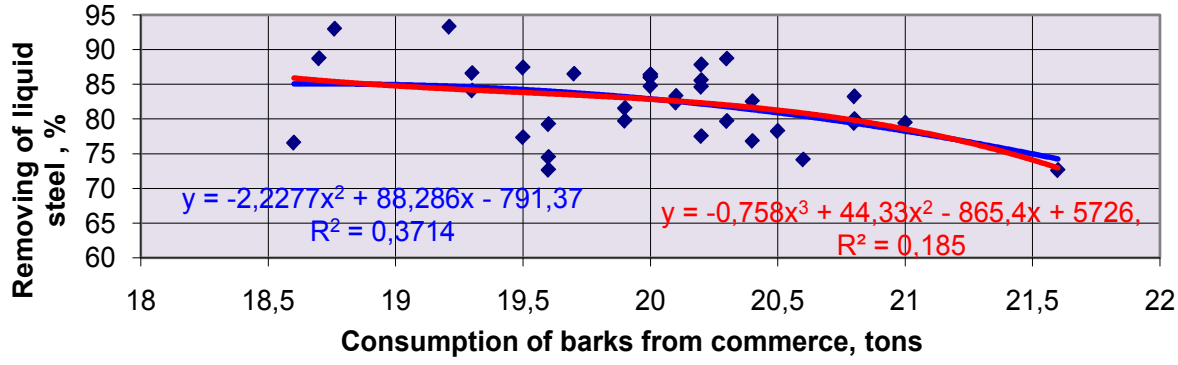


Fig.1. The variation of removal of steel on the basis of the quantity of barks from commerce

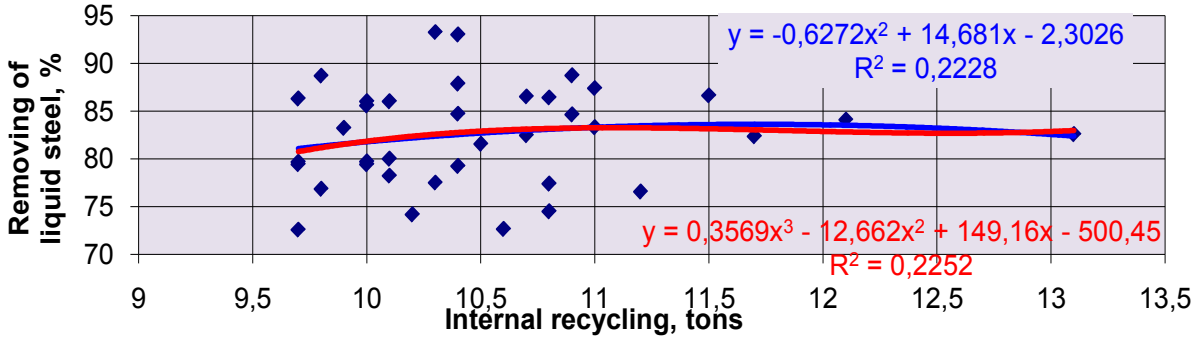


Fig.2. Variation of removal of steel on the basis of the quantity of scrap iron from internal recycling

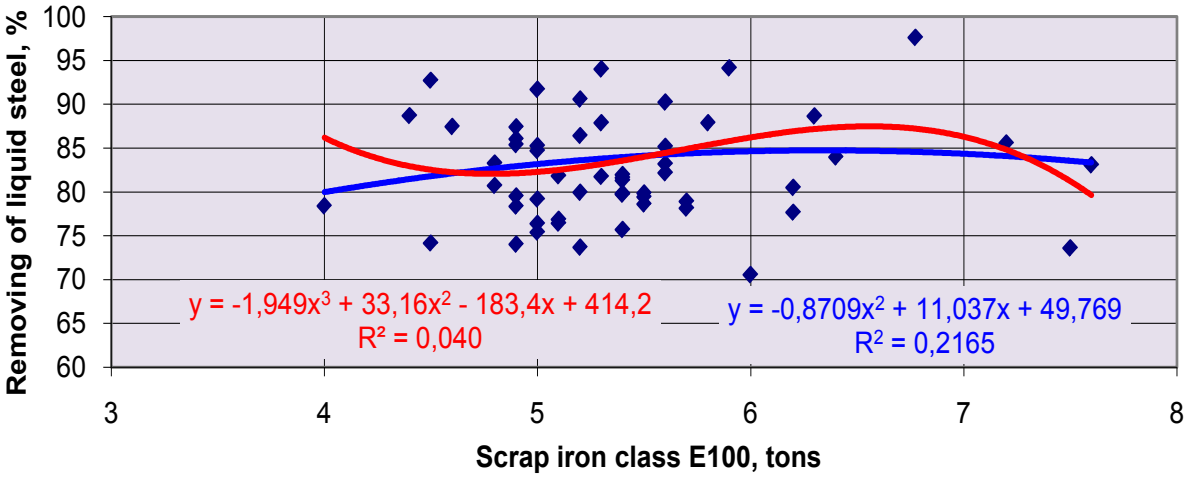


Fig.3. Variation of removal of steel on the basis of the quantity of scrap iron class E100

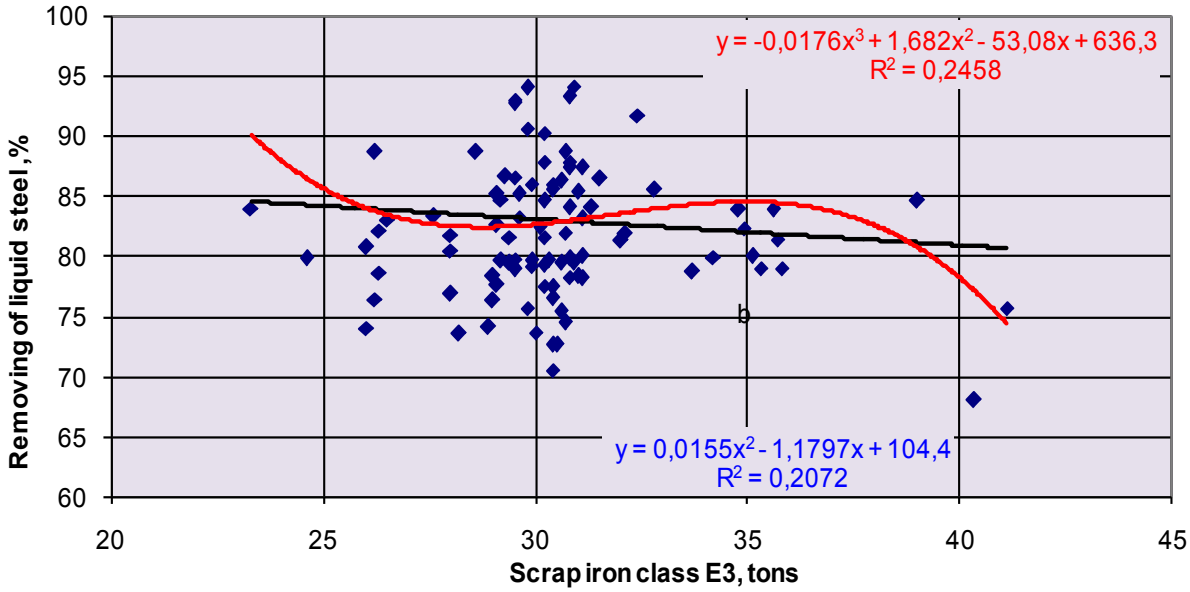


Fig.4. Variation of removal of steel on the basis of the quantity of scrap iron class E3

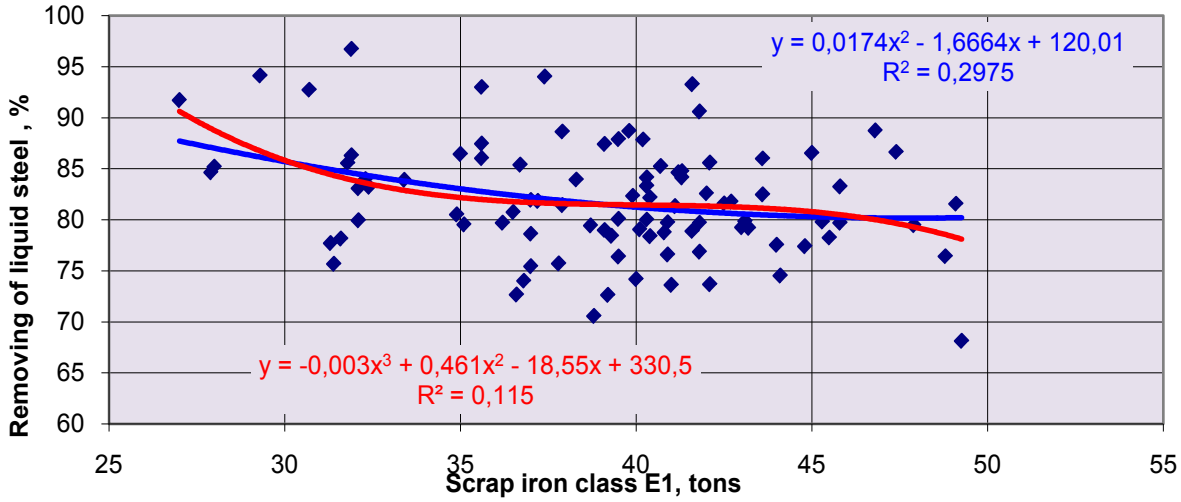
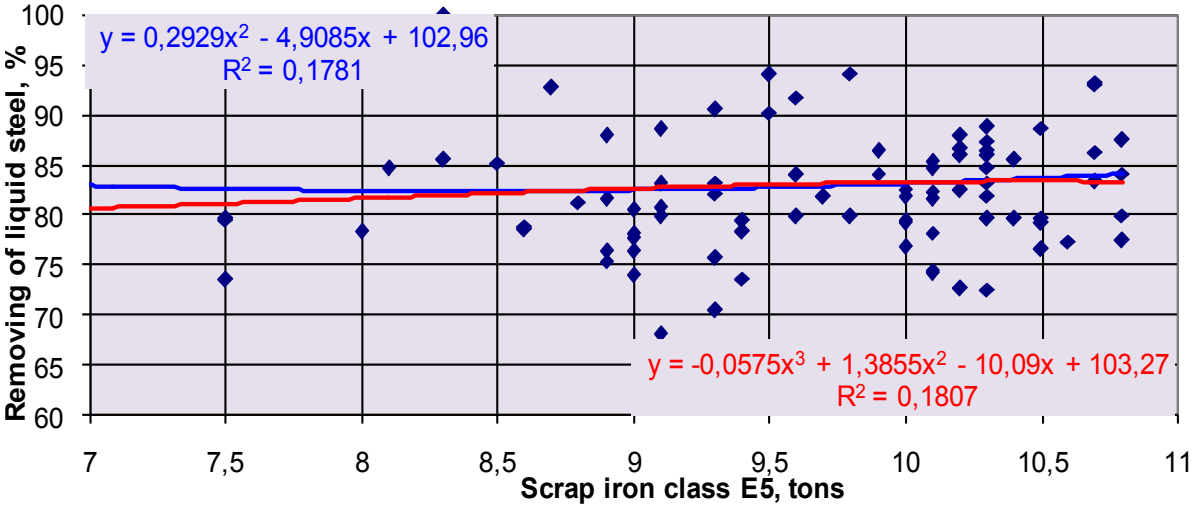


Fig.5. Variation of removal of steel on the basis of the quantity of scrap iron class E1



Fg.6. Variation of removal of steel on the basis of the quantity of scrap iron class E5

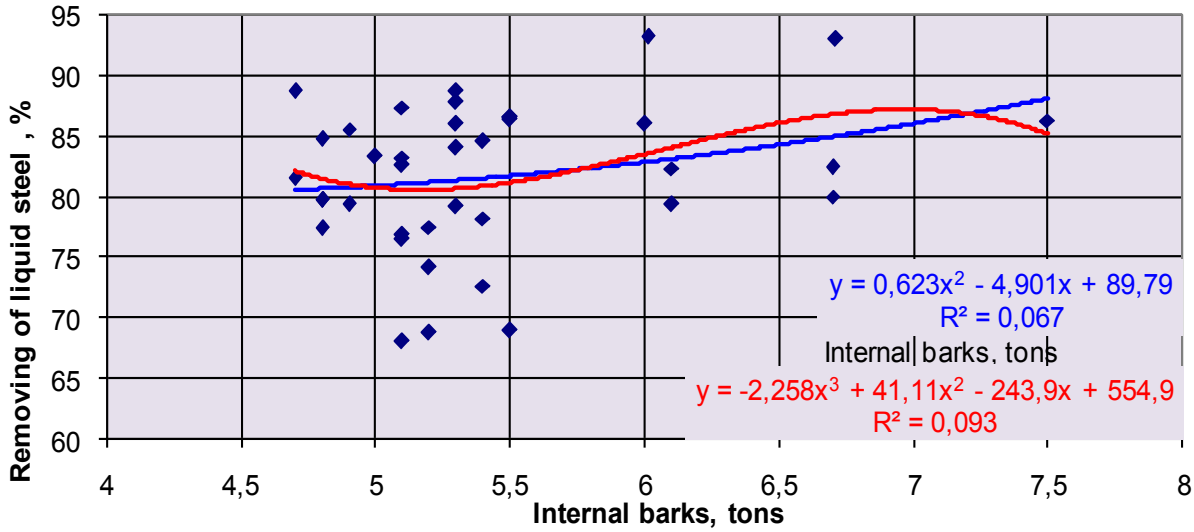


Fig.7. Variation of removal of steel on the basis of the quantity of ferrous internal barks (less than 8t/batch)

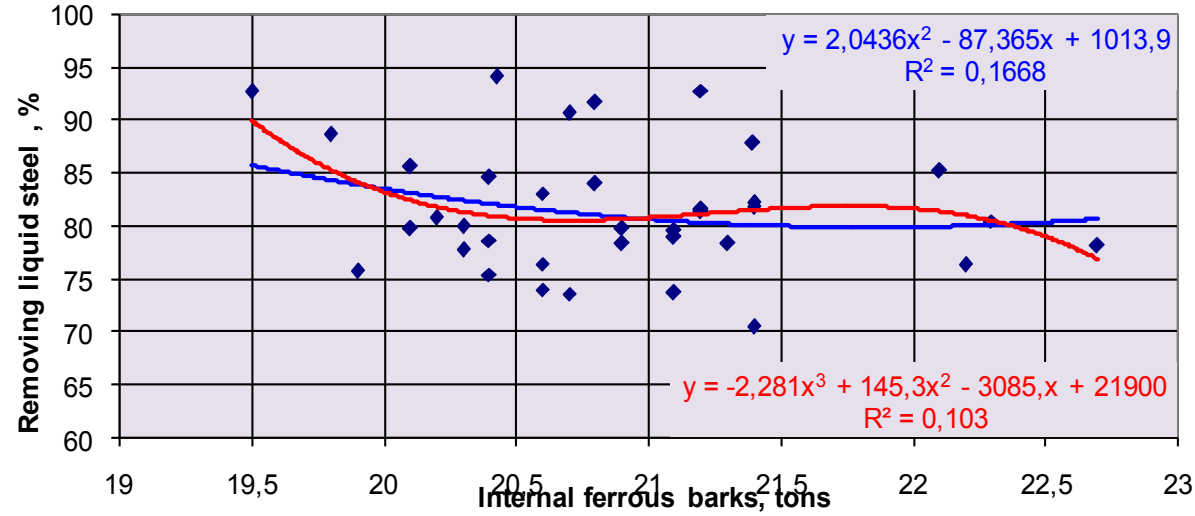


Fig.8. Variation of removal of steel on the basis of the quantity of ferrous internal barks(19–23t/batch)

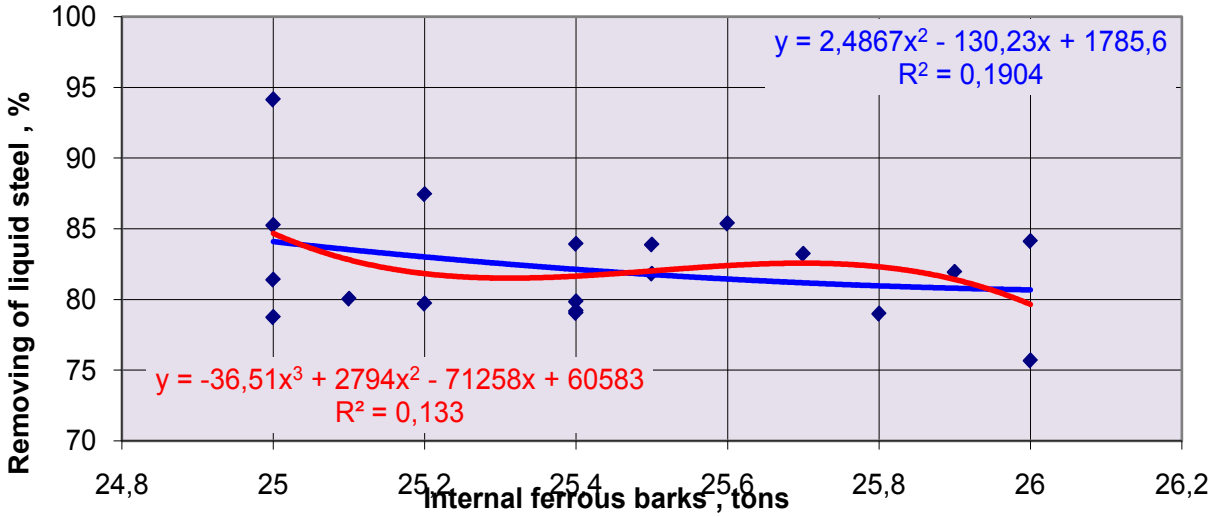


Fig.9. Variation of removal of steel on the basis of the quantity of ferrous internal barks(24–26t/batch)

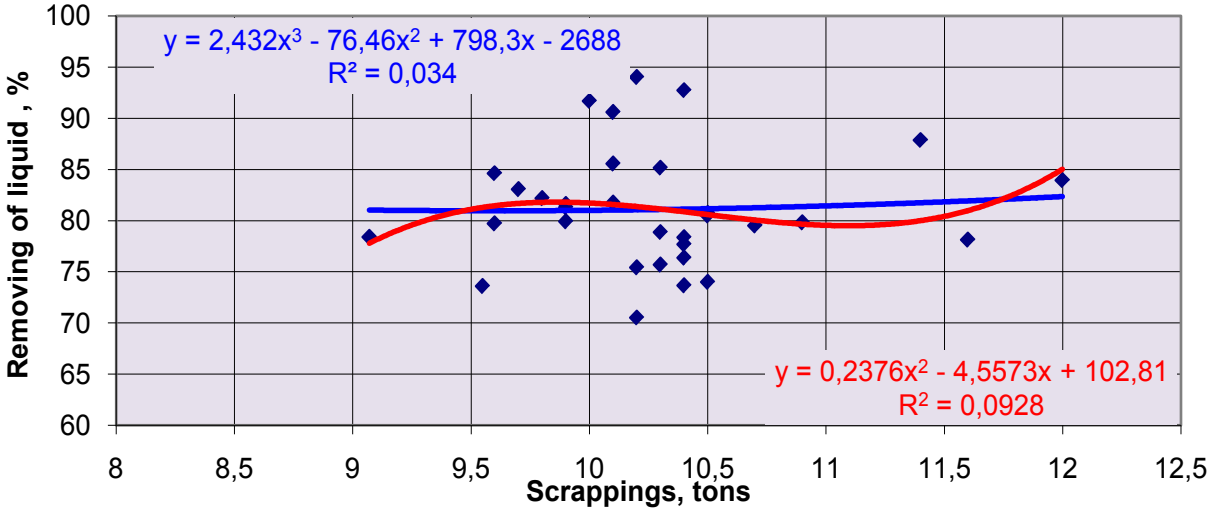


Fig.10.Variation of removal of steel on the basis of the quantity of scrap iron from scrappings (8–12t/batch)

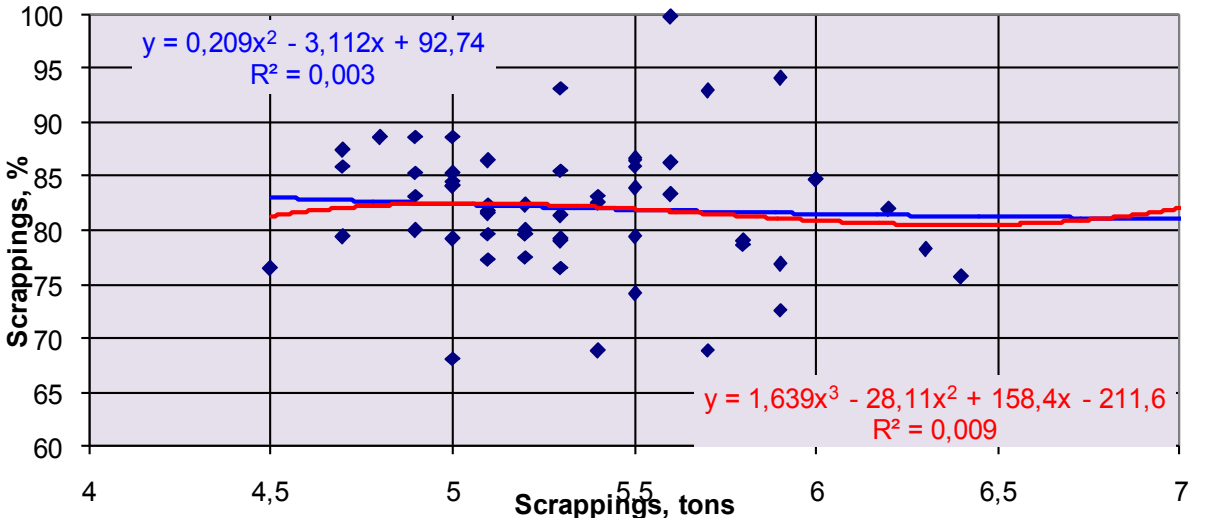


Fig.11. Variation of removal of steel on the basis of the quantity of scrap iron from scrappings (4–7t/batch)

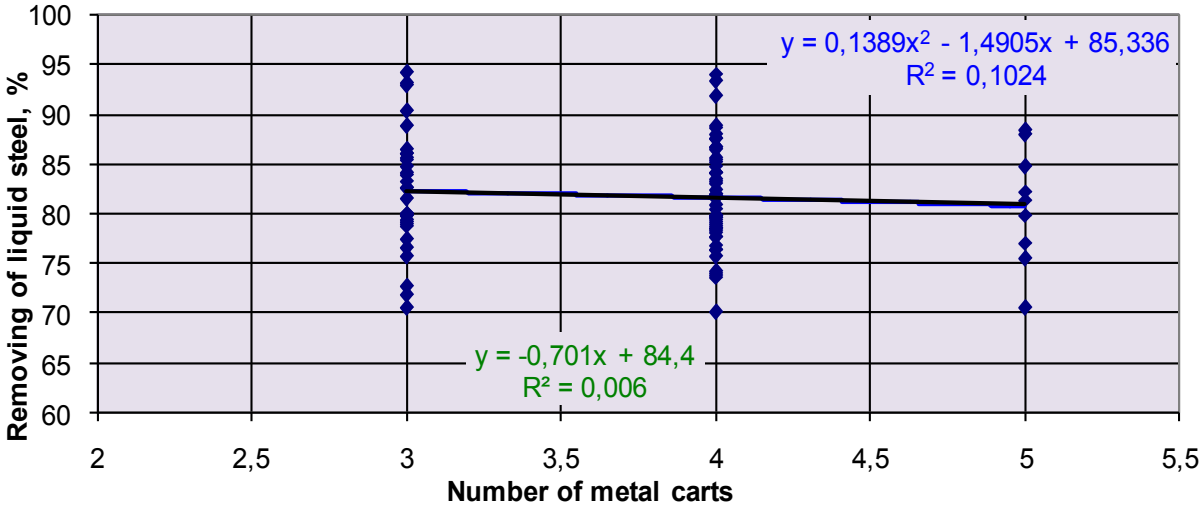


Fig.12. Variation of removal of liquid steel depending on the number of metal carts loaded in the oven

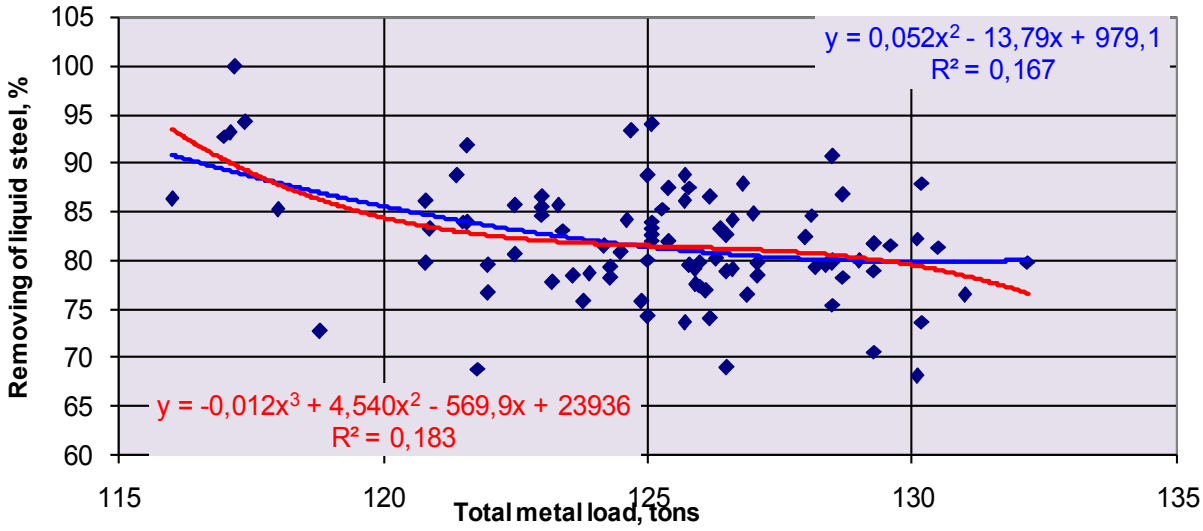


Fig.13. Variation of removal of liquid steel depends on the weight of the load metal

TECHNOLOGICAL ANALYSIS

The following technological aspects resulted from the technological analysis of the graphical charts presented in the figures 1–13:

- in fig.1 it is observed a decrease in the removal of liquid steel because of the growth of consumption scoarte originating in commerce, main reason being the impurities content of the latter in particular dross and sometimes scrap of refractory materials and is not indicated increase what proportion of this grade above 20 %;
- in fig. 2 and fig. 3 there is a slight increase of removal of liquid steel up to a proprtie approximately. 11T/1 batch internal recycling, respectively 6t/batch scrap iron E100 after which remains constant, which is partly due purity of these varieties:
- in Fig. 4 and Fig 5 is a slight decrease in growing scosterii sorts of weighting of the scrap iron E1 and E3, are not shown exceeding the proportion of 40 %;
- Fig. 6 emphasizes the fact that removing steel licid is not significantly influenced by the proportion of scrap iron class E5 within the limits of 7–11%
- of the influence of the quantity of assorted bark internal metal used in load on metal removal of liquid steel is shown as follows: in Fig. 7 to a metal load up to 6–7 tons of internal out there is an increase in the removal of steel, a fact explained by an increase in

other kinds of scrap iron with a low non–metallic components; a larger quantity of bark decreases removing internal metal steel,

- in Fig. 8 and Fig. 9 there is a slight decrease in the removal of steel determined by the content of the slag this type;
- related to the quantity of material from disposals and used In oven load can be ascertained from Fig.10 and Fig.11 that it does not have a significant influence, as a slight decrease of removal, which can be caused by preparing neavansata (dimensionally sort by chemical composition etc) of this grade;
- the data of Fig.12 recommends that the loading your oven to be carried out in 2–3 up to 4 bene, what technology means that we have a load of good quality, advanced pregarita from the point of view dimensional space, the specific weight, of non–ferrous materials etc;
- from Fig.13 it is found that an increase in the load weight to be particularly over 120 t will lead to a reduction in the release because this increase is due to the large share of ferrous metals with relatively low content of iron;
- analysis of metal structure of the kiln load it is to be noted that an increase in the quantity of bark will lead to a reduction in the disposal of liquid steel, it is recommended that scrap iron to be as far as possible ready, the load Metal to be more compact, which recommended that a quantity of bark as low.

The analysis performed showed the influence of the metal charge structure and quality on the steelmaking process, and the justification for extending the results throughout the manufacturing process.

CONCLUSIONS

The electric arc furnace of EBT type is the most appropriate unit for processing scrap in order to obtain steel, both in terms of charge quality and the number of scrap assortments introduced in the charge;

It is necessary to observe the metering recipe of iron, in the structure laid down in the instructions common technological, for the operation electric arc furnace, 100 t type EBT;

Stitching metal load electrical furnace must provide: compactness as high for judicious use of the working area in question protect Vatra Romaneasca, walls and of a dome of the impact of heavy pieces of scrap iron at the time of loading and the electric arc radiation.

- demand for scrap iron is not covered in full;
- scrap iron from recirculari does not raise any difficulties from the point of view of sorting on alloying elements and no qualitative, because recirculation period is relatively short. this category does not cover but society needs, as they are about. 20 %;
- scrap iron collected raised a number of issues in the first place due to the fact that there is no control of collection and sorting of the alloying elements and secondly because its impurificarii non–ferrous materials, non–metallic materials, concrete, earth, etc;
- due to the fact that, in quantitative terms, it is not guaranteed quantity of scrap iron required to operate electric ovens with a spring with a high efficiency, the time required for preparation it is very short and because of this load is not appropriate (both in terms of quality as well as the degree of compactness);
- the charge structure may vary within wide limits in terms of assortment, provided to be advanced prepared;
- the metal charge weight varied within wide limits due to the variation in the share of different assortments of scrap;
- the scrap assortment structure did not result in exceeding the content of trace elements that could lead to heat downgrading;
- the quality of scrap and skull is reflected in the yield;

- in practice, the charge quality is also determined by economic considerations, who are depending on the steel grade, which obviously varies from one steel plant to another.

Acknowledgement

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NEW DIDACTIC METHODS IN CLOUD TEACHING

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Abstract— This article deals with how gamification can open new ways in the education of cloud security. The new generation needs more exciting, more engaging tools at all stages of the flow of information – browsing webpages, reading news, using apps on mobile devices. This article focuses on those elements of gamification which can give a pleasant experience for the users, making them stay on the browsed pages and making them engaged for the downloaded applications. Cloud Computing is a widely used platform – and cloud security rules have to be kept by every user. But how can we make the users feel responsible for this security policy if they have no motivation to read at least the terms of use? A possible solution would be: gamification didactics tools.
Keywords—cloud; cloud computing; cloud security; cloud awareness; gamification; education

INTRODUCTION

This article deals with new training solutions which make long-term education more enjoyable and less expensive. In a previous article [2] the characteristics of personal trainings were examined – these can be highly enjoyable, however they are the most expensive form of education. Of course not any subject is suitable for gamification – In the following, a novel approach is made to gamify a seemingly uninteresting topic: for example cloud security.

Two different user groups will be observed, describing the ways of teaching in these different platforms. Useful ideas will be discussed with the aim of reaching the audience and maintaining their attention. After having achieved the engagement of the audience for the gamified education app, a self-educating, satisfying IT teaching method can be established.

WHERE TO TEACH CLOUD SECURITY

Cloud Computing is a widely used platform in different environments. Several service providers make their services or applications accessible for all types of users from the cloud. It is essential to develop safer and more reliable apps which can be suitable for all users. Although safe using is the end user's responsibility, service providers create more and more simple and compact applications with built-in safety elements.

End users can be divided into two main groups, focusing on the course of the utilization. The first one: the so-called grouped using, when users are under a mobile device group management, under a company policy. These users' devices are under protection from outside threats but this gives them less freedom of use. The security policies are written by the company and all end users have to keep all rights by the enterprise. Cloud Security awareness is low but the developing could be organized and managed by the company. All education types could be suitable for the users because of the company's supervision. If the goal is engaging the participant, it is necessary to find and apply didactic elements that give success and self-motivation.

The second group includes consumers who can access the cloud using any device. The market offers the mainstream in usage but the device protection belongs to the end users. A wide range of apps address mobile users and most free apps are available with a simple free cloud account.

In most cases, free of charge apps are the most expensive goods in the market – users pay with data, with usage information, user habits.

In this case there is no obligatory action to force end users to learn the security rules or comply with them. Here the only way that makes end users more compliant is creating an attractive platform which can be lovely, exciting and addictive enough to open it whenever the user has some free time.

HOW TO TEACH CLOUD SECURITY

First of all, teaching cloud security is the most important task we have to manage. Security questions are here, the cyberspace era poses frightening issues. Any IT device, software, hardware is reachable for everybody, and one cannot mention any kind of job not using an IT application via Internet. IT became an essential service, and all parts of business and private life use IT and cannot manage most actions without IT service.

Cloud computing brings new training and learning tools into education. Teachers or trainers reach their students in an easy way on different platforms, for example using web conference, social community sites, common sites, hosting sites or they can evolve a closed user group for a training team.

The advantages of cloud computing mean new possibilities for students as well. Students have access to the internet anywhere and anytime, they can even attend lectures of various universities simultaneously. Borders disappear, there is no physical barrier, and there is no distance between students in different universities, different countries. Students can use any device they have and connect easily to the university cloud. Studying can be supported by a range of interactive or online elements, students can help each other solve a problem or they can work together on the same project using co-working apps.

Another advantage of using cloud at the university is the fact that students can get in-depth knowledge of the cloud which can be an asset for a job application. Students can take part in foreign scholarships or foreign projects without travelling abroad.

In Hungary, some universities have started to use advantages of the cloud. For example, the Óbuda University started a course in 2014, which is available for students at partner universities. The Informatics Faculty of ELTE was the first in Hungary that moved to the cloud, providing several features to its students. The University of Miskolc and the University of Debrecen have also moved to the cloud and provide their students mailbox, SharePoint sites, OneDrive cloud storage with 1 TB and professional web conference with presence and chat functions.

GAMIFICATION

Gamification is the straightest way to engage the customer. These days, one of the biggest problems in the online world is how to pay attention and maintain this attention for a while. Browsing a web page, downloading an application – it is engaging the attention just for a few minutes, or just for a few days. The best market-leading game software companies know the secret to keep the users in front of the application for hours. With gamification we can reach the end users regardless of age, geography or IT platform.

Nowadays website visitors need more visual information and less text, less uninteresting information. Text length is reduced, and the imagery is more expressive. But this is not enough to make the user an engaged user. Users want to be part of the story, part of the act, have influence on social networks, and have responsibility for the other users. Gamification can give all these features for all end users.

Chao Liu from Microsoft Research says that an average website visitor spends only 10 seconds on the site before deciding whether he/she wants to keep on reading or not. If the visitor spends 30 seconds more on the same website, there is a chance that he/she stays 2 whole minutes

more. In mobile platform the results are more worrisome: according to Localytics research, 69% of the users use an average app at most 10 times. [5]

Gamification can be a motivation tool for every customer:

- Desire
- Motivation
- Task
- Challenge
- Compliance
- Reward
- Feedback
- Excellence

And what does engaging mean? If we can evolve an engaged user, we can get a variety of information on his/her habits:

- Actuality – When was the last login?
- Frequency – How frequently are the users visiting the app/site in a time period?
- Period of time – When do the users log in and how long do they stay there?
- Spreading – How many users refer to the app or site?
- Assessment – How do they like and evaluate the app or site?
- Awareness – In test methods, how many users identify, recognize a specific brand or product?

EFFECTIVENESS OF GAMIFICATION IN EDUCATION

Applying game theory online involves more than creating a contest. It applies the concepts of game design thinking into non-game applications. Gamification is a psychological process, utilizing public recognition and online competition to generate interest. [1]

Gamification could be a better way to get hold of crowd to increase the awareness of cloud security. Gamification techniques could be an enjoyable, long-term, impulsive and motivating education or marketing didactic tool. Some companies with different profiles tried it and could achieve higher or stronger profit. There are some significant results in cloud CRM usage of gamification, SalesForce could increase the sales process with 70%. [1]

Compared to other methods, gamificiation is a much more effective way to transmit information to large publics. Online trainings are less efficient, but they can reach more and more students in the world, in different languages at the same time. A subjective observation is that users do not take offline e-learning lessons seriously, not even the exam at the end. Online trainings are not free from restraints: tutor and students need real-time communication, so they have to be online at the same time. Tutors invest more energy to draw the attention – but in fact students give less heed.

Using gamification, tutors and developers make students into real participants – by involving them in a community or a motivating system. It is an interesting challenge to draw the cloud users' attention to the weak points or dangerous situations of usage of cloud computing. With gamification, users can learn how to use IT and cloud in a secure way – they can teach each other, debate issues, create workgroups and collect points for all these activities in the cyberspace.

With gamification it could be easier to teach the public and achieve educational goals than with any other web-based didactic tools. The author of this article has experience in editing e-learning materials, which can reach more students at the same time, in more languages, but she is not convinced of their effectiveness.

Using Gamification the users can be kept focused in a very addictive and motivating way, utilizing their social and game passions. It is a success if an enjoyable and interesting way can be found to inspire trainees to keep on learning.

Some elements of games that may be used to motivate learners and facilitate learning include:

- Progress mechanics (points/badges/leaderboards)
- Narrative
- Player control
- Immediate feedback
- Opportunities for collaborative problem solving
- Opportunities for mastery, and leveling up
- Social connection

Some of the potential benefits of successful gamification initiatives in the classroom include:

- allowing students to work on their own
- opportunities for identity work through taking on alternate selves
- freedom to fail and try again without negative repercussions
- chances to increase fun and joy in the classroom
- opportunities for differentiated instruction
- making learning visible
- providing a manageable set of subtasks and tasks
- inspiring students to discover intrinsic motivations to learn

Statistical research has been done [3] about the effectiveness of gamification in education. Comparing gamification with any other web-based education method, it is clearly seen that the involvement of gamification in the education of participants has significant advantages.

There are clear differences in engagement levels between the groups (see *Figure 1* for a summary of the results which showed a clear increase in engagement in the experimental gamified group). [3]

Specifically, it found that the gamified, experimental group:

- had more members who gave responses(83% vs. 68% of members)
- was more likely to start discussions, as a greater proportion of posts were in response to other members' answers rather than directly to our structured questions (37% vs. 3% of posts were comments in response to other members' answers)
- had a higher average number of posts per participant (2.3 vs. 1.5)

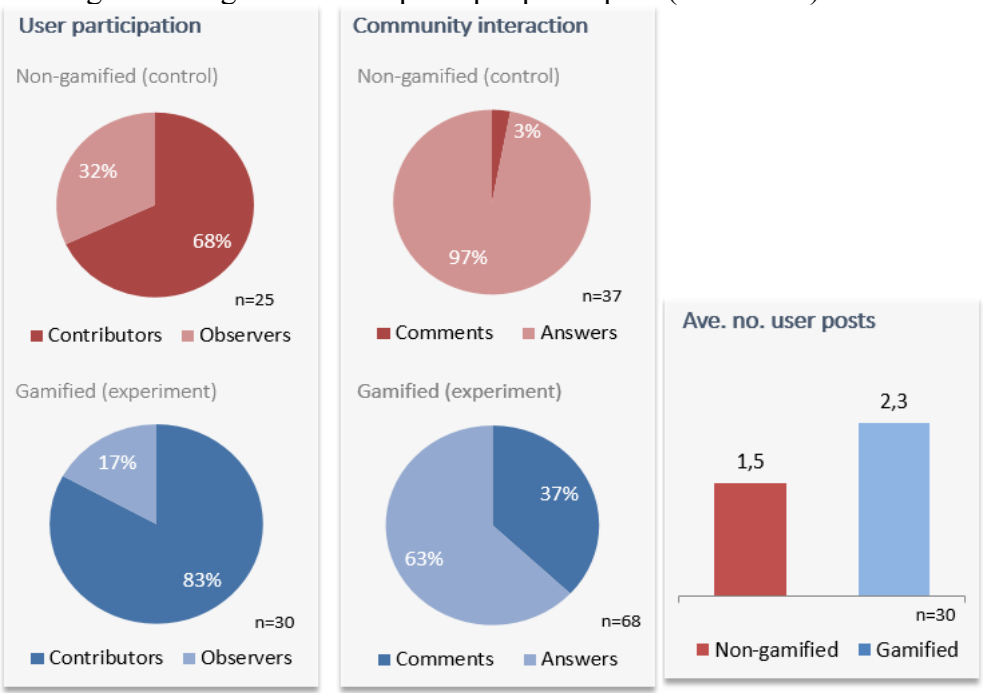

Figure 1: Proportion of non-gamified and gamified participants

Unfortunately, due to the relatively small size of the group, it was not possible to take the results as clear-cut evidence for gamification's effectiveness, regardless of how compelling the results appeared. [3]

Kevin Spier and Dan Maier of Bunchball published another case study of gamification effectiveness. Bunchball integrates game elements into websites and non-traditional game media. They partnered with NBC Universal to revamp the fan site for their comedy series, *Psych*. Bunchball added several game elements to the site in order to achieve this goal, including allowing fans to accumulate points for completing tasks such as watching videos, solving puzzles and listening to songs. These points could be redeemed for prizes such as T-shirts, mugs and small autographed items. In addition, high-scoring fans competed with each other via an online scoreboard. [4]

The results seem to justify the value of creating a compelling online experience through game elements:

- Overall site traffic increased by 30%
- Page views increased from 9 million to 16 million within the last gamified season
- The average visitor came four to five times a month instead of only twice a month
- The average time spent on the site increased from 14 minutes to 22 minutes
- Online merchandise sales increased by 47%

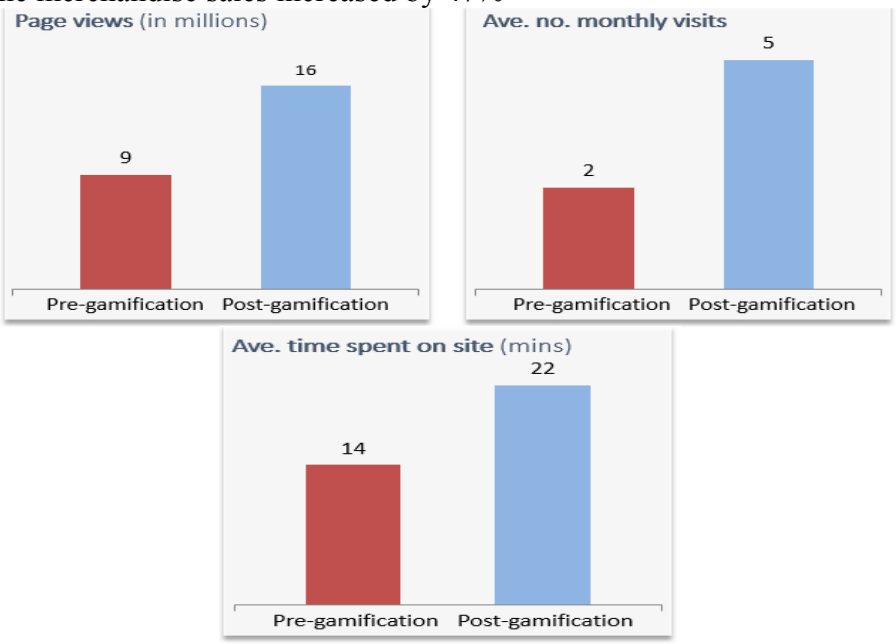

Figure 2: The effect of gamification in visiting, and spent time

CONCLUSION AND FUTURE WORK

The author's future plan is to test gamification in a real enterprise environment. It will be a challenging task to select the most suitable platform, the suitable device, the methods, and the types of gamification to be applied. The author has already started collecting ideas for this test and its results are eagerly awaited.

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ANALYSIS OF THE RESULTS OF REGIONAL DEVELOPMENT PROJECTS IN THE FIELD OF INTEGRATED WASTE MANAGEMENT SYSTEMS IN SALAJ COUNTY (RO)

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Abstract: It is well known that worldwide there are serious problems in the management of waste. Before the change of regime in Romania is quite primitive waste treatment plants were operating. After 1990's changes through local and European financial support relatively acceptable results were obtained in order to improve the situation. Of course, there is still much to be done in this area. In this paper, the authors describe the Salaj County (Romania) waste actual situation, and the result of latest regional and European projects in this direction,
Key words: waste management, integrated systems, European projects

1. INTRODUCTION

In Salaj County there were 140 not in conformity waste yards that had to be closed and ecologised, out of which 136 were in rural areas and were already closed in July 2009. The other 4 are not in conformity urban waste yards. According to the collected data, the 4 waste yards lie on a surface of 9.51 ha and it is estimated that they house a quantity of waste of about 386.000 t.

General objective: reaching the agreements of European Union Accession Treaty for Romania regarding life and environment standards improvement. Currently the project „Integrated waste management system in Salaj county" is in progress, having ERDF – SOP Environment 2007 – 2013, Priority Axis 2, Major domain of intervention 1.

2. THE USE OF FUNDS BASED ON STRUCTURAL INSTRUMENTS

The project wants to solve the significant environment and operational problems associated to the generation and management of waste and to develop an integrated management system of waste in the county, fact which will improve the life standard of its citizens and will support Romania to achieve the goals of waste management imposed by the Treaty of Accession. The system in this form will be in complete conformity with the environment principles and with the European and national legislation and will address to all the elements of waste management, from prevention of waste generation and their collection to the waste storage.

The proposed system is adapted to the county needs and was identified a the most efficient and accessible from the costs point of view for the county citizens.

The project intends to perform major investments to assure the infrastructure needed for the waste integrated management in Salaj County, as follows:

- Building in Dobrin The Centre of waste integrated management that will include the ecologic waste storage, the sorting unit and the unit for mechanic-biological treatment;
- Execution of 3 transfer stations at Crasna, Sînmihaiu Almaşului and Surduc;
- Closure of 4 urban waste storage units which are not in conformity from Crişeni, Cehu-Silvaniei, Jibou and Şimleu Silvaniei;

- Purchase of mobile equipment: lorries, chargers, compactors, waste containers, press-containers and garbage cans.

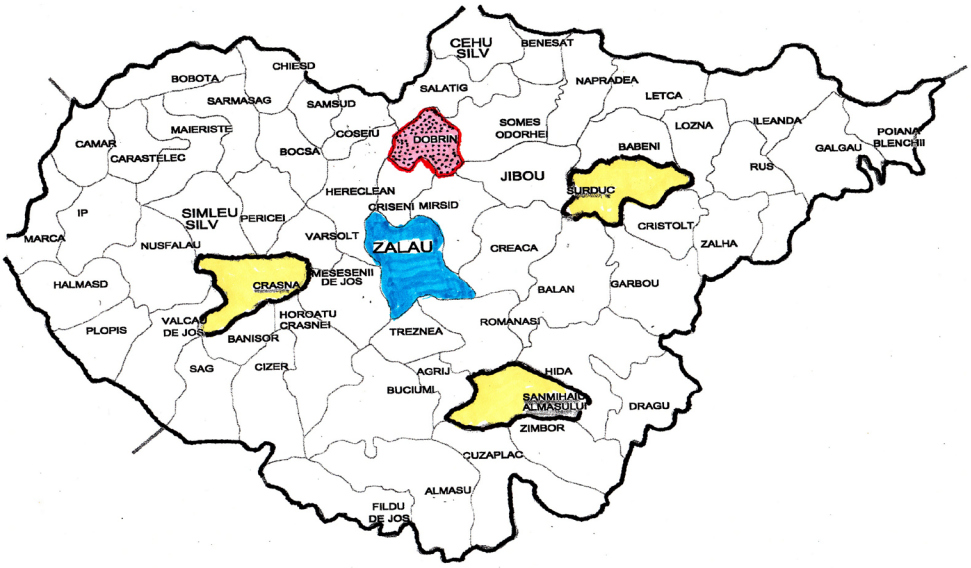

Figure 1. the largest waste storage units from Salaj County (Romania)

In fig. 2 are mentioned the largest waste storage units from Salaj county.

In yellow and blue are the present large waste storage units and in red is the waste storage unit that is going to be built in Dobrin as part of this project.

3. CURRENT STAGE OF INTEGRATED WASTE MANAGEMENT SYSMENS IN SĂLAJ COUNTY

Currently, in SĂLAJ county is generated an annual quantity of waste estimated to 60.000 t, which comply with a quantity of 244 kg/ inhabitant/ year. The waste structure presents normal differences between the urban (62%) and rural (38%) areas, especially in terms of biodegradable and recyclable fraction.

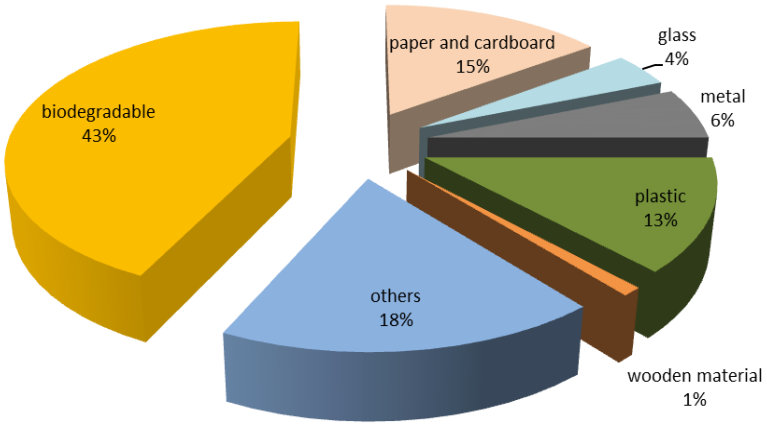

Figure 2. Current composition of waste

At the beginning of November the beneficiary will start another important activity of the project: The first public awareness campaign regarding the youth education in schools and the population awareness regarding the importance of the environment protection and the efficient waste management.

The campaign that took place in November 2014 in the whole county contained the following activities: press conference, youth education in schools regarding the environment protection, awareness and involvement of citizens in selective collection and efficient waste management, distribution of project promoting materials.

The initial infrastructure stage is emphasized in the regions – cities where the investments proposed in the project will be implemented:

- poor condition of roads infrastructure
- unincorporated area to be set as deposits
- poor condition of current waste storage units

Figure 3 presents the current poor condition of the roads infrastructure, while Figure 4 reveals the deplorable condition of the waste storage units.

Figure 3. Poor condition of road infrastructure

Figure 4. Deplorable condition of the waste storage units

Figure 5. Unincorporated area set up thorugh the project

As part of the project, the first works for the unincorporated area setup have been conducted (Figure 5, 6).

Main objectives to be achieved through this project:

- Center of integrated waste management (CIWM) Dobrin, with a total surface of 195.577 s.m. and a capacity of aprox. 1.100.000 cm, having the following facilities: ecological deposit, sorting station, mechanical-biological treatment station, epuration station;

- 3 transfer stations:
- Crasna with o surface of 6.966 s.m. and a capacity of 13.900 t/year;
- Sînmihaiu Almaşului with o surface of 6.024 s.m. and capacity of 3.400 t/year;
- Surduc with o surface of 5.990 s.m. and capacity of 2.600 t/year;
- 4 urban waste storage units which were uncomforbly have been closed (Cehu Silvaniei, Jibou, Şimleu Silvaniei and Zalău – Crişeni);
- 6,1 km of access roads have been modernised / improved (Dobrin - 2,1 km; Crasna - 1,2 km; Sînmihaiu Almaşului - 1,8 km and Surduc - 1,0 km);

Figure 6. Intermediary phase of central storage unit preparation

Figure 7.Equipment installation for transfer stations

4. DEFICIENCIES AND PROBLEMS THAT MIGHT OCCUR IN THE PROJECT COURSE

An essential part of the waste management system which is proposed is represented by the increase of the awareness level of population for two reasons:

- Active participation of citizens to reduce the wastes and collection of the garbage separately are crucial for the system success;
- The proposed system will increase the waste management taxes. The citizens will be informed about how this increase will correspond to the improvement of life standard and the value of waste management scheme that is going to be implemented will overtake that additional amount that the citizens will need to pay.

5. CONCLUSIONS

Developing sustainable waste management systems will be achieved by improving the waste management and reducing the number of historically contaminated areas.

The negative impact on the environment will be decreased and climate changes caused by urban heating system in the most polluted cities will be mitigated.

Biodiversity and national heritage will be protected and improved of by supporting the protected areas management, including implementation of Natura 2000 network.
The risk of natural disasters affecting the population will be decreased by implementing preventive measures in most vulnerable areas.
The most important projects' objectives are:

1. Expansion and modernization of water and wastewater infrastructure;
2. Development of integrated waste management systems and rehabilitation of historically contaminated sites;
3. Rehabilitation of municipal heating centers as a prerequisite of pollution decrease;
4. Implementation of adequate management systems for nature protection;
5. Development of infrastructure to prevent natural hazards in most risk exposed areas;
6. Technical assistance.

- Increased number of citizens benefiting from municipal waste collection and appropriate quality management services with affordable tariffs;
- Reducing the amount of waste deposited;
- Increase the amount of waste recycled and recovered;
- Implementation of effective structures for waste management;
- Reducing the number of historically contaminated sites.

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ASSESSMENT THE IMPACT OF EXPOSURE TO HAND-TRANSMITTED VIBRATION ON THE HEALTH

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ABSTRACT: The article deals with the assessment of the effects of vibration on health of employees in forestry. Article describes technological activities in the wood processing and negative factors affecting the health of employees at work. The article describes methods and process of measurement of the vibration acceleration and presents results of experimental measurements of exposure to vibration implemented in actual conditions of practice.
Keywords: vibration, measurement, chainsaw, health

INTRODUCTION

People spend about half of his life at work. There he is exposed to a number of factors so it can be said that the greater part of his health affects precisely those factors that act on him while performing work activities.

In each work area, people are exposed to different environmental factors. There is a several work areas where an increased risk of impact of those factors which have lasting effects on health and which causes the occupational diseases. Progress in machinery and tools innovation facilitates especially hard manual work of workers. However, on the one side that equipments facilitates the work, but on the other hand they may be a source of negative impacts which can damage health of workers.

The work environment affects the organization of work, the workplace, the state of the technical development, architectural design work interior and exterior, physical factors of workplace and hygiene level of work operation. Every work environment represents factors which has influence on workers health. The risk factors of work environment are the physical, chemical and biological factors, physical load, heat and cold load, visual and psychological load and the other factors which has influence on health.

The physical factors of environment are the one of the important factors which influence occupational disease formation. The high of risk depends on the intensity, frequency and lenght of applied energy [1,4].

One of the work areas which in terms of the health influence belongs to the most critical is timber harvesting. A forest creates specific work conditions. Workers are exposed to injurious physical factors like vibrations, noise, solid aerosols, excess expense and one-sedie load. Mentioned factors arising from the use and operation of machinery and equipment that are part of everyday work in the forest or in the timber-yard. Given that employees are the effects of these negative factors exposed every working day, it is necessary to pay close attention to identifying critical points arising from the use of machinery at work and then provide measures for their elimination.

Authors of this paper focused on assessing the impact of the vibrations transmitted to the hand when working with a chainsaw. For measurements follow the existing work processes accredited workplace in which the author's contribution operate [2, 5].

MATERIAL AND METHODS

Preparation of vibration measurement

Size measuring vibration acceleration were carried out under normal operating conditions. When measurements are being complied with standards EN ISO 5349-1:2003, ISO 5349-2:2003 and STN 2631-1. Measurement of vibration acceleration was conducted work activity using that hand tools. For gripping hand tool with two hands were the measurements of vibration acceleration for both hands.

The size of vibration emission expressed values of equivalent weighted vibration acceleration $a_{weq\ t}$ in different coordinate axes (a_{xweq}, a_{yweq}, a_{zweq}), as well as the value of the resultant equivalent acceleration value and calculated according to the equation:

$$a_v = \left[\left(k_x . a_{xweq}\right)^2 + \left(k_y . a_{ayweq}\right)^2 + \left(k_z . a_{zweq}\right)^2\right]^{1/2} \quad (4)$$

Where: $\mathbf{a_{xweq}}$, $\mathbf{a_{yweq}}$, $\mathbf{a_{zweq}}$ - values of equivalent weighted vibration acceleration in the coordinate axes (x, y, z), $\mathbf{k_x}$, $\mathbf{k_y}$, $\mathbf{k_z}$ - assessment factors in the direction of the coordinate axes of vibration transmitted to the hand ($k_x = 1$, $k_y = 1$, $k_z = 1$), the vibrations transmitted to the whole body ($k_x = 1.4$, $k_y = 1.4$, $k_z = 1$),

Subsequently is equivalent to the weighted vibration acceleration converted to normalized vibration acceleration $a_{weq,\ Tn}$ depending on the duration of the shift according to the equation:

$$a_{weq,Tn} = \left(T / T_n\right)^{1/2} . a_{weq,T'} \quad (4)$$

For the calculation of normalized vibration acceleration measured values were used for each measurement. The normalized vibration acceleration are then compared to the action and limit values of exposure to vibrations. To assess the risk to the health and safety of employees in the work environment is the determining factor, for the vibration transmitted to the hand resulting normalized vibration acceleration in the frequency range 5.6 Hz to 1400 Hz (weighting filter on hand w_h). For the final assessment should take into account the value of the hand with the higher measured values [3].

For the assessment was chosen profession, which is the most critical on human health in term of impact of negative factors - sawyer. The basic activity logger is working with a chainsaw. For measurements, working with a chainsaw STIHL brand.

Workload of chainsaw operator during the change consists in carrying out the measurement, marking and cutting strains using chainsaws outdoors. In their activity varies between strains of wood that are placed side by side and prune them for shorter parts.

The length of the sawyer shift was running eight hours with 30 minutes breaks. Employee performs servicing chain saws every day for seven hours.

RESULTS AND DISCUSSION

Measurement conditions of sawyer activity were the same as the normal job description. The results are shown in Tab. 2 Parameters a_{xweq}, a_{yweq}, a_{zweq}, the measured vibration acceleration in each axis and in the resultant acceleration.

Based on the results in Tab. 2 it can be said that has not exceeded the limit value standardized acceleration vibration transmitted to the hand of the employee but the action level is exceeded normalized vibration acceleration. The employer in this case is required to establish and implement a program of technical and organizational measures to reduce exposure to vibration and interacting risks to the lowest possible level.

Fig. 1 shows the progress of the measured acceleration transmission of vibration to the hand of an employee over time. In this particular case, the first 7 seconds when first cut went to

saw idling, speed was constant. All three axes have the same course, are not significant variations between them. Figure 2 shows the vibration acceleration at each frequency.

Tab. 2 Measurements results of vibrations acceleration transmitted to the hand

Measurements results of vibrations acceleration transmitted to the hand					
Hand	Measurement duration s	a_{xweq} $m.s^{-2}$	a_{yweq} $m.s^{-2}$	a_{zweq} $m.s^{-2}$	a_v $m.s^{-2}$
Right	60	5,39	2,76	1,71	6,29
Left	60	4,53	2,30	1,83	5,4
Normalized vibration acceleration for the profession chainsaw operator $a_{weq,8h}$ $m.s^{-2}$					2,22
The assessed value of the vibrations acceleration transmitted to the hand $a_{weq,8h}$ extended the uncertainty (22%) $m.s^{-2}$					2,71
Action value standardized vibration acceleration transmitted to the hand $a_{v,8h,a}$ $m.s^{-2}$					2,5
Limit value normalized vibration acceleration transmitted to the hand $a_{v,8h,L}$ $m.s^{-2}$					5

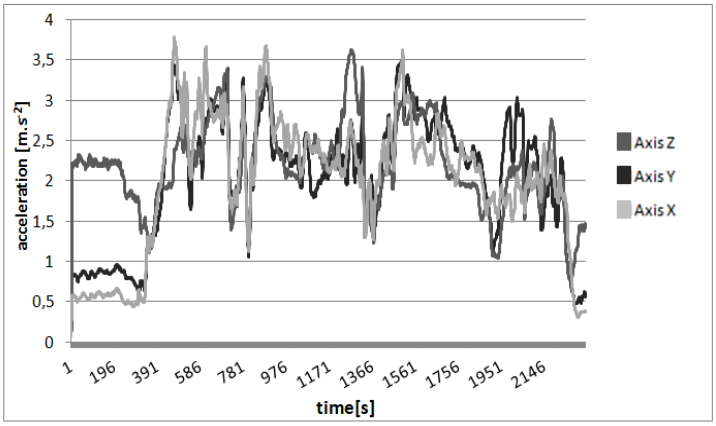

Fig. 1 Course of vibration acceleration transmitted to the hand of the employee at the time

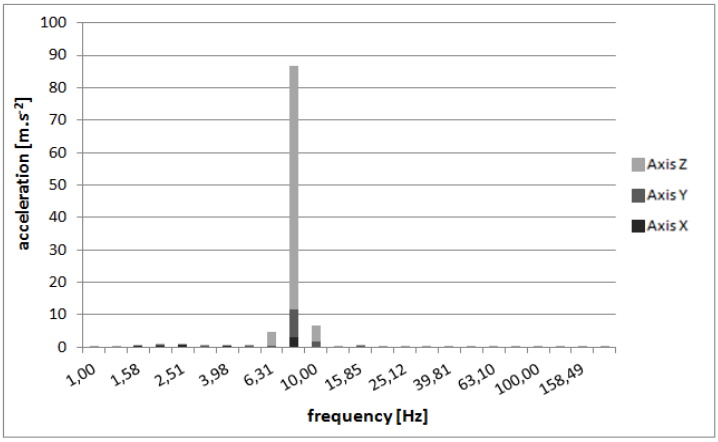

Fig. 2 Acceleration of vibration transmitted to the hand of the employee, depending on the frequency

From the frequency analysis of vibration acceleration transmitted to the hand of an employee it can be stated that the increased value of vibration acceleration occur at frequencies in the range of 6.5 to 10 Hz. Other values of vibration acceleration at lower frequencies are negligible compared to them.

CONCLUSION

In case of the exceeded value of vibration the employer has to prepare and implement a program of technical and organizational measures to reduce exposure to vibration, and affect the risks to the lowest possible level according to Slovak legislation.

It is necessary to focus on the identification of critical points which are the source of these factors and, consequently it is important to take the measures to eliminate them.

When designing technical measures, the decisive role played by engineers who are based on the results of statistical processing of measured values, they can construct or improve protective equipment that workers use at work (for example antivibration gloves).

ACKNOWLEDGEMENT

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COMPARATIVE ANALYSIS OF STRESS DISTRIBUTION BASED ON ALUMINUM ALLOYS

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Abstract: The research through numerical modeling provides lots of information about temperature, stress, strain and electrostatic condition to optimize the elaboration process of Al alloys, but also to approach a geometric position corresponding to mechanical requests according to the product's destination. The paper presents the author's personal research, using Autodesk Simulator CFD on two Al and Al-5Ti-1B alloy parts differently shaped to evaluate their behavior to a certain force linear oriented on coordinate Ox. The results have a major importance to establish the maximal strasses and strains in the parts made of aluminum alloys.

Keywords: Al, Al-Ti-B, AS-CFD, Stress Distribution.

1. INTRODUCTION

The Autodesk CFD Simulator (AS-CFD) is a simulation program that can help us to determine physical, mechanical characteristics of certain processes, materials or complex installations so that we can give an overview and insight into the future in terms of the studied property of the element, but also the economic benefits.

In this paper we have chosen two models of Al materials and Al-Ti-B alloys and studied using AS-CFD the stress distribution but also the influence it has on certain parts of the material.

AS-CFD programme is widely used in different simulation, including also Metallurgy Industry (loading and distribution of raw materials in the furnace, oven, congestion, elaborate analysis of certain physical properties of ferrous and nonferrous materials. The aluminum industry can highlight: the influence the chemical composition on the behavior of Al alloys in various processes, porosity analysis, static stress etc. All these features can be combined and analyzed also in Autodesk Simulation Mechanical (Figure 1).

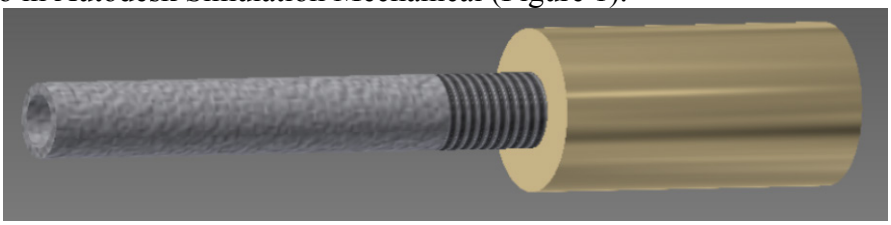

Figure 1. AS-CFD- Al/ Al-Ti-B Bar

With AS-CFD we can improve ductility of Al / Al-Ti-B alloys using stress parameters (mechanical), in our case we chose only unidirectional tests. A similar program was used by some Japanese researchers [1-4].

2. MATHEMATICAL MODELLING AS-CFD/AS-M

The geometric model developed in Audesk Inventor Professional consists in an Al bar of a 70cm length (Figure 1), and the chemical composition shown in Table 1. To highlight the variation of stress distribution we have compared different pattern to a bar of an of Al / Al-Ti-B alloy.

The empty inner diameter of the Al bar is 5cm and 2cm thick. The empty inside diameter of the Al-5Ti-1B Bar is 7cm to 8cm thickness bar.

Table 1. Chemical composition used in Al-Ti-B alloys bar

Alloy %	Ti	B	Fe	Si	V	Al
Al-5Ti-1B	4.80	0.85	0.09	0.08	0.04	94.14

Kinetics simulation requires an analysis of two models: a process of clash infiltration, between two materials but also the interaction between particles after mechanical strain (Figure 2).

According to the AS-AC the friction coefficient has been set to a value of 0.1. The calculated values were used Al alloy Al6061 with a density of 2.71g / cm^3 and Ti with the density of 4.51g / cm^3 (data outlined in the simulation conditions for materials - Table 2). The max magnitude was 310MPa and 344.5MPa.

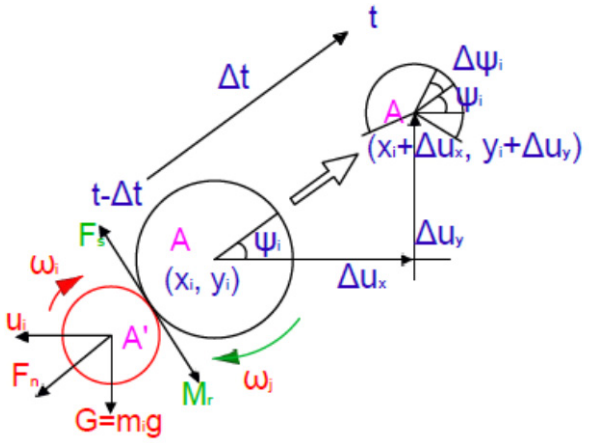

Figure 2. The forces who act between particles and schematic representation of Mathematic model used into simulation AS-CFD

where: M_r - Force moment, Nm; Δt - The time variation, s; F_n - normal force, N; ω -angular velocity, radian/s; G - Force of gravity, N; A, A' - A particle, B particle; ψ -acute angle between direction of mechanical stress and horizontal, radian, Δu - decomposition of particles on a flat surface coordinates O, X, Y.

3. RESULTS AND DISCUSSIONS

The simulation was performed with AS-M and AS-CFD for each material pursuing the stress variation of distribution in certain areas. The simulation was done in within 8 seconds per sample material to the dimensions given in the previous chapter.

The basic data used are given in Table 2, for materials in Table 3. According to the experiment on the part it has been actioned with a magnitude of 20sqm, and a parallel force magnitude 100N.

Table 2. Mesh settings

Avg. Element Size (fraction of model diameter)	0.08
Min. Element Size (fraction of avg. size)	0.2
Grading Factor	1.5
Max. Turn Angle	60°
Create Curved Mesh Elements	No
Use part based measure for Assembly mesh	Yes

Figure 3 shows the stress vectors analyzed according to AS-CFD for the 2 parts: in the first version the Al-Ti-B piece is placed halfway of Al Bar, in the second version two Al-Ti-B alloy parts barriers are placed at the end of Al bar. It can be highlighted areas with a minimum and maximum stress distribution depending on Al-Ti-B piece location: in a first phase in the mid of the assembly (maximum values of voltage tending to gain maximum values at the

assembly extremities), in the second phase in the same conditions for applying tension and force to the ends of the assembly (maximum values tend to concentrate toward the end of Al-Ti-B - less subject to the influence of tension - without force-right end).

Table 3. Material(s)

Name	Titanium	
General	Mass Density	4.51 g/cm^3
	Yield Strength	275.6 MPa
	Ultimate Tensile Strength	344.5 MPa
Stress	Young's Modulus	102.81 GPa
	Poisson's Ratio	0.361
	Shear Modulus	37.77 GPa
Part Name(s)	Part1	
	Part1	

Name	Aluminum 6061	
General	Mass Density	2.71 g/cm^3
	Yield Strength	275 MPa
	Ultimate Tensile Strength	310 MPa
Stress	Young's Modulus	68.9 GPa
	Poisson's Ratio	0.33
	Shear Modulus	25.9023 GPa
Part Name(s)	Part1	
	Part1	

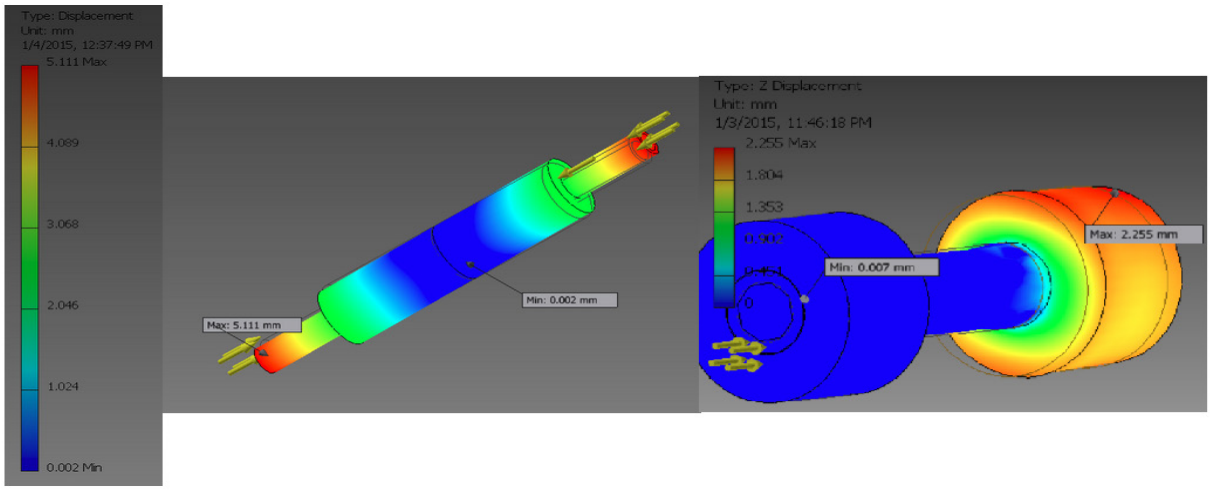

Figure 3. The stress distributions according to the analyzed parameters

Table 4. Frequency variation to simulation

Frequency	Value
F1	83609.34 Hz
F2	101756.86 Hz
F3	105522.40 Hz
F4	106167.83 Hz
F5	107055.79 Hz
F6	133660.22 Hz
F7	140877.16 Hz
F8	145425.25 Hz

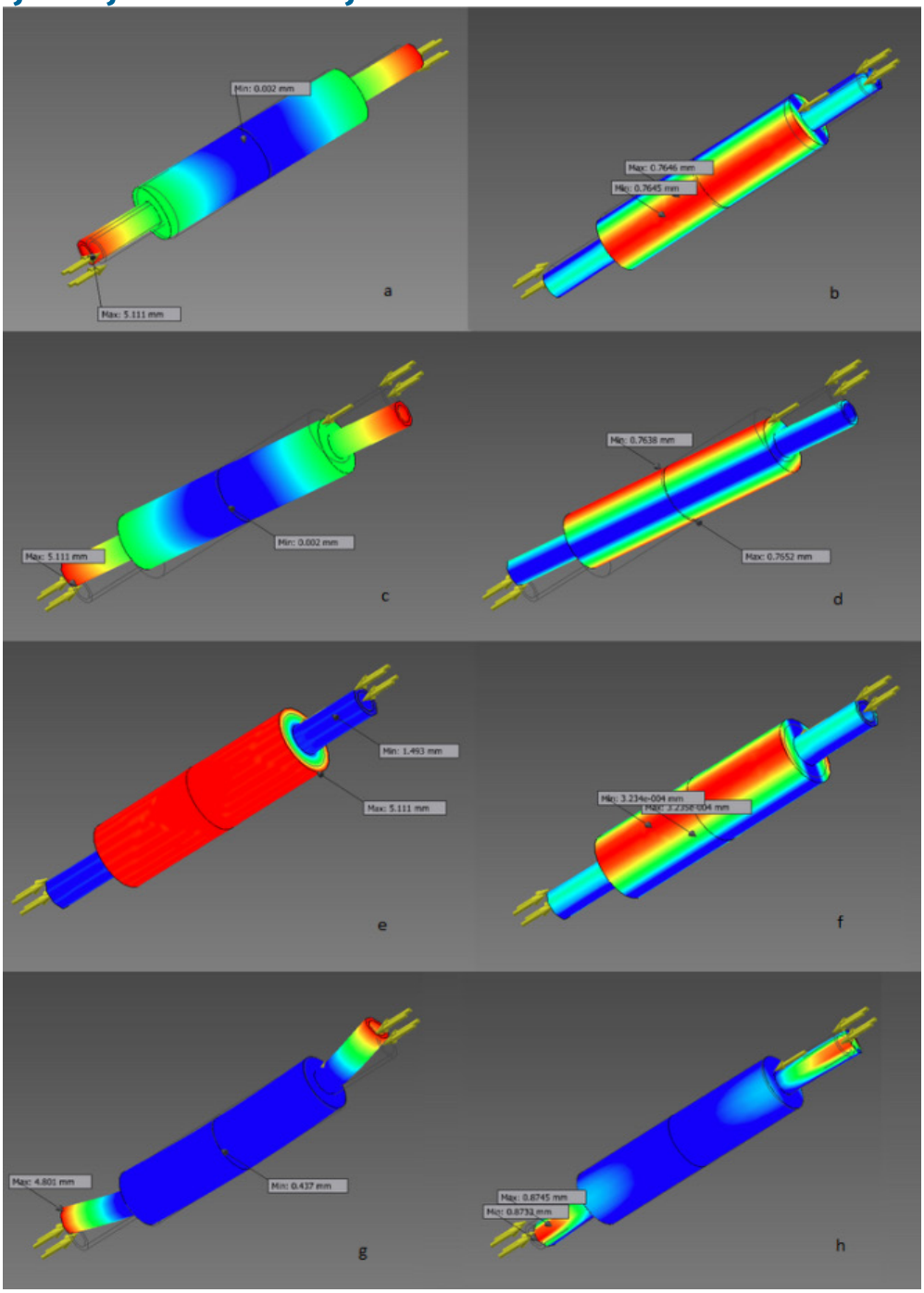

Figure 4. Variation of stress distribution for the first piece, maximum and minimum values recorded at the start of the simulation (a), and to the end of simulation (appearance of faults-weakening mechanical properties-h).

Figure 4 shows the magnitude variation of the first piece (middle alloy-ends of aluminum) failed linearization attempt and its evolution till the end of simulation. Figure 4a shows the beginning of the experiment conditions, the action on the piece voltage and minimum and maximum values initially recorded. The same conditions are shown in Figure 4c, only in this case, a shift of the axis simulation causing tension and force them to action under an angle of about 15 ° to the horizontal plane of the simulation can be seen. Later we can see the stress distribution on the entire surface of the workpiece (Figure 4b and 4d) maximum points reaching on parallel areas to the tension and force action. In this case we can see inside the blue piece section remaining unchanged even at an angle of 15o action.

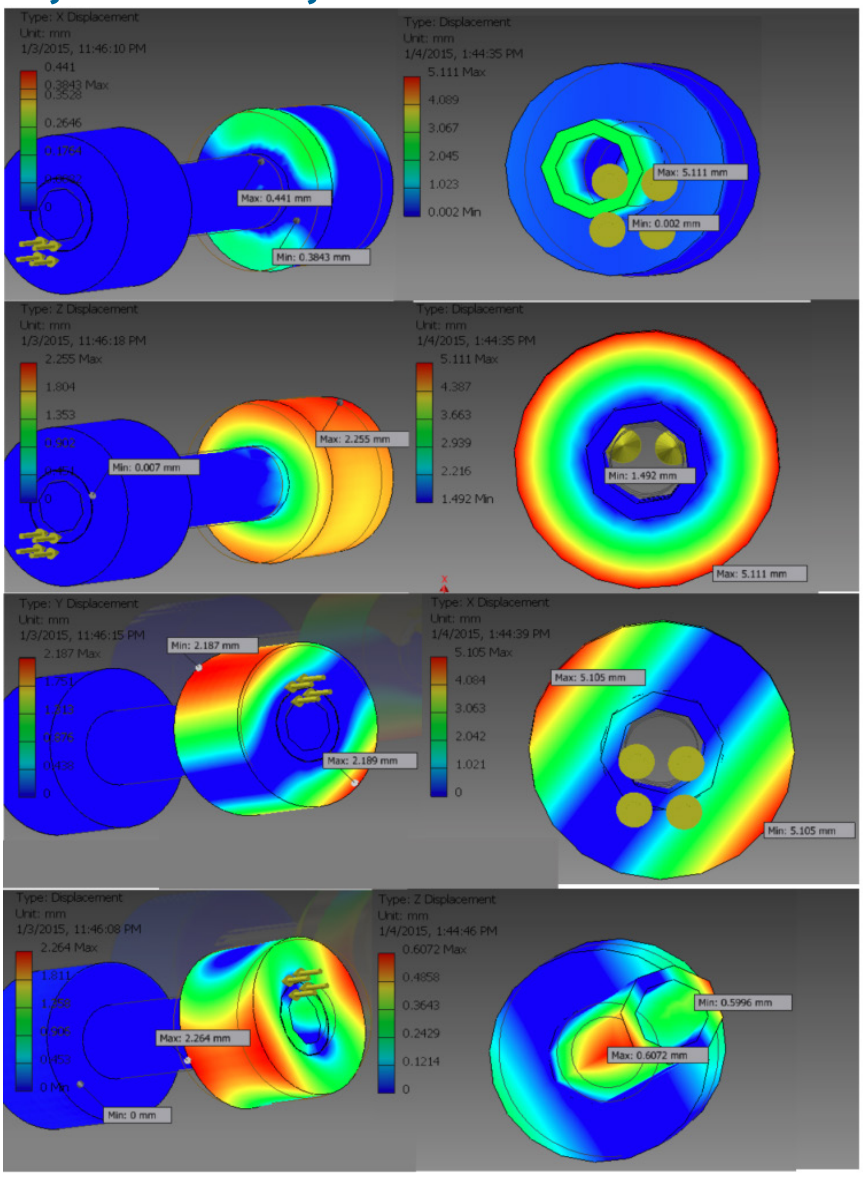

Figure 5. Variation of stress distribution for the second piece, maximum and minimum values recorded at the start of the simulation, and the end of it.

At the end of the simulation we can notice the tendency of plastic deformation but also the damage of the mechanical resistance properties of Al Bar (end piece). Deformation is symmetrically performed at both ends in the same direction and at the same angle. The Al structure retained all tension exerted on the retained piece, deforming in plastic at the end of the simulation, by losing their mechanical resistance strength.

The parallel evolution to the piece form Model 2 is shown in Figure 5, the presentation being made on OX axis (standard plan) and OY (vertical view). Since the first stage of the test we can notice the voltage variation on the right piece surface. Intensity tends to increase, taking over the entire circumference of the piece, and in response to the magnitude of the alloy it is applied the dispersion of the tension- in the 4th stage on the sideways of the piece, and in the 5th the alloys tries to standardize the tension and force applied, work that ultimately fails, deforming the plastic piece. Following this analysis we observe a tendency to accumulate tension only on one of the 3 bodies of the piece (2 sideway heads - Al-5Ti-1B alloy and fix central bar - Al), on the right side end, the result of which was applied besides that magnitude and a force of 100N. In a first phase the tension builds up on the outside of the piece, the Al center remaining untouched. At the end of the simulation, after the plastic deformation of the

right body of the piece, stress distribution if uniform, it is affected also the Al core, but the smoothing could not prevent the plastic deformation

4. CONCLUSIONS

In the work presented was analyzed according to AS-CFD the stress distribution built on two different pieces: first with an Al-Al-1B alloy center and extremities of Al, 2nd the other way around: alloy extremities and the connection of Al. The simulation was performed according to data from Tables 1,2,3,4 thus obtaining the following results:

- When modeling the first piece in the central part - the Al-5Ti-1B body remains relatively unchanged, the unidirectional values coincide with those alternatives, and uniformity occurs successfully. The ends of the Al piece of Al- do not register the same alternative values with a double preventing the uniform distribution of tension in the piece so these are plastically deformed.
- For the second part the uniformity occurs on the central body -of Al- and the left extremity component, instead on the right aggregate (where it has been acted with F force in plus) a plastic deformation occurs, the piece loses its mechanical strength properties.
- In case of Al-5Ti-1B components the uniformity occurs faster, providing a higher resistance to stress, and by default to the mechanical stress. The Al components tend to deform rapidly, weakening the mechanical characteristics of the entire piece.

Tests showed maximum variations of tensor stress in the two extremities of the first pieces, involving plastic deformation of Al components. For the second piece the deformation occurs only at one end of Al-5Ti-1B, where it acts with an additional force F.

Of the two simulations we can observe that the uniformity process of stress distribution is successful done only in case of Al-5Ti-1B components, and even in our case only to one component of this type of alloy the deformation occurred, it has been achieved in a much smaller angle as in the first piece.

These tests are highly important to determine and use exact components,of a specific chemical composition in different equipment, machinery, etc. so that this meets the standards of mechanical stress, in accordance with each destination.

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RESEARCH ON THE USE OF DUSTS RESULTING FROM IRON AND STEEL PROCESSES

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ABSTRACT: The powdery and fine ferrous waste, resulted in the various phases of the industrial processes (in most cases, siderurgical), represents an intrinsic value determined by the ferrous content (chemically bounded iron, sometimes metallic iron), which can adequately replace some of the raw materials used in siderurgy, i.e. the iron ore. In the experiments carried out, we considered the recycling of powdery ferrous waste (dust from steel plant, sinter plants and blast furnaces) and fine ferrous material (scale). The processing aimed obtaining self–reducing ferrous briquettes, which is why in the recipe composition we added graphite powder and, as binder, lime and bentonite. The quality of briquettes was assessed through their mechanical properties, resistance to cracking and crushing, and the crushing range, considered dependent parameters. As independent parameters, we considered the component percentages in the recipes. The data obtained were processed using Excel spreadsheet and MATLAB programs, and the obtained correlations were analytically and graphically expressed. The results were technologically and economically analyzed, resulting in a series of conclusions useful for the steelmaking practice.
Key words: waste, dust, iron, carbon, briquettes, recovery, siderurgy

INTRODUCTION

In the industrial processes, in addition to the primary product are sometimes resulting secondary products and wastes. In the steel production flow, the economic operators generate continuously fine and powdery waste containing iron, carbon and iron & carbon, in appreciable amounts proportional to the obtained production.

In the various stages of the technological processes within a steel company, besides the primary product, there are also generated significant amounts of materials, usually called wastes, but because of the possibilities to recover them through recycling and / or reuse they fall into the category of by–products. Depending on the circumstances of each steel unit, and according to the local market demand (time–variant) of each usable material, any waste can become by–product and any by–product can become waste. [1, 2, 3, 11]

Currently, the problem of recovery through recycling of the powdery and fine waste generated in siderurgy arises worldwide, being proposed the application of the integrated recycling concept. The entire quantity of powders, slurries and scale, steel plant slag – the ferrous fraction, generated within an integrated iron & steel plant, are recycled in the various stages of the technological flow, the mostly used processes being: sintering, pelletizing and briquetting.

Compared with the practices and trends worldwide, Romanian steel industry records backlogs in the collection, transport and storage of the powdery waste, as well in the technologies for recovery through recycling or reuse. In these conditions, we considered necessary and appropriate to approach the issue of higher recovery of the powdery waste generated within an integrated iron & steel plant, recovery achievable with minimal costs. [1, 11]

The higher recovery of siderurgical waste in general and of those fine and powdery in particular, represents an important issue, because turning them into by–products (i.e. in economic goods) can lead to a rational exploitation of the raw materials and energy resources, thus ensuring either the needs of human society or the environmental protection, major

problem at the end of the second millennium and the beginning of the third millennium. [1, 2, 3, 6, 7]

STUDY OF THE ISSUE

In the experiments carried out, we assessed the possibilities to recover certain siderurgical wastes (i.e. dust from sinter plants & blast furnaces, dust from steel plant, and scale) through briquetting. We chose this method because the first two types of waste are powdery and the third is fine, which corresponds to this process. Since we chose the production of self–reducing briquettes, we used graphite powder as reducer and lime & bentonite as binder.

The waste chemical compositions are shown in the Tables 1 – 3, and the recipe compositions are shown in Table 4.

Table 1. Chemical composition of the slurry from sinter plants – blast furnaces (after drying) [1, 16]

Chemical composition, %											
FeO_{tot}	FeO	Fe_2O_3	SiO_2	Al_2O_3	CaO	MgO	MnO	S	P	C	PC
30.40	8.84	33.61	10.35	9.33	10.47	2.47	0.89	1.38	0.13	22.04	1.272

Table 2. – Chemical composition of the dust from steel plant electro–filter [1, 16]

Chemical composition, %										
Fe_{tot}	FeO	Fe_2O_3	SiO_2	Al_2O_3	CaO	MgO	MnO	P_2O_5	S	ZnO	Others
53.67	2.98	73.37	3.49	1.07	5.11	2.34	4.80	0.74	0.34	0.84	4.918

Table 3. Chemical composition of the scale, % [1, 5]

FeO	Fe_2O_3	MnO	SiO_2	CaO	MgO	Al_2O_3	Others
63.0– 70.0	18.0– 30.0	0.8 – 1.5	1.0 – 3.5	0.1 – 0.40	0.3 – 0.5	(0.9 – 2.0	3.0– 4.0

Table 4. Composition of recipes, [%]

Sr. no	Used waste	Composition of recipes [%]									
		R1	R2	R3	R4	R5	R6	R7	R8	R9	R10
1	Dust from sinter plant and blast furnaces	25	30	35	35	40	45	50	55	60	65
2	Dust from steel plant	50	40	35	30	25	20	24	19	15	10
3	Scale	14	17	19	25	25	25	14	15	13	13
4	Bentonite	2	3	3	3	3	3	4	4	5	5
5	Lime	3	3	3	3	3	3	3	3	3	3
6	Graphite powder	6	7	5	4	4	4	5	4	4	4

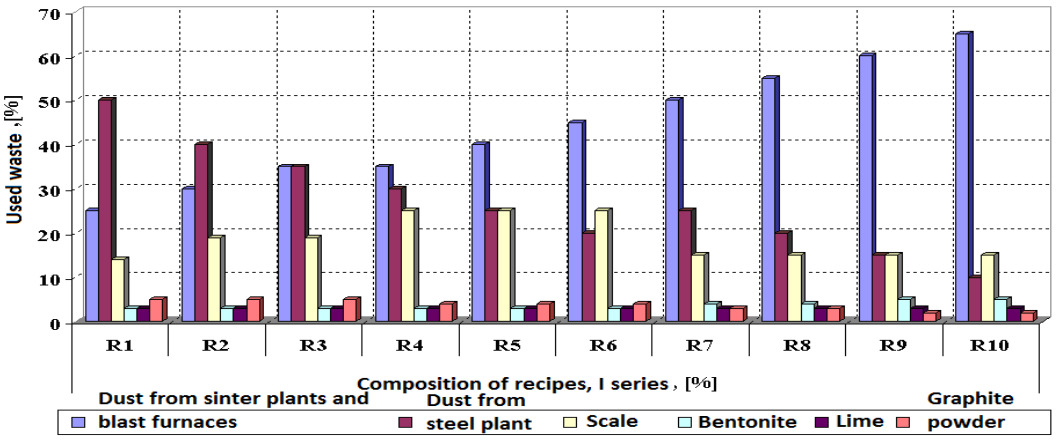

Figure 1. Composition of recipes

To assess the quality characteristics of resistance to handling and transportation of the briquettes, we found by experiments three technological proprieties:

- Resistance to cracking:

$$R_f = \frac{F_f}{A}, [kN/cm^2] \quad (1)$$

where: F_f – cracking force, [kN]; A – sectional area of the sample (briquette), [cm^2]
In case of the studied briquettes (cylindrical), the above relation can be written:

$$R_f = \frac{4 \cdot F_f}{\pi \cdot d^2}, [kN/cm^2] \quad (2)$$

The cracking force, F_f, is considered to be the force at which the first visually detected cracks occur. Following a large number of preliminary tests and on the basis of literature data [1, 2, 6], this force is considered to have the value recorded at $\tau = 2$ seconds.

- Crushing strength:

$$R_s = \frac{F_s}{A}, [kN/cm^2] \quad (3)$$

where: F_s – crushing force, [kN]; A – sectional area of the sample (briquette), [cm^2]
In case of the studied briquettes (cylindrical), the above relation can be written:

$$R_s = \frac{4 \cdot F_s}{\pi \cdot d^2}, [kN/cm^2] \quad (4)$$

Based on the literature data and the preliminary observations, the crushing force is considered to have the value recorded at $\tau = 12$ seconds.

- The crushing range:

$$\Delta R_{fs} = I_s = R_s - R_f, [kN/cm^2] \quad (5)$$

Regarding the possibility of using the material by recycling, any research must relate with the permissible values for the resistances mentioned above.
In the literature [1, 2, 3], we found information about the pellets to be loaded into the blast furnace, products that are in the same category with the briquettes subject to this research.
Given the fact that the briquettes for processing in the blast furnace undergo multiple handling operations, in many cases being transported over long distances (hundreds of kilometres), and taking into account the data found in the literature [1, 2, 6, 8, 9], we consider that, provided that the obtained briquettes will be used in a siderurgical company, located not far from the briquetting plant, the resistance to cracking must correspond to the relation:

$$R_f > 0.2, [kN/cm^2] \quad (6)$$

The literature [1, 2, 6] regarding the briquettes which contain more than 70% dust from electric steel plant (EAF) presents the following relation for the crushing strength R_s:

$$R_s = (1.2–1.35)\ R_f, [kN/cm^2] \quad (7)$$

Obviously, we are going to establish below a correlation relation of these resistances, for the briquettes produced according to our recipes.
In order to recover, as briquettes, the fine and powdery waste coming from the iron & steel, energy and mining industries, I considered the following types of waste: dust from the electric steel plant, dust (slurry) from the sinter plant & blast furnaces, scale (scale slurry), and as binder, we considered lime, bentonite and cement.
For each recipe, we produced a briquetting heat of 1.5 kg, to be possible to obtain a number of 5 briquettes.
After producing them, the briquettes were left to harden in the atmosphere for 15 days, after which they were tested for determining the quality characteristics.
The data from experiments were processed in Excel calculation program, for obtaining simple correlation equations, and in MATLAB for obtaining multiple correlation equations (triple

and double). We mention that the same data were processed in both programs. The correlations obtained are presented analytically and graphically. Below, I present the data about the production of briquettes.

The results of data, processing using the Excel program, are presented in the figures 1–8.

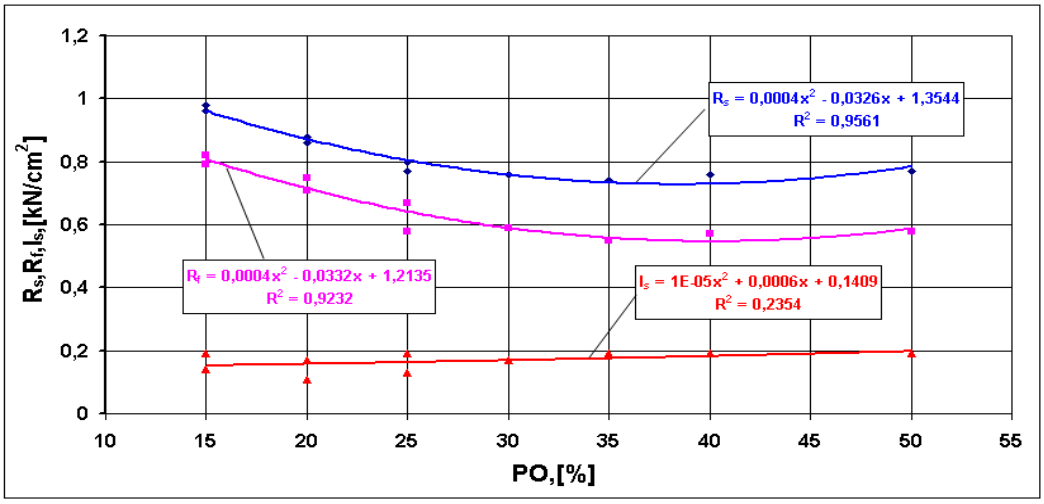

Figure 2. R_f, R_s, I_s versus the percentage of dust from steel plant

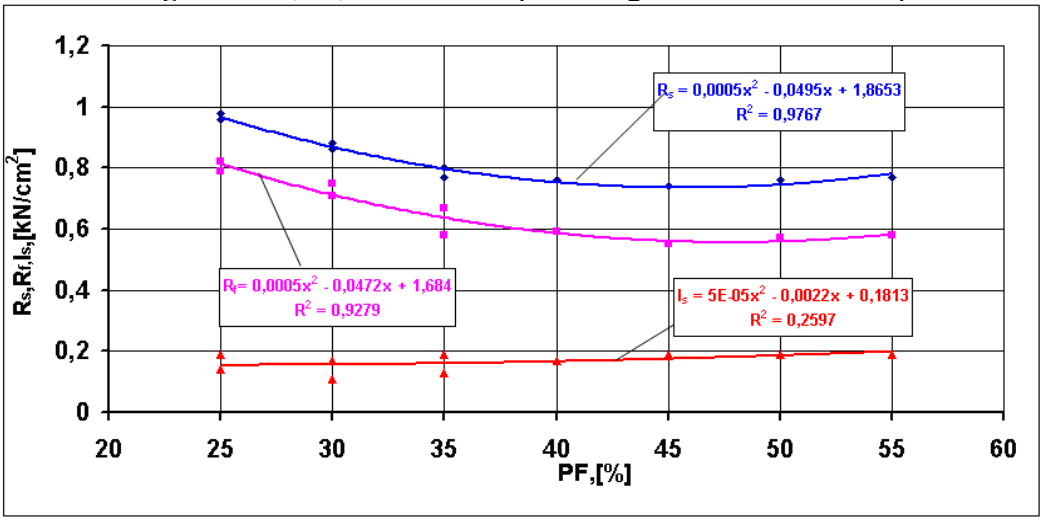

Figure 3. R_f, R_s, I_s versus the percentage of dust from sinter plant and blast furnaces

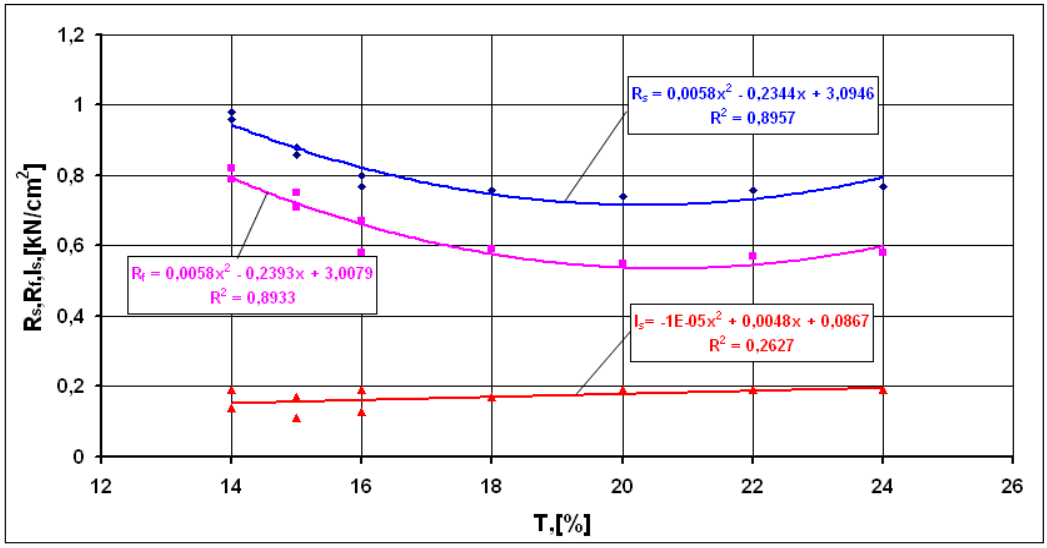

Figure 4. R_f, R_s, I_s versus the percentage of scale

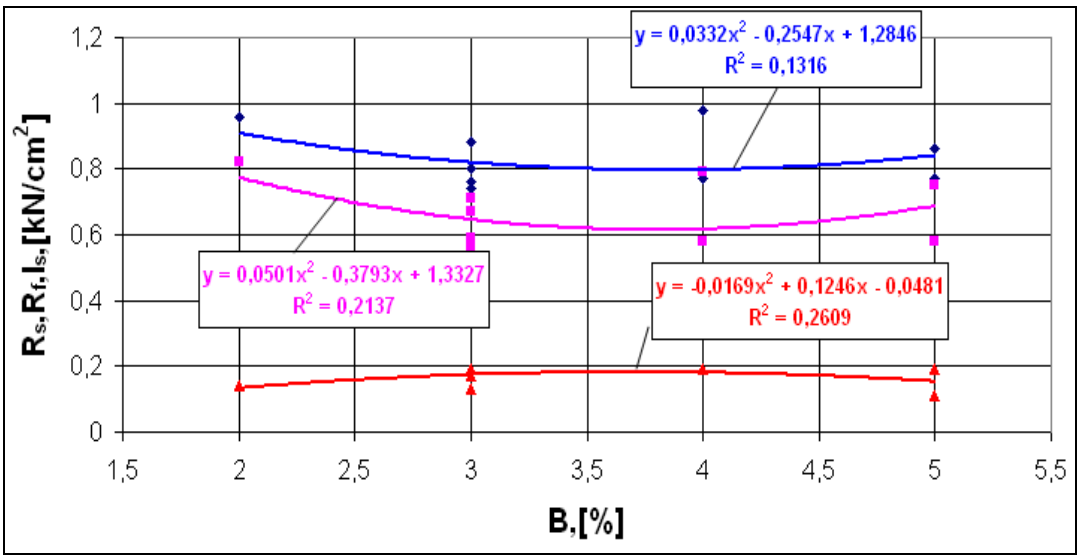

Figure 5. R_f, R_s, I_s versus the percentage of bentonite

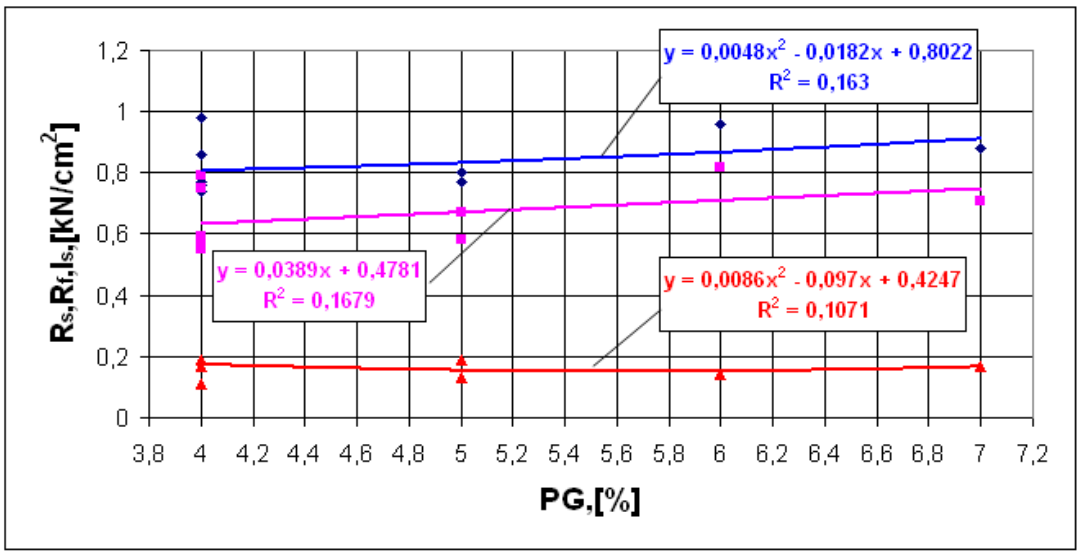

Figure 6. R_f, R_s, I_s versus the percentage of graphite dust

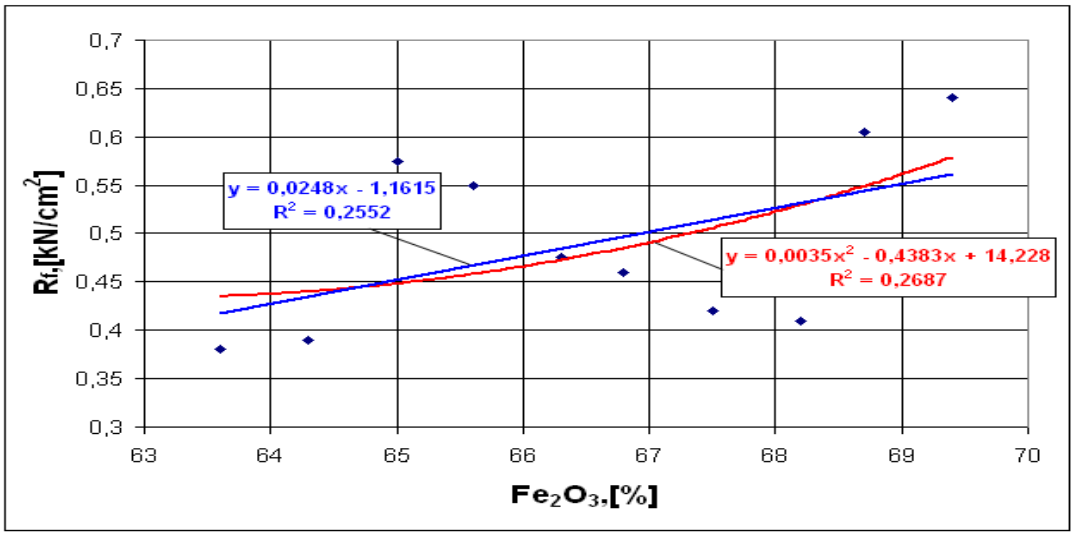

Figure 7. Influence of the Fe_2O_3 percentage on the cracking resistance

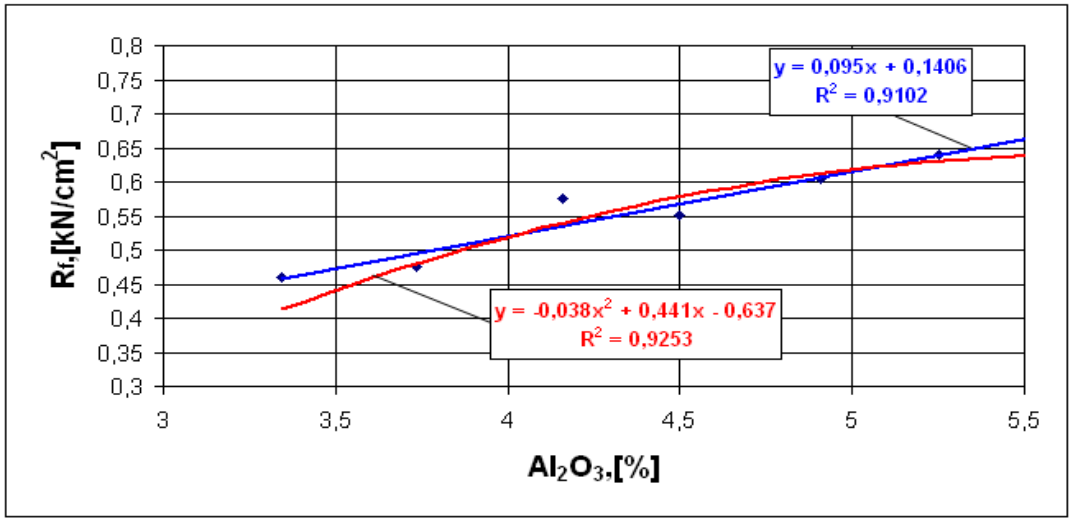

Figure 8. Influence of the Al_2O_3 percentage on the cracking resistance

The crushing strength

$$R_s = 0.0003(PO)^2 - 0.0004(PF)^2 + 0.0073(T)^2 + 0.0004(PO)(PF) - 0.0024(PO)(PF) + 0.0001(PF)(T) + 0.0149(PO) + 0.0241(FF) - 0.2470(T) + 2.5680 \quad (1)$$

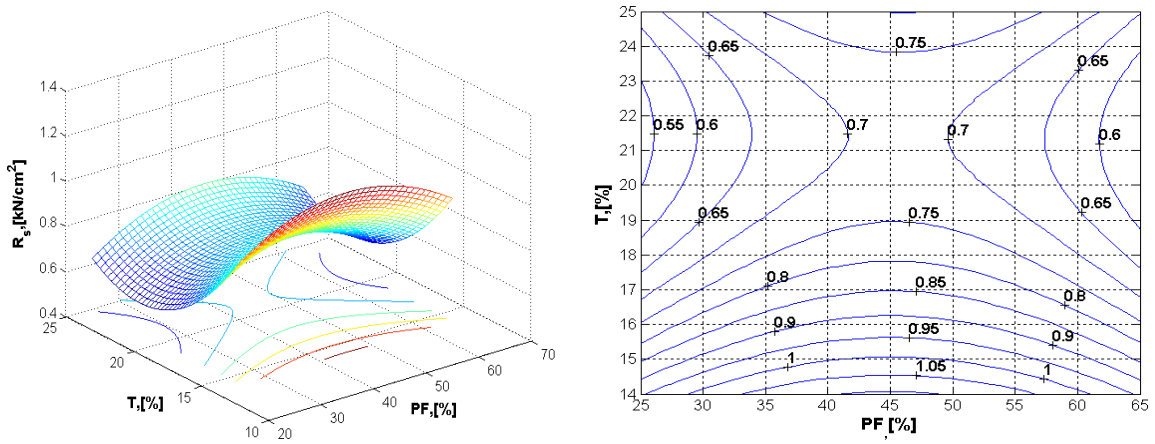

Figure 9. Crushing strength of briquettes versus the percentages of dust from sinter plant & blast furnaces and scale

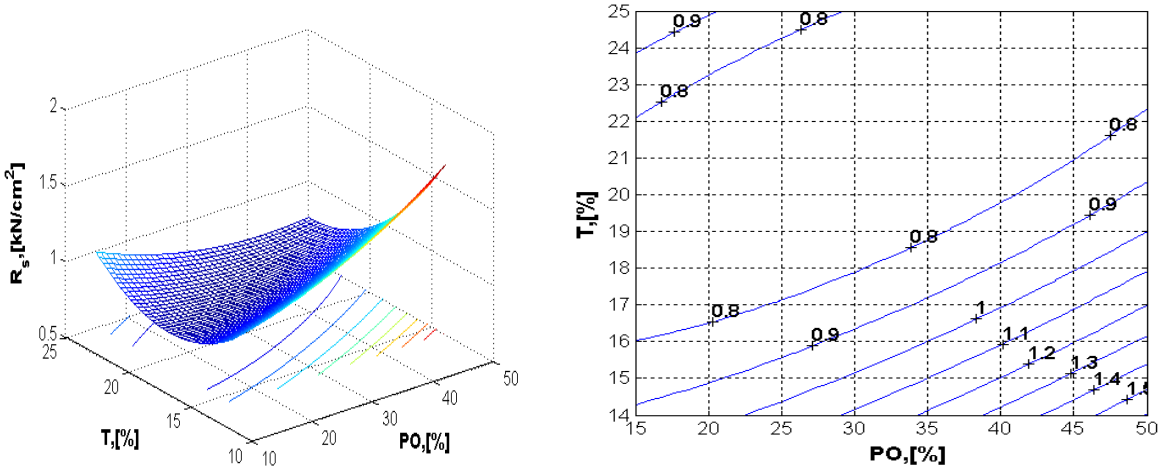

Figure 10. Crushing strength of briquettes versus the percentages of dust from steel plant and scale

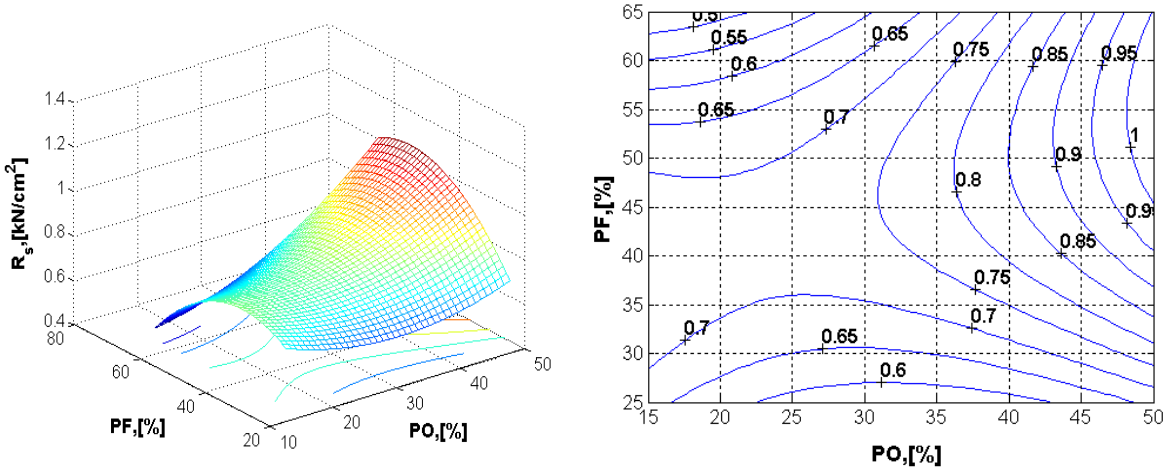

Figure 11. Crushing strength of briquettes versus the percentages of dust from steel plant and from sinter plant & blast furnaces

For $PO_{med} = 29.375\%$, it results:

$$R_s = -0.0004(PF)^2 + 0.0073(T)^2 + 0.0001(PF)(T) + 0.0357(PF) - 0.03171(T) + 3.2851 \quad (2)$$

For $PF_{med} = 43.125\%$, we have:

$$Rs = -0.0003(PO)^2 + 0.0073(T)^2 + 0.0024(PO)(T) + 0.0319(PO) - 0.212(T) + 3.6065 \quad (3)$$

For $T_{med} = 19.25\%$, we have:

$$Rs = -0.0003(PO)^2 - 0.0004(PF)^2 + 0.0004(PO)(PF) + 0.039(PO) - 0.039(PF) + 2.1875 \quad (4)$$

The cracking resistance of the briquettes R_f is given by the relation:

$$R_f = 0.0004(PO)^2 - 0.0005(PF)^2 + 0.0093(T)^2 + 0.0005(PO)(PF) - 0.0029(PO)(T) + 0.0002(PF)(T) + 0.0203(PO) + 0.0293(PF) - 0.3236(T) + 2.9856 \quad (5)$$

For $PO_{med} = 29.375\%$, we have:

$$R_f = 0.0005(PF)^2 + 0.0093(T)^2 + 0.0002(PF)(T) + 0.0426(PF) + 0.2398(T) + 3.5832 \quad (6)$$

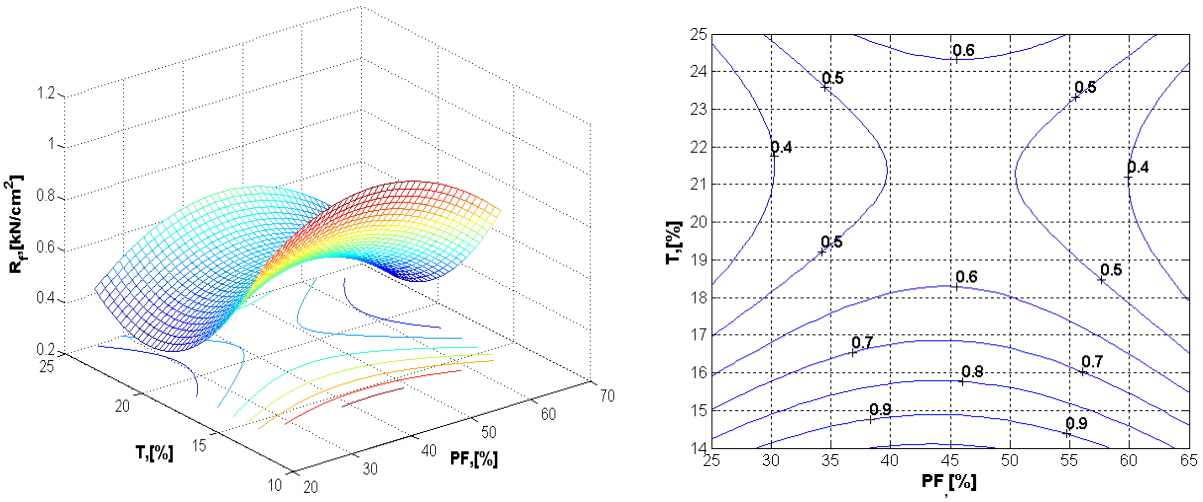

Figure 12 Cracking resistance of briquettes versus the percentages of dust from sinter plant & blast furnaces and scale

For PF_{med} = 43.125%, it results:

$$Rf = 0.0004(PO)^2 + 0.0093(T)^2 - 0.0029(PO)(T) + 0.0418(PO) - 0.315(T) + 3.3193 \quad (7)$$

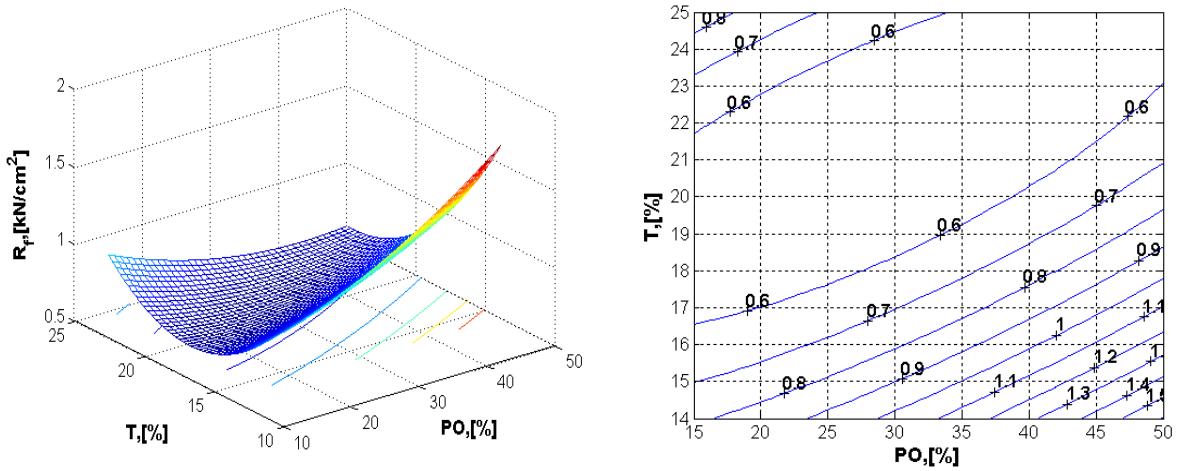

Figure 13 Cracking resistance of briquettes versus the percentages of dust from steel plant and scale

For T_{med} = 19.25%, we have:

$$Rf = 0.0004(PO)^2 - 0.0005(PF)^2 + 0.0005(PO)(PF) - 0.0335(PO) + 0.0331(PF) + 5.8089 \quad (8)$$

The crushing range I_s of the briquettes is given by the relation:

$$I_s = -0.0001(PO)^2 + 0.0001(PF)^2 - 0.0008(T)^2 + 0.0002(PO)(PF) - 0.0003(PO)(T) - 0.0017(PF) - 0.0061(PF) + 0.0474(T) - 0.2171 \quad (9)$$

For PO_{med} = 29.375%, we have:

$$I_s = 0.0001(PF)^2 - 0.0008(T)^2 - 0.0149(PF) + 0.0532(T) - 0.3532; \quad (10)$$

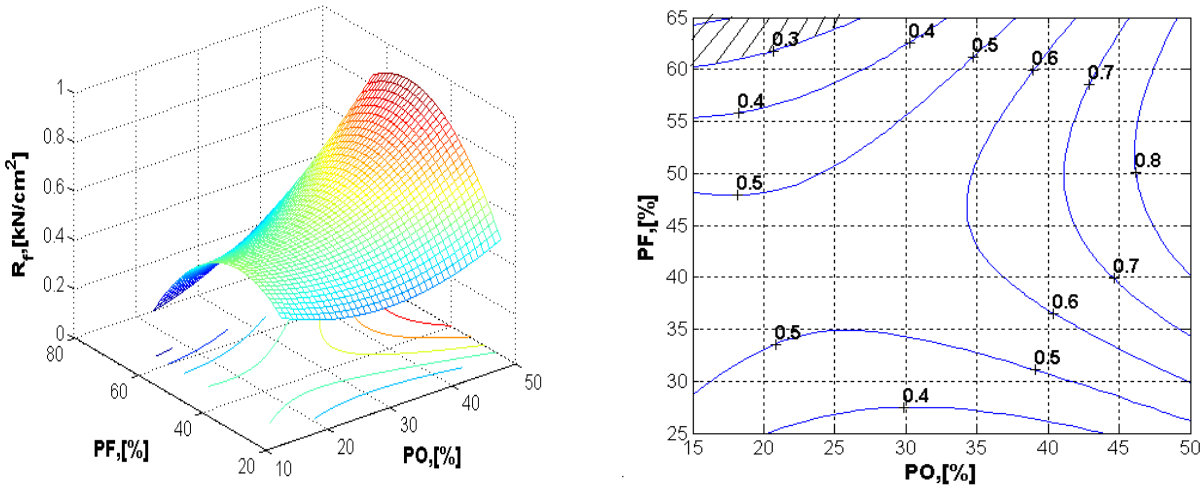

Figure 14 Cracking resistance of briquettes versus the percentages of dust from steel plant and blast furnaces

For PF_{med} = 43.125%, we have:

$$I_s = -0.0001(PO)^2 - 0.0008(T)^2 + 0.0002(PO) * (T) - 0.0017(PO) + 0.0216(T) + 0.666 \quad (11)$$

For T_{med} = 19.25%, we have:

$$I_s = -0.0001(PO)^2 + 0.0001(PF)^2 + 0.0021(PO) - 0.0118(PF) + 0.3989 + 0.3989 \quad (12)$$

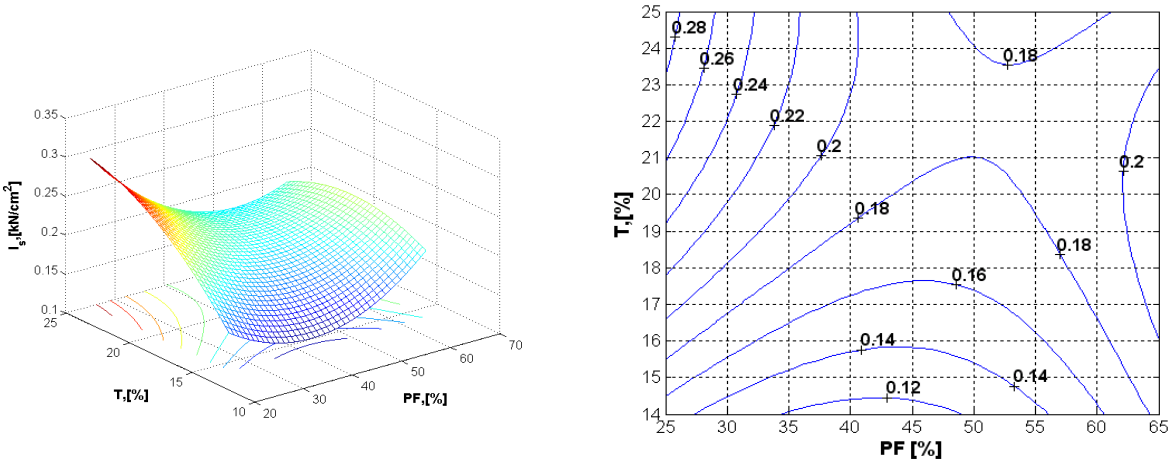

Figure 15 Crushing range of briquettes versus the percentages of dust from sinter plant & blast furnaces and scale

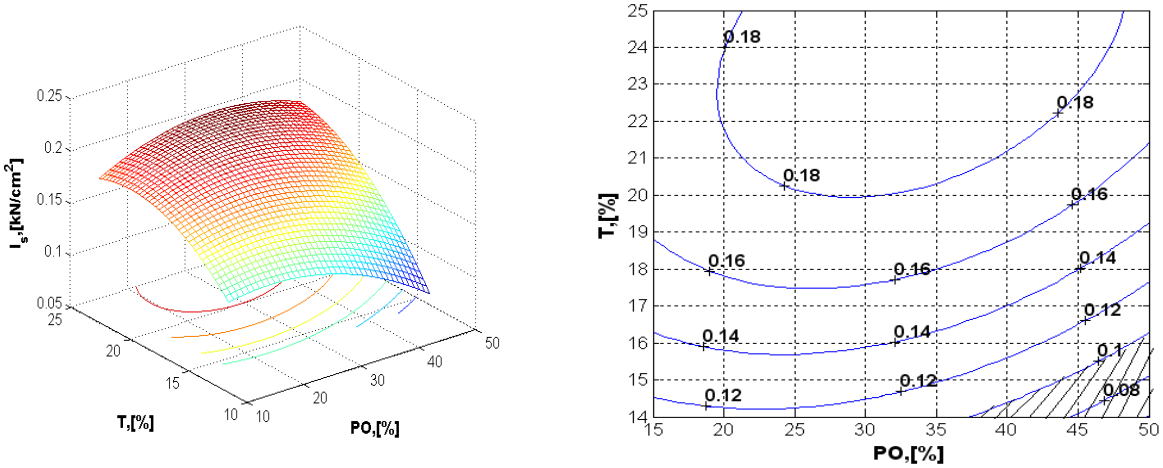

Figure 16 Crushing range of briquettes versus the percentages of dust from steel plant and scale

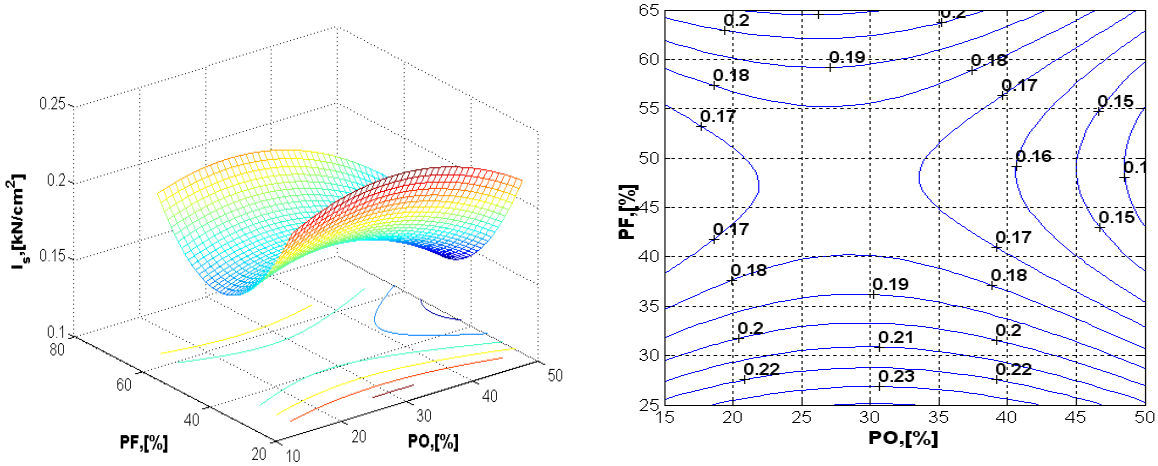

Figure 17 Crushing range of briquettes versus the percentages of dust from steel plant and blast furnaces

TECHNOLOGICAL ANALYSIS OF THE RESULTS

For a good behaviour in the process of handling and transportation, the literature [1, 2, 3] indicates, for the resistance to cracking, $R_f > 0.2$ kN/cm^2 (relation 6), and for the crushing strength $R_s > 0.3$ kN/cm^2 (relation 6.7). Regarding the crushing range, it is $I_s = \Delta R_{fs} = (0.2 – 0.35)R_f = (0.04 – 0.075)$, according to relation (5).

When analyzing the results, I considered, for a greater safety in the handling and transportation of the briquettes, to impose the following values for the strength properties: $R_f \geq 0.3$ kN/cm^2, $R_s \geq 0.4$ kN/cm^2, and $I_s \geq 0,1$ kN/cm^2.

Since we produced briquettes according to 5 recipes, in which the percentages of components with iron / iron & carbon varied, the technological analysis is presented separately for each recipe, taking into account either the results obtained in Excel calculation program or in MATLAB.

The results of the correlations obtained in EXCEL calculation program, led to the conclusion that the existing variation limits provided for the properties R_f, R_s and I_s higher values than those imposed as lower limit.

The values obtained for the correlation coefficients confirmed their validity.

Regarding the double correlations, in most cases, for the variation limits of the load components, the values of resistance properties are higher than the imposed limits.

The areas in which they do not fall are hachured; the values of independent parameters should vary so that the values of resistance properties to be always located within the unhachured area. For example, from the data shown in Figure 16, for the percentage of blast furnace dust of 5%, the scale content must be minimum 25%. For an increase in the steel plant dust content of 37–50%, the scale percentage must increase from 14% to more than 16% to obtain appropriate values for the crushing range. The other correlations shall be analysed similarly.

CONCLUSIONS

The following conclusions were drawn from those presented above:

- In the industrial processes, i.e. metallurgical and especially siderurgical, one or more secondary products (waste) are obtained in addition to the main product. The secondary products can, in terms of quality, be recycled in the iron & steel industry;
- The fine and powdery ferrous wastes, found in the western region of Romania (hence also in Hunedoara industrial area), the ones with basic character, as well as those with carbon content, can be reintroduced into the siderurgical economic circuit;
- The results obtained in the experiments lead to the conclusion that the analyzed wastes can be processed by briquetting (obtaining, for the mechanical strength properties, higher values than the minimum values associated with this process), this process allowing the recovery of waste materials with large variation limits in terms of grain size (desirable less than 2 mm);
- The recipe compositions will be determined based on the availability of fine and powdery waste and the final destination of the processed material (steel plant or blast furnaces);
- Under the locally existing conditions, due to a strong economic restructuring, a large amount of fine and powdery ferrous waste remained unused. Therefore, I consider necessary to intensify the recovery process of such wastes, mainly because they are a source of iron (scanty raw material), but also on technological considerations and, last but not least, ecological;
- I consider that either the waste routinely resulted from the process streams or those disposed in ponds and dumps can be successfully recovered.

Acknowledgement

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THE APPLICABILITY OF THE METHOD AS-CFD INTO THE ANALYSIS OF DUCTILITY AND DISTRIBUTION OF STRESS OF AN ALUMINIUM ALLOY

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Abstract: The aluminium alloys become increasingly higher into the metallic materials category for transport, aerospace, electrochemical, electronics and microelectronics, chemical, industrial and civil construction industries and so on, mainly due to high ratio between mechanic strength and density, high corrosion resistance, thermal conductivity and electrical which were perfectly raised. The research of aluminium alloys can be done through direct physical and chemical laboratory methods, but also through indirect methods that highlights the research through simulation and physical or mathematical modelling. Autodesk Simulator is a programme for simulation which can help us determine physical characteristics, mechanical properties of certain processes, materials or complex installations so that we can give an overview and insight into the future in terms of the property of the element studied but also the economic benefits. The paper presents the authors' personal research over the significant qualitative characteristics of certain aluminium alloys through simulation and modelling using Autodesk Simulator CFD. For the analysis it was used an alloy bar Al-5Ti-B and has been studied its behaviour to a certain magnitude and strength oriented linear on coordinate Ox. The results have a major importance to establish the stress resistance and ductility of the alloy.
Key words: Al-Ti-B, AS-CFD, ductility, Stress Distribution

1. INTRODUCTION

Worldwide, improving of aluminium alloys, especially the ones deformable are obtained through finishing grained, inoculating into the melt, before casing, an Al-Ti-B master alloy which contains TiB2 particles and TiAl3.

In this paper it has been chosen an Al-Ti-B alloy and has been studied, using AS-CFD, the stress distribution but also the influence it has on certain areas of material ductility.

AS-CFD programme is widely used in various simulations including in Metallurgy Industry (loading and distribution of raw materials into the furnace, oven, congestions, and the analysis of certain physical properties of ferrous and nonferrous elaboration). Into the Aluminium Industry we can highlight: the influence of chemical composition on the behavior of Al alloys in various processes, porosity analysis static stress etc. All these features can be combined and analysed also in Autodesk Simulation Mechanical (figure 1).

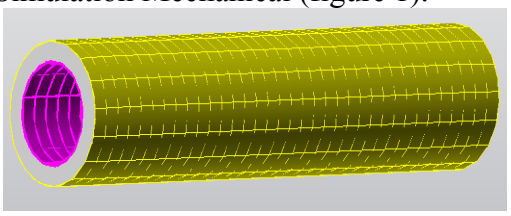

Figura 1. AS-Mechanical-Aluminium Bar

With the help of AS-CFD we can improve the ductility of alloys Al/Al-Ti-B using stress parameters (mechanical characteristics), in our case we have chosen only the unidirectional tests. A similar program has been used by others Japanese researchers [1-4].

Numerical modelling provides lots of information regarding the temperature conditions, stress, mechanical stress, electrostatic to optimize the development process of Al alloys, but

also to approach a geometrical position corresponding to the mechanical request according to the product's destination.

2. MATHEMATICAL MODELLING AS-CFD/AS-M

The geometric model developed into Audesk Professional Inventor consists of a bar of Al-Ti-B of 70cm length (figure 2) and the chemical composition shown in Table 1

Table 1. Chemical composition used in Al-Ti-B alloys bar

Alloy	Ti	B	Fe	Si	V	Al
Al-5Ti-1B	4.80	0.85	0.09	0.08	0.04	94.14

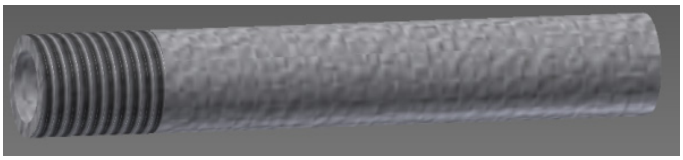

Figure 2. Model used into simulation

The inner diameter of the hollow Al-Ti-C bar is 5 cm, and 2 cm thick. Kinetics simulation requires the analysis of two models: a process of infiltration, clash, between 2 materials, but also the interaction between particles after the mechanical strain (Figure 3).

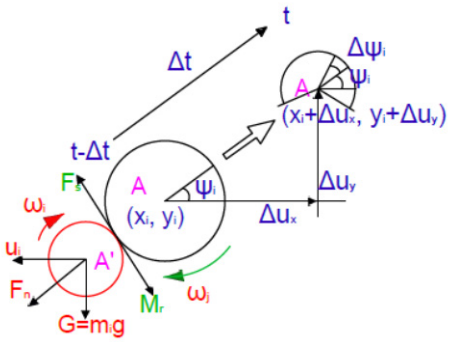

Figure 3. The forces who act between particles and schematic representation of Mathematic model used into simulation AS-CFD

where: M_r - Force moment, Nm, Δt - The time variation, s, F_n - normal force, N, ω -angular velocity, radian/s, G - Force of gravity, N, A, A' - A particle, B particle, ψ -acute angle between direction of mechanical stress and horizontal, rad, Δu- decomposition of particles on a flat surface coordinates O, X, Y.

3. Results and discussions

The simulation was performed with AS-M and AS-CFD for each area tracking the distribution variation of stress onto certain areas. The simulation was carried out into a period of time of 8 seconds for each surface of the work piece to the previous size.

The basic data used are given in Table 2, for materials in Table 3. According with the experiment of this piece it has been acted with a magnitude of 20sqm, and a parallel force with the magnitude of 100N.

Table 2. Mesh settings

Avg. Element Size (fraction of model diameter)	0.08
Min. Element Size (fraction of avg. size)	0.2
Grading Factor	1.5
Max. Turn Angle	60 deg
Create Curved Mesh Elements	No
Use part based measure for Assembly mesh	Yes

Figure 4 shows stress vectors analysed according to AS-CFD on the 3 axis X, Y, Z, as well as the plot vector of interference stress length. The minimum values are found in the imaginary center of the piece, following that the values to grow symmetrically on the sides of the piece. Following the simulation we have obtained minimum and maximum values, according to Figure 5 there are 2 maximum vales, one of them more pronounced due to the use of F force in the direction of action of magnitude of Ox axis.

Table 3. Material(s)

Name	Aluminum 6061	
General	Mass Density	2.71 g/cm^3
	Yield Strength	275 MPa
	Ultimate Tensile Strength	310 MPa
Stress	Young's Modulus	68.9 GPa
	Poisson's Ratio	0.33 ul
	Shear Modulus	25.9023 GPa
Part Name(s)	Piesa1	
	Piesa1	

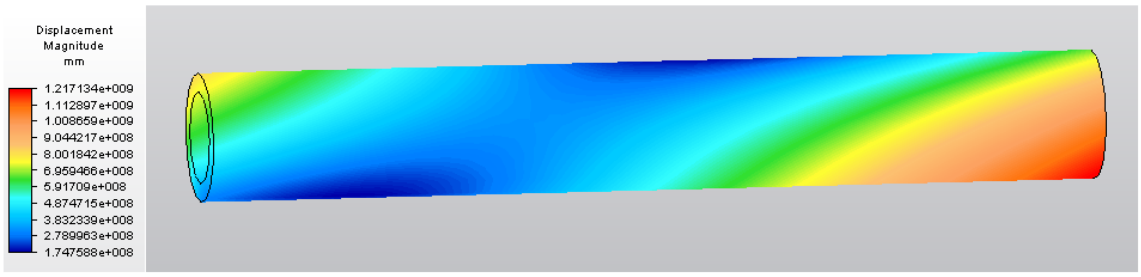

Figure 4. Stress distribution according to the analysed parameters.

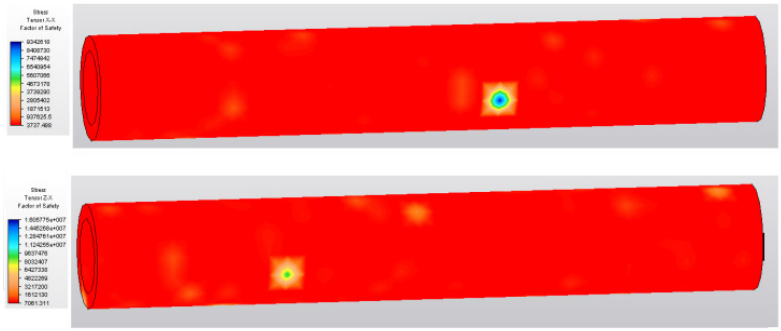

Figure 5. The tensor's stress variation on axis XX and ZX

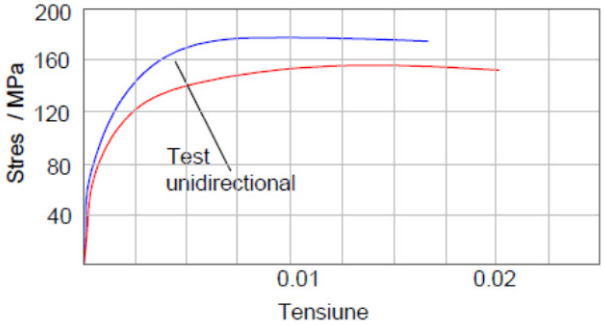

Figure 6. Curve of voltage-stress parameters of the experiment

From Figure 6 we can see that following the attempt to a magnitude of 20sqm, the unidirectional simulation test has raised to a closer value to alternative value given in the first place by the experiment (in our case highlighted with a red line). For a smaller diameter of the piece, the result was with 0.004 smaller than the results obtained to the alternative test (0.02).

If it should be used only an Al material, the bar or wire would not satisfy the conditions of ductility, but into this alloy Al-Ti-B the analysed material will satisfy both requirements: 160sqm magnitude and higher voltage than 0.015.

According to AS-CFD the coefficient of friction has been set up to a value of 0.1. The calculated values were Al alloy used A16061 with a density of 2.71g/ cm^3 and Ti with the density of 4. 51g/cm^3 (dates highlighted in conditions of the simulation in Materials Table 3). The magnitude was 310MPa and 344.5MPa max.

Von Mises stress represents an equivalent stress which combines the values of 6 stress values on different individual axis. We can compare the value von Mises with the normal stress value highlighted on the piece to predict the materials breaks with major implications on the ductility of the piece. Under normal frequency, the optional stress and result tension is calculated to return relatives values of distribution stress and tension on the analysed model. Combined with the analysis of plot vector, we can highlight already in Figure 7 the surface in which the percentage of occurrence of a fracture grows, but also the area in which we register small values of ductility on unidirectional tests towards the alternatives.

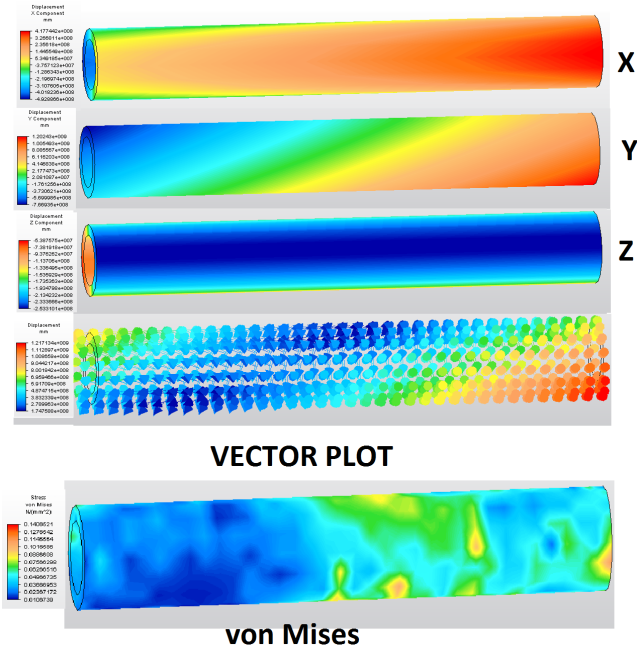

Figure 7. Magnitude distribution on the three axes X, Y, Z, and distribution vector / von Mises stress

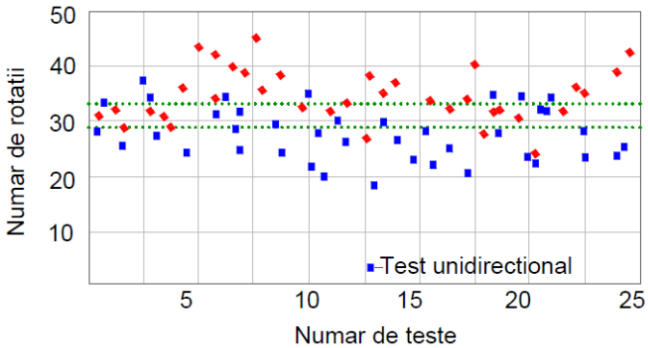

Figure 8. Variation characteristics for determining torsional ductility

Figure 8 shows the twisted values resulted after the simulation. By using the alloy Al-5Ti-B we can observe that the number of rotations per unidirectional test is very close to the same value of the alternative test result. For a given material or wire from Al, the value per rotations of the alternative test must of been almost double, establishing a value with 50%

better ductility and stress resistance. Our bar used in the experiment performed talking values almost identical on both test models (29.5rot.- 32rot.). These closed torsional values are shown also graphic in Figure 6 through the vector variation of surface von Mises. The figure shows a linearization of the tension distribution on bar/wire, an attempt to behave symmetrically towards both ends and to distribute evenly the tensions which appear, retaining the highest values towards the center of the material.

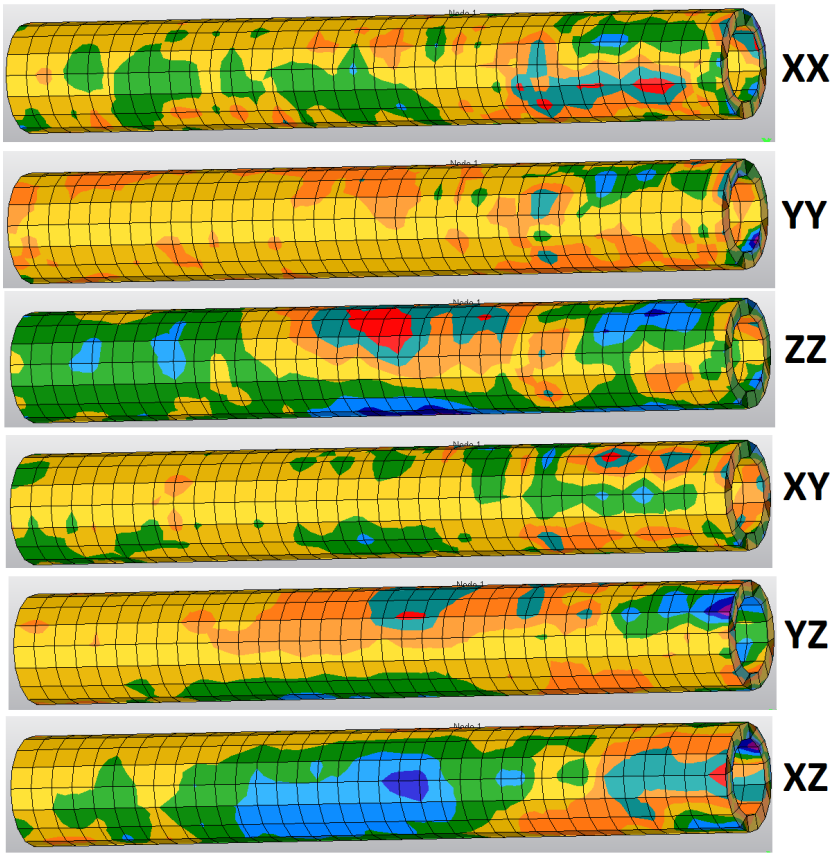

Figure 9. Stress linearization for each component part of barriers and test results.

Figure 9 and 10shows the phenomenon of linearization of stress distributions, the analysis was made with Autodesk Simulation Mechanical 2014 (AS-M) on all the axis of symmetry of the bar to be able to analyse the distribution of charged vector surfaces by a load of 20-160MPa and 100N. On 3 of the axis presented YY, ZY and YZ it can be best observed the phenomenon of linearization of vector distribution to resist to imposed request. Maximum points are shown on axis ZZ and partially on XX, and the minimum points are on XZ axis.

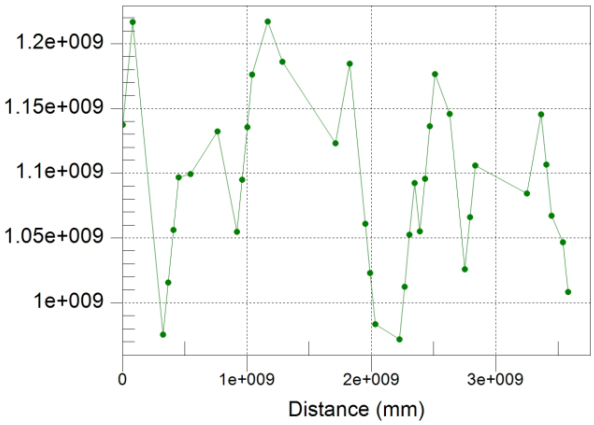

Figure 10. Symmetric variation of stress distribution over a certain distance

In The work presented was analysed according to AS-CFD stress distribution and the importance into the ductility analysis of Al-5Ti-B alloy emphasizing the following:

- The alternative and unidirectional test values were very close; in our case the unidirectional test was smaller with 0.004 than the one alternative to a value of equalization decreasing value of the tension,
- The simulation on the Al alloy has passed the ductility test, resisting to a stress variation higher than 160MPa to a tension greater than 0.015. On this line, the torsional fatigue characteristics recorded improved values.
- The ductility values are close to both unidirectional and alternative tests, in the studied alloy produce a linearization on the piece length of stress distribution, which is highlighted by the vector values of surface into the Mises analysis.

The test showed maximum variations of stress tensor in 2 points of maximum towards the bar center, the piece passing the ductility test: magnitude 160MPa and tension higher than 0.015.
In terms of vector orientation is observed a linearization of stress distribution to the whole surface of the piece, the alloy trying to resist to tension is higher than distributing them equable depending on the piece surface.
In conclusion, the test shows that using this alloy leads to obtaining a very close value for both tests: alternative and unidirectional, which is impossible in case of using only an Al material.

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DOPING CONCENTRATION PROFILE CORRECTION OF THE EPITAXIAL THIN FILM LAYERS, MEASURED BY ELECTROLYTIC METHOD

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Abstract: Here, the solution of a concentration profile measurement problem in the epitaxially grown III/V type compound semiconductor layers is dealed. The III/V based materials have large significance in the optoelectronic and microwave device production. At these materials, the epitaxial growth is the fundamental technological step. During this epitaxial process is possible to change the doping concentration in the grown layer. In most cases, the electrolytic capacitance-voltage technique serves for the measurement of this concentration profile. This method combines the conventional capacitance-voltage measurement with the anodic dissolution, to avoid the electrical break-down at the junction. The disadvantage of this method is that the contact surface increases during the measurement, because of the dissolution of the material. At certain layer structure, this method causes error in the determination of the doping profile. In present work, we give a software based solution for this problem. The software developed in Matlab™. This algorithm calculates and summarizes the wall capacitance and subtract from the measured data, in each step. We demonstrate the operation of the program on different sample data series.

INTRODUCTION

The microwave and optical communications directed the researchers attention to the family of III/V compound semiconductors. These materials are e.g. GaAs, AlAs, AlGaAs, InAs, InGaAs, InSb, InP etc.. Many favorable properties (e.g.: direct band transition, higher charge carrier mobility) allows us to make such electronic devices, which we cannot prepare from silicon or we can produce only with lower parameters. In the technology of III/V-based compound semiconductors, the epitaxial growth is one of the most important step. Usually, in the silicon-based device technology, the differently doped layers are made by process of diffusion. This method is not applicable in case of compound semiconductors, because of thermal decomposition. During the epitaxial growth is possible to change the doping concentration of the growing layer, so a proposed concentration profile can be created. However not only the dopant, but the components of the semiconductors are also changeable. Hereby, the heterostructures of these materials can be produced by this method as well. In the different semiconductor technologies, the various qualifying measurements have very important role. These studies give us a chance to verify, for instance how we realized the required dopant distribution layer. For this goal, in most cases we apply the capacitance-voltage (CV) measurement. The disadvantage of this method is an electrical break-down of the junction, when the critical field intensity is reached. This effect can be avoided by electrochemical CV (ECV) measurement, which essence is, that the semiconductor is contacted with an electrolyte, what is operated like a quasi-Schottky diode [1]. The layer removal is achieved by anodic dissolution of the semiconductor. Nevertheless there is another problem, because the wall capacitance of the etched range falsifies the measured results.

In this paper we are looking for the solution of this problem using our software, which we have developed in Matlab™ environment. This algorithm calculates and summarizes the wall capacitance in each step and subtract from the measured data. We demonstrate the operation

of the program on different sample data series. In this work, we show the simulation results on a dataset, which contains 8000 measured sample data.

EXPERIMENTAL PRELIMINARIES

By the reason of the technological feedback, we have to verify the epitaxially grown layers. One of the most important parameter is the doping concentration profile. By this property, we can satisfy, whether the realization of the required dopant distribution is successful or not. The most widely used method to measure the dopant distribution is the CV measurement, because the depth distribution of the free charge carriers is dependent from the capacitance, which is strongly related to dopant profile. Unfortunately, the measurement depth is limited, because of the electrical break-down of the junction, when the critical electrical field intensity is reached. At first - in order to try to avoid this phenomenon – the researchers etched the layer after the measurement, and measured the CV characteristics again. The problem of this method, that the measured results are hardly and inaccurately matched to each other and this work is time-consuming. In 1973, Ambridge and his colleagues suggested another method. The technique is that the semiconductor is contacted with an electrolyte, which operates as a quasi-Schottky diode. This examination method is the ECV measurement. Compared to other methods, there is an advantage of this technique, that the maximum depth is not limited by the maximum break-down voltage.

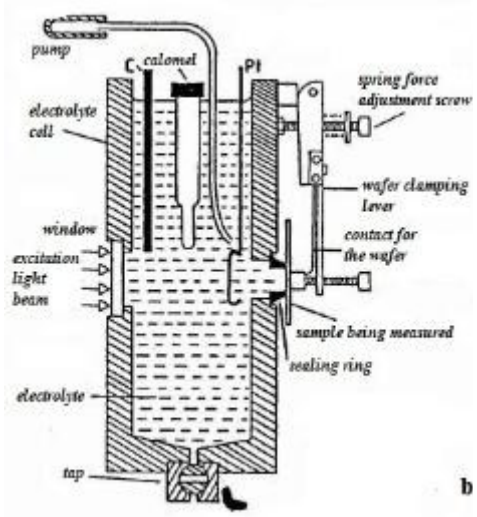

Fig. 1. The cross-section of the electrochemical cell

Our experiments are realized by the PN4100 Semiconductor Profile Plotter, which is produced by Polaron Ltd [2]. With this equipment, we can measure the III/V-based compound semiconductor doping concentration profile. The process of the measurement is the following: we take the semiconductor sample to an electrochemical cell (Fig. 1.) and apply DC bias voltage. After them, etching/measurement cycle comes. A Schottky junction is formed between the semiconductor and the electrolyte. The diameter of the contact surface is 3 mm. In our case the electrolytes were 0.1 M Tiron and NaOH:EDTA solutions. There are two different steps in this experiment. The first is, that we measure the CV characteristics, by a 3 kHz and a 30 Hz AC signal, superimposed on DC bias. The second is the etching of the material. During the examination, these two steps are repeated sequentially. The illumination initializes the anodic dissolution, which is caused by the photocurrent. This current is generated by holes and it is proportional to the number of holes. It is worth to note, that the greater part of the photocurrent is realized via valence band. The charge carrier concentration at the inner edge of Schottky junction can be computed from CV profile. In Fig. 2, the flow chart of the measurement process is shown. But a problem occurs, that the capacitance of etched range wall is falsifies the measured data.

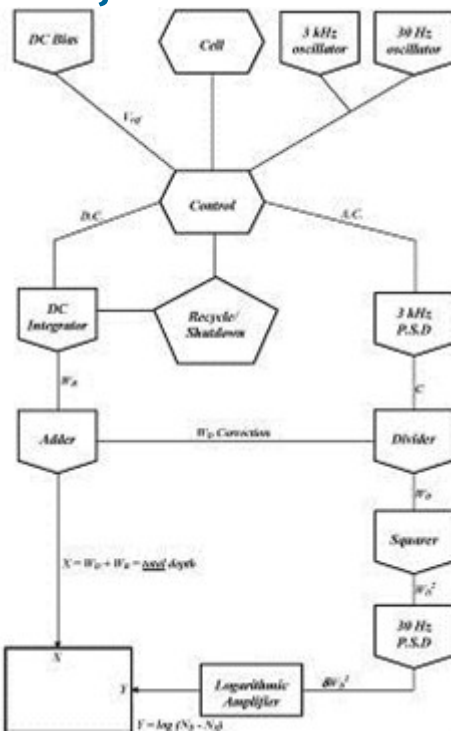

Fig. 2. The flow chart of the analogue ECV measurement

DISCUSSION AND RESULTS

The measured capacitance (C') contains the board (C) and the mantle capacitances (C_m) together. The correction - made in discrete steps - is based on the following consideration: in the zero step, there is no wall capacitance. In the other steps, first, we compute the width of the depleted layer and the current wall capacitance. So we receive the wall capacitance increment. These wall capacitances are cumulate in each step. This is the mantle capacitance. We subtract the mantle capacitance from the actual measured capacitance, so we calculate the charge carrier concentration. The correction is more precisely, in case of the finer resolution. In the Fig. 3, the increase of the interface is visualized.

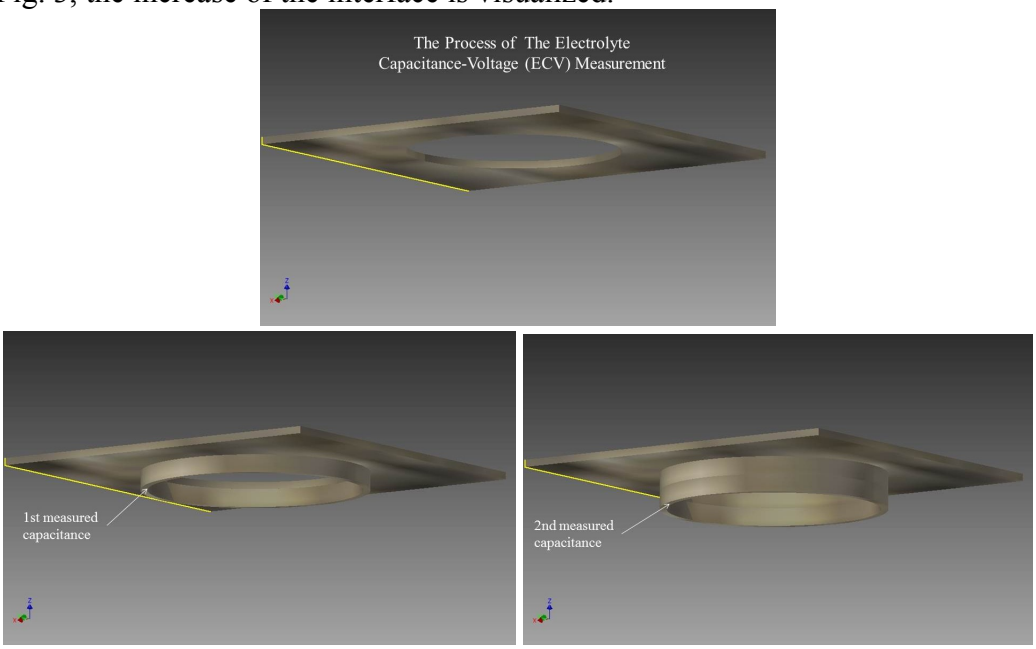

Fig. 3. Step-by-step visualization of the electrochemically etched deepness

The essence of the algorithm, that we compute and summarize the wall capacitance in each step, and subtract from measured data. In the Fig. 4, the flowchart of this program is shown.

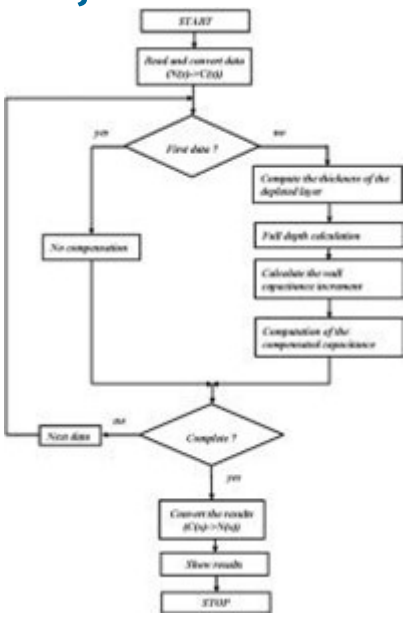

Fig. 4. The schema of the work of the compensation software

The first step is to read data and calculate the capacitance distribution from the doping atom concentration distribution (1). The measured C_{me} (x) is the capacitance distribution of the doping atom, N(x) is the distribution of the doping atom, q is the charge of one electron, ε_0 is the vacuum permittivity (ε_0 = 8.9*10-12 F/m), the εr is the relative permittivity (ε_r = 13 in case of GaAs), a V is the bias voltage, A is the area of the surface, x is the number of the current step:

$$C_{me}(x) = \sqrt{((q*\varepsilon_0*\varepsilon_r*N(x))/2)}*1/\sqrt{V}*A. \quad (1)$$

The first compensated value is the same as the first measured value, because in this case the wall capacitance is zero. In other cases, first we calculate the thickness of the depleted layer (w(x)) (2). The Cmeasured(x) is the capacitance distribution of the doping atom, ε_0 is the vacuum permittivity, ε_r is the relative permittivity, A is the area of the surface, x is the number of the current step:

$$w(x) = \varepsilon_0*\varepsilon_r*A/(C_{me}(x)). \quad (2)$$

The next step is we compute the complete depth $l_{comp}(x)$ (3). The d is the thickness of the etched layer (this is the step size of the simulation), w(x) is the thickness of the depleted layer (x is the number of the current step) calculated by (2):

$$l_{comp}(x) = d+w(x). \quad (3)$$

After this, we calculate the wall capacitance increment ($C_{wall}(x)$) (4):

$$C_{wall}(x) = \varepsilon_0*\varepsilon_r*A/((x-1)*l_{comp}(x)) \quad (4)$$

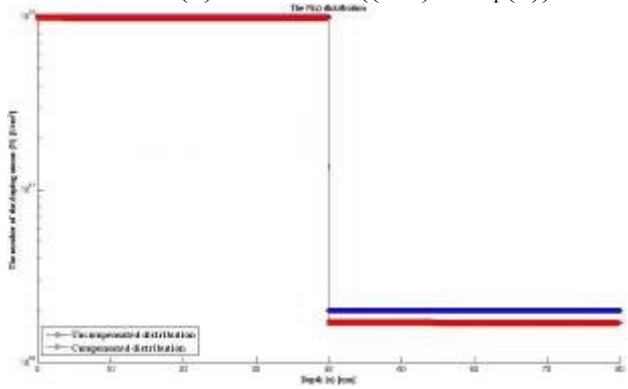

Fig. 5. The corrected concentration profile after a contact layer, where the result is presented in the case of 8000 measured values

In the next formula, the wall capacitance is summarized, which is the – above mentioned – mantle capacitance ($C_{cilinder}(x)$) and the k is the running variable (5):

$$C_{cilinder}(x) = \sum\_(k=0)\text{^}x \; ⟦C\_wall\,(k) \quad (5)$$

After this, the mantle capacitance $C_{cilinder}(x)$ is subtracted from measured capacitance ($C_{me}(x)$) (6):

$$C_{corr}(x) = C_{me}(x) - C_{cilinder}(x). \quad (6)$$

The $C_{corr}(x)$ is the result. Finally, we calculate the compensated doping atom distribution (7). The $N_{corr}(x)$ is the corrected distribution of the doping atom, q is the charge of one electron, a V is the bias voltage, x is the number of the current step:

$$N_{corr}(x) = 2/(q*\varepsilon_0*\varepsilon_r)*((C_{corr}(x)*\sqrt{V})/A)\text{^}2. \quad (7)$$

In the Fig. 4, we can follow the operation of the described algorithm, in a sample dataset, which contains 8000 measured value. In the horizontal axis we show the depth (in linear scale) and in the vertical axis we represent the charge carrier concentration (in logarithmic scale). The simulation is performed in 0.01 μm steps. The results, in case of 8000 measured values (Fig. 5).

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