TEMEL-ij

Technology | Engineering | Management | Entrepreneurship | Learning | International Journal

TEMEL-ij

Technology | Engineering | Management | Entrepreneurship | Learning | International Journal

Indexing and Abstracting – TEMEL International Journal

RESEARCHER ID
THOMSON REUTERS

THOMSON REUTERS
ENDNOTE

MENDELEY **ELSEVIER**
eArmin.com | Armin Kanfiroozie, Mendeley Advisor

Journal TOCs
The latest Journals Tables of Contents

Academia.edu
follow research

ResearchGate
SCIENTIFIC NETWORK

Academic Resource Index
ResearchBib

Google
Scholar

Content:

TEMEL-ij
Technology | Engineering | Management | Entrepreneurship | Learning | International Journal

VISUAL MANAGEMENT AS A PROJECT MANAGEMENT TOOL – HOW TO BE MORE EFFICIENT IN COMMUNICATING PROJECT GOALS

Predrag Dotlić[1], Aleksandar Erceg[2]

Abstract: Project management can be considered as a kind of art of co-ordinating and managing the project team, stakeholder relations, and allocation of available resources. Project goals are within the context of the three fundamentals: the time and budget available and the expected quality by the contracting authority. One of the key assumptions for meeting these goals is the exceptional efficiency of the project team and the senior project manager as the person responsible for the success of the project, with an effective internal and external communication playing a major role.
Efficient communication can have a significant influence on project implementation success precisely for the large and complex projects run by multidisciplinary project teams where there is high need for a standardized communication standard to avoid potential misunderstandings. As one of the potential tools for efficient communication, project teams are offer using visual management. Visual Management is the concept of management and tool for improving the efficiency of communication within the system by removing unnecessary noise in communication channels, simplicity and consistency in the transfer of information. The basis of the visual management tool is the use of colour, images and diagrams in a systematic way that makes communication within a project team faster, clearer and simpler, and more efficient.
Paper will present several visual management tools which are helping in increasing communication in project management together with one example of successful use of visual management in project implementation.

Key words: project management, visual management, efficiency, communication

1. INTRODUCTION

Process of the project management is considered by co-ordinating and guiding the project team to meet project requirements, stakeholder relationships, and allocating the resources needed to carry out the project task. On the other side, visual management is used as a tool to simplify the process flow and improve the efficiency of communication within the system.

Project management (Westland, 2006) includes skills, tools and processes, and Heerkens (2002) compares the project management with art because it is necessary to guide people on a project aimed at people doing something, and science for defining and coordinating the necessary work. Project management uses organizational skills and techniques that are geared towards project realization. Choice of resources and structure used in project depends on the area, type, size and complexity of the project. Therefore, it can be emphasized that the structure of project management can be a simple task list, but also a complex organization of companies whose purpose is to carry out the project with the support of the project program. Movement and progress of the project is presented in the project life cycle that has its beginning and its end. It should be noted that each project has its intermediate steps and how the transition from one step to the next takes place at the exact locations of the project because each phase of the project has its beginning and its end. A unique definition of the ideal project life cycle does not exist because it depends on the type and specifics of the project. Westland (2006) states that the project life cycle consists of four project phases: project initiation, project planning, project implementation and project closure. Sanghera (2007) describes the project lifecycle during the phases: initiation phase approves the project by naming the project leader, planning phase defines the project goals and plans the job, implementation phase conducts the project, monitoring phase controls the implementation of the project and whether everything is done in the plan, and the closing phase formally closes the project. So, we can say that for each successful phase of project management it is necessary to achieve its goals.

Main aim of the paper is to look upon the relationship between the project management and the visual management tools for increasing communication. Efficient communication has a significant impact on the success of the project, which is visible in large and complex projects led by multidisciplinary project teams. With using various visual management tools, it is possible to enhance communication within project team members as well as other stakeholders, all to better project performance. In the first part of the paper need

---

Corresponding author: [1]Predrag Dotlić, M.Sc., Universital Hospital Osijek, pdotlic@gmail.com [2]Aleksandar Erceg, PhD., Assistant Professor, Josip Juraj Strossmayer University of Osijek, Faculty of Economics in Osijek (aerceg@efos.hr)

for the efficient communication during the project will be explained. Next, we will introduce concept of the visual management, its definition and characteristics. In the third part, we will present several tools which are helping in increasing efficiency in project management communication. In the last part, we will give recommendation for the further research about influence of use of visual management as a communication tool.

2. EFFICIENT COMMUNICATION AS A QUALITY OF THE PROJECT

Whether it is a small, routine, or a large, new and complex, successful and high-quality project, there are many assumptions. Among other things, it is necessary to create a quality project team, engage a good, preferably experienced project manager, provide support within the organization and use tried-and-tested project management tools and activities. Among them, the importance of quality communication is particularly important.

Gasperini (2013) cites the results of research conducted by PMI, according to which successful organizations are different from the others, because of more efficient project communication. The report suggests better communication with key project definitions such as goals, budget, scope and project benefits, and strategy link. Communication is timely, clear, informative and transparent, with meaning to all participants in the process and is ensured by using formal and standardized communication plans.

According to Drinkwater (2013), communication can be viewed as a "blood" test for a project. The analogue that the blood supplies body with oxygen and keeps it alive is perhaps represents the best importance of communication in project management and organization. The heart's role in this system is taken over by the project leader who continuously distributes information between the environment and external project stakeholders to project team members and stakeholders within the organization that the project is implementing. The consequences of blood circulation are obvious. In the case of a project team, there are similar effects that result in making decisions based on assumptions that inevitably lead to errors in performance.

Project Management Institute (2008) describes communication as an exchange of information whereby the sender's responsibility is to provide the information clearly, unambiguously and completely as long as the recipient should provide complete and fully understandable information. They emphasize the diversity of communication dimensions, depending on the mode of transmission, the degree of formality, the data character and the direction of communication within or outside the organization.

One of the communication dimensions that can be further considered has a direct impact on the project management process. It is about the effectiveness or efficiency of the communication process. Although they are often covered by the same term, efficiency, there have very different terms. Communication can be effective without being effective. Adizes (2009) clarifies the differences between the two terms in the following way: the effective process creates what the system is and thus establishes the desired function. Achieving effectiveness implies often trying out different solutions to achieve the goal, which inevitably leads to mistakes or unnecessary waste of energy. Long-range effectiveness implies innovation, it is necessary to adapt to the needs of the environment and clients. Efficiency is the way of executing the process with the least amount of energy or resources, therefore assuming a well-organized system and respecting a standardized form. The danger of such an approach lies in the possible ignorance of innovativeness and consequently the loss of effectiveness over a longer period.

In the context of project management, strictly limited time frame, budget, and the required quality of results, communication as a process must be efficient in ensuring as much as possible the efficiency of the entire project management process. Effectiveness implies, otherwise the project is sentenced to failure. The potential danger of ignoring innovation can be prevented by using communication tools that will encourage all project stakeholders, especially project team members, to actively approach and continually seek improvement. One of these tools, proven by applying lean business principles is just visual management.

3. VISUAL MANAGEMENT

Visual management as data visualisation has a long history as communication tool in different activities: from construction in old Egypt, army activities in China to moral behaviour evaluation and visual control of production (Tezel, Koskela and Tzortzopoulos, 2010). Visual management is a process of displaying critical system information so that everyone who comes to the workplace, even those who are not familiar with the details of the process, can quickly understand and know what is under control and what is not. Galsworth (1997) concluded that visual management is approach which utilises one or more information and makes them self-explanatory by using visual devices for communication with "doers". Ad Esse (2007) for visual management emphasizes how it helps in the current understanding of the status of operations. Visual

management has been created at factories, but its principles can be applied in offices, call centres, medicine, schools, etc. Visual management requires that the entire work area needs to be equipped with visible and intuitive signals which allow employees to know immediately what happens, understand each process and clearly see what is being done properly and what is wrong. Visual management achieves its goals with a systemic and holistic approach to helping businesses progress. Liff (2012: 31) points out that this is done by *translating critical organizational requirements into visual stimuli, thereby:*

- *creating an environment that enhances employee commitment to the success of the organization by ensuring that the work environment and culture directly connects them to and supports the mission and values of that organization;*
- *presenting key data and information through use of compelling sensory messages that reinforce what is important to the organization;*
- *addressing performance issues and keeping people focused on the real mission and goals of the organization; and*
- *providing a mechanism for continuous improvement through system alignment, goal clarification, and engagement of people in the process, and improved communication and information sharing throughout the organization.*

Most recent academic research on visual management shows that it should be used as an integral management system to guide the company in its journey of continuous improvement (Jaca et al, 2013). With use of different visual techniques companies generate an influential and effective guidance system for improvement. These systems will be used for directing and stimulating company's employees to increase their capacity of making decisions and nurture their participation in the process of continuous improvement. (Figure 1)

Figure 1: Visual management tools and techniques
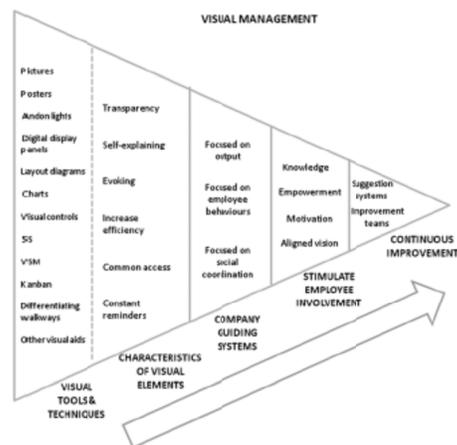
Source: adapted from Jaca et al, 2013: 1758

The techniques used in visual management are classified into the following categories: *workplace, visual information, visual control of production, automation, visual efficiency management, and visual security management* (Ad Esse, 2007: 2-3). Common visual management mechanisms include notification characters, protection tags, labels and various colour markers. Visual management is used in various business opportunities using characters, labels, and images, and Ortiz and Park (2011) point out that some of the key vision for vision management in the 21st century is superior communication, increased security, people connectivity and promotion.

Figure 2: Visual management functions
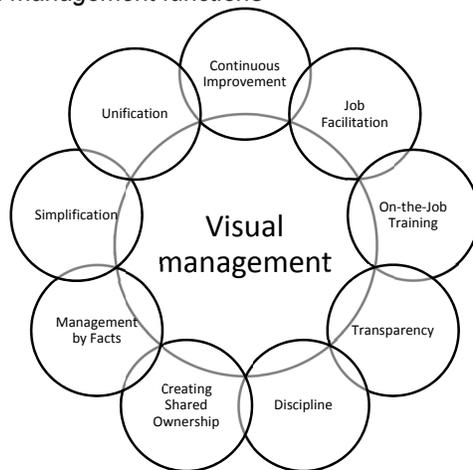
Source: adapted from Tezel, Koskela, Tzortzopoulos, 2010: 4

Figure 2 shows different functions visual management can have in companies and how visual management can be used in the entire business, all to better and easier to get acquainted with employees with certain changes, activities, business results, etc.

It is important to state that visual management is not an individual activity although many companies undervalue the strategic significance and impact visual management can secure to the workplace. Facilitated visual management can serve a broad range of functions for organization (Tezel, Koskela, Tzortzopoulos, 2010) and its tools can bring important positive influence on and within any company's department and business function i.e. strategic management (what if analysis), product management (product lifecycle management), marketing and communications (marketing campaign management), finance (risk analysis) and project management (project timeline).

4. VISUAL MANAGEMENT TOOLS IN PROJECT MANAGEMENT

Different stages of the project cycle and activities within the project management process dictate the adaptation of the communication process and, accordingly, the tools used to achieve more efficient communication. Williams (2015) divided tools of visual management used in project management in following three categories:

- Visual thinking tools that support project management
- Visual project reporting tools
- Visual project collaboration tools

First category simplifies process of idea development and fosters common language used for communication within project team and it includes among other following tools:
mind maps, storyboarding, root cause analyse, graphs, sketches. Second category points importance of effective and efficient communication as s significant part of project management and it includes following tools: earned value analysis, dashboards, infographics, burn down charts. Last category shows importance of collaboration and facilitation as a critical soft skill for project managers and it includes following tools: project display wall, project flight status board and project gamification.

4.1. VISUAL MANAGEMENT IN PRACTICE
In the following part of the paper we will present several important visual management tools that are used in one Croatian company for communicating with project team members during execution of a project of implementing e-custom tool Authorized Economic Operator. Company has used several visual management tools including Gantt chart, Ishikawa diagram, colour schemes and visual management board for team briefing. In the next part of the paper we will present how company used visual management tools to communicate activities in project.

Gantt - tracking of the project's term plan
Gantt Chart or Gant Folder is one of the oldest and most commonly used project management tools. In the same time, it represents one of the simplest visual management tools used in project management. It is used in project defining and planning phase to gain insight into the realistic duration of the project and review critical project activities and level up resources and is used as a project monitoring tool during the implementation phase of the project in relation to the set deadlines.

The example shown in Figure 3 allowed project manager to monitor project implementation and facilitates management. Shown example helped project manager to influence certain activities which were part of the project which resulted in carrying the project in accordance to agreed time and budget and required quality - getting the certificate for Authorized Economic Operator. The Gantogram allows all project participants to simply monitor the project and at any time see the phase of the project. With use of this visual tool it is possible to identify critical activities which could lead to shortening time needed for project running. So, project manager was considering two project activities – "Fulfilling tasks" and in case project team was faster than predicted, the project could be finished earlier than planned.

Figure 3: Examples of gantogram and Ishikawa diagram
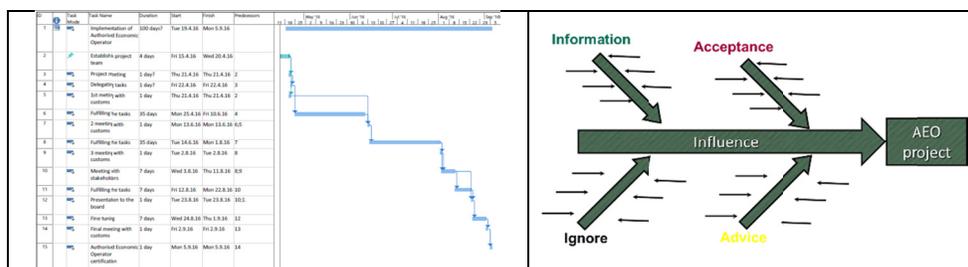
Source: Authors, 2017

Ishikawa (Fishbone) Diagram - Problem Analysis
Initially conceived and most commonly used for problem analysis and cause detection, this diagram can be used very efficiently also for stakeholder analysis of this risk, depending on the type and level of impact on the project management process. In the early phases of the project cycle, such as defining, it provides a systematic approach to analysis while implementing it provides clear information to all members of the project team about impact analysed and projected on the project. By using this visual management tool, it is possible to clearly show the impact that various stakeholders may have on the project and, consequently, act or co-operate with stakeholders. In AEO project team used Ishikawa diagram to show influence and relationship with different stakeholders. For instance, production, R&D and maintenance department were put in "Ignore" part since they didn't have any connection with project but IT, sales, purchasing and export departments and Croatian Chamber of Commerce were in "Advice" section, board of directors was in "Information" section and Customs office was in "Acceptance" section since they were the one issuing the certificate once everything was in order. With Ishikawa diagram printed and placed on the wall it was easier for every member of the project team to know and understand potential influence stakeholders had on the project implementation.

Colour scheme - clear prioritization
Red, yellow and green colours or semaphore represent one of the most common and most recognizable forms of visual communication. Most of these signals make people react almost instinctively since we have been referred to their meanings from the earliest of youths and we meet them every day in the environment. So even people who are not educated about project management rules can at first glance gain insight into the importance of certain information in the given context. If we apply these principles to the above tools, we will clearly and unambiguously communicate the importance of certain deadlines or activities in the schedule (Gant chart) or importance of stakeholders (Ishikawa diagram) or set priorities that will make it easier for all project team members to plan their time and thus provide a more efficient process. Furthermore, the visually clearly defined likelihood of occurrence and the weight of the consequences of certain risks during the project process or the degree of influence of certain stakeholders will facilitate risk management activities for the project manager and the project team and ensure a better management of stakeholder relations, which in many cases can prevent misunderstandings and conflicts.

In AEO implementation project, project team used different colours to show priorities and which activities are more important in relation to others. Team used colour schemes for presenting different potential risks which

could occur during project and team members knew on which to pay the most attention – ones presented in red. Colour scheme was used for putting activities in the Gant chart and chart itself was also presented in two colours - red and green where red was used for critical activities which could influence time and quality of the project

Team Management briefing - Visual Management Board
The basic method of communication or transfer of information within the project team during all phases of the project cycle are project team meetings. From the definition and planning itself through implementation to the conclusion of the project, the project manager must ensure efficient dissemination of information and co-ordination of project team members. If they are not well-organized and prepared, meetings can often be effective but not efficient. The same goes for physical meetings as well as for virtual meetings with the use of information technology. Thus, the solution is a visual management tool known as the Visual Management Board (VMB), physical or virtual, which represents a predefined framework and plan of each meeting and an information point that ensures continuous and transparent communication between project team members regardless of the formally agreed meeting date. Bateman, Philid and Warrender (2016: 13) concluded that visual management board are *an attractive approach for organisations wanting to engage their teams and first line managers in participative discussions and problem-solving*. Today's technology enables the use of a variety of collaborative software solutions that is essential for project teams composed of individuals living in geographically remote locations participate. However, many project teams or project managers emphasize the importance of personal contact during a project team meeting, and in such cases, the use of VMB tools and the predefined form and duration of the meeting greatly contributes to increasing the efficiency of communication.
In examined AEO implementation project there was three teams (IT, commercial and legal) and each of the teams has its own team board on which were following sections: team members, team tasks, tasks deadlines, etc. Team board were used for quick meetings or the project teams which lasted 5-10 minutes and people were standing next to the board. This made project teams meetings both effective and efficient. Boards were also used by project manager and company's board of directors to whom this boards were excellent source of information about project implementation.
During project implementation, several other visual tools has been used by different project teams (different charts, diagrams, etc,) which were constantly monitored and updated, thus making the communication process interactive and open to innovative approaches of people outside project teams.

5. CONCLUSION

Project management must be an efficient and effective process. Otherwise, time and cost determinants can easily remain unfulfilled. So, the project can easily be estimated as either partially or completely unsuccessful. To ensure the efficiency of the entire project management process, it is necessary to provide the most efficient methods and tools, among which communication plays one of the main, if not the most important role.
This is precisely the question of the efficiency of the communication process and of the old saying that one picture is worth a thousand words. It represents the best explanation and the foundation of visual management as a concept and tool for managing communication processes within any organization, including the project team. Contemporary visual management is promoted as one of the fundamental tools used in organizations that apply lean business principles but the roots derive from much further history. Symbols and colours have always played an important role in communicating the entire civilization. So why to ignore their power now when the environment mercilessly dictates the need for quick and efficient adaptations.
Presented case showed just insight in possibilities visual management can offer in project management but not only in this area. Different tools of visual management are helping project implementation and communication about project flow with stakeholders within and outside of the company.
Further research should be conducted to find how many companies are using virtual management in helping them with project management and how it helps them in running efficient and effective project. Second proposal is to research use of visual management during regular business of the examined company and to check its influence in running daily operations.

6. REFERENCES

[1] Ad Esse Consulting (2007). Visual Management: Seeing Clearly, from *http://www.ad-esse.com/resources/documents/Articles/visual_man.pdf*, accessed on 2017-8-2

[2] Adizes, I. (2009). Kako i zašto organizacije rastu, stare i umiru (i kako se nositi s time)?, lecture held at Faculty of Economics in Osijek on February 3, 2009

[3] Bateman, N., Philp, L., Warrender, H. (2016) Visual management and shop floor teams – development, implementation and use, *International Journal of Production Research,* vol. 54 , no. 24, p. 2-14.

[4] Drinkwater, A. (2013). Communication: The Lifeblood of a Project, from *http://www.projectsmart.co.uk/communication-the-lifeblood-of-a-project.html*, accessed on 2017-7-8

[5] Gasperini, A. (2013). Uspjeh projekta ovisi o učinkovitoj komunikaciji, from *http://www.vecernji.hr/kompanije-i-trzista/uspjeh-projekta-ovisi-o-ucinkovitoj-komunikaciji-624426*, accessed on 2017-7-10

[6] Galsworth, G. D. (1997), *Visual Systems: Harnessing the Power of Visual Workplace*. AMACOM, New York

[7] Heerkens, G. R. (2002), *Project management.* McGraw-Hill, New York, USA

[8] Jaca, C., Viles, E., Jurburg, D., Tanco, M. (2014), Do companies with greater deployment of participation systems use Visual Management more extensively? An exploratory study, *International Journal of Production Research*, vol. 52, no. 6, p. 1755-1770.

[9] Liff, S. (2012), Shaping Space for Success: The Power of Visual Management, from *http://www.astd.org/Publications/Magazines/The-Public-Manager/Archives/2012/Spring/Shaping-Space-for-Success-the-Power-of-Visual-Management*, accessed on 2017-7-20

[10] Ortiz, C. A., Park, M. (2011), *Visual Controls: Applying Visual Management to the Factory.* CRC Press, USA

[11] Project Management Institute (2008), *A Guide to the Body of Knowledge*, 4th edition, Project Management Institute, Pennsylvania, USA

[12] Sanghera, P. (2007), *Program Management Professional Exam Study Guide.* Wiley Publishing Inc., USA

[13] Tezel, B. A., Koskela, L., Tzortzopoulos P. (2010), Visual management in Construction - Study report on Brasilian Cases, SCRI Research Report 3, Salford Centre for Research and Innovation, United Kingdom

[14] Westland, J. (2006), *The Project Management – Life cycle.* Kogan Page Limited, USA.

TEMEL-ij

Technology | Engineering | Management | Entrepreneurship | Learning | International Journal

THE METHODOLOGY FOR MEASURING WATER STREAMFLOWS.
CASE STUDY: RIVER "BISTRICA PEJA", KOSOVO

Drita Lokaj – Qerimi[1], Cvete Dimitrieska[2], Sanja Popovska-Vasilevska[2], Shpetim Lajqi[2]

Abstract*: One of the basic requirements for the proper development of the water sector is to know the discharge flow of rivers, streams or other water sources. The discharge flow (streamflow) is the flow of water in streams, respectively it is the volume of water passing a point in a given time. Therefore, the study of water flow fluctuations in streams has a significant economic and practical importance. The construction of water treatments plants, hydropower plants, irrigation canals or other water facilities would not be a rational investment without the recognition of the fluctuation of water flow over different periods of time.*

Thus, the measurement of the stream flows is a very dynamic and complex process compared with the measurement of the water level. For the location where the measurement is made, it is necessary to construct the curve between the flow and the water level in the river. The process of measuring and calculating the flow in streams passes through several phases. Initially, the cross-section streams profile at the measuring point and the measurement of water velocity at different points of this profile should be determined. After defining the stream cross-section profile and water velocity, the calculation of the water flow into the stream is performed in accordance with the developed mathematical expressions for cross-section surface and velocity. However measuring the water level in streams is a simpler process.

In this paper, multiple techniques for measuring of the water flow in streams are studied. Particularly, the methodology for measuring water flows in the river "Bistrica Peja" at the location Gryka e Rugovës, Peja, Kosovo is presented.

Keywords: *Methodology, Stream flows Measuring, Water Level, Cross-section, Power Generation, Hydrometric Station.*

1. INTRODUCTION

The water level measurements occur in certain locations called hydrometric stations. Kosovo has a relatively short history of hydrometric measurements, although the water level measurements in some rivers of Kosovo date back to 1923. Regular and systematic measurements with an increasing number of hydrological stations, covering the entire territory of Kosovo, began after the Second World War. Initially water level readings were conducted manually from stage boards, later main river proles were equipped with self-recording limnigraphs. After the war, the build-up of the hydrometric monitoring network started with 22 stations, which were equipped with automatic pressure sensors for water level recording. By the end of 2015 the existing hydrometric network was expanded to 27 stations, Figure 1.

In contrast to the water level measurements, the flow calculation goes through several phases:
- determining the transverse profile of the flow where the measurement is performed,
- measuring water velocity at different points of the transverse profile of the flow,
- then on the basis of the gained values the calculation of the flow is determined.

As a case study, the river "Bistrica Peja" is selected which belong to the river basin "White Drin", at the hydrometric station "Gryka", with an altitude of 569 [m] above sea level,the distance to mouth 41.5[km], and the water catchment area is 264 [km^2], Fig 1.

---

[1] Corresponding author: Drita Lokaj-Qerimi, University of Prishtina "Hasan Prishtina", Kosovo, drita_lokaj@hotmail.com

Fig. 1 Hydrometric station network of Kosovo [3]

2. THE GOAL OF MEASURING THE WATER LEVEL

The study of the fluctuation of the water level in the rivers, lakes, waters and seas has a great study, economic and practical significance. Construction of hydropower plants, bridges, irrigation channels, construction of roads near the river bed, etc. can not be rational without taking into account the water level fluctuation regime in the deployment area [1, 2].

Another great important factor for measuring of water level is the determination of the water flow based on the connection between the level and the flow of water. The simplest and least expensive tools that serve to measure the water level are static hydrometers. Mostly, the water level has small fluctuations and the coasts have gentle slopes, the hydrometers are installed in more scaled piles and placed perpendicular to the river flow. In the hydrostation Gryka three hydrometers are placed, two in the right side of the river and one in the left side as seen in Figure 8. In order to analyze the water-level fluctuations and the streamflow during the day or during several hours, after the war the limnigraphs for water level were used, which are now out of function. Nowadays, the measurements are made with SEBA sensors. In the Table 1 are presented the water level measurements for 2015.

Table 1. Data of the measuring water level [m] in river "Bistrica Peja" for 2015(source IHMK)

River basin: White Drin River name: Bistrica Peja Station: Gryka						Station altitude: 569 [m] sea level Distance to mouth: 41.5 [km] Catchment area: 264 [km^2]						
Day	Months											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1	0.59	0.62	0.60	0.74	0.86	0.58	0.55	0.41	0.36	0.36	0.43	0.48
2	0.59	0.60	0.60	0.71	0.87	0.58	0.53	0.40	0.35	0.35	0.42	0.49
3	0.59	0.58	0.61	0.69	0.87	0.57	0.51	0.41	0.35	0.35	0.42	0.49
4	0.59	0.58	0.60	0.65	0.90	0.56	0.50	0.42	0.35	0.35	0.41	0.49
5	0.53	0.57	0.60	0.63	0.98	0.58	0.49	0.40	0.35	0.35	0.41	0.49
6	0.48	0.70	0.58	0.61	1.04	0.57	0.48	0.40	0.37	0.34	0.41	0.48
7	0.48	0.69	0.56	0.59	1.07	0.55	0.48	0.39	0.36	0.36	0.40	0.47
8	0.48	0.64	0.55	0.58	0.98	0.54	0.47	0.39	0.35	0.41	0.40	0.46
9	0.48	0.61	0.54	0.57	0.94	0.53	0.47	0.38	0.35	0.48	0.40	0.46
10	0.48	0.59	0.54	0.57	0.92	0.52	0.47	0.38	0.41	0.44	0.39	0.45
11	0.50	0.58	0.53	0.62	0.87	0.53	0.46	0.38	0.39	0.61	0.39	0.44
12	0.54	0.57	0.53	0.68	0.83	0.51	0.45	0.39	0.37	0.59	0.39	0.44
13	0.52	0.56	0.52	0.74	0.83	0.50	0.45	0.39	0.36	0.50	0.39	0.43
14	0.51	0.56	0.52	0.79	0.84	0.50	0.45	0.39	0.36	0.46	0.39	0.43
15	0.51	0.56	0.52	0.76	0.84	0.49	0.44	0.40	0.35	0.44	0.38	0.42
16	0.51	0.56	0.54	0.81	0.84	0.49	0.44	0.39	0.35	0.43	0.38	0.42
17	0.50	0.56	0.57	0.89	0.83	0.50	0.43	0.39	0.35	0.43	0.38	0.42
18	0.51	0.55	0.57	0.97	0.81	0.49	0.43	0.39	0.35	0.42	0.38	0.41
19	0.53	0.54	0.56	0.96	0.81	0.48	0.44	0.38	0.34	0.41	0.38	0.41
20	0.55	0.53	0.54	0.85	0.79	0.52	0.43	0.39	0.35	0.46	0.37	0.41

21	0.55	0.52	0.54	0.81	0.76	0.66	0.42	0.39	0.36	0.52	0.37	0.40
22	0.59	0.52	0.55	0.80	0.74	0.59	0.41	0.40	0.37	0.51	0.65	0.40
23	0.65	0.52	0.54	0.80	0.80	0.55	0.40	0.40	0.36	0.52	0.63	0.40
24	0.65	0.52	0.56	0.81	0.75	0.53	0.40	0.39	0.35	0.51	0.59	0.39
25	0.62	0.55	0.63	0.84	0.71	0.51	0.40	0.38	0.35	0.49	0.63	0.39
26	0.59	0.58	0.69	0.85	0.67	0.51	0.43	0.38	0.35	0.48	0.60	0.39
27	0.58	0.58	0.78	0.86	0.66	0.55	0.44	0.37	0.36	0.47	0.56	0.39
28	0.58	0.59	0.90	0.88	0.64	0.54	0.41	0.37	0.36	0.46	0.52	0.39
29	0.57		0.79	0.88	0.61	0.53	0.40	0.36	0.36	0.45	0.50	0.39
30	0.60		0.73	0.85	0.60	0.55	0.40	0.36	0.36	0.44	0.48	0.38
31	0.64		0.70		0.59		0.40	0.36		0.43		0.37
Min	0.47	0.50	0.51	0.55	0.57	0.47	0.39	0.35	0.34	0.34	0.37	0.36
Aver.	0.55	0.57	0.60	0.76	0.81	0.54	0.45	0.39	0.36	0.45	0.45	0.43
Max	0.71	0.82	0.96	1.12	1.17	0.76	0.60	0.49	0.42	0.73	0.82	0.51

With daily data of water levels, a chronological chart of water levels for river "Bistrica Peja", which gives a clear picture of the level regime and the fluctuation of water supply throughout the year, is created.
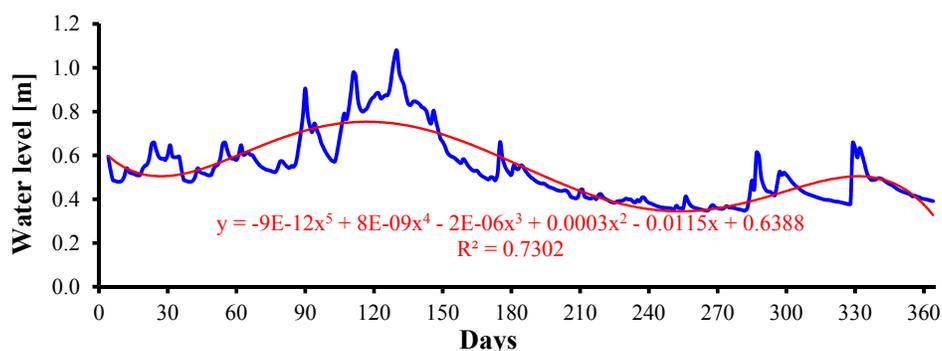

$$y = -9E\text{-}12x^5 + 8E\text{-}09x^4 - 2E\text{-}06x^3 + 0.0003x^2 - 0.0115x + 0.6388$$
$$R^2 = 0.7302$$

Fig. 2 Chronological chart of water level, the river "Bistrica Peja" for 2015

3. THE METHODS FOR MEASURING WATER STREAMFLOWS

Water streamflow is among the main hydraulic elements of the river which is determined by other parameters such as **water level** and **velocity flow**. Methods for determining the water streamflow are divided into two main groups: direct measurements and indirect determinations.

The direct measuring falls the volume method, which is based on measurement of the water streamflow with the help of metering plates placed under the water stream. With this, the filling time of the plates is measured. The water streamflow is determined by dividing the water volume of the plates by the filling time.

The indirect determination of the water streamflow can be done via different methods, in this paper the surface-velocity method has been analyzed, as the most common method. The particular of this method is that the water flow itself is not measured, but the special elements of water such as the velocity flow and the cross-sectional area of the water stream.

3.1 The surface-velocity measurement method

The surface-velocity measurement method is the most common method in the hydrometric measurements of rivers. Depending on the atmospheric conditions and the water level, the equipment with which the measurements are made varies. Before starting the water streamflow measurement, the equipment and all of its parts must be checked along with technical safety measures at work. In the water streamflow measurement, the river condition, time and other factors that define the working conditions are described: the water level is observed, water depths at the given profile and different points of the profile (in hydrometric locations at the vertical speeds) are measured.

In the measurement of the water velocity, the measurements can be made at a point in the vertical (in 0.6 of the depth from the water surface), in two points (at 0.2 and 0.8 of depths) and as the best

method is that at five points (on the surface, at 0.2, 0.6, 0.8 and the end). In all three methods the measurements are made 30 [s] for each point.

Based on the cross-section profile and the measured velocities, the water streamflow is calculated using the formulas below [4,5].

$$Q = k \cdot v_1 \cdot A_0 + \frac{v_1 + v_2}{2} \cdot A_1 + ... + \frac{v_{n-1} + v_n}{2} \cdot A_{n-1} + k \cdot v_n \cdot A_n \quad [\text{m}^3/\text{s}] \tag{1}$$

Where are:

$v_1, v_2, ..., v_n$ [m/s] - average speeds in the vertical,

A_0 [m²] - the first wet surface from the coast to the first vertical of the speeds,

A_1 [m²] - the wet surface between the first and second vertical of velocities

A_n [m²] - the wet surface between the latest vertical of speed and coastline,

k - empiric coefficient: 0.7 for a slightly sloping shore, with a zero depth on the water's edge, 0.8 for the non-flat walls, 0.9 for the flat wall, 0.5 when there is a dead zone.

3.1.1. The elements of cross-section profile of the river

The river bed constitutes the lower part of the valley and generally has a very unstable character because of the dynamic action of water flowing through the bed (Figure 3). We mainly distinguish the main bed and the side shores. The river bed in general has a parabolic shape, consisting of the river part that flows the average water. The side shores are part of the river that large waters flow through and mainly have a trapeze shape.
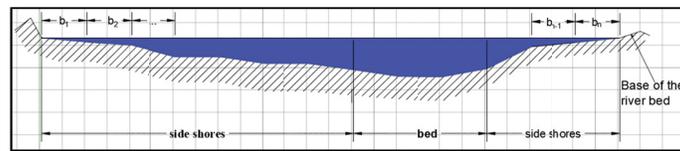
Fig. 3 The shape elements of the river bed

The case study is by the river "Bistrica Peja" as seen in Figure 4a) the measurements were made in May 2017 Figure 4b), and the measurements were made in October 2008. It is seen that we only have a level change because the measurements are made in different seasons, while the bed is approximately the same even after almost a decade.
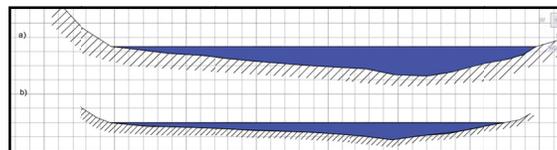
Fig. 4 Presentation of the cross-section of the river "Bistrica Peja": a) May 2017, b) October 2008

In the natural river beds, in contrast to the hydraulic models adopted, the profile varies from one point to another, both by the shape and the surface.

a) **The section area** (A [m²]) is calculated analytically by the following expression: [4,5].

$$A = \frac{h_1 \cdot b_1}{2} + \frac{h_1 + h_2}{2} \cdot b_2 + ... + \frac{h_{n-1} + h_n}{2} \cdot b_{n-1} + \frac{h_n \cdot b_n}{2} \quad [\text{m}^2] \tag{2}$$

Where are:

$h_1, h_2, ..., h_n$ [m] – vertical depths of measuring points,
$b_1, b_2, ..., b_n$ [m] – the distance between verticals.

b) **The width of the river water surface** (B [m]) is the distance between the two edge waters of the coast and is accounted for:

$$B = b_1 + b_2 + ... + b_{n-1} + b_n \quad [\text{m}] \tag{3}$$

c) **The average depth** (h_{mes} [m]) is calculated according to the formula:

$$h_{mes} = A / B \text{ [m]} \tag{4}$$

d) **The wet perimeter** (P [m]) is the line under the water surface, and is calculated according to the formula:

$$P = \sqrt{b_1^2 + h_1^2} + \sqrt{b_1^2 + (h_2 - h_1)^2} + ... + \sqrt{b_n^2 + h_n^2} \tag{5}$$

e) **The hydraulic radius** (R [m]) is calculated as the ratio of the general area of the section to the wet perimeter:

$$R = A / P \tag{6}$$

All of the elements mentioned above change their values with the change of water level, therefore for different needs; we can build their dependencies on water levels.

3.2 Universal current metering Wing F1

Universal current meter Wing F1 is used for measuring the water streamflow where the water level is not too high. This equipment consists of base rod, impulse cable and propeller intended for speed measurement. In Figure 5.a) is presented measuring equipment while in Figure 5.b) its application in the river "Bistrica Peja" at Hydrometric Station Gryka.

a)   b)

Fig. 5 Universal current metering Wing F1

First, the metric cross-section of the river is placed; given that the width of the river is not very large the measurements were carried out every 1 [m]. The depth measurement is done with the base bar, then the helix at point 0.4 from the base of the river where the speed measured for 30 [s].

In the Table 2 are presented obtained result for measurements of the 13 points

Table 2. Measuring data for point "Gryka Rugova" in River "Bistrica Peja", 08.06.2017

Level at the beginning 46.20 [cm]		Level at the end 46.20 [cm]	
Verticals	Distance from the edge [m]	Water depth [m]	Number of rotations [n]
The edge of water	0	0	0
1	1	0.10	22
2	2	0.16	21
3	3	0.42	35
4	4	0.43	45
5	5	0.55	49
6	6	0.58	50
7	7	0.71	68
8	8	0.86	80
9	9	0.88	96
10	10	0.69	70
11	11	0.29	71
12	12	0.11	26
13	12.1	0	0

Based on the measurements realized with the instrument Universal current meter Wing F1 the cross-sectional profile Figure 6 in the river "Bistrica Peja" has been drawn using AutoCad.
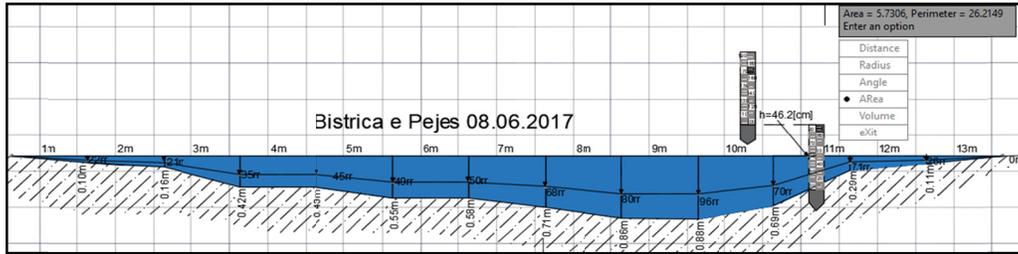
Fig.6 Presentation of cross-section on the river "Bistrica Peja" measured 08.06.2017

By application of mathematical formulas the water streamflow is **Q = 3.89** [m^3/s].

3.3 Cable way type SKA

The principle of measurement from the shore is realized when you cannot cross through the river, meaning when the water level and velocity are higher. As seen in Figure 7, a carrier cable is placed across the river (often the cable 16 [mm] that keeps weight up to 2 [t]). Then
the load is dragged with a crane every 1 [m] to make the measurements. This measurement is
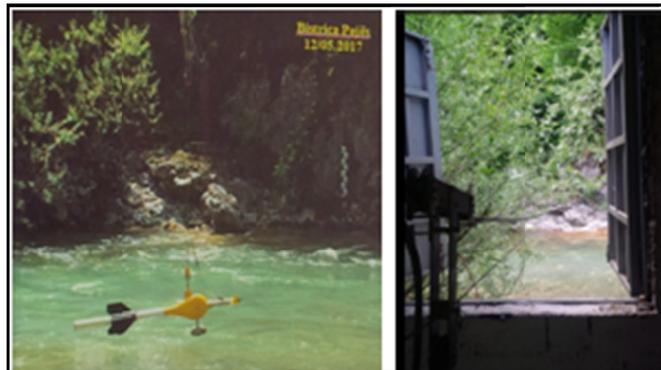
Fig. 7 Cable way type SKA

valid for weights up to 80 [kg] and river width up to 100 [m]. The measurements carried out with Cableway SKA at the Hydrometric Station "Gryka" are given in Table 3.

Table 3. Measuring data for point "Gryka Rugova" in River "Bistrica Peja", 12.05.2017

Level at the beginning 46.20 [cm]		Level at the end 46.20 [cm]	
Verticals	Distance from the edge [m]	Water depth [m]	Number of rotations [n]
The edge of water	0	0	0
1	1	0.12	41
2	2	0.23	46
3	3	0.30	55
4	4	0.42	67
5	5	0.52	70
6	6	0.59	71
7	7	0.68	80
8	8	0.74	93
9	9	0.78	106
10	10	0.99	123
11	11	1.04	141
12	12	0.90	101

13	13	0.62	99
14	14	0.45	96
15	14.5	0.32	59
The edge of water	0.5	0	0

Based on the measurement made with the crane, the cross-section of the river in which velocity measurement is made at a point 0.4 from the base. The perimeter and surface are also obtained with AutoCad, Figure 8.
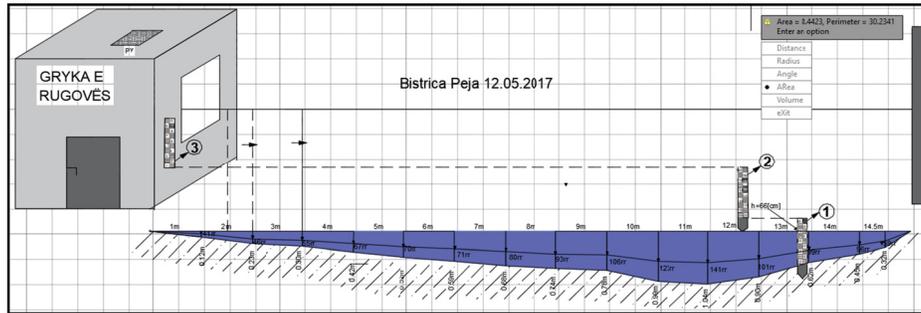
Fig.8 The measurements carried out with the crane in the river "Bistrica Peja", 12.05.2017

By application of mathematical formulas the water streamflow is **Q = 8.57** [m^3/s].

3.4. Teledyne RD Instruments Stream Pro ADCP

The Stream Pro ADCP is another very suitable equipment, as shown in the following figure. With this equipment the measurements can be realized from the shore, in the existing case the equipment is mounted on the crane, but in different cases the measurements can also be made from the bridge and in these cases the device is being dragged with ropes. In order to have the most accurate values the measurements are made up to 4 times, in the existing case the measurements are realized twice.

Fig.9 Teledyne RD Instruments Stream Pro ADC

Unlike the other methods mentioned above, the results are obtained electronically, which means that the equipment is connected to software, and the moment the measurements are completed the results can be read on a computer. It is worth noting that measurements made with ADSP are of a very high accuracy.

The measurements realized with Stream Pro on 18.04.2017, with a crane in the river "Bistrica Peja' at the Hydrometric station "Rugova" are given in the Table 4.

Table 4. The measurements realized with Stream Pro

Tr. #		Edge Distance		Ens.	Discharge						Width	Area	Time		Mean Vel.		% Bad
		L	R		Top	Middle	Bottom	Left	Right	Total			Start	End	Boat	Water	Ens.
001	R	2.50	1.50	92	1.73	3.48	1.09	0.175	0.326	6.44	15.3	8.4	11:07	11:08	0.16	0.77	32
003	R	2.50	1.50	95	1.30	3.61	1.02	0.125	0.244	6.30	14.7	8.3	11:12	11:13	0.15	0.76	19

Mean	2.50	1.50	93	1.34	3.55	1.06	0.150	0.285	**6.37**	15.0	8.3	Total	00:04	0.15	0.76	25
SDev	0.00	0.00	2	0.048	0.09	0.043	0.035	0.057	0.03	0.4	0.1			0.01	0.00	
SD/M	0.00	0.00	0.02	0.03	0.03	0.05	0.24	0.20	0.02	0.03	0.01			0.04	0.00	

4. CONCLUSION

The inevitable increase in population and the economic development that must necessarily occur in many countries have serious implications for the environment, because of the increase in energy demand, energy generation processes are harmful and polluting to the ecosystem. More than 95% of electric power generation comes from lignite coal in Kosovo, therefore research on renewable energies is of a specific importance. One of the renewable energies is Hydro energy, a condition for the construction of hydropower plants is to know the discharge flow and the level water of rivers.

Therefore, in this paper we have analyzed the water level in the Hydrostation "Rugova' for year 2015, where are: minimum 0.35 [cm], annual average 0.53 [cm], maximum 1.08 [cm].

The measurements for the water stremflow in the river "Bistrica Peja" were also obtained for the months of April, May and June under surface-velocity method using different instruments. The results are presented in Table below.

Parameters obtained after calculation			Universal current metering Wing F1	Cable way type SKA	SteamPro (ADCP)
Water flow	Q	[m^3/s]	3.89	8.57	6.37
Mean velocity	v	[m/s]	0.49	0.79	0.77
The wet profile surface	S	[m^2]	5.73	8.43	8.30
Mean Depth	h	[m]	0.47	0.56	
The profile width	B	[m]	12.10	15.00	15.00

Based on the calculation we can conclude that the largest flow is in May when the water level is the highest.

REFERENCES

[1] **Lajqi, Sh., Lajqi, N., Hamidi, B.,** (2016). Design and Construction of Mini Hydropower Plant with Propeller Turbine. International Journal of Contemporary ENERGY, vol. 2, pp. 1-13.

[2] Lajqi, Sh., Fejzullahu, Xh., Lajqi N., Hajdini, H., (2017) Analysis of the Mini Turgo Hydro Turbine Performance for different Working Regimes, International Journal of Contemporary ENERGY, Volume 3, Issue 1 (2017), pp. 1-8.

[3] Vjetari Hidrometeorologjik 2014, Instituti Hidrometeorologjik i Kosovës

[4] Shehu,B. Karanxha, K. (2003). Hidrologjia Inxhinierike I, Tiranë.

[5] Kuspiliç, N. (2013). "Hidrologjja 2",Zimski semester akademske godine'12/'13, Zagreb.

REDEFINING THE ROLE OF ENTREPRENEURIAL MIND-SET IN EMPLOYABILITY – THE EMPLOYERS' PERSPECTIVE

Ljerka Sedlan König, Mia Hocenski

Abstract: *When addressing the issue of unemployment, unavoidable issue is the ability of graduates to meet the needs of the employers. The purpose of this paper is to examine the employers' views on which enterprising skills, behaviors and attributes graduates in Croatia need when seeking employment. It has previously been confirmed that employers seek to hire graduates who, apart from specific knowledge, possess a range of skills, attributes and capabilities, but there has been little research into the role of entrepreneurial mind-set for employability, especially in the Croatian context. It has also been found elsewhere that entrepreneurial mind-set positively influences future employment prospects of graduates. The empirical research, which included 134 employers from Croatia, has shown that employers value problem solving as the most important skill for employment. Other enterprising skills such as thinking out of the box, desire for achievement, positive attitude towards change, opportunity recognition, taking initiative, work under pressure, independence or making judgment on basis of limited information were also identified by employers as valuable for getting and keeping the job.*

Key words: *employability, graduates, enterprising skills, employers.*

1. INTRODUCTION

The issue of employability has been a key issue for many years. The context of rapidly changing information and knowledge-intensive economy, as well as recent changes in labor markets resulted in universities being placed under increasing pressure to produce employable graduates. Campbell and Meadows (2001) note that a role of government is to encourage, develop and support individuals into employment. Therefore, it is critical to engage with graduate employability agenda by re-examining which attributes graduates should possess, which might make them appealing to multiple employers across multiple contexts and industries. However, vagueness exists regarding exactly what constitutes employability and which graduate attributes are required to foster employability in graduates.

Although the debate on employability has emphasized the supply side of the labor market (graduates and employees), the views of employers (the demand side of the labor market) are increasingly important. This paper examines employers' views on whether graduates in Croatia need entrepreneurial mind-set when seeking employment. It proposes that entrepreneurial mind-set could be a valuable asset in a constantly changing world of work. This paper adopts the dominant skills agenda in understanding graduate employability in which once popular term 'transferable skills' is used alongside terms such as 'key', 'core', 'generic' and 'employability skills', together with 'capabilities' and 'personal competences'.

Although employability agenda has been researched internationally, in the Croatian context such research is lacking, especially one that focuses on the role of entrepreneurial mind-set in employability.

The first part of the paper reviews current literature on employability skills and entrepreneurial mind-set. After that research methodology is presented, followed by research results and discussion. In the end, recommendations are put forward.

2. EMPLOYABILITY SKILLS

Very often employability is being equated with gaining and retaining of fulfilling work (Hillage and Polland, 1998). In the modern knowledge-intensive economy, employees must retain knowledge and

skills that are specific to their discipline, but must also possess skills, behaviors and attributes that are transferable to many occupational situations and areas to be not only immediately, but also sustainably employable.

There is an on-going debate about what constitutes employability. A brief review of the academic literature on employability identifies a host of conceptualizations of employability ranging from the general and inclusive (see for example Hillage and Pollard, 1998) to highly specific and contextualized (see for example Philpott, 1999). Yorke (2006) defines employability as "a set of achievements – skills, understandings and personal attributes – that makes graduates more likely to gain employment and be successful in their chosen occupations, which benefits themselves, the workforce, the community and the economy" (p. 8). Moreover, employability refers to an individual's ability to find a job, retain a job and move between jobs should the need arise (Brown et al. 2003). Hillage and Pollard (1998) conclude that for the individual, employability depends not only upon the possession of employer relevant knowledge, skills and attitudes, but also upon the way these assets are used and exploited; how they are presented to potential employers, as well as upon the context within which the individual works, e.g. labor market and personal circumstances.

Narrow definitions of employability, which are dominant, emphasize skills that might make an individual attractive to potential employer and focus on short-term employment outcomes. More holistic approaches, on the other hand, emphasize self-belief and an ability to secure and retain employment and learning to learn (International Labour Organization, 2000), reflectiveness, acting autonomously and interacting in groups (Rychen and Salganik, 2005). In the recent literature there is a growing recognition of the difference between the old and new skills set in the context of flexible labor markets. Van der Heiden (2001) suggests that the 'old' skills set was based on facets of employability related to functional and job-specific competencies, whilst the new skills set "revolves around a motivational currency of job enrichment and competency development".

3. ENTREPRENEURIAL MIND-SET

Recently the change has taken place in labor market policy orientation, from counting on long-term employment with a single firm, to employability by many firms. This shift from employment security to 'employability security'(Kanter, 1995; Opengart and Short, 2002) implies a fundamental change in what employees expect from their employers, and how employers should think about their interests and obligations. In such a situation individual workers must constantly adapt to rapidly changing work environments and requirements, including emerging technologies (Butterwick and Benjamin, 2006).

Several authors, (e.g. Bridgstock, 2008) have claimed that generic skills development is an inadequate answer to the question of graduate employability and that for enhanced graduate outcomes on a sustained basis, students should develop broader career management competences. Claims have been made elsewhere (Hartshorn and Leigh, 2004) that individuals will only be employable within a competitive economy if they develop and possess enterprising skills and competencies. As a matter of fact, there is an emerging body of evidence (see for example Pavis et al., 2000; Centre for Enterprise and Economic Development Research, 2003) that enterprising skills may provide a vehicle for connecting different groups of individuals such as the unemployed, school leavers and graduates with opportunities in the labor market.

It is obvious that employability involves far more than possession of generic skills listed by graduate employers as attractive. Rather, for optimal economic and social outcomes, graduates must be able to proactively navigate the world of work and self-manage the career building process (Bridgstock, 2008). Such an approach acknowledges the importance of self-management and career building skills to lifelong career management and enhanced employability.

Several authors (Gibb, 1993; Curran and Blackburn, 2001; Rae, 2007) have observed that the possession of enterprising skills positively influences self-employment opportunities of individuals. This paper builds upon the notion of enterprising skills (See Figure 1) designed by Gibb (1993) to offer a set of initial insights into what may constitute the new employability skills set in Croatia, from the perspective of employers.
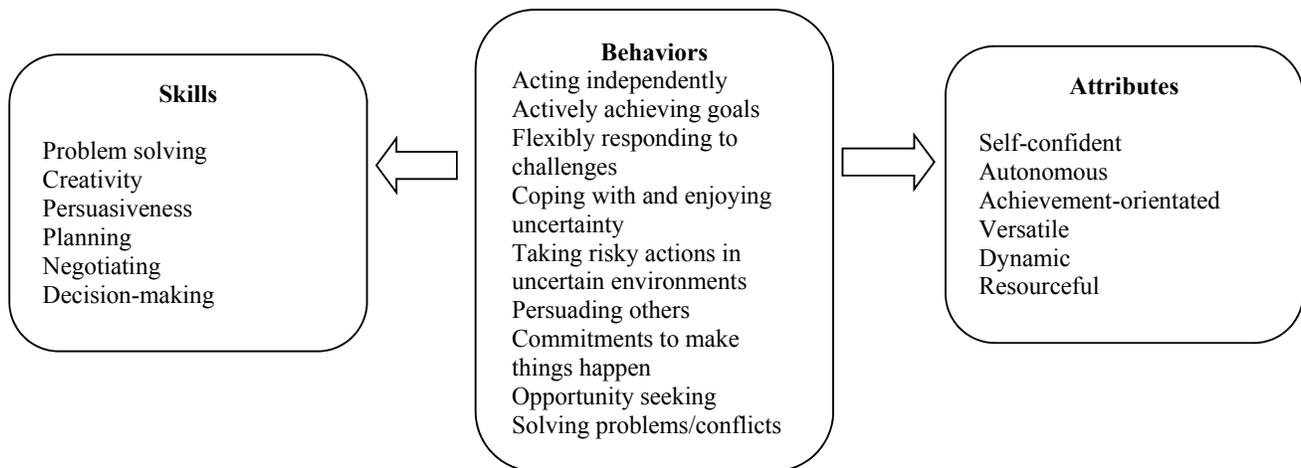
| **Skills**

Problem solving
Creativity
Persuasiveness
Planning
Negotiating
Decision-making | ← | **Behaviors**
Acting independently
Actively achieving goals
Flexibly responding to challenges
Coping with and enjoying uncertainty
Taking risky actions in uncertain environments
Persuading others
Commitments to make things happen
Opportunity seeking
Solving problems/conflicts | → | **Attributes**

Self-confident
Autonomous
Achievement-orientated
Versatile
Dynamic
Resourceful |

Figure 1. Behaviors, skills and attributes of enterprising people
Source: Gibb (1993, p.14)

Gibb (1993) distinguishes between enterprising behaviors, skills and attributes, and within the set of enterprising skills includes: self-awareness, self-confidence, creativity, perseverance, persuasiveness, resourcefulness, negotiating skills and motivation and commitment to achieve. It is believed that gaining such a set of skills will help individuals ' employment prospects, and result not only in greater self-confidence when looking for a paid employment, but also when opting for self-employment.

There are several qualities that are characteristic for the entrepreneurial mindset: capitalization of uncertainty, creation of simplicity where others see complexity, learning from taking calculated risks, quick response to fleeting opportunities (McGrath et al.2000). Additionally, people who are endowed with an entrepreneurial mindset seek and pursue the very best new opportunities with enormous energy, focus on execution and engage and inspire other people, and all of these behaviors can considerably benefit any organization. In various surveys, employers have been recorded talking about the sort of person they want: for example, `proactive', `a self-starter', `confident', `enthusiastic' and so on (these are all characteristic for entrepreneurial mindset), which signals that employers have expectations about how graduates go about their work, and how they perform at work.

The new employability skills set, incorporating entrepreneurial mindset, could be particularly interesting for countries/regions once dominated by traditional, heavy industries and predominantly large employers, a situation which resulted in 'employment for life' and is nowadays characterized by high unemployment. Covin and Slevin (1991) saw that increasing global competitiveness, rapid technological change and innovation require businesses to adopt a more entrepreneurial outlook; otherwise they would be overwhelmed by competitors. They proposed that a business with an entrepreneurial posture was characterized by a belief in change and innovation as inherently positive and essential for long-term organizational survival. The organizational culture reflected this by supporting employees openly expressing novel or radical ideas, by empowering middle- and lower-level employees and by the spirit and practice of teamwork in carrying out the day-to-day operations of the business. Drawing upon the Lumpkin and Dess (1996) notion of organizational entrepreneurial orientation (which includes: autonomy, innovativeness, risk taking, proactiveness and competing intensively), the hypothesis could be made that employers would be interested in enterprising graduates who would add value to their organization, and that enterprising graduates would more effortlessly gain employment in large and small businesses.

4. METHODOLOGY

Main objective of the empirical research was to determine what enterprising skills, behavior and attributes employers in Croatia expect from their new employees. It also aims at establishing to what extent graduates demonstrate enterprising skills, behaviors and attributes.

The questionnaire employed open and closed questions, as well as seven-point Likert scales as answers, and was conducted online. Total of 1,647 questionnaires was sent to employers, with a response rate of 8.14%. Responses were received from 134 employers. Of the companies surveyed,

34% were micro companies, 36% small, 13% came from medium companies, and 17% were large organizations. Hence, the research captures the views of employers from both large and small companies. A high number of micro and small companies participating in the research highlight the importance of recruitment to these businesses. Although the sample is not representative of all enterprises employing graduates in Croatia, it does cover a wide range of branches of economic activity and different sizes (by number of employees) of enterprises. It, therefore, provides useful information that can be used for taking action to improve graduate employability in Croatia.

5. RESULTS AND DISCUSSION

The research generated a number of insights into the type of enterprising skills, behaviors and attributes employers in Croatia consider relevant. (See Table 1). Interestingly, the views are similar across different sizes of companies and different regions of Croatia.The result show that employers in Croatia put substantial value to all enterprising skills and behaviors, but value problem solving skills and enthusiasm and motivation most in graduates. These results are consistent with similar surveys (Sarkar et al., 2016). On the other hand, enterprising skills valued the least important in this research are: making judgments on basis of limited information, critical thinking and persuasion.These results are surprising because in a situation when more and more businesses are forced to adopt entrepreneurial orientation, which they cannot have without employees behaving in an enterprising manner, it could be expected that management would empower their employees, support them to openly express their ideas and challenge the existing ways of doing things. Interestingly, other research (Lowden et al., 2011) has found that employers from both science and non-science sectors in the UK expected graduates to have, among others also critical thinking skills.The reason for this might be that Croatian employers do not expect new employees to engage in situations which require such skills, and expect their employees to develop these skills with time, on the job.

As this paper is a part of a more comprehensive research of employability skills, it is possible to compare the importance of enterprising skills in correlation with other employability skills.It can be assumed that (with the exception of problem solving skills and enthusiasm and motivation) Croatian employers consider other enterprising skills, moderately important for finding, getting and retaining a job. For example, intelligence, usage of IT, foreign language skills and teamwork were identified as more relevant than most enterprising skills. However, enterprising skills scored higher than for example public speaking, practical experience or subject knowledge. One explanation why enterprising skills are not valued more highly could be because employers are aware that entrepreneurially-minded people are likely to leave secure positions to start project that have meaning and value for them, for example their own businesses, when an opportunity presents itself. In this way, Croatian employers, especially in small businesses, fail to realize the potential that enterprising individuals have.

Table 1. Differences between the estimation of importance of enterprising skills, behaviors and attributes, i.e. demand side and graduates demonstrations of enterprising skills, behaviors and attributes, i.e. supply side

Dimensions	Demand		Supply		*pValue**	Gap
		Rank		Rank		
Problem solving skills	6,28	1	4,02	2	0,000	-1
Enthusiasm and motivation	6,26	2	3,60	7	0,000	-5
Desire for achievement and competitiveness	5,98	3	3,80	5	0,000	-2
Innovativeness	5,95	4	3,49	9	0,000	-5
Positive attitude towards change	5,93	5	3,89	3	0,000	2
Proactivity	5,67	6	3,45	10	0,000	-4
Acting Autonomously	5,66	7	3,84	4	0,000	3
Work under pressure	5,58	8	4,19	1	0,000	7
Making judgments on basis of limited information	5,46	9	3,45	11	0,000	-2

| Critical thinking | 5,37 | 10 | 3,71 | 6 | 0,000 | 4 |
| Persuasion | 5,34 | 11 | 3,57 | 8 | 0,000 | 3 |

*p-value is given for Mann-Whitney test

Similar to previous research, Croatian employers do not seem to be interested in skills per se; rather, they want the graduates they recruit and employ to perform in desirable ways competently and effectively. It is the behavior, or performance that is required. Therefore, the survey has also researched to what extent new employees demonstrate enterprising skills developed through higher education. The data show that values employers give for the demonstration of enterprising skills by graduates are much lower than the values given for their importance, which indicates a significant mismatch between supply and demand side of the labor market. Croatian employers share the view that graduates are the most successful in demonstrating work under pressure and problem solving skills. They believe graduates exercise innovativeness, taking initiative and making judgments on basis of limited information the least clearly. The biggest gap between what employers appreciate and what graduates demonstrate has been observed in enthusiasm and motivation and innovativeness. On the other hand, students show they can work under pressure well, but employers do not regard it as particularly critical for employability. We can conclude that graduate employability depends heavily (apart from the context in which a graduate seeks employment) upon what enterprising skills, behaviors and attributes are acquired, but also how they are presented to potential employers.
This exploration has highlighted that apart from other skills, graduates need to possess a set of enterprising skills behaviors and attributes in order to be competitive on the labor market. This surely has implications for higher education institutions, as educators at HEI should promote enthusiasm and motivation and innovativeness more intentionally in their curriculum, and thus improve the employability of their students.

6. CONCLUSION

This paper confirms the views on the employability of graduates but also brings to light new evidence on the requirements of companies in Croatia. This research also reinforces the notion that enterprising skills, behaviors and attributes, i.e. the entrepreneurial mindset should be considered among the employability skills set, as demonstration of skills such as problem solving, enthusiasm and motivation, desire for achievement, competitiveness, innovativeness and positive attitude towards change will help graduates find and retain a job, and move between jobs.
The findings of the research clearly demonstrate the need to develop a better understanding of the demand side of the labor market, and might motivate employers to consider steps they might take to better inform universities of their needs and work with them to develop lists of desirable employability skills, behaviors and attributes and, and thus more employable graduates who can add value to companies through their careers. Employer organizations in Croatia need to work in partnership with the universities to ensure that their programs meet the needs of business. Stronger signals from employers are needed about what enterprising skills are of importance for them, so that students can be better informed of the employability demands of businesses. It is in the best interest of universities in Croatia to build stronger relationships with employers. University can assist students through raising their awareness of what employers seek in graduates, thus helping them acquire these skills through their university education. Career advisory services should work closely with employers on the development of employability skills, too and help graduates learn how to demonstrate these skills in their CVs and at the interview. Students should seek to articulate what they claim they can do in terms that relate to the practices relevant to the occupational settings they wish enter. The potential for student career management skills development unfortunately remains mostly unrealized in universities and graduates are under-prepared for the shifting employment. It is clear that such a change is only to be expected if Government makes public funding for universities partially contingent upon demonstrable graduate outcomes, with an emphasis on the production of work-ready, competent graduates.

REFERENCES

[1] Bridgstock R. (2009). The graduate attributes we've overlooked: Enhancing graduate employability through career management skills, *Higher Education Research & Development*, 28:1, pp. 31-44

[2] Brown, P., Hesketh, A., Williams, S. (2003). Employability in a knowledge-driven economy. *Journal of Education and Work*, Vol. 16, No.2, pp.107-26

[3] Butterwick, S., Benjamin, A. (2006). The road to employability through personal development: A critical analysis of the silences and ambiguities of the British Columbia (Canada) life skills curriculum. *International Journal of Lifelong Education* 25.1: pp. 75-86.

[4] Campbell, M., Meadows, P. (2001). *What works locally?: Key lessons on local employment policies*. York Publishing Services, from: http://www.voced.edu.au/content/ngv:17171, (accessed on 2017-08-20).

[5] Covin, Jeffrey G., Slevin, Dennis P. (1991). "A conceptual model of entrepreneurship as firm behavior." *Entrepreneurship: Critical perspectives on business and management* 3: pp.7-24.

[6] Curran, J., Blackburn Robert A. (2001). Older people and the enterprise society: Age and self-employment propensities. *Work, Employment and Society* 15.4: pp. 889-902.

[7] Gibb, Allan A. (1993). Enterprise culture and education: understanding enterprise education and its links with small business, entrepreneurship and wider educational goals. *International small business journal* 11.3: pp.11-34.

[8] Hartshorn, C., Sear L. (2005). Employability and enterprise: evidence from the North East. *Urban studies* 42.2 : pp. 271-283.

[9] Hillage, J. and Pollard, E., (1998). Employability: developing a framework for policy analysis. *Department for Education and Employment*. Institute for Employment Studies. London: DfEE.

[10] International Labour Organization.(2000). *Training for employment: Social inclusion, productivity and youth employment*. Geneva: Author.

[11] Kanter, R. M. (1995). Nice work if you can get it: The software industry as a model for tomorrow's jobs. The American Prospect, 23, pp. 52–65.

[12] Lowden, K., Hall, S., Elliot, D., & Lewin, J. (2011). *Employers' perceptions of the employability skills of new graduates.* London, UK: Edge Foundation.

[13] Lumpkin, G. T., Dess, G. G. (1996). Clarifying the entrepreneurial orientation construct and linking it to performance. *Academy of Management Review*, 21, pp. 135-172. From: http://amr.aom.org/content/21/1/135.short, (accessed on 2017-07-08).

[14] McGrath, Gunther R.,MacMillan Ian C. (2000). *The entrepreneurial mindset: Strategies for continuously creating opportunity in an age of uncertainty*. Vol. 284. Harvard Business Press, from https://books.google.hr/books?hl=en&lr=&id=we7-hg9YGbgC&oi=fnd&pg=PR9&dq=McGrath,+Gunther+R.,MacMillan+Ian+C.+(2000).+The+entreprene urial+&ots=t_Z-g4Moo7&sig=XVS8gBRfb5oz3bDE2p66O7nUYOQ&redir_esc=y#v=onepage&q=McGrath%2C%20G unther%20R.%2CMacMillan%20Ian%20C.%20(2000).%20The%20entrepreneurial&f=false, (accessed on 2017-07-22).

[15] Opengart, R., Short, D. (2002). Free agent learners: The new career model and its impact on human resource development. *International Journal of Lifelong Education*, 22(1), pp. 220–233.

[16] Pavis, S., Platt, S. and Hubbard, G. (2000). *Young People in Rural Scotland: Pathways to Social Inclusion and Exclusion*. York: Joseph Rowntree Foundation.

[17] Philpott, J. (1999). *Behind the Buzzword: 'Employability'*. London: Employment Policy Institute.

[18] Rae, D. (2007). Connecting enterprise and graduate employability: challenges to the higher education culture and curriculum? *Education+ Training* 49.8/9 : pp. 605-619.

[19] Rychen, Dominique S., Salganik Laura H.,(2003). eds. *Key competencies for a successful life and well-functioning society*. Göttingen, Germany: Hogrefe Publishing, from https://books.google.hr/books?hl=en&lr=&id=CUhfAgAAQBAJ&oi=fnd&pg=PR5&dq=Rychen,+D.S.,+ Salganik,+L.H.+(2003).+Key+competencies+&ots=fbIZedQdk0&sig=Nc5M5GF3DzTWr1dSzBpZj-FrDko&redir_esc=y#v=onepage&q=Rychen%2C%20D.S.%2C%20Salganik%2C%20L.H.%20(2003). %20Key%20competencies&f=false, (accessed on 2017-08-09).

[20] Sarkar, Mahbub, et al. (2016). Graduate employability: views of recent science graduates and employers. *International Journal of Innovation in Science and Mathematics Education (formerly CALlaborate International)* 24.3: pp.33.

[21] Van der Heiden, B. (2001). Pre-requisites to guarantee life-long employability. *Personnel Review,* Vol 31, No.1 pp. 44-61.

[22] Yorke, M. (2006). *Employability in higher education: what it is – what it is not*. Learning & Employability Series one. The Higher Education Academy, from:

http://www.heacademy.ac.uk/assets/was%20York%20-%20delete%20this%20soon/documents/ourwork/tla/employability/id116_employability_in_higher_education_336.pdf , (accessed on 2014-02-26).

RESULTS FROM IMPLEMENTED FMEA METHODOLOGY – FOLOW UP ON A IMPLEMENTED pFMEA

Ivo Kuzmanov[1], Roberto Pasic[2]

Abstract: *The aim of the paper is to present small part from the aimed results from already implemented FMEA methodology into an entity from Bitola, R. Macedonia. According to the previous results from the period November 2016 – January 2017, and according to the conducted folow up onto the same one, the paper presents fresh results after the implemented FMEA matrix, on a six mounth folow up period. The results shown into the paper are from June 2017. The business entity once again is an fireplace producer from Bitola, one of the most older ones in Macedonia and into the Balcans, and one of the largest one according to it's year production and employees (among fireplace producers). Having in mind that this is a folow up on a previous published paper, the same one has some simularities to the previous one, but finally presents the results after a several implemented matixs regarding several sub processes into the business entity, such as: cutting, shaping and drilling metals. The benefits from the implemented matrix were already mentioned in a previous paper, but after an extensive research and implementation of the FMEA methodology on a daily base, the results are more than visiable. The paper represents the same ones in addition.*

Key words*: FMEA, long term implementation of FMEA matrix, pFMEA, industrial entity from the metalworking industry, R. Macedonia*

1. INTRODUCTION

The basic aim of the paper is to present a follow up on a previously done FMEA into an industrial entity which works into the metal cutting industry, to be more precise into a fireplace production, and has a market share into the Balkan's more than 60 years. The same one is one of the largest ones in this region, by year production and employees, and has one of the best production lines among competition. This paper presents a follow up onto a previously published publication and a previously done research. The same one is also published into the TEMEL International Journal, and was done into the time frame November 2016 – January 2017. What was published into the previous publication was about the process of implementation and real daily base usage of the pFMEA matrix, which brought the company real benefits. This one is a follow up on the same one, and presents a momentarily view (done as a research into the same business entity) onto the matrixes and it's real benefits to the business entity.

Just for reminding, the first implementation brought the company reducements into the non-conformities, problem reducements, quality improvements, reducement of expenses and bigger profits through a processes of continuous reducements of the non-conformities into the production stages. So, the starting view and hypothesis according to the previous information's were that we should have small RPN's and more quality production into the business entity.

Having in mind, that the paper presents follow up on a previous done research and real implementation, done by a multidisciplinary team (conducted from person with a long term experience into the field of Technical sciences, person from a long term experience into the field of implementation of such systems, persons from the management team, workers from direct sub processes) the follow up was done from representatives from the management team and representatives from the workers from the direct processes where the matrix's were used during the 6 month period. So, in addition of the papers some of the aimed results are presented.

---

[1] Ivo Kuzmanov, PhD., Associate Professor, Faculty of Technical Science in Bitola (ivo.kuzmanov@tfb.uklo.edu.mk)
[2] Roberto Pasic, PhD., Assistant Professor, Faculty of Technical Science in Bitola (roberto.pasic@uklo.edu.mk)

2. PRESENTING FMEA METHODOLOGY

The methodology that was used while the research, same one as previously, was FMEA methodology. The same one is known as a methodology which primarily is used for detection and analyses of potential non-conformities, and is known as a method for systematically detection of potential non-conformities, but also as a one that creates potential solutions. This method is worldwide knowing as a FMEA (Failure Mode and Effect Analysis). The methodology most common is used for:

- Detection of potential non-conformities, which has a crucial influence to the system productivity
- Evaluating the effects of each detected non-conformity and its influence to the system, the influence over the functions of the elements and sub systems

FMEA is a world known as a methodology which is based on team work and it's accepted as one of the most common methods for system improvements directly, but also as one of the methods which indirectly has an influence to the quality of processes, quality of final products, business performance and finally brings financial benefits to the entity. The same one as a method has influence to all of the production stages, with a final aim of improvements from a process to a process. Whit it's usage the same one brings the subject to a situation where all of the potential non-conformities could be evaluated and could be segmented as primary, secondary ones and non-conformities as a result of human mistakes.

The methodological approach to the same one is based on a team work and created tabular views which are a multiplication of three common factors (the severity, the occurrence and the possibility for detection). Multiplication brings us to a created RPN number, shown in addition:

$$RPN = severity (S) \times occurrence (O) \times detection (D)$$

Each of the multiplication factors shown into the formula above are on a scale from 1 to 10, and could be exactly read from generated tables. Considering previous mentioned, the maximum RPN number could be 1000. One of the most important things to say at the moment is also the approach to the problems (solving approach). The same one is based from top to bottom considering the RPN number. The implementation of the method is developed considering several steps: team creation, defining time and place for implementation, creating structural, functional and non-conformity analyses after which the team approaches to a realization of a recommended steps and solutions after which there is an additional monitoring on the system.

3. REVIEW OF THE PRODUCTION PROCESS

Having in mind that the paper presents a follow up from extensive research done previously into a business entity from Bitola, which after the implementation of the FMEA methodology has some benefits and adopted the same one on a daily base use, it's more than necessary to show all of the production processes and sub processes.

The same one is a part from a production line which produces stoves, where the process is separated to the following sub processes:

- Buying raw materials
- Quality control – on the raw material
- Segmenting the raw materials into magacines
- Cutting on small and large scissors
- Making holes to the material
- Using hydraulic presses
- Delivering the final piece to magacine or to another process

Generally, the first research and implementation had in mind all of the characteristics of the sub processes which could bring to non – conformities, and according to the policy of doing right follow up, the same one was taken into consideration once more. So, these were the characteristics which were also taken into consideration:

- Machines
- Methodology of work
- Material
- Human factors
- Measurement instruments
- Work conditions

Seeing things once more after a period of 6 months, and after a daily base usage, the mistake factor is more than smaller. We could say at this point that the workers which use the same one on a daily base had some routine and have considered how to use the same one better and better. But as a live mathery the business entity still has some problems, especially with the newest employees, while their adaptation process, where non-conformities and problems still show up.

4. PRESENTING THE RESULTS FROM THE FOLLOW UP

This segment maybe is the most important part from the paper. The same one presents three tabular views, which present the results from the first conducted FMEA matrix ever done, the ACTIONS done and the redocument of the RPN factor into the frame January 2017, and finally the results from the follow up done into the two weeks period in June 2017. So, seeing the same one the reducements are more than valuable.

Process	Potential Failure	Nus – effects	S	Reason	O	Reason	D	RPN
Transferring the done pieces into the warehouse	Damaged piece	Replacement time sequences which are long	4	Mistakes made by workers while transfer	3	Checking piece by piece	4	48
	Long time for transfer	Production delaiment, free work force with no activities to do	5	Transport equipment which is more than old	7	Checks on every piece	2	70
	Not appropriate conditions into the warehouses	Nus products	3	Mistakes made by the warehouse workers, and the transport workers	4		6	72

The first table, shown above presents the starting point, or to be more precise it's the first matrix ever done into the business entity. The same one is done after a long-term cooperation between the multidisciplinary team members, and presents the firstly spotted non-conformities into the sub process – transferring the done pieces into the warehouse.

The second table shown below, presents the matrix made after a while (with actions taken with an aim to reduce the raw pieces and non-conformities) and presents the benefits in a short period of time after the implemented pFMEA methodology into the business entity.

Actions TO DO	Actions TAKEN	RESULTS FROM THE TAKEN ACTIONS – NEW RPN			
		S	O	D	RPN
Motivation on work force – control of the materials, pieces	Motivation and TEAM BUILDING actions	3	5	2	30
Replacement of the transport equipment, as well as maintaining the ones that are already in use	Done maintance on all of the machinery which is in use	3	4	2	24
New warehouses, and taking some measures to renovate the ones in use	Generating warehouses which are with appropriate conditions for the use.	2	3	2	12

But, what is more than important is to present the momentarily view of the same sub process, where we could see real benefits after using the pFMEA methodology on a daily base. These benefits are achieved only by the members of the team, created only by the members of the business entity, which uses the pFMEA matrix on a daily base with a real communication with the employees. The tabular

view number 3 is more than appropriate view of the benefits. The same one is shown in addition. Seeing the tabular view, it's more than important to say that the daily base usage of the methodology brought the company smaller RPNs and brought them to visualize all of the problems which are the reasons for non-conformities, and also to face the same ones. Such things weren't practice in the past into the same industrial entity, so we could say that the implementation of such methodology is more than necessary for every business entity.

Process	Potential Failure	Nus – effects	S	Reason	O	Reason	D	R P N
Transferring the done pieces into the warehouse	Damaged piece	Replacement time sequences are faster since the past, but still take some time	3	Mistakes done by workers who are new at the company and made such mistakes	3	Checking piece by piece Checking the pieces brought by employee who are new	2	1 8
	Human mistakes (made usually by the newest employees)	Production delay, free work force with no activities to do Additional training and coaching activities to the newest employees	2	Transport equipment which is older and heavy to use No training activities while the process of employment	5	Checking the pieces Checking the work of the newest employees	4	4 0
	Mistakes made by the employees which work into the wearhouse's	Nus products	2	Mistakes made by the warehouse workers, and the transport workers	2	Checking pieces before using the same one	2	8

Seeing the table, show above and comparing the same one with the first one, we could see one newest potential failure with a high RPN, but also, we could see smaller RPNs into the other two potential failures. The reason why these RPNs are smaller are the daily base activities done by the team, but also the commitment of the management team for such activities, after seeing the financial benefits of the same one.

4. CONCLUSION

Having in mind that the paper presents a follow up on a previous done research and real implementation, from which a paper was published already, the basic aim is to present a small part from the aimed benefits from an everyday usage of methodology such FMEA, or pFMEA. Seeing the tabular views, it's more than visible that the company had benefits in several key points: team commitment, management commitment, financial benefits, reducement of non-conformities. What is necessary to say at this stage is to say that the company usage and implementation of such methodology brought some benefits and brought the team from a multidisciplinary team (from inside and outside members) to an inside team, with a knowledge to do such things. On the other hand, we could say that the research previously done and it's follow up have considered several processes into the company, and here in the paper only one sub process is presented, so more papers in near future could be published with general information about the benefits and the processes.

REFERENCES

[1] Ivo Kuzmanov, Roberto Pasic, Oliver Slivoski, *Implementing FMEA methodology into industrial capacity from Macedonia*, page numbers 18-21, TEMEL International Journal, Volume 1, Issue 1, May 2017, temel-ij.org, ISSN 2545-4390

[2] Ivo Kuzmanov, *pFMEA methodology, follow up activities done into real industrial entity*, Bitola, June 2017

[3] Ivo Kuzmanov, *FMEA methodology, internal documents for application into real entities*, 2016

[4] Ivo Kuzmanov, *research conducted into real industrial entity in Bitola's region*, 2016-2017

TEMEL-ij

Technology | Engineering | Management | Entrepreneurship | Learning | International Journal

IMPACT OF INTELLECTUAL CAPITAL MANAGEMENT ON SUSTAINABILITY OF PROJECTS RESULTS

Jamila Jaganjac[1]

Abstract: *This paper presents a part of the research that has been conducted from August 2016 to mid-January 2017 in order to determine the impact of IPA CBC projects on the promotion of small and medium enterprises in rural areas as well as to identify business improvement after the implementation of projects. Successful implementation of projects empowers the creation of long-term contacts and connections between people and stakeholders from communities on both sides of the border. Established cooperation between partners can lead to joint activities within defined priorities and measures, as well as to joint regional strategy. In this paper, the author determines if there is a system of monitoring and maintenance of the results achieved, and to what extent project results are sustainable. Sustainability of project's results indicates the ability to maintain and improve results after financial and intellectual assistances have been given. The principal research results showed that there is a need to improve intellectual capital management to ensure sustainability regarding achieved results and cooperation.*

Key words: Intellectual capital, Project sustainability, Improvements

1. INTRODUCTION

Successful implementation of Cross Border Cooperation (CBC) projects empowers the creation of long-term contacts and connections between people and stakeholders from communities on both sides of the border. Established cooperation between partners can lead to joint activities within defined priorities and measures, as well as to joint regional strategy. It supports sustainable development along the EU's external borders, helps reducing differences in living standards and addressing common challenges across these borders [1]. The goal of Cross Boarder institution Building (CBIB+) is to generate and share knowledge among stakeholders contributing to the improvement of procedures and tools to achieve a high level of quality in programme implementation [2], focusing on management and implementation of IPA CBC programmes between two Western Balkans countries.

When it comes to measuring the impact and effects of the CBC programmes, there are certain conditions to be fulfilled for the proper quantification. They relate to the statistics of CBC beneficiary countries and appropriate databases. It is also necessary to have analytical capabilities to deal with such complex issue. In that case the methodology and methods should be uniform for all of the beneficiary countries so that results are comparable on the level of all CBC programmes. That is because according to Communication on EU Enlargement Policy Reports from 2016 [3], not any of IPA beneficiaries in the region, with the status of the potential candidate or candidate to EU have fully adequate statistical system, so that can measure CBC impact independently.

Indicators of socio-economic development, in which CBC programmes can have the direct or indirect impact, are GDP and employment rate. Increasing employment reduces economic migration, having the positive effects on population indicators. When it comes to the exchange of people and ideas, it takes longer to achieve wider impact. Creating joint CBC knowledge platform would be useful and operational for all CBC beneficiary countries, taking in consideration both tangible and intangible impact factors. This would create a possibility for CBC beneficiary countries to measure effects on the macro level, also using data for the common cross-border strategies. EU would have the possibility to create the value-added model for measuring the long-term impact of the entire funding through CBC programs. The hierarchical model would enable measurements of the impact of individual projects and programmes as well. The knowledge platform is a part of structural capital i.e data bases, related to intellectual capital management of CBC projects.

Other element of structural capital, as a part of IPA projects sustainability, is intellectual property. Only

---

Corresponding author: [1] Phd., Jamila Jaganjac, University Vitez, jamila.jaganjac@unvi.edu.ba

the grant beneficiaries can provide project information and documents for primary research purposes. This restriction is in line with contract provisions on ownership, intellectual and property rights and influences the possibility of measuring beneficiaries attitudes and experience with CBC projects. Primary research examines the attitudes of applicants, partners and target groups participating in the projects in order to measure their experience with projects.

Research results can be used for corrective measures for maintaining and improving achieved projects' results. To achieve it, an intellectual capital model for sustainability of achieved projects' results need to include additional components: Validation of Sustainability and Redefiniton of intellectual property. For all types of measurements, there is a need to differentiate the outcome (short and medium term changes) from impact (long-term changes). For proper identification of the impact, it is necessary to follow long-term changes in the economic and social environment.

2. SUSTAINABILITY OF PROJECTS RESULTS

The issue of project sustainability relates to both outcomes and impact. Outcomes are short-term and intermediate changes that occur as an effect of interventions output. They relate to project goals. Sustainability is more related to impact since it presents long-term changes. These changes are not achievable during the life cycle of the project or in short period of time after successful implementation of the project. It requires further engagement of the beneficiaries in order to maintain or improve achieved results. There are two levels of measuring projects' success:

- from the standpoint of successful implementation of projects and programs in general, achieving short-terms changes
- from the standpoint of the transformation of short-term changes into the long-term changes through defined activities for sustainability and their validation

IPA CBC projects envisage the continuation of the established partnership through the formation of joint bodies; applying for joint projects; the inclusion of other similar organizations etc. The IPA programme introduced "light" impact indicators, in addition to the required output and results indicators. In line with the "proportionality principle", indicators measure "perceived benefits" of various groups of beneficiaries (in the form of case studies, through surveys), rather than measure standard economic indicators [4].

In order to conduct researches and identify perceived benefits through surveys, access to project documents, contacts and Final project reports is required. While identifying projects to be researched and used as case study, it was not possible to get inputs from some contacted project applicants and partners. The redefinition of intellectual property in regard to availability of Final reports, project proposals and contact lists of beneficiaries would improve intellectual capital management regarding monitoring activities for sustainability of project results. Redefinition would also match CBIB goals regarding knowledge sharing. Surveys also provide new knowledge about the sustainability of projects' results and give valuable inputs for improvements.

Measurements include the level of expected changes resulting from projects' activities. When measuring impact, the results can show that impact is not equal to the achieved results and outcomes of the project. For determining successful implementation of projects within the program, secondary data from IPA CBC programme website and some project documents were sufficient. To determine the impact, there is a need for socio-economic data, primary research, and statistics from the fields covered by projects within the programme. Since there is a lack of some of these components, developing CBC knowledge platform would be usefull. The best way to determine the impact of CBC programmes on the life of citizens in the target areas is to combine secondary and primary research.

3. METHODOLOGY

Research refers to IPA 2007-2013, Component II, between Bosnia and Herzegovina and Serbia. The subjects of the primary research were two projects (Beekeeping and Safe Food Region) from the second call, measure 1.2., the exchange of people and ideas. Overall projects objectives were to promote rural development of the border areas of Serbia and Bosnia and Herzegovina and to improve competitiveness of SMEs in eligible area.

To identify whether there is a system of monitoring and maintenance of achieved projects results, both secondary and primary research have been conducted, based on the hypothesis: Impact of the CBC programmes on creation of opportunities for socio-economic development in the eligible area depends not only on the successful implementation of the programmes but also on the capacity to use and improve acquired knowledge and experience. After reviewing secondary data based on documentation; CBC publications [5] and reports, questionnaires were formed for primary research.

To process data, SPPS 20 is used. For the analysis of primary research results descriptive statistics is used.

4. RESULTS AND DISCUSSION

The complete primary research of the two projects, taken as a case studies, includes: a) attitudes of target groups regarding importance of project activities for strengthening competitiveness of the companies; specific results achieved by project activities; increased Cross-border cooperation and business networking; the thematic significance of training courses for the business; degree of achievement of general and specific objectives of the projects after its implementation in Year 2014 and in Year 2016; the importance of activities for the achievement of general and specific objectives and their sustainability; overall results achieved through project activities; b) comparison of the attitudes between different target groups within the projects, as well as c) the comparison of attitudes between respondents of both projects in terms of the achieved results of the project activities and their sustainability. The research was carried out two years after the implementation of the projects. Considering that the paper deals with one segment of the overall research, here are presented the results related to the sustainability of the project results and possibilities to maintain them.

Table 1: Increased Cross-border Cooperation, Business Networking and SME competitiveness (Safe Food Region)

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
To what extent you have increased cross-border cooperation and business in general	19	1.00	5.00	3.3158	1.45498
Valid N (listwise)	19				

The average mean of this question is 3,3158, with a deviation of 1.45498. Standard deviation shows that the deviations from the mean are quite high. That indicates a significant difference in the responses between respondents. Respondents were companies participating in the project. The range from the minimum 1 to maximum 5 means there is a wide dispersion of responses to this statement.

Project applicants (Regional Chambers) have responded to the following question:, If you believe that the results of the project decreased in the period from the year 2013 to the year 2016, please list some of the reasons. Regional Chamber of Commerce from Valjevo cited following reasons: lack of funding needed to maintain the achieved results; lack of incentives for these programmes, impossibility of applying to the calls for projects of this type within the IPA projects. The Chamber proposed further development of food safety systems and standards under financial, consulting and other support from appropriate institutions. Regional Chamber of Commerce Bijeljina stated that the results are the same level as they were after the realization of the project, but not at cross-border level.

Both applicants (Chambers) and target groups (companies) are satisfied with the project activities and benefits in terms of knowledge improvements, increased implementation of HACCP during the implementation of the project and food safety education which continued at local level, after implementation of the project. On the other side, they stated that there were no significant further cross-border cooperation activities, such as: business cooperation among SME's in the eligible area; cooperation among Chambers through joint projects; networking. Project implementation was successful, but there is no capacity to use and improve acquired knowledge and experience at cross-border level.

Table 2: The Expansion of Business Networks and Cross-border Cooperation as a Result of the Project (target groups of Beekeeping project)

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
To what extent you have increased cross-border cooperation and business networks as a result of this project.	12	3.00	5.00	3.8333	.95346
Valid N (listwise)	12				

Respondents are slightly more satisfied than it was the target group of the project Safe Food Region. Still, the mean for this question was lower than the mean for the rest of survey's results for this project. Standard deviation is 0.95346 and is acceptable.

Table 3: The Importance of Activities for the Achievement of General and Specific Objectives and their Sustainability (applicants/partners of Beekeeping project)

Descriptive Statistics					
	N	Min	Max	Mean	Std. Deviation
Trainings for beekeepers and fruit growers	5	4.00	5.00	4.8000	.44721
Visits to learn about best practices	6	4.00	5.00	4.3333	.51640
Establishing joint cross-border committee on beekeeping	*6*	*2.00*	*5.00*	*3.5000*	*1.22474*
Procurement of equipment for beekeeping	6	4.00	5.00	4.8333	.40825
Introducing bee production to preschool children	6	4.00	5.00	4.8333	.40825
Organization of the 2 tribunes in Prijepolje and Goražde	6	4.00	5.00	4.5000	.54772
Participation in beekeeping fairs	6	3.00	5.00	4.1667	.98319
The importance of all the activities implemented during the project	6	4.00	5.00	4.5000	.54772
Valid N (listwise)	5				

The analysis of the collected and processed data determined the importance of activities for the achievement of general and specific objectives and their sustainability. Respondents consider the transfer of knowledge through trainings for beekeepers and fruit growers as highly important for the sustainability of achieved objectives. Average means are high for most of the activities. Deviations from the mean are negligible. The average mean for establishing joint cross-border committee on beekeeping is 3.5 with significant deviation of the mean. That shows that there are differences in responses.
The purpose of the Committee was to continue cross-border activities and to maintain and develop established networks, ensuring sustainability of projects' results and established cooperation. The attitudes of the respondents, therefore indicates that there are deviations from planned activities. The mechanism of the sustainability of the achieved results is not fully in use, when it comes to the activity of joint cross-border committee. In order to ensure the sustainability of achieved results, it is necessary to activate Joint Cross-Border Committee or involve new mechanism.
Both target groups and applicants/partners agreed that results of the project activites mainly remained the same at local level in terms of organising fairs and seminars. There is no activity with regard to joint projects; networking, expansion of market access and branding. The mean for the question regarding Promotion of Rural development of the border areas of Serbia and Bosnia and Herzegovina was 3,5. The mean for the question regarding Improvement of Conditions for the development of

beekeeping in the border communities of Prijepolje and Gorazde was 4.5. This indicates that implementation of the project was successful and outcomes very satisfactory, but since there was no significant sustainability activity at cross-border level after implementation of the project, overall rural development is rated lower.

Table 4: Overall Results achieved through Project Activities (applicants from both projects)

Paired Samples Test				
	Paired Differences	t	df	Sig. (2-tailed)
	Mean			
Applicant 1: Overall results achieved through project activities Applicant 2: Overall results achieved through project activities	-.33333	-1.483	11	.166

There is no significant statistical difference between the two samples tested since the p = 0,166 > 0,05.

When it comes to the achievement of general and specific objectives of the projects after its implementation in the year 2014 compared to the year 2016, respondents from both projects agreed that results are lower in the year 2016 at cross-border level, but remained the same at local level. Most of the activities after the project implementation take place at the local level, while cross-border cooperation is in stagnation when it comes to activities for sustainability of project results of these two projects. These activities for Safe Food Region included: Cooperation among Chambers through joint projects and networking. For Beekeeping, activities for sustainability included regular activities of Cross Border Beekeeping Committee according to adopted 5-years working plan: fairs, seminars, joint projects, networking. None of these activities were taken at cross-border level after successful implementation of the projects, according to given responds.

According to secondary data from Catalogue of 2nd CFP Projects, primary research results from the perspective of project participants regarding successful implementation of the projects and envisaged mechanisms of sustainability match to those mentioned in the Catalogues. When it comes to validation of sustainability, there is no database to use. Intellectual capital management of the project itself is efficient for the successful implementation .There is a need for upgrading model in order to achieve sustainability. Since the projects end with evaluation and audit, upgraded model of intellectual capital management starts from that point.
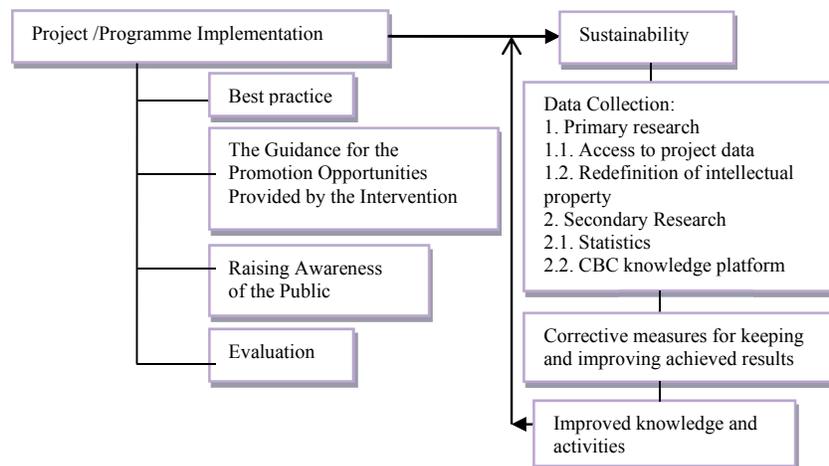

Fig. 1 Upgraded model of project cycle intellectual capital management for sustainability of project results

The upgraded model allows maintenance and improvement of achieved project's results after financial and intellectual assistances have been given. The improvements relate to structural capital in the domain of databases, processes and intellectual property. As for relational capital, the model involves enhanced partner collaboration and the dissemination of improved knowledge.The benefits for human capital are improvements of the knowledge and skills of all involved in the processes.

5. CONCLUSION

Research based on primary and available secondary data showed that implementation of CBC programme was successful. Respondents' opinion is that the biggest benefits of projects are the acquisition of new knowledge and study visits to learn about best practice. Estimated project results are achieved. Secondary and primary research confirmed the hypotesis that Impact of the CBC programmes on creation of opportunities for socio-economic development in the eligible area depends not only on the successful implementation of the programmes but also on the capacity to use and improve acquired knowledge and experience. Most of the projects' activities resulted in the formation of a joint committee or other forms of associations with the aim to continue established cooperation. It is necessary to monitor the implementation of planned joint activities which may have a greater impact on the wider community. CBC knowledge platform would allow better access to information for primary research and to overcome shortcomings in the statistics of the beneficiary countries. Intellectual property can be redefined accordingly. The scope and content of the information would depend on the objectives of monitoring impact and cost-effectiveness of investing in a platform. The platform could be used for creation and implementation of local and regional development strategies.

REFERENCES

[1] European Neighbourhood Policy And Enlargement Negotiations. Cross Boarder Cooperation, from *https://ec.europa.eu/neighbourhood-enlargement/neighbourhood/cross-border-cooperation_en,* accessed on 2016-09-12

[2] Cross Boarder Institution Building , from *http://www.cbibplus.eu/about-us*,accessed on 2016-09-12

[3] European Neighbourhood Policy And Enlargement Negotiations, Reports, from *https://ec.europa.eu/neighbourhood-enlargement/news_corner/key-documents_en*, accessed on 2016-10-04

[4] Cross Border Programme 2007-2013 CBC Serbia-Bosnia and Herzegovina, from *http://www.dei.gov.ba/dokumenti/default.aspx?id=8228&langTag=bs-BA,* accessed on 2016-10-25

[5] Catalogue of 2nd CFP Projects, Cross Border Cooperation Programme Serbia, Bosnia and Herzegovina, from http://srb-bih.org/?lang=en, accessed on 2016-10-25

TEMEL-ij

Technology | Engineering | Management | Entrepreneurship | Learning | International Journal

AVERAGE WIND VELOCITY, DIRECTION AND DISTRIBUTION IN SIX REGIONS OF KOSOVO

Gazmend Krasniqi[1], Cvete Dimitrieska[2], Igor Andreevski[3], Sevde Stavreva[4], Korab Krasniqi[5]

Abstract: *The purpose of this research is to present the average wind data for some regions of Kosovo. As a developing country, Kosovo is facing challenges, especially in the energy sector. The high amount of pollution that the two power plants of Kosovo release enforced the country to seek for other possibilities of producing energy. From many possible sustainable solutions, energy production from the wind turbines is one of the options. The average wind velocity in the area of Kosovo differs from 5-7 m/s depending on the region. This paper gives data for wind velocity, direction and distribution for the region of Kosovo, divided into six regions. The data will be given with the help of global wind atlas released by DTU (Danish Technical University).*

Key words: *Wind resources, Wind turbines, Wind velocity, Sustainable, Wind atlas.*

1. INTRODUCTION

Like every developing country, Kosovo faces its own development challenges, and when it comes from the energy sector, these challenges become more difficult for many reasons. At the moment, Kosovo is producing more than 95% of the power requirements from two coal-based power plants, Kosova A with 610 MW power generation capacity and Kosova B with 670 MW power generation capacity. Kosova A has a deadline to be closed until the end of 2017, while Kosova B deadline is the end of 2030. Old technology used and the years of work have depreciated the power plant, and have made them the biggest pollutants in the area of Kosovo. The pollution of the environment from these blocks includes pollution with PM10, PM2.5, SOx, NOx and other pollutants. But still, being the main energy power source in Kosovo, makes these power plants very important and crucial in the energy sector.

Investing in those plants to reduce the pollution has been proven an interim solution, and so, the investment in sustainable and renewable resources have to be taken seriously into consideration. Among many options of renewable resources, wind energy is a resource, that together with other renewables can fulfill a very big part of Kosovo energy needs. Some studies have been made in some regions of Kosovo, to see the possibilities of installing wind turbines. Although the wind data from these studies are available for these regions, the more accurate wind data for Kosovo region are still missing. Data like wind velocity, direction, distribution, wind power density and so remains yet to be known. This paper gives general information about wind data in the whole region of Kosovo, split in districts. The data for the Kosovo region was made possible by the Global Wind Atlas, an online wind atlas provided by DTU (Danish Technical University).

2. KOSOVO DISTRICTS WIND DATA

2.1. KOSOVO MAIN DISTRICTS

Kosovo is divided into seven regions, or so-called districts. Until later Kosova had six regions, and a region has been added more recently. Peja as the district number 3 dovided again and Gjakova was added as the 7th region. Since Peja and Gjakova together have a small area, and because of other circumstances, in this paper they will be presented together. A map with all seven regions is shown in figure 1, starting from Prishtina as the Capital.

Gazmend Krasniqi, PhD candidate at Faculty of Technical Sciences, University "St. Clement of Ohridski;-Bitola, Macedonia. E-mail: gazmendkrasniqi89@gmail.com.

Figure 1. Kosovo map with the main seven districts

The mayor district of Kosovo, Prishtina, is also the biggest one and has the largest number of population. Table 1 provides the surface in km^2, for each district.

Table 1. Area and population for each district of Kosovo

Nr.	District name	Area (km^2)
1.	Prishtina	2,470
2.	Mitrovica	2,077
3.	Peja and Gjakova	2,571
4.	Prizren	1,397
5.	Ferizaj	1,030
6.	Gjilan	1,206

2.2. WIND DATA FOR KOSOVO DISTRICTS

Danish Technical University (DTU) has provided an online software, that gives the most important wind data for any selected region. The information can be taken from two sources, which are The Modern-Era Retrospective analysis for Research and Applications (MERRA) and Climate Four-Dimensional Data Assimilation (CFDDA). Our focus will be CFDDA, since it gives data for small areas, like Kosovo Districts, information that MERRA sometimes doesn't show. This software will be used in this paper to show the main wind data for Kosovo Districts. Data will be given from the graphics: for wind velocity in histogram and wind direction in windrose. Also, data for power density will be given depending on the availability. Wind rose will be presented as given with 12 sections. Data will be provided for two different heights, 50 and 100 meters. Table 2 shows the average wind velocity (m/s) and power density (W/m^2), for the six regions mentioned above, in the height of 50 meters above the ground.

Table 2. Average wind velocity and power density at the height of 50 meters above the ground

Nr.	District name	Average wind velocity (m/s)	Average power density (W/m^2)
1.	Prishtina	5.22	165.95
2.	Mitrovica	5.23	170.23
3.	Peja and Gjakova	6.26	277.57
4.	Prizren	5.55	195.88
5.	Ferizaj	5.40	179.13
6.	Gjilan	5.27	139.37

Table 3 shows the same data but for a height of 100 meters above the ground.

Table 3. Average wind velocity and power density at the height of 100 meters above the ground

Nr.	District name	Average wind velocity (m/s)	Average power density (W/m^2)
1.	Prishtina	6.25	170.65
2.	Mitrovica	6.26	169.23
3.	Peja and Gjakova	6.86	252.52
4.	Prizren	6.58	199.66
5.	Ferizaj	6.43	179.00
6.	Gjilan	6.27	149.01

As a region Peja and Gjakova have shown better results comparing with other districts. Next will be presented every regions graphics, showing windrose, histogram and power density for every district. Figures 2 to 13 show these graphics, for the district mentioned at the height of 50 and 100 meters.
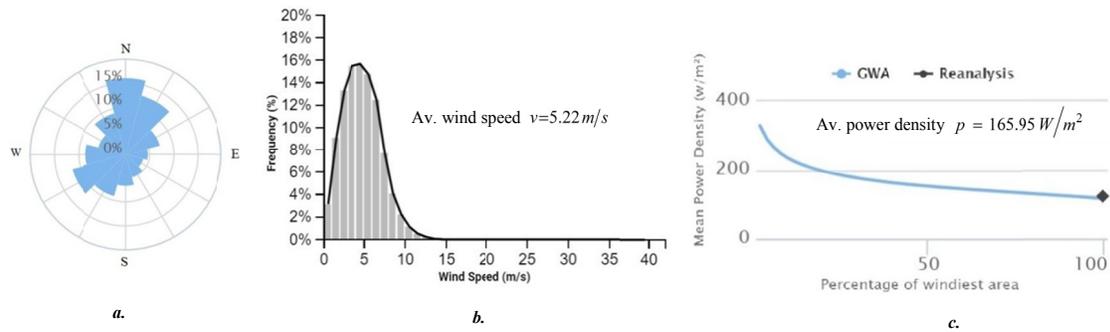
Figure 2. Prishtina District wind data at the height of 50 meters: a. Windrose, b. Histogram and c. Power Density
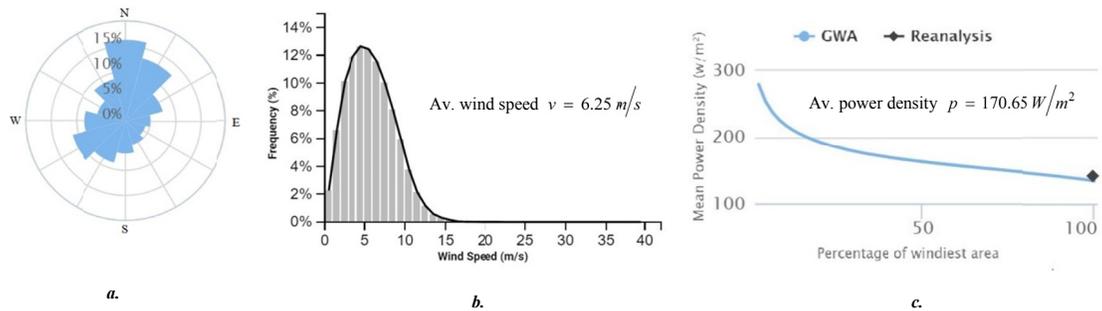
Figure 3. Prishtina District wind data at the height of 100 meters: a. Windrose, b. Histogram and c. Power Density
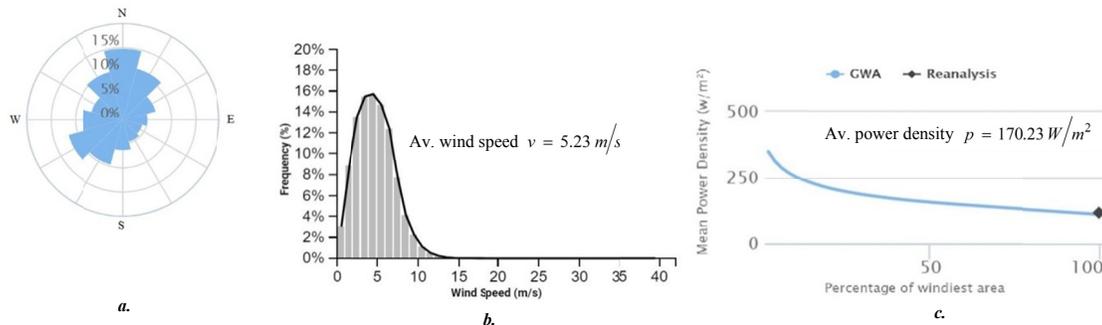
Figure 4. Mitrovica District wind data at the height of 50 meters: a. Windrose, b. Histogram and c. Power Density
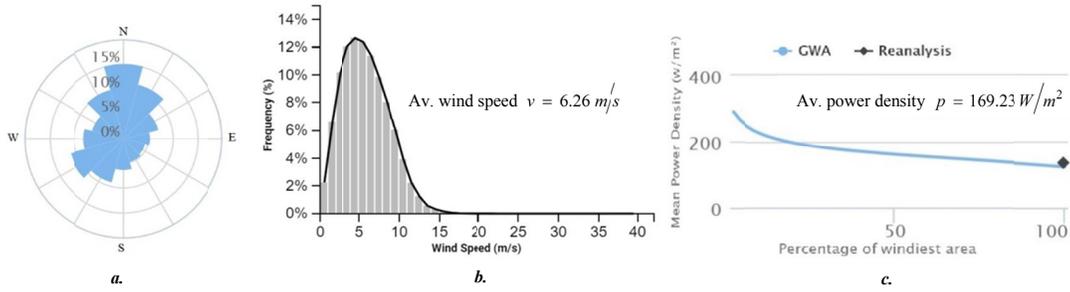
Figure 5. Mitrovica District wind data at the height of 100 meters: a. Windrose, b. Histogram and c. Power Density
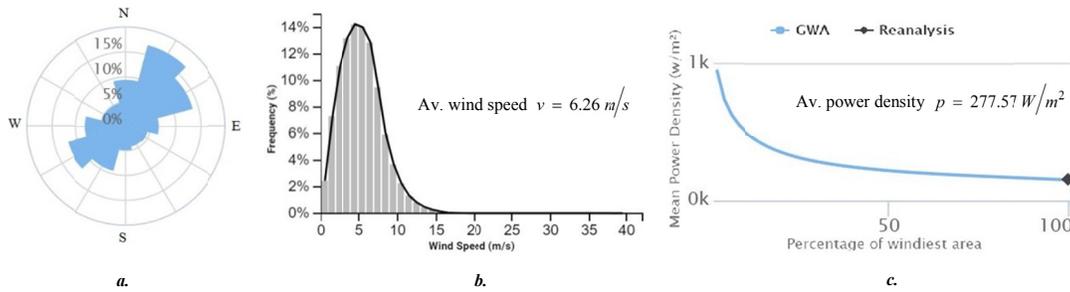
Figure 6. Peja and Gjakova region wind data at the height of 50 meters: a. Windrose, b. Histogram and
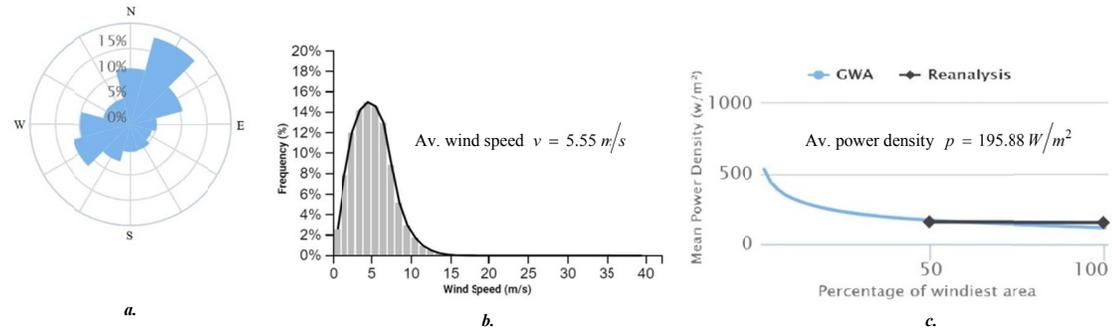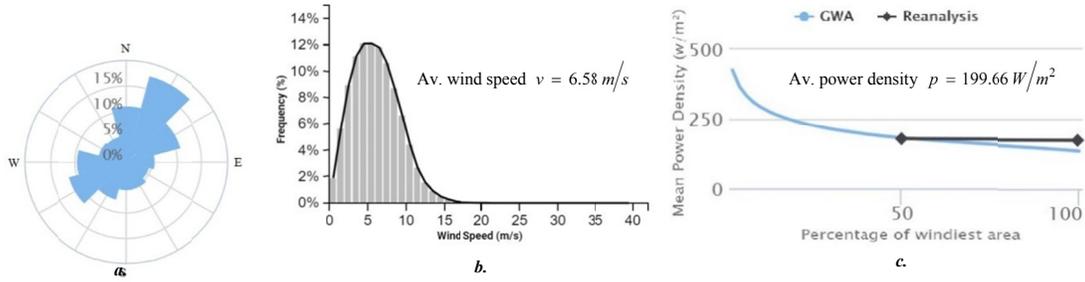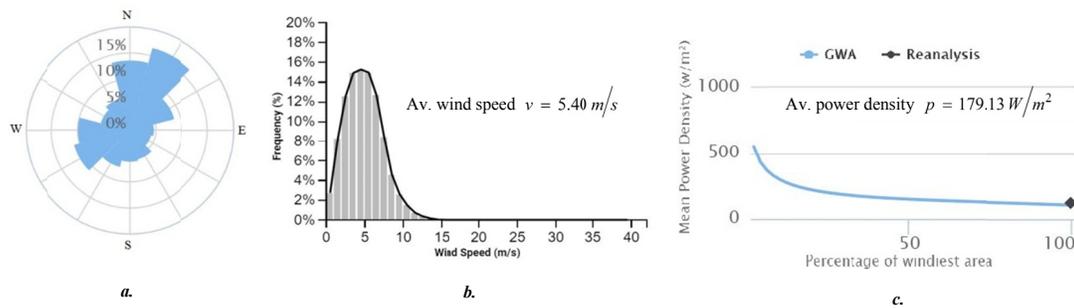*c. Power Density*
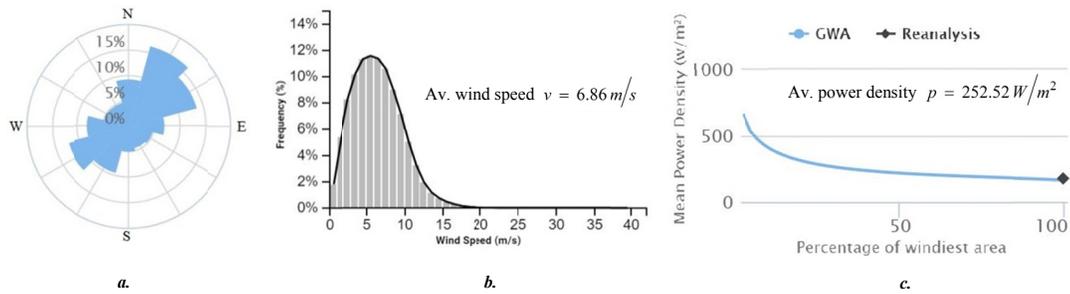
Figure 7. Peja and Gjakova region wind data at the height of 100 meters: a. Windrose, b. Histogram and
c. Power Density

Figure 8. Prizren District wind data at the height of 50 meters: a. Windrose, b. Histogram and c. Power Density

Figure 9. Prizren District wind data at the height of 100 meters: a.Windrose, b.Histogram and c.Power Density

Figure 10. Ferizaj District wind data at the height of 50 meters: a. Windrose, b. Histogram and c. Power Density
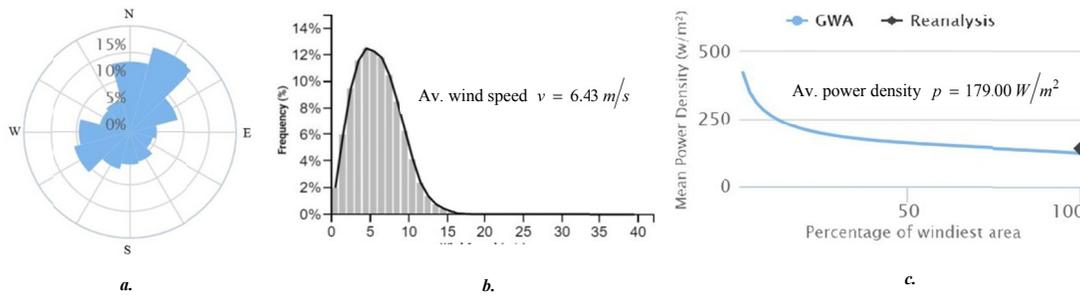

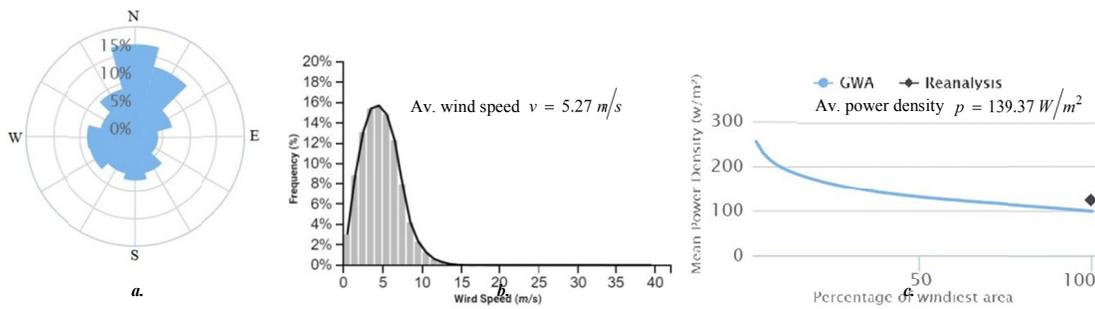Figure 11. Ferizaj District wind data at the height of 100 meters: a. Windrose, b. Histogram and c. Power Density

Figure 12. Gjilan District wind data at the height of 50 meters: a. Windrose, b. Histogram and c. Power Density
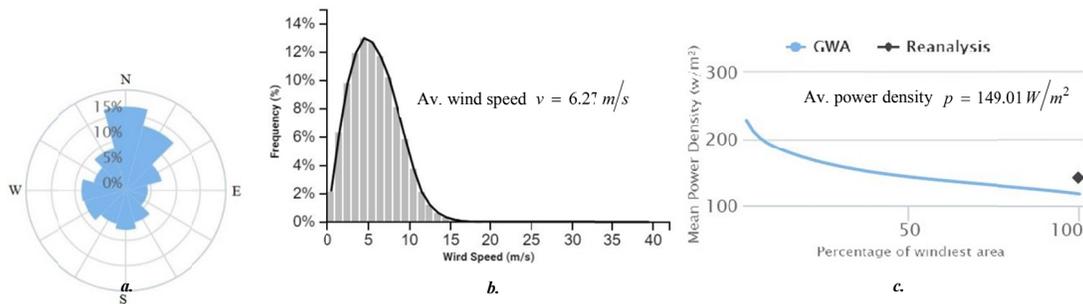
Figure 13. Gjilan District wind data at the height of 100 meters: a. Windrose, b. Histogram and c. Power Density

Graphics presented above show quite different data between districts. Although the average results are not that high, there are regions in every district that have great wind data results. The maximum wind velocity in some regions is up to 20 meters per second, while power density reaches a maximum up to 750 watts per square meter in some regions of Peja District.

3. CONCLUSION

The very high amount of pollution released from the two-existing coal-based power plants, urgencies immediate actions by the responsible authorities in Kosovo. Many countries have already passed this phase of development, by using the available renewables in their areas. Results from many researches show that a number of renewable resources are available in some areas of Kosovo. Together with other renewable resources, wind turbines could fill a quite amount of Kosovo energy needs. This will for sure cost a fortune, but considering that a clean area is essential for EU framing, and more important, it is crucial for population lives, it is worth it. The data presented in this paper show a very good wind data results in some areas of Kosovo. This for sure requires more detailed studies for every region before wind turbines could be installed.

REFERENCES

[1] Jefferson W. Tester, Elisabeth M. Drake, Michael J. Driscoll, Michael W. Golay and William A. Peter: SUSTAINABLE ENERGY CHOOSING AMONG OPTIONS;
[2] Noah Kittner, Hilda Dimco, Visar Azemi, Evgenia Tairyan, and Daniel M. Kammen - Kosovo Civil Society Consortium For Sustainable Development (KOSID): *SUSTAINABLE ENERGY PATHWAYS FOR KOSOVO.*
[3] NEK UMWELTTECHNIK AG: *20555 WIND RESOURCE ASSESSMENT, FINAL REPORT for KOSOVO;* Zurich, December 6th, 2010.
[4] Ministry of Environment and Spatial Planning of Kosovo: *Hydrometeorological Yearbook of Kosovo 2014,* Version 1.0, September 2016.
[5] Ministry of Environment and Spatial Planning: *REVISING AND UPDATING THE KOSOVO ENVIRONMENTAL STRATEGY (KES) AND NATIONAL ENVIRONMENTAL ACTION PLAN (NEAP) 2011 - 2015.* Prishtina, May 2011
[6] Kosovo Districts map: https://commons.wikimedia.org/wiki/File:Harta_e_Rajoneve_t_C3_AB_Kosov_C3_ABs.svg
[7] Kosovo Districts data: https://www.citypopulation.de/php/kosovo-admin.php
[8] Global Wind Atlas: http://globalwindatlas.com/map.html

R. Lazarova; R. Dimitrova. Vol.1.Iss.2. (Oct. 2017) 40 - 45

TEMEL-ij
Technology | Engineering | Management | Entrepreneurship | Learning | International Journal

NANO-SIZED POWDERS APPLICATION IN METAL CASTING, WELDING AND COATING

Rumyana Lazarova[1] and Rossitza Dimitrova[2]

Abstract. *Abstract. The current trends in the metal science of using nano-sized powders in the casting, welding, and coating processes are presented. The modification and refinement of microstructure and improvement of metals and alloys properties by the introduction of nano-sized powders are analysed. The role of nanoparticles as crystallization centers, refiners, modifiers and reinforcing the matrix material is established and the attempts to clarify the mechanisms of the relevant processes based on a literature review are considered.*

Key words: *nano-sized powders, metal casting, welding, coating, microstructure characterization, properties*

1. INTRODUCTION

Many studies have been carried out on the effect of nanoparticles introducing in liquid metal and alloys over the last decade. The changes in the microstructure and properties of the crystallized metal are investigated, i. e. the role of nanoparticles as modifiers, refiners, and reinforcement components are clarified to a great extent. A lot of attention is paid to the question of the practical application of the materials obtained as structural and machine-building materials. Considerably less has been investigated the role of nanoparticles in the liquid metal as centers of crystallization and this role is not fully and convincingly proven. The question of wetting, absorption, and activation of the nanoparticles in the metal melt is also not sufficiently elucidated.

Nanoparticles of diamond and high temperature melting compounds with sizes up to 100 nm are incorporated in appropriate ways into the molten metal in the casting, welding and coating processes over the last decade.

The aim of the present paper is to review the publications dealing with the application of nanoparticles in casting, welding, and coating.

2. NANO-SIZED POWDER APPLICATION IN METAL CASTING

2.1. Nano-sized powders introducing in the liquid metal

The introduction of particles into the molten metal is realized via master's alloys to which they are added in advance. Nano-sized powders LaB_6 and TiO_2 are introduced in the standard Al-Ti masters alloy [1 and 2], leading to the intermetallic compounds refining in the microstructure as compared to the microstructure of alloy without nano-sized powders. Masters alloys with TiN and TiCN nano-sized powders additions are specially designed for aluminum alloys. Nanoparticles may also be introduced directly into the melt. In this case, the powders are compacted in the form of rods [2 and 3], tablets [4], strips [5] and the like.

2.2. Influence of nano-sized powder on the metal casting microstructure and properties

All reviewed publications on this topic report the modifying and refining effect of nano-sized powders on the formed microstructure [1, 2, 4, 6-9]. Remarkable results with respect to the microstructure refining and modification of aluminum alloys have been achieved in [10].

[1] Associate professor, Ph.D. Rumyana Lazarova, Institute of Metal Science Equipment and Technology with Hydro- and Aerodynamic Centre "Acad. A. Balevski" – BAS, 67 Shipchenski Prohod Str. 1574 Sofia, Bulgaria, Tel.: 395 2 46 26 304, R.Lazarova@ims.bas.bg

[2] Chief assistant professor, Ph.D. Rossitza Dimitrova, Institute of Metal Science Equipment and Technology with Hydro- and Aerodynamic Centre "Acad. A. Balevski" – BAS, Rossy@ims.bas.bg
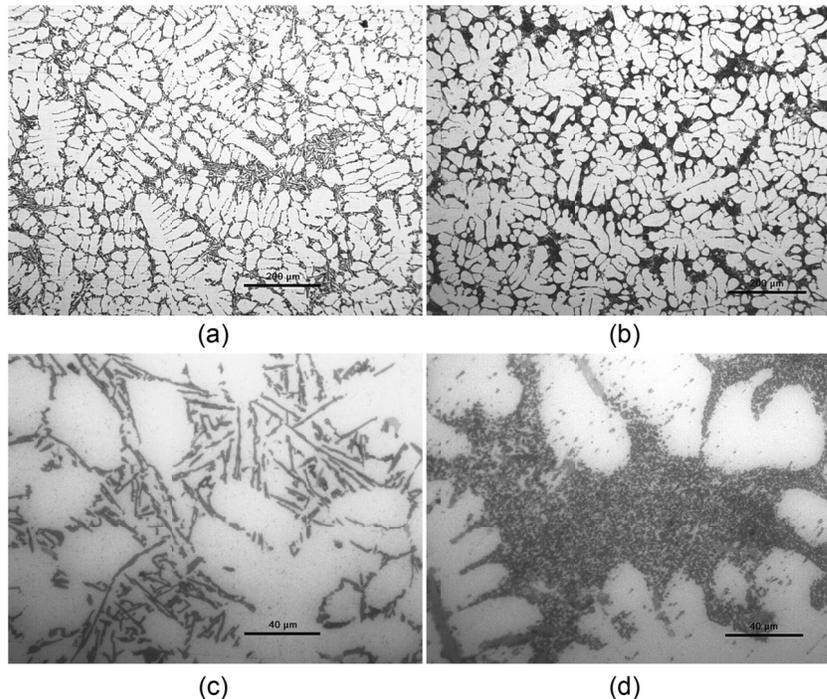
Fig. 1. Metallographic images of castings of AlSi7Mg alloy: (a) initial alloy; (b) modified with 0.1% SiC + Cu alloy; (c) Si particles in the initial alloy and (d) Si particles in the modified alloy. [10]

Some of the best results with regard to the microstructure of steel castings are published in [7 and 9]. The results of [9], which are related to the microstructure of cast iron, deserve great attention.

All reviewed publications concerning mechanical properties of metal materials with nanoparticles additions report the improvement of yield strength, tensile strength, hardness, elongation and wear resistance with several percent [5, 8, and 9].

3. NANO-SIZED POWDERS APPLICATION IN WELDING.

An opportunity to modify the metal of the seam with nanoparticles during the processes of welding or overlay welding is created with the development of nanotechnology. The introduction of nano dispersed materials with unique physical, chemical and mechanical properties in the fused steel furthers the modification of the metal, steers the redistribution of harmful impurities, decreases the grain size, and leads to formation of a zone or a layer with increased strength, micro hardness, and wear resistance [11, 12]. The influence of the iron clad nano modifiers TiCN, TiCN and Y2O3 in welding of low carbon steel is examined in [13]. It is found that the employment of nano modifier alters the micro structure of the welded joint and improved strength properties and Vickers micro hardness in width and height of the weld are registered.

Technology for nanoparticles introducing in the welding seam during welding overlay process is developed [14] in IMSETCHA "Acad. A. Balevski" – BAS. Experiments using this technology for TIG method are performed on plates with thickness 4[mm] made of steel S235JR according to DIN17100/Rst 37-2; EN10025/ S235JR with nano-sized powders of TiN clad with Cr [15]. The results are: grain refinement of the structure in the weld zone and increasing the microhardness of the surface layer of the weld seam with 23%.

TIG weld overlay with introduction of nano-sized TiN powder embedded in coated electrode wire was applied on a low carbon steel grade to study the effect of the nanoparticles on the properties of weld overlaid layers [16]. The comparison between microstructures of single-layer overlaid weld with and without nano-modifier revealed the presence of ferrite-pearlite structures in both cases. In the modified specimen however, the pearlite refines and its morphology changes from lamellar with separate grains towards sorbite-like one. Nano-modification changed the ferrite morphology to acicular and decreases the average grain diameter from 31 to 15µm in the samples with double-layered overlays. The microhardness in nano-modified specimens is 44% higher for single-layer weld

and 28% for double-layer weld in comparison to unmodified samples with the same number of layers. The relative wear resistance increases with 210% after single layer weld overlay with nano-modifying.

4. NANO-SIZED POWDER APPLICATION IN METAL COATING

It could be supposed that structures which have been influenced during their formation by nanoparticles, present in the crystallized metal, should be suitable for coatings of some products that must possess high surface hardness and wear resistance [17]. The nanoparticles introducing in the superficial layers of the metal part could be realized by deposition of nanopowder on the substrate surface and then melting and simultaneously stirring the melt for embedding nanoparticles in depth of the bathing pool. The more appropriate technics for this are electron beam and laser beam irradiation of the metal surface in optimal process parameters.

Some researchers have already realized this idea.

Powders of refractory nanoparticles were deposited by laser cladding on steel [18]. Iron nanopowders were introduced by electron beam irradiation in an aluminum alloy substrate and composite layers have been formed [19]. Al_2O_3 nano-sized powder was introduced into the aluminum surface scanned by an electron beam [20].

In the two recent years TiCN nanoparticles coating was obtained by electron beam treatment in Bulgarian Academy of Sciences (IMSET "Akad. A.Balevski" and IE"Akad.E. Djakov"). The electron beam motion is circular rotating which allows re-melting and good stirring the molten metal on the surface layer [21]. The nanoparticles are absorbed by the liquid metal without being activated by a metal-protector.

Nanoparticles influence both microstructure formation and properties of the solidified metal composite coating.

4.1. Influence of nanoparticles on the microstructure

The electron beam treatment changes the surface microstructure of the metal. The microstructure formation of the re-solidified grains varies with their position in the melted pool. The morphology is cells near the interface between the melted layer and the substrate, cells-dendrites at the center of the melted pool and dendrites near the surface – *fig. 2* [22]. The microstructure of the melted layer becomes much finer than that of the base aluminium alloy. Therefore, the laser beam treatment itself defines the microstructure formation of the re-solidified superficial layers. The nanoparticles introducing additionally refines the grains. They are located inside the grains in single or in clusters. In this way, they obstruct the movement of the dislocations and cause the metal strengthening.
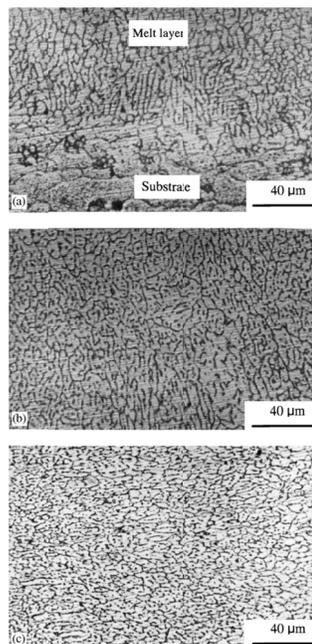

Fig. 2. Optical micrographs showing the microstructure of base 2024 aluminum alloy and electron beam melted pool bottom (a); center (b); and surface (c). [22]

4.2. Influence of nanoparticles on the metal properties.

Nanoparticles introduced in the metal coatings influence their mechanical properties. The microhardness and wear resistance of the coatings are enhanced. The microhardness in the TiCN nanoparticles coating is increased many times in a comparison to base metal *fig. 3* [21].
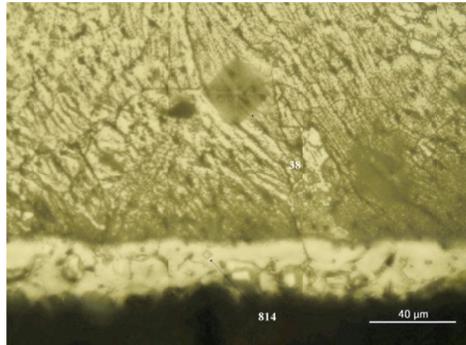

Fig. 3. Microhardness imprint on TiCN nanoparticles addition coating on aluminum substrate

Nanoparticle modification of tool steel (1.2709) and nickel base alloy Hastelloy X (2.4665) was carried out by adsorption of 1 wt% aluminum oxide nanoparticles on the metal powder surfaces by laser irradiation. Modified materials show a significant increase in microhardness in the sphere of influence around the particulates [18].
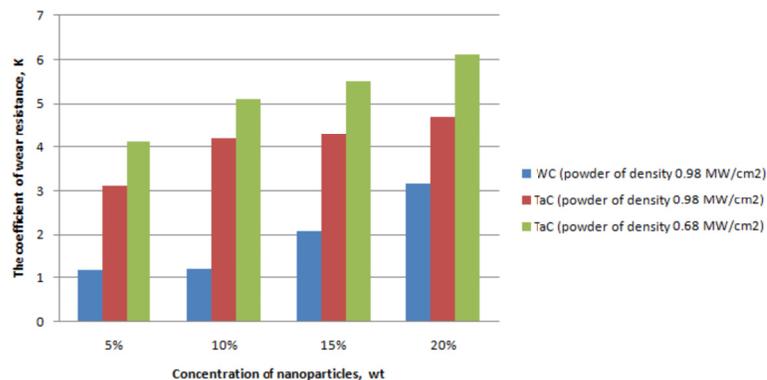Wear resistance of nanoparticles modified coatings is also improved – *fig.4*.

Fig. 4. Wear resistance coefficient at different concentrations of nanoparticles and different power densities [18]

5. CONCLUSIONS
1. The nanoparticles addition in the molten metal during casting, welding, and coating affects both microstructure and properties.
2. The effect of nanoparticles addition on microstructure is expressed in its refining and morphology modification.
3. The effect of nanoparticles addition on mechanical properties is expressed in strength properties increasing, hardness raising, and wear resistance improving.
4. The nanoparticles should be clad with a metal protector in all cases including in electron beam treatment introducing.

REFERENCES
[1] Krushenko G. G., Balashov B. A., Miller T.N. et al., New Technological Processes in Foundry. *Materials of the Scientific and Technical Conference*. Omsk, OmSTU, 1997, p. 20-22.
[2] Krushenko GG, BA Balashov, Vasilenko ZA et al., Increase of Mechanical Properties of Aluminum Casting Alloys with the Help of Ultrafine Powders. *Foundry Production*, 1991, No 4, p. 17-18.

[3] Krushenko GG, Torshilova SI, Krushenko SG. Complex Modification of Pre-eutectic Aluminum-Silicon Alloys. *Foundry Production*, 1984, №2, p. 32.

[4] N.E. Kalinina., O.A. Kavatz, V.T. Kalinin, Technological properties improvement of cast aluminum alloys after modifying with nanodispersed particles. *Airsp. Tech. Technol*. 4(4), 7–21 (2010) (in Russian).

[5] Borodianskiy K., Zinigrad M., Gedanken A. Aluminum A356 Reinforcement by Carbide Nanoparticles. *Journal of Nano Research*. Vol.13(2011), p. 41-46.

[6] N.E. Kalinina et al., Nanomaterials and Nanotechnologies: Obtaining, Structure, Application. *Publishing Hous U.V. Makovetskiy*. Dnepropetrovsk, 2012

[7] R. Lazarova, R.H. Petrov, V. Gaydarova, A. Davidkov, A. Alexeev, M. Manchev, V. Manolov, Microstructure and mechanical properties of P265GH cast steel, after modification with TiCN particles. *Mater. Des*. 32, p. 2734–2741 (2011).

[8] R. Lazarova, P. Kuzmanov, R. Dimitrova, A. Cherepanov, V. Manolov. Properties of 110C13LK steel and SCh 25 cast iron modified by refractory nanopowder. *Steel Transl*. 42(4), p. 298–301 (2012).

[9] P. Kuzmanov, R. Dimitrova, R. Lazarova, A. Cherepanov, S. Popov, R. Petrov, V. Manolov. Investigation of the structure and mechanical properties of castings of alloy AlSi7Mg, cast irons GG15 and GG25 and steel GX120Mn12, modified by nanosized powders. Proc. Inst. Mech. Eng., Part N: *J. Nanoeng. Nanosyst*. 228(1), p.11–18 (2014).

[10] R. Dimitrova, S. Stanev, A. Velikov, A. Cherepanov, R. Lazarova and N. Bojanova. Investigation of AlSi7Mg Casting Refined with SiC Nano-Powder. *Journal of Materials Science and Technology*, Vol. 20, 2012, Number 4, p. 319-326.

[11]. Cherepanov A.N. et al. On the Application of Nanopowders of Refractory Compounds in the Welding and Processing of Metals and Alloys. *Heavy Engineering*, № 4/2. 2008. p. 25-26.

[12]. Troshkov A.S. Modification of the Weld Metal Structure by Nanodispersed Tungsten Carbides. *Polzunovsky Almanac* No. 2, 2009.

[13]. Drozdov, V.O. et al. An Experimental Study of Laser Welding of Metals Using Nanopowder Additives. Dokl. V *All-Russian Conferences "Interaction of Highly Concentrated Energy Flows with Materials in Advanced Technologies and Medicine*". Novosibisirsk, March 26-29, 2013, p. 97-101.

[14] Tashev P., T. Petrov, Y. Lukarsky, G. Stefanov. Technology for Nanosized Particle Insertion in Welding Seam in Welding Processes", *Engineering Sciences*, year L, 2013, № 3, Journal of Engineering Sciences Department, to the Bulgarian Academy of Sciences, p. 82-93.

[15] P. Tashev, R. Lazarova. Examination of Layer Overlaid with Addition of TiN Nano Particles, *Mechanics Transport Communications*, Vol. 11, Issue 1, 2013, XIII-1 – XIII-6, ISSN 1312-3823.

[16] Tashev, P., R. Lazarova, M. Kandeva, R. Petrov and V. Manolov. Tungsten Inert Gas Weld Overlay using Nano-sized TiN Powder, *Journal of the Balkan Tribological Association*, Vol. 22, No 3, p. 2238-2254.

[17]   Draper, C.W.; Poate, J.M. Laser surface alloying. *International Metal Review*, 30 (2), 1985, p. 85-108.

[18] Murzakov, M. A.; Chirikov, S. N.; Markushov, Y. V. Research on microstructure and wear resistance of coatings obtained by adding nanoparticles of refractory compounds in laser cladding. *Journal of Physics*: Conference Series 747, 2016, 012062, p. 1-4.

[19] Weipo, Xin; Deqiang, Wei. Study on the Microstructure Modification of 6061Aluminum by Electron Beam Surface Treatment.   *Sixth International Conference on Measuring Technology and Mechatronics Automation* (2010), Changsha, China, Mar. 13, 2010 to Mar. 14, 2010, p. 665-668.

[20] Deqiang, Wei; Weipo Xin; Rong Wang. Study of electron-beam scanning on the surface of aluminum alloy with nano-sized Al_2O_3-Al powder. *International Conference on Advanced Technology of Design and Manufacture* (ATDM 2010), 2010, p. 357 – 360, Beijing, China.

[21] R. Lazarova, R. Dimitrova, St. Valkov, P. Petrov. Coatings Obtained by TiCN Nanopowder Deposition on Al Substrate and Subsequent Electron-Beam Treatment, Proceedings of 6th National conference with international participation "Metal science hydro- and aerodynamic, national security '2017", Sofia, in press.

[22] Song, R. G.; Zhang, K.; Chen, G.N. Electron beam surface treatment. Part II: microstructure evolution of stainless steel and aluminum alloy during electron beam rapid solidification. *Vacuum 69,* 2003, p. 517–520.

STRUCTURAL AND THERMAL STUDY OF HOLLOW MICROSPHERES FILLED SYNTACTIC FOAMS

Rositsa Petkova-Slipets[1], Penka Zlateva[2]

Abstract: The influence of types and parameters of hollow microspheres on the structure and coefficient of thermal conductivity of syntactic foams has been studied. It was established that better heat insulating properties belong to syntactic foams with composition of 60 vol.% ceramic microspheres with size of 1-40 μm (k=0,029 W/m.K, R=0,008 (m^2.K)/W) and with composition of 80 vol.% glass hollow microspheres with size of 9-25 μm (k=0,087 W/m.K, R=0,008 (m^2.K)/W). The results demonstrate that application of syntactic foams as thin insulating coatings is appropriate and they are an energy efficient material with number of benefits compare with the common thermal insulators.

Key words: syntactic foams, hollow microspheres, microstructure, infrared thermography, thermal properties

1. INTRODUCTION

Syntactic foams are new generation gas-filled composite polymeric materials with low density, low thermal conductivity, and good workability, as well as a satisfactory mechanical strength [1-5]. There is plenty of information, both scientific and industrial, but it is highly diverse in terms of the thermophysical parameters of syntactic foams (thermal conductivity coefficient from 0.0001W/m.K to 0.2 W/m.K) and their effectiveness [6-9].

Syntactic foam is a composition of an organic binder (mono- or bi-component [6-12]) and microspheres as filler. The addition of spherical particles – solid or hollow, glass, ceramic or polymer [7, 8, 13, 14, 15], forms specific closed porosity. Each particles type has its share in achieving of optimal physical-mechanical properties of the composite, but ceramic and glass hollow microspheres appear to be the most suitable.

The application of syntactic foams as thin-layer heat insulating coatings is a perspective direction that is still at the stage of development. The main purpose of the research is to study the impact of the type and parameters of the filler in syntactic foams used as insulating coatings on their structure and thermal conductivity coefficient.

2. EXPERIMENTAL

Four compositions (SFC-1, SFC-2, SFG-1 and SFG-2) of syntactic foams based on water dispersion of an acrylic polymer with hollow microspheres of different type (alumino-silicate and glass) and quantity were studied (Table 1).10 pieces of each type were prepared by using of glass plate pads with size 200x200x8 mm (Fig. 1a). A coating of each composition was applied with a spray gun in two layers. The coatings thickness was measured at 144 points of a coordinate machine.

The structure of the samples was studied by a light inverted microscope METAM LV-41 and was photographed with the visualization complex TC-500. Different optical magnifications were used in conditions of a bright field with differential-interference contrast, a bright field with oblique illumination and a dark field for better visualization of the studied objects and a better highlight of the structural components.

Corresponding author: [1] Assoc. Prof. PhD Rositsa Petkova-Slipets, VFU "Chernorizets Hrabar", r_slipets@abv.bg's degree, name, institution, (e-mail address) (10 Pt normal)

Table 1 Composition of the tested samples with thin heat-insulation coatings

Composition	Microsphere type	Size / quantity of microspheres	* mm	** kg/m^3
SFC-1	Alumino-silicate	1-40 m / 60%	0,253±0,020	315±6,2
SFC-2	Alumino-silicate	1-40 m / 80%	0,347±0,020	215±6,4
SFG-1	Glass microspheres	9-25 m / 80%	0,716±0,012	125±3,4
SFG-2	Glass microspheres	20-80 m / 80%	0,465±0,040	165±5,1

* - thickness of coating, values are averaged for all samples

** - density of coating, values are averaged for all samples

The thermophysical parameters were determined by analyzer for thermal conductivity TCi (Fig. 1b), which is based on the modified transient plane source method. 10 measurements in 10 different points were carried out on each of the tested samples for an integrated assessment of the heat-conducting properties. All tests were conducted by observing the methodology for work with TCi analyzer and the requirements of the ISO 22007-2:2015 [16]. Before each measurement, a test with Pyrex calibration material was carried out.

Fig. 1 General view of a testing specimen (a) and of the TCi analyzer (b)

The equivalent thermal conductivity coefficient k_{eq} was measured for the system glass plate pad - thin syntactic foam coating. The thermal conductivity coefficient of the coating k was calculated by the methodology developed and described in [17].

An infrared camera FLIR E60bx with a resolution of 320x240 pixels and lens FOL18 was used. Due to the high emission capability of the coatings, work was performed at an emission coefficient of 0.70. Specialized software FLIR Tools and FLIRResearchIR was used for data processing.

3. RESULTS AND DISCUSSION

3.1 STRUCTURAL ANALYSIS OF THE COATINGS

The structures of the thin coatings are shown in Fig. 2. All of them have a relatively homogeneous structure with uniform distribution of the microspheres within the polymer matrix.

The structures of coatings with *composition SFC-1* and *SFC-2* have a well-expressed relief on the surface (Fig. 2a, b). Air gaps are formed between the spheres and the matrix. The *composition SFC-1* forms the thinner layers (Table 1). *Composition SFC-2* has a non-compact structure and rough surface (Fig. 2b). Due to the doubled size of the microspheres, they remain unenveloped by the matrix.
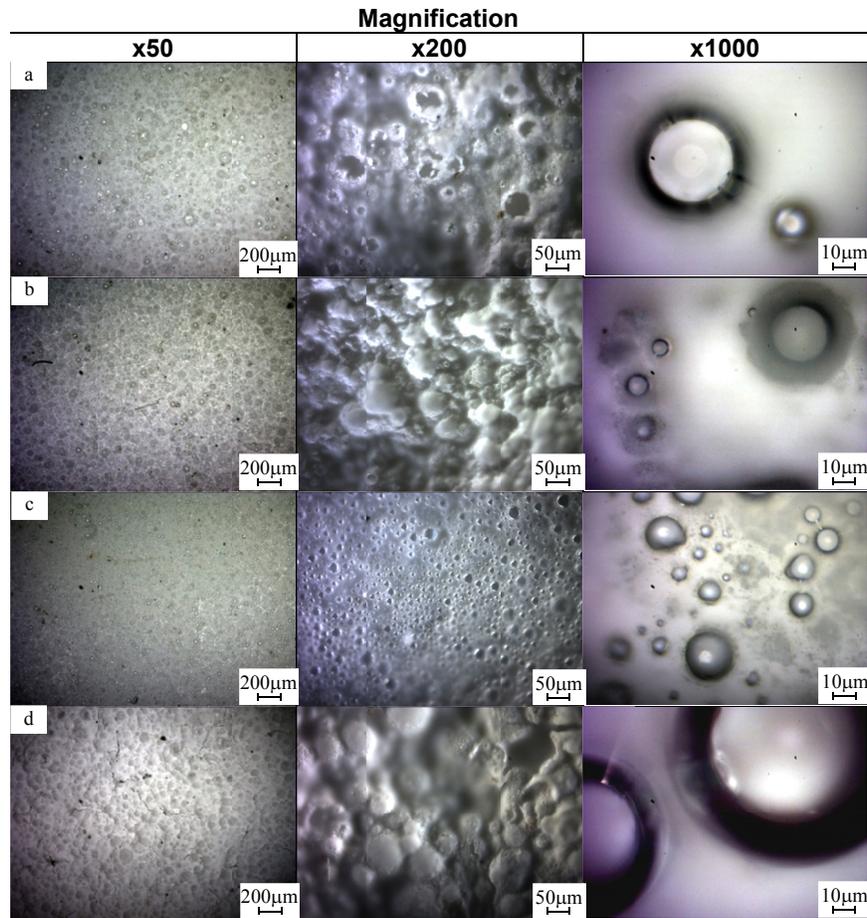
Magnification

x50	x200	x1000

Fig. 2 Structures of the studied samples at different magnifications: a) SFC-1; b) SFC- 2; c) SFG-1; d) SFG-2

Composition SFG-1 coating has relatively smooth surface. The glass microspheres are well enveloped without the presence of air gaps (Fig. 2c) and as a result the structure is compact and with low density (Table 1).

The *composition SFG-2* coatings show most coarse surface with strongly-expressed relief (Fig. 2d). The great number of microspheres and their coarse granularity results in formation of a non-compact and rough structure. The microcapsules are not well enveloped by the binder and air gaps are visible between them and the matrix.

3.2 THERMOPHYSICAL PROPERTIES

The results obtained from testing the samples on a TCi analyzer are presented in *Table 2*. The relative standard deviation (RSD) for all measurements is less than 1%.

Table 2 Results for the thermal characteristics of the tested samples

Composition	k_{eq} , W/(m.K)	RSD, %	k, W/(m.K)	R, (m^2.K)/W
SFC-1	0,395	0,7	0,029	0,008
SFC-2	0,722	0,5	0,116	0,002
SFG-1	0,421	0,6	0,087	0,008
SFG-2	0,818	0,5	0,205	0,002

The lowest value of thermal conductivity coefficient belongs to the coating with *composition SFC-1* (*k*=0.029W/m.K). The equivalent coefficient k_{eq} is almost 3 times lower than the thermal conductivity coefficient of the glass plate (k_{glass}=1,18 W/m.K [17]) and the thermal conductivity coefficient *k* of the coating is nearly 10 times lower than that of the composite matrix ($k_{acrylic}$=0,2W/m.K [18]).

By increasing the concentration of the ceramic microspheres in *composition SFC-2*, the thermal conductivity coefficient *k* and the equivalent thermal conductivity coefficient k_{eq} increase.

The coating with *composition SFG-1* has a very low thermal conductivity coefficient (*k*=0.089W/m.K), but it is higher than that of the coating with *composition SFC-1* (*k*=0.029W/m.K). It should be noted, that the finer glass microspheres have a smaller volume of the gas phase closed within them in comparison with the ceramic microspheres, which have a larger volume share of hollowness.

Composition SFG-2 shows the highest thermal conductivity coefficient (*k*=0.205W/m.K) in comparison with the other studied compositions.

The thermal conductivity resistance *R* of *composition SFC-1* and *composition SFG-1* is four times higher than that of *composition SFC-2* and *composition SFG-2*, which indicates much better heat insulating properties of these syntactic foams compositions.

3.3 INFRARED THERMOGRAPHY

Fig. 3 shows the results from the infrared thermography of the tested compositions of thin heat-insulation coatings. They fully correspond to the established thermal parameters of the tested compositions of thin coatings. Indicative of that are the established temperature differences *Δt* of the temperatures on both sides of the experimental samples (Table 3).
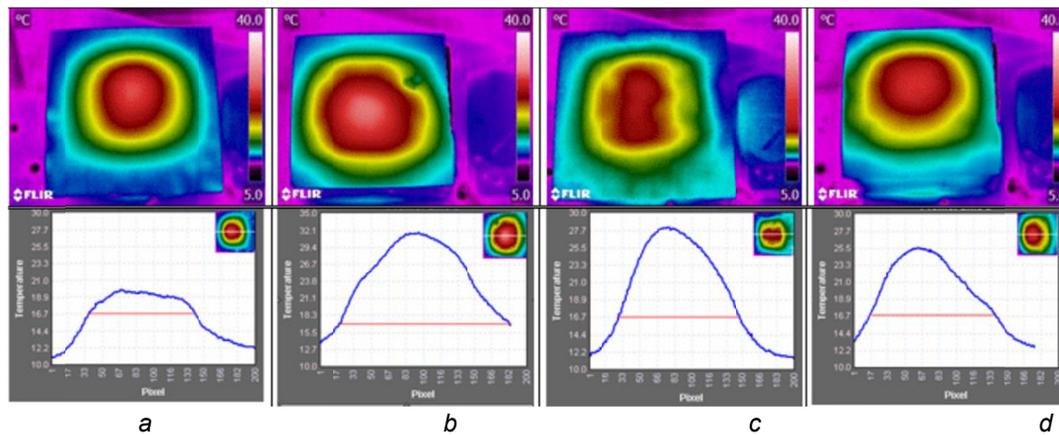

a   *b*   *c*   *d*

Fig. 3 Infrared thermography and linear profile of temperature distribution
a) SFC-1; b) SFC-2; c) SFG-1; d) SFG-2

Table 3 Results of testing the samples with infrared camera

Composition	Δt, ^{o}C	D_{tmax}, cm	$D_{t=16,7\ ^{o}C}$, cm
SFC-1	10,4	8,5	10,4
SFC-2	6,8	10,8	16,8
SFG-1	7,8	4,3x10	11,8
SFG-2	7,0	9,3	12,4

D_{tmax} - the diameter of the temperature field with a maximum temperature /highlighted in red/

D_t - the diameter of the temperature field with a temperature of 16.7^{o}C, which is determined graphically

The infrared photographs demonstrate also the thermal diffusivity of the coatings. Thin coating *SFC-2* has greater thermal diffusivity compared to coating *SFC-1*. The smallest thermal diffusivity belongs to coating *SFG-2* (Fig. 3).

4. CONCLUSION

Based on the results obtained from this study of thin coatings with different syntactic foams compositions, the following conclusions could be drawn:

1. Better heat insulating properties belong to thin coatings with composition of 60 vol.% ceramic microspheres sized 1-40 μm and to these with composition of 80 vol.% glass hollow microspheres sized 9-25 μm. These two are also the compositions which have a compact structure and relatively smooth surface.

2. With the increase of the volume proportion of the ceramic microspheres from 60 vol.% to 80 vol.%, the thermal conductivity coefficient increases 4 times.

3. As finest are the glass hollow microspheres as compact is the structure of the composite, the lower is the layer density, and the lower is the composition thermal conductivity coefficient.

4. Larger-sized glass hollow microspheres enable lower thermal diffusivity of the thin coating.

5. At identical volume proportion of filler (80 vol.%), better heat insulating properties belong to the coating made of the finest glass microspheres.

The results, analyses and conclusions presented above give reason to state that thin heat-insulation coatings based on syntactic foam with ceramic or glass hollow microspheres are superior in terms of heat-conducting properties to a number of commonly used heat insulating materials and that they rival heat insulating materials, based on foamed plastics.

REFERENCES

[1] Gao, J., Wang, J., Xu, H., Wu, C. (2013). Preparation and properties of hollow glass bead filled silicone rubber foams with low thermal conductivity. *Materials Design*, vol. 46, p. 491-496.

[2] Swetha, C., Kumar, R. (2011). Quasi-static uni-axial compression behaviour of hollow glass microspheres/epoxy based syntactic foams. *Materials Design*, vol. 32, p. 4152-4163.

[3] Liang, J., Li, F. (2007). Heat transfer in polymer composites filled with inorganic hollow microspheres: A theoretical model. *Polymer Testing*, vol. 26, p. 1025-1030.

[4] Liang, J., Li, F. (2006). Measurement of thermal conductivity of hollow glass-bead-filled polypropylene composites, *Polymer Testing*, vol. 25, p. 527-531.

[5] Yu, M., Zhu, P., Ma, Y. (2011). Effects of particle clustering on the tensile properties and failure mechanisms of hollow spheres filled syntactic foams: A numerical investigation by microstructure based modelling. *Materials Design*, vol. 32, p. 80-89.

[6] Allen, M., Baumgartner, R., Fesmire, J., Augustynowicz, S. (2004). Advances in microsphere insulation systems. *AIP Conference Proceedings*, vol. 710:1, p. 619-626.

[7] Bozsaky, D. (2015). Laboratory tests with liquid nano-ceramic thermal insulation coating. *Procedia Engineering*, vol. 123, p. 68 – 75.

[8] Ryzhenkov, A., Pogorelov, S., Loginova, N., Belyaeva, E., Plestsheva, A. (2015). Syntactic foams efficiency with the use of various microspheres for heat supply equipment and pipelines heat insulation. *Modern Applied Science*, vol. 9, p. 319-327.

[9] Li, B., Yuan, J., An, Z., Zhang, J. (2011). Effect of microstructure and physical parameters of hollow glass microsphere on insulation performance. *Materials Letters*, vol. 65, p. 1992-1994.

[10] Park, S.-J., Jin, F.-L., Lee, C. (2005). Preparation and physical properties of hollow glass microspheres-reinforced epoxy matrix resins. *Materials Science and Engineering A*, vol. 402, p. 335-340.

[11] Geng, H., Liu, J., Guo, A., Ren, S., Xu, X., Liu, S. (2016). Fabrication of heat-resistant syntactic foams through binding hollow glass microspheres with phosphate adhesive, *Materials Design*, vol. 95, p. 32-38.

[12] Ryzhenkov, A., Loginova, N., Belyaeva, E., Lapin, Y., Prischepov, A. (2015). Review of binding agents in syntactic foams for heat-insulating structures in power industry facilities. *Modern Applied Science*, vol. 9, p. 96-105.

[13] Mee, S. (2011). *The Synthesis, Characterisation and Properties of Self-Assembled Hollow and Low Density Microspheres*. PhD Thesis, University of Birmingham

[14] Hu, N., Dai, J., Zhu, Z., Huang, X., Wu, P. (2012). Synthesis and characterization of hollow glass–ceramics microspheres. *Composites Science and Technology*, vol. 72, p. 528-532.

[15] Yung, K., Zhu, B., Yue, T., Xie, C. (2009). Preparation and properties of hollow glass microsphere-filled epoxy-matrix composites. *Composites Science and Technology*, vol. 69, p. 260-264.

[16] ISO 22007-2:2015 Plastics – Determination of thermal conductivity and thermal diffusivity – Part 2: Transient plane heat source (Hot disk) method

[17] Zlateva, P., Petkova-Slipets, R. (2014). Comparative analysis of the results of measurements of the thermal conductivity of the insulating coating Akterm. *Proceedings of University of Ruse "Angel Kanchev"*, vol. 53, p. 41-46.

[18] Thermal Conductivity for some common Materials, from
http://www.farm.net/~mason/materials/thermal_conductivity.html, accessed on 2017-09-15.

TEMEL-ij

Technology | Engineering | Management | Entrepreneurship | Learning | International Journal

ADVANTAGES AND EXPECTED RESULTS OF INTRODUCING THE NEW TOP-LEVEL DOMAINS

Ljubisa Stefanoski, PhD.,[1] Goce Naumovski, PhD.,[2]

Abstract: *The basic mission of the Internet Corporation for Assigned Names and Numbers (ICANN) is to provide a stable and unique global Internet network, as well as to ensure the security and stability of the Domain Name System (DNS), in order to take measures and promote competition at domain registration, in 2005 began a policy development process of introducing new Top-Level Domains (new gTLDs).*
By establishing new top-level domain names, users of the Internet are also protected, in such a way that this type of domain signifies a Internet site where content sites can be found, and thus avoid situations to access the site with unwanted Content.
The advantage offered by the program for establishing new generic domain names is that it provides the ability to register a secondary domain depending on the activity we perform, and in this way it gives the opportunity to become recognizable within a specific domain on the Internet.

Key words: *Domain Name System, New Top Level Domains, Internet Corporation for Assigned Names and Numbers, Internet.*

1. INTRODUCTION

The expansion of the number of users on the Internet as a global communications network, and an increasing interest in registering internet domain names in the most diverse sectors and areas of market activity, imposes the need for the introduction of new generic top-level domains (New gTLDs).
The main characteristic of gTLDs is that they are sponsored top-level domains. A sponsored top-level domain (sTLD) is one of the categories of top-level domains (TLDs) maintained by the Internet Assigned Numbers Authority (IANA) for use in the Domain Name System of the Internet. A sponsored TLD is a specialised top-level domain that has a sponsor representing a specific community served by the domain. The communities involved are based on ethnic, geographical, professional, technical or other theme concepts proposed by private agencies or organisations that establish and enforce rules restricting the eligibility of registrants to use the TLD.3 On the other hand, an unsponsored gTLD registry operates under the policies established by the global Internet community directly through the ICANN process.

2. ESTABLISHMENT AND IMPLEMENTATION

After introducing the first eight new generic top-level domains, on November 16, 2000 the so-called "new generic top-level domains: .biz, .info, .name, .pro, .aero, .coop, and .museum were established. Some of these new gTLDs are open to registration by the public (unsponsored gTLDs), while the others are intended for registration and use by specific users (sponsored gTLDs).[4] For example, those open for registration by the public or unsponsored gTLDs are the following: .biz, .info, .name and .pro, while sponsored top-level domain names are: .aero, .coop and .museum. For example, unsponsored gTLDs .biz, operated by NeuStar, Inc., is intended for registration to users who use it or intend to use it bona fides, for business or commercial activities, while the domain .name, operated by Verisign Information Services, Inc. intended solely to register personal names of individuals in commercial and non-commercial aims. For example, the .aero TLD is sponsored by Societe Internationale de Telecommunications Aeronautiques (SITA INC USA), which limits registrations to members of the air-transport industry.

[1] Assistant Professor, Faculty of Law, International Slavic University "Gabriel Romanovich Derzhavin" in Sveti Nikole and Bitola, (stefanoski_ljubisa@yahoo.com)
[2] Full Professor, Faculty of Law „Iustinianus Primus", University Ss. Ciril and Methodiuous in Skopje, (gocenaum@gmail.com)
[3] Sponsored top-level domain, Lennox Raphael Eywindr (ed.), Crypt Publishing, Mauritius, 2012. Avialable at:
https://www.iberlibro.com/Sponsored-Top-Level-Domain-Paperback-Crypt-Publishing/20187419893/bd, 12.08.2017.
[4] Domain Name Dispute Resolution, United Nations and World Intellectual Property Organization, 2003, p.6.

In 2004, a new wave of domain names that were approved by ICANN (.asia, .cat, .jobs, .mobi, .tel, and .travel) [5] followed. Approval for putting into use these so-called special domain names, has caused an interest in the registration of new generic names of top-level domains not only for businesses, but also for individuals engaged in specific activities.

In this regard, the Internet Corporation for Assigning Names and Numbers (ICANN), whose basic mission is to provide a stable and unique global Internet network, and to ensure the security and stability of the Domain Name System (DNS), in order to take measures and promote competition in domain registration, in 2005, began the process of introducing new gTLDs (New Top-Level Domains). The main policy maker for the introduction of this type of domain is the Organisation for the Promotion of Generic Names (GNSO), which promotes global participation in the technical management of the Internet. After long-term consultations with governments, civil society, business sector, intellectual property rights holders and technologists, on June 26, 2008, during the 32nd International Public ICANN Meeting in Paris,[6] the ICANN Board of Directors adopted 19 specific GNSO recommendations regarding the implementation and establishment of new top-level generic domain names (New gTLDs), with predefined criteria for allocating this type of domain and agreed terms.

One such recommendation provided that ICANN should introduce New gTLDs in rounds until the scale of demand is clear.[7]

After adoption of the policy, in October 2008, ICANN undertook an open, inclusive, and transparent implementation process to address stakeholder concerns, such as the protection of intellectual property and community interests, consumer protection, and DNS stability. This work included public consultations, review, and input to multiple draft versions of the Applicant Guidebook. In June 2011, ICANN's Board of Directors approved the Applicant Guidebook and authorised the launch of the New gTLD Program.[8]

3. APPLICATION AND APPROVAL PROCEDURE

The procedure for the application and approval of new top-level domain names began on January 12, 2012. The great interest in obtaining approval for the management of this type of domain is also shown by the fact that only in 2013, ending on October 12, 2013, 1930 applications were submitted for registration of new names of top level domain names in the following categories:[9]

▪**Generic**

These are the new top-level domain names that in most cases contain a generic name, such as: academy, .accountant, .actor, .adult, .cafe, .baby, .camp, .car, .bike, .camera, .sexy, .clothing, .city, .country, .education, .house, .kitchen, .islam, ,catholic, .food, .film, .fun, .family, .flights, .university итд;

▪ **City**

These are the new top-level domain names that contain the name of cities, such as: .berlin, .boston, .vegas, .london, .madrid, .rio, .paris, .tokyo, .roma, .moskow, .dubai etc.;

▪ **Geo/Cultural**

These are the new top-level domain names that contain the names of a geographical or cultural origin or a specific area, such as: .africa, .swiss, .catalonia, .arab, .irish itd;

▪ **International, ASCII;**

These are international new names of the highest level domain names with Latin transcription, such as: .casa, .gratis, .vivo, .moto, .uno, blanko, .mosaic, etc.;

▪ **International, not ASCII;**

These are international new names of domains of non-Latin transcription, for example: .ком, .москва, .рус, .орг, .сайт (means: .site), .企业 (means: .enterprises), .手机 (means: .phone), etc.;[10]

▪ **Brand TLDs**

These are the new top-level domain names that contain brand names, or registered trademarks or

---

[5] For more information, see the following website: http://newgtlds.icann.org/en/applicants/customer-service/faqs/faqs-en, 22.02.2014.

[6] For more information, see the following website: http://archive.icann.org/en/meetings/paris2008/, 12.08.2017.

[7] For more information, see the following website: http://newgtlds.icann.org/en/about/program, 12.08.2017.

[8] For more information, see the following website: http://newgtlds.icann.org/en/about/program, 12.08.2017.

[9] The current status of the submitted application, or the application for the registration of new domain names (New TLDs), as well as the list of new TLDs waiting for approval are available on the following website: https://gtldresult.icann.org/application-result/applicationstatus/viewstatus, 25.08.2017.

[10] For more information see: Stefanoski Lj., „Role and Function of Internationalized Domain Names in the Business Environment", Technology, Engineering, Management, Entrepreneurship, Learning (TEMEL) – International Journal, EURO STARTER, Volume 1, Issue 1, pp. 45 – 50, May, 2017.

well-known trademarks, such as: .alibaba, .airbus, .mcdonalds, .fujitsu, .nokia, .lexus, .bmw, .toyota , .nike, .gucci, .calvinklein, .hilton, etc.

In the meantime, some of the applicants have already provided the necessary approval by ICANN, which means they can start registering secondary domain names within the new top-level domain names. Thus, for example: the reception of applications for the registration of secondary domain names within the new domain name of the highest level .bike started on January 29, 2013, for .clothing on January 29, 2013, for .camera on February 5, 2014, for .sexy on February 24, 2014, while for .works started on May 14, 2014, for .watch May 7, 2014, for .voting July 22, 2014.[11]

The fact that there is a great interest in registering secondary domain names within new top-level domains is also the fact of the number of registered (more than 1.5 million sub-domains), and the most attractive new domains are shown in the following table:

Table 1. The most popular 10 extensions of the new top-level domain names[12]

	New generic top-level domain names (New gTLDs)	Number of registered subdomains
1.	.web	157.346
2.	.hotel	42.820
3.	.app	31.080
4.	.music	29.906
5.	.free	23.562
6.	.sport	21.766
7.	.radio	14.261
8.	.med	13.159
9.	.gay	11.101
10.	.secure	10.768

4. ADVANTAGES AND EXPECTED RESULTS

The advantages of the new internet domain names of the first level name are multiple.

Namely, the advantage offered by the program for establishing new generic domain names, bearing in mind the fact that the number of new top-level domain names is getting bigger, is that it provides the ability to register a secondary domain depending on the activity we perform and in this way, it provides an opportunity to become recognizable within a specific domain space on the Internet.

Such a case was with the introduction of the .xxx internet domain (Sponsored Top Level Domain, sTLD), specially designed for the needs of the global pornographic industry, where the adult entertainment sites can be found. The decision on the establishment of .xxx domains was made on March 31, 2011, and the responsibility for registration and management was assigned to the authorised registry of ICM Registry LLC.[13] ICANN's decision to establish the .xxx domain was followed by an extensive process of justification of requests, along with a number of proposals, public reviews, comments, assessments by an independent panel of experts, and a longer period of review by the ICANN Governing Board and other parties.[14] Therefore, the economic interest in establishing the .xxx top-level domains is multiple. On the one hand, it is for the benefit of industries that deal with the production and distribution of materials with adult content, by increasing their economic benefit by a threefold increase, which is also reflected in the interest in registering over 215,000 .xxx domains. On the other hand, there is an economic interest in the relevant registry of ICM Registry LLC, which is obvious, having in mind that immediately after the establishment of this domain, it applied for a registration and management license and the following first level domains .SEX, .PORN and .ADULT.[15]

From the internet users point of view, by establishing the new top-level domain names internet users

---

[11] For more information, see the following website: https://www.names.co.uk/domain-names/new-domain-extensions, 22.08.2017.

[12] The ranking list of 50 most wanted new top domains is available on the following website: http://www.uniteddomains.com/newgtld-ranking/, 25.08.2017.

[13] For more information on registering .xxx domain names, see the following website: http://www.icmregistry.com/, 24.08.2017.

[14] More on the process of adopting the conclusion on the establishment of .xxx domain names of the first level, see the Report on the following website: https://www.iana.org/reports/2011/xxx-report-20110407.pdf, 25.08.2017.

[15] For more information, see the following website: http://www.icmregistry.com/press/xxx-operator-applies-to-icann-for-more-adult-top-level-domains/, 24.08.2017.

are also protected in such way that this type of domain signifies the place where web sites can be found with specific content, thus avoiding situations when typing and searching a particular site, access the site with spam.[16] For example, by establishing new .xxx domain name, on the one hand, a clear idea about the nature of the site is given, and on the other hand, there is the possibility of introducing restrictions and blocking access to minors, as well as banning access to these sites in countries where pornography is forbidden by law.

All of the mentioned advantages are also reflected at the cost of applying for evaluation and approval of new domain names. Namely, after the opening of the application process on January 12, 2012, anyone interested in registering and receiving approval for managing a specific domain had to pay a sum of 185,000 US dollars.[17] This also affects the amount of the price that all interested parties must pay when registering a secondary domain name within a new domain name. Namely, the sum is much higher than the amount paid by applicants when registering and maintaining a secondary domain name within a generic domain name (not more than $ 10, because it amounts to at least $ 30).[18]

5. CONCLUSION

In addition to the above advantages, one of the reasons for establishing the new generic names of top level domain names is to discourage the malicious registration of third-party domains, or to influence the suppression of cybersquotting. However, practice speaks quite the opposite, that is, in that direction, the introduction of this type of domain did not yield the expected results.

REFERENCES

Journal Papers:

[1] Stefanoski Lj., (May, 2017) „Role and Function of Internationalized Domain Names in the Business Environment", *Technology, Engineering, Management, Entrepreneurship, Learning (TEMEL)* – International Journal, EURO STARTER, Volume 1, Issue 1, pp. 45 – 50.

Books:

[2] Lennox Raphael Eywindr (ed.) (2012), *Sponsored top-level domain*, Crypt Publishing, Mauritius.

Standards:

[3] *Domain Name Dispute Resolution, United Nations and World Intellectual Property Organization, 2003.*

WWW pages:

[4] *http://newgtlds.icann.org/en/applicants/customer-service/faqs/faqs-en*, accessed on 22.02.2014.

[5] *http://archive.icann.org/en/meetings/paris2008/*, accessed on 12.08.2017.

[6] *http://newgtlds.icann.org/en/about/program*, accessed on 12.08.2017.

[7] *http://newgtlds.icann.org/en/about/program*, accessed on 12.08.2017.

[8] *https://gtldresult.icann.org/application-result/applicationstatus/viewstatus*, accessed on 25.08.2017.

[9] *https://www.names.co.uk/domain-names/new-domain-extensions*, accessed on 22.08.2017.

[10] *http://www.uniteddomains.com/newgtld-ranking/*, accessed on 25.08.2017.

[11] *http://www.icmregistry.com/*, accessed on 24.08.2017.

[12] *https://www.iana.org/reports/2011/xxx-report-20110407.pdf*, accessed on 25.08.2017.

[13]*http://www.icmregistry.com/press/xxx-operator-applies-to-icann-for-more-adult-top-level-domains/*, accessed on 24.08.2017.

[14] *http://www.101domain.com/domain_registration_xxx.htm,* accessed on 24.08.2017.

[15] *http://newgtlds.icann.org/en/applicants/customer-service/faqs/faqs-en,* accessed on 25.08.2017.

[16] *http://www.newgtldsite.com/register-new-tld-domains/,* accessed on 25.08.2017.

---

[16] For more information, see the following website: http://www.101domain.com/domain_registration_xxx.htm, 24.08.2017.

[17] Available on the following website: http://newgtlds.icann.org/en/applicants/customer-service/faqs/faqs-en, 25.08.2017.

[18] An example for this can be seen on the following website: http://www.newgtldsite.com/register-new-tld-domains/, 25.08.2017.

TEMEL-ij

Technology | Engineering | Management | Entrepreneurship | Learning | International Journal

PERFORMANCE EVALUATION OF SOCIAL ENTERPRISES SUPORTED BY EU FUNDS : CASE OF THE CZECH REPUBLIC

Jarmila Šebestová[1], Zuzana Palová [2]

Abstract: *In the last programming period 2007-2013 the financial support from European Social Fund (ESF) lead up to creation of social enterprises. In the Czech Republic, the financial support was distributed through the Human Resources and Employment Operational Programme. In this programme, the financial support for social entrepreneurship was in priority axis 3 Social integration and equal opportunity. The aim of this paper is to make evaluation of efficiency of all created social enterprises, supported within this programme, using the method of social return on investment (SROI).*

Key words: *ESF, NGOs, Social Enterprises, Social Innovation, SROI*

1. INTRODUCTION

The social economy began to be formed in 1980's in France. Then it started to spread into other European countries, when the Social Economic Charter was accepted by the National Council for relations between mutual societies, cooperatives, and associations in 1980. This Charter considers the social economy is a group of organizations which do not belong into public sector, are democratic and it has a special scheme for their profit redistribution for further development and improvement for its members and for society (Monzon and Chaves, 2008). In the last decade, the social economy has managed much stronger position on the European level also. The social economy has been admitted by European Commission in 1989. According DG Enterprise the social economy contains cooperatives, mutual societies, associations, foundations and social enterprises (Dohnalová, 2009).

Basic principles of social entrepreneurship were globally by defined the Nobel Peace Prize winner, Muhammad Yunus (2010), in his book Building Social Business, where he defined basic principles of social entrepreneurship on global level and used them in practice. He confirmed that social entrepreneurship helps to end poverty and promote economic growth. Finally, he mentioned that nongovernmental organizations (NGO) such as the organizations in the "third sector" have important role in the creation of social enterprises, because they know actual needs of society. The third sector (non-profit) belongs into social-economic partners of social enterprises. This term comes from three sector division of the economy. The first sector belongs to commercial organizations, the second sector consist of public (non-profit) institution and the third sector relates to private non-profit sector. In some cases, the fourth sector is mentioned, which is created by household or shadow economy.

Haken (2005) explains that it is possible to place all organizations which are not founded to generate and distribute their profit to shareholders into the non-profit sector. Following that "wide" concept, the third sector includes political parties, university campuses, labour unions, guilds, associations of legal entities, associations, chambers, professional associations and various contributory organizations. Opposite of that, a narrower definition of the third sector exists, which is sometimes very misleading, as Bavučík (2005) stated in his study and it is connected with frequently used term such as "*non-profit nongovernmental organization*". Those organizations are standing mostly behind the creation of social enterprises, whether they operate within their current legal form or they establish subsidiaries, which have legal form of ordinary commercial companies or cooperatives, when research platform TESSEA (2011) proposed the most widely used definition of social enterprises in the Czech Republic as follows: "*Social enterprise means a subject of social entrepreneurship, i.e. a legal entity established under private law or any part thereof or natural person which fulfils principles of the social enterprise. Social enterprise fulfils the public benefit objective, which is formulated in the founding documents. Social enterprise arises and develops on the concept so-called threefold benefit - economic, social and environmental*".

The European Union (EU) uses the social entrepreneurship for solving social problems, especially on level of employment. The financial support from the EU is devoted for the creation and development

---

Corresponding author: [1] Jarmila Šebestová, MSc., Ph.D., Silesian University in Opava, School of Business Administration in Karviná, Email: sebestova@opf.slu.cz

of social enterprises. The first projects with the links on social economy were realized in the Czech Republic after 2000 with support of the Programme Phare before the Czech Republic joined EU in 2004. More sophisticated concepts of social entrepreneurship in the Czech Republic began to show up after joining EU. In programming period 2004-2006 and 2007-2013, there were announced calls for support of social entrepreneurship (Dohnalová, 2009). In the second programming period (2007-2013), it was possible to obtain financial support for creation and expansion of enterprises from the Human Resources and Employment Operational Program (HREOP) and from Integrated Operational Programme (in this program there was possible to obtain financial support only for investment costs). The social enterprises have been created under the call no. 30 "Social economy", which was opened for all period. Currently, in the operational period 2014-2020, there is open call for "Social economy" in the Employment Operational Programme.

Although organizations have been able to draw fund for 16 years there has not been a clear government document created yet. This document would solve concept of social economy and explain it. It is paradoxical that without any government document the concept of social economy takes part in social policy and regional development of the EU [20]. In the Czech Republic, there is still not any legal regulation of social enterprise and entrepreneurship. That is why many organizations are pressing for a law on social entrepreneurship, which is indeed prepared but still rather at an embryonic stage. Social enterprises in the Czech Republic may take any legal form which the Czech legislation allows. The limited liability of companies, charity organizations, civic associations and cooperatives and new social cooperatives are the most often legal form of social enterprises.

If we return into the programming period 2007-2013, where the social enterprises were supported by the call no. 30 „Social economy ", we can see that social enterprises had to achieve some conditions. Social enterprise contributes to unemployment reduction and support of social inclusion. At least 40% employment from whole number of employment had to consist of the target group. Into the target group there were people with disabilities, youth, and young adults, the homeless, persons leaving facilities designed for institutional or protective care and people leaving prison sentence, victims of crime, victims of domestic violence, etc., persons caring for a relative, a person with experience in substance abuse, people who are long-term unemployed, etc. included. Places of work were mostly created for people with disabilities and long-term unemployed persons (MoLSA,2016).

The main goal of this paper is to evaluate the effectiveness of the investments through the method social return on investment (SROI). This SROI index will be calculated for all supported social enterprises from Human Resources and Employment Operational Programme.

2. PERFORMANCE EVALUATION IN SOCIAL IMPACT CONTEXT

According Viturka (2010) each priority axis of Governmental Support is determined by quantifiable indicators of input, output, outcome and impact, a part with qualitative performance indicators is still missing. This is the reason why within new period will be applied in the evaluation of projects a system of indicators for local action groups (LAGs) and LEADER principles for community led development. The number of people supported by the project or number of innovation generated by the project does not answer the question about real contribution to the development of local communities, increase local prosperity and security in life.

On the other hand, Richmond, Mook, and Quarter (2003) suggested social accounting, but for many organizations it was still difficult to evaluate their work because of really quantitative approach. The New Economics Foundation introduced social index called social return on investment (SROI) of business entities (Clifford et al., 2010). The European Union then recommended using of the SROI for evaluation of the impact of the operational programs after programme period evaluation. The member states were asked to create their own versions of the SROI (Moody et al., 2015). But this approach is still not widely used in the Czech Republic, as well as in other member countries. According that, Cooney and Lynch-Cerullo (2014) suggested procedure for measurement using the method SROI. SROI index is calculated from the expected earnings (earnings before interest and taxes, EBIT) during the period of five years after the investment:

$$SROI = number\ of\ persons\ supported\ through\ PROJECT * \frac{change\ in\ their\ income}{program\ costs} \qquad (1)$$

Economic issues and ratios could be measured by standard financial ratios covered in cost-benefit analysis. EBIT was used as standard indicator of revenue flow; costs were explained as amount of allocated money. SROI indicator was used to improve efficiency evaluation of the programme. Several modifications have to be made to be more effective with evaluation within operational

programmes. Basic SROI ratio covers EBIT and programme costs. The basic indicator had to be modified according to meet the needs of the actual challenges. The modification of the EBIT calculation is below (table 1). The data for the calculation were obtained from the HREOP projects implemented (ESF, 2014).

Table 1 Modifications SROI indicators for the challenge no. 30 "Social Economy"

SROI model	Authors	EBIT calculation
Basic type	Cooney and Lynch-Cerullo (2014)	Equation (1)
Call no. 30 „Social economy"	Šebestová and Palová (2016)	The number of newly employed persons * savings arising from unemployment compensation (5 months) per person

Based on those data, information the amount of financial support and created jobs for the target group was obtained. The unemployment benefit was calculated from the average monthly gross incomes in the Czech Republic within observed period; because 5 months are guaranteed form the Ministry of Labour and Social Affairs. Calculations were conducted for the period 2010-2015; this period was key period for the implementation of projects.

2.1 PRIMARY DATA EVALUATION

Authors send a questionnaire in period 2015-2016 to 1 051 respondents which received financial support from Human Resources and Employment Operational Programme in period 2007-2013 in observed regions. They received 165 completed questionnaires (response rate of 15.69 %). From these questionnaires only 120 respondents answered that due to the financial support societal impact of their project was completed in form of social enterprise. Economic entities were divided into five groups according the size according EU definition of small and medium sized companies (28% till 9 employees; 28% till 49 employees; 26% till 249 employees and 18% in size of 250+ employees). The result was confronted with the "Map of social businesses", where 214 entities was registered (figure1).
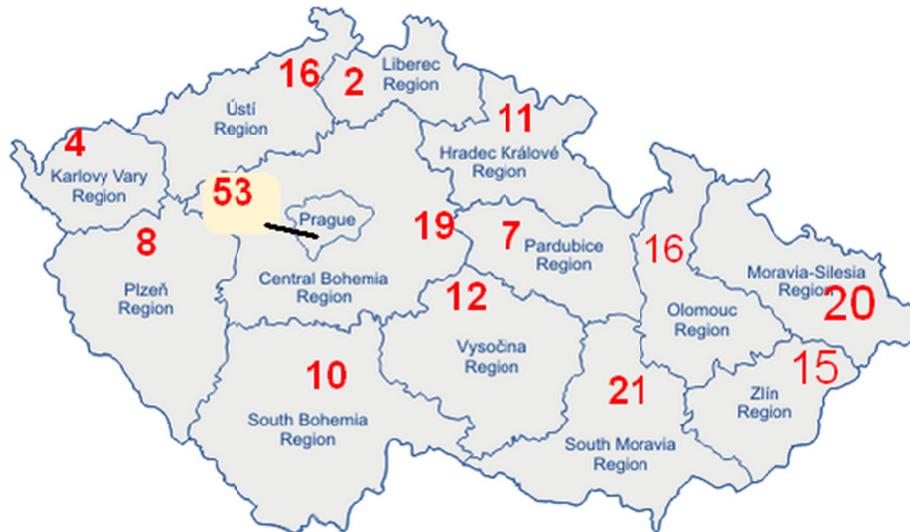
Fig. 1 Number of Social Businesses in the Czech Republic (regional numbers) source: http://www.ceske-socialni-podnikani.cz/cz/adresar-socialnich-podniku/misto-vykonu2

It means that nearly half of social businesses in the Czech Republic was supported by this operational programme (56.07%). Other data (table 2) had been collected for precise evaluation of project performance. SROI was calculated for each project separately.

Table 2 Data sources for SROI evaluation

Type of data	Data source	Indicators	
Primary	Respondents	• Number of supported persons	EBIT evaluation
Secondary	Czech statistical Office	• Wage rates in observed regions	
	Database of HREOP recipients	• Project cost	Costs

Finally, the data was adjusted (N=112) of extreme values of calculated SROI indexes to be sure that results have normal distribution (fig. 2) to be able to evaluate their statistical importance.
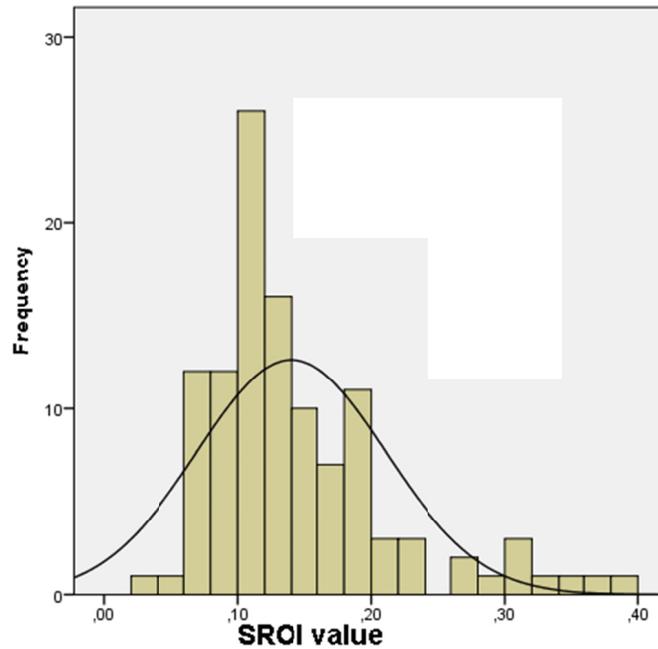
Fig. 2 Histogram of SROI values

The average value of the SROI index was 0.14 (Std.dev = 0.071). The median value of SROI index was 0.12 and the modus was 0.11 (table 3). The range of the all SROI indexes obtained 0.36. The minimum value of SROI index was 0.03 and the maximum was 0.39.

Table 3 Data description for SROI index evaluation

N	112
Mean	0.1403
Median	0.1200
Mode	0.1100
Std. Deviation	0.07079
Variance	0.005
Skewness	1.499
Std. Error of Skewness	0.228
Kurtosis	2.330
Std. Error of Kurtosis	0.453
Range	0.36

Minimum		0.03
Maximum		0.39
Percentiles	25	0.1000
	50	0.1200
	75	0.1700

The most organizations (75%) had SROI index larger than 0.10. 50% of social enterprises had SROI index larger than 0.12. Only 25% of social enterprises obtained SROI index value higher than 0.17. It means that return ratio is 0.17 CZK per 1 CZK invested into the project.

When we examine variable distribution (skewness), distributions of SROI results have slightly positive skew and extreme flatness (platykurtic distribution according kurtosis value). It means that all projects connected with that main goal are less risky than normal projects due to number of extreme values (low returns or high returns). Finally, societal impact is in average return, but with low level of risk (beneficiaries deliver their proposed project output).

2.1.1 Discussion of results

When we focused on the recommended values of SROI index we can use the study of Kadeřábková and Moghadam-Saman (2013). They perceive value for societal return index (SROI) from 2 to 3 as recommended. In presented case, there are other uncountable savings, which have indirect impacts on total index, but it is not possible to account them in financial ratios (well-being, people networking, coaching, individual development and growth). According to those values, SROI index in that area (Social enterprises) fell into range 0.12 to 0.17 (52.67 % SROI values).

Social entrepreneurship is such special kind of social projects which are almost necessary to improve socially oriented innovation. The EBIT indicator should include more than only cost savings from unemployment benefit, but also increase the income of the target group, contributions into the state budget for social insurance and other primary non-financial benefits for the target group. Also, created place for the target group should be evaluated not in the same way for everyone but for the disabilities linked with the kind of workplace as being mentioned by Ganguly (2016) as intangible value to the community. This approach means, that we need to account more value into community benefits, which are not mentioned in accounting books. SROI modification is finally like:

SROI = (Tangible + Intangible value to community) / Total resource investment (2)

It is interesting to compare the results of SROI index for social enterprises and SROI index for the whole priority axis 3 Social integration and equal opportunities where the call for social entrepreneurship was included in HREOP programme. Šebestová and Palová (2016) in their research rated the whole priority axis through this method for the four regions in the Czech Republic. The individual SROI indexes were calculated as follows: in the Moravian-Silesian Region - 1.74, in the Usti Region - 1.41 in the Plzen Region - 1.53 and in the Hradec Kralove Region - 2.54. The calculated values were higher than values for evaluation of call no. 30 Social entrepreneurship.

These problems with SROI evaluation and wide range of SROI indexes were observed by Banke-Thomas et al. (2015), when SROI index was in 1.1 till 65 in area of social and health care services. In cases of long term projects, where the cost or benefits span multiple years, the concept of time value of money maybe used and Net Present value (NPV) of the social impact will increase visibility of project performance (Watson et al., 2016).

3. CONCLUSION

This paper has been focused on the creation of social enterprises within the financial support from European Social Fund, the Human Resources and Employment Operational Programme in the operating period 2007-2013. In this period 120 organizations were supported by call no. 30 Social economy for the creation or development of social enterprises. The largest representation of beneficiaries had a legal form as limited liability companies (59 %). Many of these commercial companies were established as subsidiaries of NGOs (especially by charities and civic associations) to eliminate the potential risk for the whole organization. If the social company got into financial problems, they closed down only the subsidiary of the NGO.

For the evaluation of effectiveness of financial support, there was used method of social return on investment. Kadeřábková and Moghadam-Saman (2013) perceive value of SROI index between 2 and 3 as the recommended. But their research has not only focused on the social businesses but on the social sector as a whole. The evaluation of social return of supported social enterprises SROI index came out only 0.14. Supporting of social entrepreneurship is a very specific form of investment, and it is necessary to create further modification for evaluating the effectiveness of social enterprises through SROI method. Not only the costs saving from unemployment benefit should be considered, but also there should be involved the income of the target group, contributions to the state budget for social insurance and other primarily non-financial benefits for the target group. The workplaces for target group have to be evaluated according demand on employees, not same for everybody in the target group. It is often easier to create a work place for "only" long-term unemployed than for somebody who is blind or with mental disability.

Acknowledgement

REFERENCES

[1] Watson, K. J., Evans, J., Karvonen, A., Whitley, T. (2016). Capturing the social value of buildings: The promise of Social Return on Investment (SROI). *Building and Environment*, vol. 103, p. 289-301.

[2] Ganguly, A. (2016) SROI – The best way to know your impact, from https://www.linkedin.com/pulse/sroi-best-way-know-your-impact-arijit-ganguly, accessed on 2017-07-07.

[3] Banke-Thomas, A. , Madaj, B., & Ameh, Ch., Broek, N. (2015). Social Return on Investment (SROI) methodology to account for value for money of public health interventions: A systematic review. *BMC Public Health,* vol. 15, no. 1, p. 582.

[4] Richmond, B. J., Mook, L. and Quarter, J.(2003) Social accounting for nonprofits: Two models. Nonprofit Management and Leadership, vol. 13, no.4, p. 308-324

[5] Viturka, M. (2007). Konkurenceschopnost regionů a možnosti jejího hodnocení. *Politická ekonomie*, vol.55, no.5, p.637-658.

[6] Bačuvčík, R. (2005). K terminologii neziskového sektoru. In: *Definice neziskového sektoru*. Brno: Centrum pro výzkum neziskového sektoru, 2005. pp. 39- 44.

[7] Clifford, A., List, M., Theobald C. (2010). *Evaluating Economic*. London: Alliance of Sector Skills Councils.

[8] Cooney, K., Lynch-Cerullo K. (2014). Measuring the Social Returns of Nonprofits and Social Enterprises: The Promise and Perils of the SROI. *Nonprofit Policy Forum*, vol. 5, no.2, p. 367–393.

[9] Dohnalová, M. et al. (2009). *Sociální ekonomika – vybrané otázky*. Praha: Výzkumný ústav práce a sociálních věcí.

[10] ESF , (2014) *Evropský Sociální Fond. Realizované projekty*, from http://www.esfcr.cz/modules/projects/index.php?lang=1, accessed on 2016-09-03.

[11] Kadeřábková, M., Moghadam Saman, S. (2013). *Evaluation of social innovations – their characteristics and impacts, cross-country comparison and implications for policy support. Social Frontiers: The next edge of social innovation research Evaluation*. Prague: Centre for Innovation Studies.

[12] Haken R, 2005. Třetí sektor. In: *Sborník příspěvků z internetové diskuze CVNS: Definice neziskového sektoru*.CVNS: Brno, p. 10-12.

[13] Monzon, J. L., Chaves R. (2008). The European social economy: Concept and dimensions of the third sector. *Annals of Public and Cooperative Economics*, vol. 79, no. 3-4, p. 549-579.

[14] Moody, M., Littlepage, L., Paydar, N. (2015). Measuring Social Return on Investment. *Nonprofit Management and Leadership*, vol. 26, no. 1, p.19-37.

[15] Muhammad, Y. (2010) *Building Social Business: The New Kind of Capitalism that Serves Humanity's Most Pressing Needs*. PublicAffairs.

[16] Ministry of Labour and Social Affairs (MoLSA) (2016)*Vyhodnocení šetření sociálních podniků podpořených v OP LZZ po ukončení podpory.* from

https://www.esfcr.cz/documents/21802/4448778/Vyhodnocen%C3%AD+%C5%A1et%C5%99en%C3%AD+soci%C3%A1ln%C3%ADch+podnik%C5%AF+podpo%C5%99en%C3%BDch+v+OP+LZZ+po+ukon%C4%8Den%C3%AD+podpory/f34beb4a-7fe1-45cd-9d7f-7a89133eb5e7, accessed on 2017-06-14.

[17] Šebestová, J., Palová, Z. (2016) *Sociální inovace: Vliv podpory fondů EU na jejich tvorbu*. Bratislava: KARTPRINT.

[18] TESSEA (2011). *Studie infrastruktury sociální ekonomiky v ČR – plná verze*. Praha: Nová ekonomika.

TEMEL-ij

Technology | Engineering | Management | Entrepreneurship | Learning | International Journal

THEORETICAL ISSUES OF ETHICS IN THE CONTEXT OF CHANGING PUBLIC ADMINISTRATION PARADIGM

Vita Juknevičienė[1], Rita Toleikienė[2]

Abstract: *Evolution of public administration was based on the development of principles and (non-) successful adaptation of them in the practice. But issues of ethics always played the particular role in all main three concepts of public administration: Traditional Public Administration, New Public Management and New Public Governance. The aim of this paper is to reveal the role of ethics in the changing paradigm of public administration. Results of the research help to formulate the deeper understanding of ethics in the discipline of public administration, to connect particular features of conceptions to ethics management (management of ethical conduct and ethical values for the personnel of public institutions).*

Key words: *Ethics, public administration, Traditional Public Administration, New Public Management, New Public Governance.*

1. INTRODUCTION

Success of the system of state governance and management depends on the competence and behaviour standards of the personnel, responsible for those functions. Personnel working in public institutions must meet high qualification requirements, besides their actions and decisions must rely on norms and values of society's morality. Moreover such personnel is acting in a particular unit (public administration organization), which is characterized by its formal purpose, structure, activities and objectives, but also by its own culture, rules and values. The integrity of such personnel is a crucial factor for ensuring the public trust in public administration organizations and in successful state governance. Therefore some countries seeking to promote the integrity of public institutions personnel, create systems of integral (principled) behaviour or integral behaviour structures, including control measures such as conduct codes, anti-corruption organizations or risk assessment strategies (OECD, 2009; Six & Lawton, 2013). However, examples from the practice show that public administration organizations are still not ready to deal with all challenges caused by permanent changes (Demmke & Moilanen, 2011). The process of governance and its final results do not satisfy the society: the trust in public administration organizations (state governance and management institutions), public services or even public sector is reducing constantly. In accordance with the society view, achievement of good results in public administration must always be based on values and ethical behaviour. In this context ethics become very important. It enables a systemic institutionalized process - ethics management, which includes the coordination of various interest groups needs, measures and tools, needed for formulation, introduction, auditing and correction of values and conduct standards in public administration organizations.

The evolution of public administration as an academic discipline that studies the implementation of government policy and prepares personnel for working in the public services sector usually is analysed by three main conceptions: Traditional Public Administration, New Public Administration or New Public Management, New Public Governance (Domarkas, 2011). Evolution of public administration has affected not only specifics of public administration organizations' management, but issues of the concept of ethics and its role as well. The aim of this paper is to reveal the role of ethics in the changing paradigm of public administration, by identifying its features and the connection to specifics of named conceptions. Results of this research contribute to the deeper understanding of ethics concept in the discipline of public administration. Scientific methods such as analysis of scientific literature, systematization, comparison and interpretation were used to achieve the aim of this research.

Corresponding author: [1] Vita Juknevičienė, PhD., lecturer, research fellow, Šiauliai University, Research Institute, e-mail: v.jukneviciene@gmail.com
[2] Rita Toleikienė, PhD student, lecturer, Šiauliai University, Department of Public Administration.

2. ROLE OF ETHICS IN PUBLIC ADMINISTRATION CONCEPTIONS

Before analysing ethics in public administration, two important levels must be emphasized: political level (public policy makers) and administrative level (civil servants as implementers of public policy). Even the question of politics - administration dichotomy is raised continually; researchers agree that both elements are highly interlinked and necessary for the concept of public administration, so both of them are important in the formulation and implementation of ethics and its management (Campbell & Peters, 1988; Cohen & Eimicke, 2000; Yang & Holzer, 2005; Georgiou, 2014). According to this issue, public policy makers and administrators - both are involved to the formulation of values and ethical conduct, ethical decision making process. Many scientific researches analyse issues of ethics based on modern paradigm of public administration, but seeking for the deeper understanding of its role it is needed to start from the analysis of ethics in the conception of traditional public administration.

2.1 ETHICS IN TRADITIONAL PUBLIC ADMINISTRATION

The first stage of public administration as a scientific conception is Traditional Public Administration (hereinafter – TPA). It is based on the model of ideal bureaucracy created by Max Weber (Roth, Weber, 1976). According to this model the administrative apparatus must have certain characteristics: hierarchy, impartiality, standardization, legality, rationality and professionalism (Dunleavy & Hood, 1994; Smalskys, 2002; Domarkas, 2005; Domarkas, 2011; Yuan, Xi & Xiaoyi, 2012). According to the ideology only the administrative apparatus is capable to meet all challenges of changing political situation. So, all legal power is given to the bureaucratic apparatus, which was formulated and is rationally and effectively operating according to principles defined by the legal system. From the point of ethics, this theory is important because the bureaucratic organization is considered as an attractive form of management offering various opportunities to control a big number of people to achieve certain goals.

The role of ethics in the conception of TPA can be revealed through few aspects. Firstly, the special attention is paid on the isolation from possible problems. It is important to know rules of acceptable/unacceptable conduct and to stay away from problems, connected to violation of ethical rules, because it is one of factors increasing costs of activities in public administration (Menzel, 2012). This factor should be minimized or eliminated; therefore, it is needed to follow recognized conduct standards. In this case the ethical/unethical conduct, the establishment of rules (the selection of initial ethical management measures) and the compliance control (the initial ethical management process) become important. The emphasis is on the dependency and hierarchical subordination. Strict subordination limits the right of individuals to act. Conduct rules more are ordering than playing the function of choice. They limit the freedom of voluntary compliance with ethical rules. Thus, basic ethics (management) structures are determined.

Secondly, it is argued that in the democratic environment the personnel (civil servants), which belong to the bureaucratic hierarchy, are more ethical than those who are motivated by their interests or working in companies in a competitive market:

- Many cases of government corruption, conflicts of interest, abuse of power are detected when civil servants, representing official government, communicate with individuals or organizations seeking money, services or influence;
- When there is no democratic government, laws, rules, social norms and / or social interactions, rational individuals and companies act according to their own interests (the idea of the public choice is the basis for the state policy and the administrative economic prospect);
- Public institutions are far more public than non-governmental institutions or state-owned enterprises (ideas of justice, equity and impartiality are more respected in public institutions than in non-governmental institutions or private companies);
- Efficiency is more valuable in private companies (with increasing market imperfections, efficiency is decreasing) (Frederickson, 1999).

Thirdly, theory of bureaucracy emphasizes the ethos of following rules. Internal rules, codes determine personnel conduct in an organization, determine the conformity of their decisions to the justice, promote their ethical reflection, responsible actions (even when no one sees). The ability of the bureaucratic apparatus (as an organization) to follow formal rules (codes of ethics) depends not only on the qualification and orientation of the personnel, but also on the ability of the leader to indicate the direction and the continuing supply of resources (Jos & Thompkins, 2004; Olsen, 2006). Thus, it is revealed that the traditional conception of public administration has formed prerequisites for the emergence of ethics and its manifestations in public administration organizations.

However, the model of Ideal bureaucracy (the conception of TPA) was criticized: too much focus on

processes and procedures, rather than on results, resulting increased costs, and this model-driven government was unable to react to changes on time, to solve problems due to the complexity of its hierarchy (Domarkas, 2005; Domarkas, 2011; Smalskys, 2002; Papšienė, 2010). Besides, the creator of the model of Ideal bureaucracy – Max Weber identified few negative aspects of the model, important for the ethics: leadership could be focused into hands of a small and unwanted group; formal rationalism could limit the individual's freedom and autonomy; once the bureaucratic control was created, it could not be destroyed; the tendency of politicians to become bureaucrats (administrators) (Guščinskienė, 2000; Juknevičienė, 2007). Those conflicts and dilemmas rising in the context of TPA have encouraged scientific and practical discussions about the future of public administration. It was started to search for other – more rational forms of management. Public administration as a paradigm was changing; new conception of New Public Management has been formulated.

2.2 ETHICS IN NEW PUBLIC MANAGEMENT

During all stages of the development of public administration paradigm (including TPA), it was possible to recognize essential ethical dilemmas of public administration: democratic accountability of the administration, legal system and principles of justice, professional integrity and accountability to civil society (Radhika, 2012). Researchers and practitioners were looking for the new conception which could deal with new needs: to develop state management, to strengthen the accountability and responsibility of various governmental institutions and levels, to reduce costs of institutions' management, to strengthen the trust in administrative apparatus. Deep managerial traditions, existing in USA, have helped to formulate such conception. Researchers (Peters, 2003; Pfiffner, 2004; Bryson, Crosby & Bloomberg, 2014) emphasized that the second stage of the development of public administration - New Public Management (hereinafter - NPM) can be characterized by clearly expressed specifics, ideas and features associated with private sector practice. There are some issues, connected to ethics:

- emphasis on management rather than policy;
- decentralization of management by introducing mechanisms of monitoring, information and reporting;
- imitation of private sector management (development of joint plans, contracts of performance, payment system linked to results, creation of a common image);
- orientation to the result (output), priority to private property, concluding of contracts for the provision of public services on the basis of the competition;
- an organization is perceived as an open system, where the control is no longer its essential management function, and its goals are not stable and permanent for a long time; here the emphasis is placed on the efficiency and reduction of operating and management costs;
- the recognition of the human factor as the main resource of the organization, forming the competitive advantage, the creation of conditions encouraging the disclosure of human potential and the formation of cooperative conduct - focus is paid on organizational culture, effective communication, collective learning;
- the recognition of social responsibility towards society and the individual, but at the same time the priority is given to monetary promotion, issues of ethics and status become secondary ones (Boston, 1991; Staponkienė, 2005; Domarkas, 2007).

Although less attention was given for ethical issues in the new conception of public administration, the application of the concept in various studies and the practice of public administration revealed the importance of ethics in the new theoretical discourse and rising ethical problems which need for solutions. Later researchers (Maesschalck, 2004; Kolthoff, Huberts & Van Den Heuvel, 2006; Kolthoff, 2007) analysed the importance of ethics as moral values, standards, principles and norms formulating the model of activity, the system, its problems and ethics management opportunities. However, the conception of NPM got the critique due to too strong orientation to values which did not conform to goals of public sector: emphasis on "profit", "costs", "risk", rather than "democracy", "citizen", "public interest". Thus, due to the failure of the implementation of the NPM concept in practice (citizens have got to cover costs of failed risky public projects), there was a need to look for other ways of managing the public sector.

It should be emphasized that the development of public administration paradigm was based on the adoption of successful (properly adapted, recognized) principles and the integration of new (timely, responsive and critically accrued accesses) principles into a new concept. Consequently, some of successful accesses of the new public administration have been taken into account for the formation of New Public Governance as a new stage of public administration paradigm.

2.3 ETHICS IN NEW PUBLIC GOVERNANCE

Modern concept - New Public Governance (hereinafter – NPG) was developed in the context of the critique of NPM and ideas given by the following conception - New Public Service, which was not popular for long period due to uprising vision of NPG. NPG introduces a new approach to the civil service and its relationship with citizens – it is defined as a "system of values, programs and institutions that helps society to manage its economic, social and political affairs" (Domarkas, 2005). Besides, principles of NPG are closely connected to ethical issues:

- Serving to citizens, not customers;
- Serving rather than regulating;
- Citizenship has higher value than entrepreneurship;
- Looking for public interest;
- Citizens engagement to decision making of public affairs;
- Priorities for the fight with reasons of negative phenomenon in public sector rather than its consequences (prevention);
- Strategic thinking, democratic acting;
- Accountability is more important than effectiveness;
- Appreciation of people rather than productivity (Osborne, 2010a; Smalskys, 2010).

Contemporary issues of ethics and its management are revealed through its compatibility to public administration conceptions (TPA, NPM and NPG) (see Table 1).

Table 1 *Compatibility of ethics concept and public administration conceptions*

Conception / Feature	Traditional Public Administration	New Public Management	New Public Governance
Relations between a state and citizens	Obedience	Customer orientation / engagement	Empowering
Accountability of senior public servants	For politicians	For organization and citizens	For citizens and social partners
Guiding principles	Compliance with rules and regulations	Productivity, efficiency, effectiveness	Accountability, transparency, participation
Criteria of success	Outcome	Result	Process
Key feature of public servants	Professionalism	Competence	Responsibility
Ethics management	Based on Law	Based on managerial attitude	Based on moral integrity
Basis for conduct	Law	Model of ethics infrastructure (including various measures and tools)	Values

Source: composed by authors, on the basis of Šiugždinienė (2006), Pevkur (2007), Babravičius & Dzemyda (2012), Palidauskaitė (2010).

TPA emphasized the compliance with rules and regulations, so the main strategy for performance was the obedience. It still kept the theoretical background of public administration organizations (especially the issue of hierarchy), important even for modern institutional structure.

NPM model, integrating more business relations, reduction of public institution responsibilities and the introduction of entrepreneurial culture in them, has led to an increase of the number of ethical dilemmas and a decrease in the individual's personal responsibility in satisfaction of public interest. Administrators' autonomy has led to blurred accountability and increased risk. The application of competition principles in the public sector to public organizations has led to a conflict rather than the co-operation. The possible demoralization of public sector personnel has emerged (Babravičius & Dzemyda, 2012), and, in some cases, the application of the NPM model has caused not only positive, but also negative consequences.

NPG highlights that public administration should have the focus not only on satisfying clients' needs, but also on the cooperation of all social partners in developing important public values such as transparency and accountability, legal order, honesty and efficiency (Osborne, 2010b). This conception emphasizes greater freedom for the provision of public services, a closer relationship between the receiver and the provider of services, the preference of public interest over the private

one, and more rights are granted to civil servants. More freedom for action also increases the responsibility of the public servant; therefore, ethics as a tool for public organizations' management is enabled by stronger principal provisions. Besides, NPG focuses on the autonomy and responsibility for the implementation of the main mission of a public sector organization. Consequently, innovative activities of the organization, decentralization, and a high level of personnel freedom as values adapted from business management practice (Smalskys, 2010) are emphasized in this conception. It is necessary to regulate performance results after giving a bigger amount of freedom of action; therefore, the establishment of certain rules of conduct and standards gives guidelines for proper performance of duties, and enables for regulation and evaluation of the eligibility of the activity.

Besides, majority of researchers agree that ethics of public administration must be modern, adaptable to new forms of management and be a part (or even the basis) of effective theories. The most important issue is not the fact that classical ethical values can be taken and transferred to a new environment or context, but it is always necessary to emphasize the transformation of these values to a harmony with managerial values (Stensöta, 2010). One of the most important challenges for the modern society was the desire immediately to move to modern management systems, destroying the classical (hierarchically-formed) public administration and the corresponding systems of accountability (Vaičaitis, 2011). This happened due to decentralization processes or ethics of the civil service and the administrative culture formed under the impact of the socio-cultural environment. However, it is still unclear whether the elimination of strict regulation on the civil service, flexibility, efforts to create an effective administration and democracy (requiring formality, rules, and strong ethical standards) can be viable as a form of assessment that could enable authorities to act responsibly without existing formalized control systems (Peters, 2001).

Therefore, it should be emphasized that changing paradigm can always be followed by the complex of various dilemmas both in theoretical and practical levels, leading to new changes of the concept. But in the case of public administration development, the importance of ethics and its management is increasing constantly. It was affected by the deeper understanding of researchers and practitioners (society, politicians and administrators) about the need to decrease costs of activity and build the trust of society by ensuring, that personnel in public administration organizations are able to understand and follow the law, ethics rules, standards of conduct in daily performance.

3. CONCLUSION

During the analysis of ethics concept and public administration conceptions, close interlinks were found. Firstly, Traditional Public Administration is based on the principle of formalism, therefore, the obedience to written legislation and policy makers is very important, rules and regulations address are taken as main important operational guidelines, and ethics management in public administration organizations is also primarily based on legislation. Secondly, the increased civil servants' freedom of action and reduced hierarchical control (through business management tools) are identified in the concept of New Public Management. In this case, the ethical infrastructure model should be adapted to individual organizations by defining appropriate standards of conduct and promoting ethical behaviour. Finally, ethics in the concept of New Public Governance is focused on strengthening values and moral thinking. Ethics management enables accountable, transparent provision of public services through cooperation with civil and social partnerships, empowers all those who are willing and capable to solve their problems to be involved to decision making processes. During the research it was found out that the most important role of ethics and its management can be reached, when it is combined with the new conception of public administration (New Public Governance), adapted and implemented in a public administration organization.

REFERENCES

[1] Babravičius, J., Dzemyda, I. (2012) Naujosios viešosios vadybos elementai: teorinis požiūris. *Ekonomika ir vadyba: aktualijos ir perspektyvos*, vol. 25, no. 1, p. 52-62.

[2] Boston, J. (1991). The theoretical underpinnings of public sector restructuring in New Zealand. Boston, J., Martin, J., Pallot, J., Walsh, P. (Editors), *Reshaping the state: New Zealand's bureaucratic revolution*. Victoria University of Wellington Print, New Zealand, p. 1-26.

[3] Bryson, J. M., Crosby, B. C., Bloomberg, L. (2014). Public value governance: Moving beyond traditional public administration and the new public management. *Public Administration Review*, vol. 74, issue 4, p. 445-456.

[4] Campbell, C., Peters, B. (1988). The politics/administration dichotomy: death or merely change? *Governance*, vol. 1, no. 1, p. 79-99.

[5] Cohen, S. A., Eimicke, W. B. (2000). Trends in 20th century United States government ethics. *International Journal of Organization Theory and Behavior*, vol. 3, issue 3-4, p. 571-597.

[6] Demmke, Ch., Moilanen, T. (2011). *Effectiveness of Good Governance and ethics in central administration: evaluating reform outcomes in the context of the financial crisis*. Study for the 57th Meeting of the Directors General responsible for Public Services in EU Member States and European Commission. European Institute of Public Administration.

[7] Domarkas, V. (2005). Viešojo administravimo raidos aktualijos. *Viešoji politika ir administravimas*, no. 13, p. 7-14.

[8] Domarkas, V. (2007). Naujųjų viešojo administravimo raidos tendencijų kritinė analizė. Raipa, A. (Editor), *Naujoji viešoji vadyba.* Technologija, Kaunas, p. 6-24.

[9] Domarkas, V. (2011). Viešojo administravimo paradigmos kaitos atspindžiai dešimtmečio pabaigos publikacijose. *Viešoji politika ir administravimas*, vol. 10, no. 1, p. 9-16.

[10] Dunleavy, P., Hood, C. (1994). From old public administration to new public management. *Public money & management*, vol. 14, issue 3, p. 9-16.

[11] Frederickson, H. G. (1999). Ethics and the New Managerialism. *Administration & Management: An Interactive Journal*, vol. 4, no. 2, p. 299-324.

[12] Georgiou, I. (2014). Seeing the forest for the trees: an atlas of the politics–administration dichotomy. *Public Administration Review*, vol. 74, issue 2, p. 156-175.

[13] Guščinskienė, J. (2000). *Organizacijų sociologija.* Technologija, Kaunas.

[14] Jos, P. H., Thompkins, M. E. (2004). The accountability paradox in an age of reinvention: The perennial problem of preserving character and judgement. *Administration and Society*, vol. 36, issue 3, p. 255-281.

[15] Juknevičienė, V. (2007). M. Weberio biurokratijos teorijos reikšmė šiuolaikinių viešojo administravimo organizacijų kontekste. *Ekonomika ir vadyba: aktualijos ir perspektyvos*, vol. 8, issue 1, p. 122-127.

[16] Kolthoff, E. W. (2007). *Ethics and new public management: Empirical research into the effects of businesslike government on ethics and integrity*. Boom Legal Publishers, Hague.

[17] Kolthoff, E. W., Huberts, L., Van Den Heuvel, H. (2006). The ethics of new public management: is integrity at stake? *Public Administration Quarterly*, 399-439.

[18] Maesschalck, J. (2004). The impact of new public management reforms on public servants' ethics: towards a theory. *Public Administration*, vol. 82, issue 2, p. 465-489.

[19] Menzel, D. C. (2012). *Ethics management for public administrators. Building organizations of integrity*. 2nd edition. M. E. Sharpe, Inc., London.

[20] OECD. (2009). *Towards a sound integrity framework: instruments, processes, structures and conditions for implementation.* Organisation for Economic Co-operation and Development, Paris.

[21] Olsen, J. P. (2006). Maybe it is time to rediscover bureaucracy. *Journal of public administration research and theory*, vol. 16, issue 1, p. 1-24.

[22] Osborne, S. P. (2010a). Editorial. The New Public Governance? *Public Management Review*, vol. 8, no. 3, p. 377-387.

[23] Osborne, S. P. (2010b). *The New Public Governance: emerging perspectives on the theory and practice of public governance*. Routledge, London, New York.

[24] Palidauskaitė, J. (2010) Lietuvos viešojo sektoriaus etikos kodeksai ir jų tobulinimo galimybės. *Viešoji politika ir administravimas*, no. 31, p. 21-34.

[25] Papšienė P. (2010). Viešojo sektoriaus reformos poveikis žmogiškųjų išteklių vadybai. *Management theory and studies for rural business and infrastructure development*, vol. 20, issue 1, p. 1-9.

[26] Peters, G. B. (2001). *Biurokratijos politika.* Pradai, Vilnius.

[27] Peters, G. B. (2003). The changing nature of public administration: from easy answers to hard questions. *Viešoji politika ir administravimas*, no. 5, p. 7-20.

[28] Pevkur, A. (2007). Compatibility of public administration systems and ethics management. *Viešoji politika ir administravimas*, no.19, p. 16-24.

[29] Pfiffner, J. P. (2004). Traditional public administration versus the new public management: accountability versus efficiency. Benz, A., Siedentopf, H., Sommermann, K. P. (Editors), *Institutionenbildung in Regierung und Verwaltung: Festschrift fur Klaus Konig.* Duncker & Humbolt, Berlin, p. 443-454.

[30] Radhika, D. (2012). Ethics in public administration. *Journal of Public Administration and Policy Research,* vol. 4, issue 2, p. 23-31.

[31] Stensöta, O. H. (2010). The conditions of care: reframing the debate about public sector ethics. *Public Administration Review*, vol. 70, issue 2, p. 295-303.

[32] Šiugždinienė, J. (2006). Competency management in the context of public management reform. *Viešoji politika ir administravimas*, vol. 1, no. 18, p. 26-33.

[33] Six, F., Lawton, A. (2013). Towards a theory of integrity systems: a configurational approach. *International Review of Administrative Sciences*, vol. 79, issue 4, p. 639–658.

[34] Smalskys, V. (2002). Kontinentinės Europos viešojo administravimo genezė. *Viešoji politika ir administravimas*, no. 1, p. 55-60.

[35] Smalskys, V. (2010). Viešojo administravimo modernizavimo priežastys ir tendencijos. *Ekonomika ir vadyba: aktualijos ir perspektyvos*, vol. 1, no. 17, p. 90-100.

[36] Staponkienė, J. (2005). Naujosios viešosios vadybos elementų identifikavimas. *Viešoji politika ir administravimas,* no. 13, p. 83-91.

[37] Vaičaitis, V. A. (2011). Konstitucinė valstybės tarnybos samprata ir valstybės tarnybos tobulinimo koncepcija. *Teisė*, no. 78, p. 119-136.

[38] Yang, K., Holzer, M. (2005). Re-approaching the politics/administration dichotomy and its impact on administrative ethics. *Public Integrity*, vol. 7, issue 2, p. 110-127.

[39] Yuan, L., Xi, C., Xiaoyi, W. (2012). Evaluating the readiness of government portal websites in China to adopt contemporary public administration principles. *Government Information Quarterly*, vol. 29, issue 3, p. 403-412.

OVERVIEW OF THE INJURIES INTO BITOLA'S REGION REGARDING THE YEAR 2016

Silvana Angelevska[1], Ivo Kuzmanov[2], Zore Angelevski[3]

Abstract: *The basic aim of the paper is to present only a small part from extensive research regarding the injuries, especially into Bitola's region regarding the year 2016. From what is presented into the paper the readers could create a real picture about the implementation of the legislation (health and safety laws in Macedonia) and the efforts of the industrial entities to prevent and to minimaze the injuries into industrial entities from year to year. The presented paper, presents only an overview and only a small part from an extensive research regarding the spotted injuries in state and private industrial entities, efforts made for minimazing the injuries and also future steps with a final aim to reduce the injuries. The paper finally presents only a part from an extensive research regarding the implementation of Macedonian legislation for health and safety and injuries spotted into real entities, started in the year 2007 and still ongoing, with a strong cooperation with the local health and safety inspectors and industrial entities from Bitola.*

Key words*: injury, OSHAS, Bitola's region, health and safety*

1. INTRODUCTION

The data presented into the paper, presents only a small part from an ongoing research regarding the Macedonian health and safety legislation, work conditions and spotted injuries into industrial entities from Bitola. The basic aim of the research is to present a real picture about the work conditions in every industrial entity from Bitola (regarding the number of employees, main field of work, market share, public or private), to create a table of injuries from year to year for Bitola's region and for every industrial entity, and while evaluating the spotted injuries to create a long term strategy for reducing the injuries on local and on industrial entity level. To create such a large an ongoing project and research, the same one was and it's still doing with a help of the lolac health and safety inspectors and with a collaboration with the local industrial entities from Bitola. The presented data are only the first step from four step strategic plan made and ongoing, into the frame January – September 2017. Firstly the data were gathered and presented as a total amount of injuries for Bitola's region and secondly the same one were presented entity by entity. After the presentation an overview with the past years (regarding entity efforts for reducing the injuries, spotted injuries and future steps for each year) were made and with a cooperation with the entities and local health and safety inspectors, and the first step for a long term strategy with an aim to reduce the injuries were made. Entity approach was used and measures were discuised and targeted together with the health and safety staff from the entities. The next steps and actions made into the frame discuised previously will be presented in some other published papers. In addition of the paper several tabular views are presented regarding the injuries, from which a real picture could be created about the injuries and the implementation of the health and safety legislation into Bitola's industrial entities.

2. PRESENTING SMALL PART FROM THE GATHERED RESULTS

The following tabular views presents some of the gathered results regarding the spotted injuries in 2016 in every industrial entity in Bitola. The presented tabular views are only a small segment of a long term research, which was made with an active usage of the local inspectors and the health and safety responsible persons into the business entities. In addition two tabular views are presented regarding the spotted injuries into Bitola's region in the year 2016 and also a comparative tabular view regarding the injuries in the year 2015 and 2016. After the same ones, an overview of the lost working

---

[2] Ivo Kuzmanov, PhD., Associate Professor, Faculty of Technical Science in Bitola, University St. Kliment Ohridski – Bitola (ivo.kuzmanov@tfb.uklo.edu.mk)

days as one of the key indicatiors (regarding the productivity and the profits of the business enties) is also given. First of all a tabular view is presented with a overview regarding the spotted injuries into the year 2016 in Bitola.

Year / Injury	Light	Heavy	Deadly	TOTAL
2016	271	14	0	285

Tabular view 1. *– Overview of the spotted injuries in Bitola's region in 2016*

	Deadly	TOTAL
2015	1	310
2016	0	285

Tabular view 2. *– Comparative view regarding the injuries in Bitola's region, regarding the years 2015 and 2016*

Seeing both tabular views previously presented and knowing the facts that the Macedonian legislation regarding health and safety has been active since 2007 on one hand and on the other that this kind of a research is on a long term period, but also knowing the fact that into the year 2014 in Bitola there were spotted totaly 323 injuries from which one was deadly, the results and efforts are more than visuable. An other fact which approves previously mentioned facts is the number of employees into the industrial entities from Bitola, which is higher in 2016 than into the 2015 and 2014. This could bring us to a conclusion that the general idea of the research and the activities taken together with the local inspectors and the health and safety responsible persons from the entities brought real and visuable results. Still the numbers of spotted injuries (285) are higher and additional steps should and will be made so every worker into the working places could be safer and safer.

Also seeing the results and knowing the same ones, regarding the extensive ongoing reseach, two more additional facts are worth mentioning. The first one is the total number of lost working days into the industrial entities from Bitola as a result of a spotted injury. The same one is totally 6482 days. Seeing this number it is more than obvious that the total numer of lost working days is more than higher. This brought us to the additional research regarding the fact that there were so many lost working days, from which several steps regarding firstly onto the safety into direct working places were made. But this could and would be published in some additional published papers. The second one is the reasons for the accidents from which more than 90 percent of the spotted injuries were from a mechanical reason and the other ones were as a lack of a health and safety equipment. Seeing such a thing, firstly several steps were made to reduce the ones with a reason lack of a safety and health equipment, knowing the fact that the Macedonian legislation is decide to a usage of the same one. So, knowing that this is a long term research and also an ongoing one, there are some results but for the same ones we will see till the end of the year 2017, and could be presented and published in additional papers.

3. CONCLUSION

The presented paper represents only a segment from an extensive research regarding the injuries into Bitola's region. The same one is a long term research started years ago and still ongoing. With an aim to get a real results and to have all of the data reguired for such a research, while doing the same one an ongoing cooperation together with the local health and safety inspectors as well as the health and safety representatives from all of the business entities is active. On the other hand, so the same result could be 100% right, cooperation while doing such a thing with the health local fund as a part of the state one and the NGO for healt and safety Bitola from Bitola is also ongoing activity. Having in mind all of the previous mentioned cooperations and knowing the fact that all of the data needed for such an research are here, the results presented are more than real. But, what is worthfully mentioning is the Macedonian legislation regarding health and safety from which every injury should be spotted and should be presented to the local inspectors. So having in mind the cooperation with the local inspectors and health and safety representatives is active, the results presented are more than real. On the other hand this paper only presents a small segment from the research which has an aim firstly to detect the injuries, but also to prevent future such injuries. So having in mind all of the thigns mentioned before, the data presented into the tabular views presents only a small segment from the same ongoing research. Seeing the results and knowing what was done in the past years,

we could say that the results are more than visuable (from 323 spotted injuries in the year 2014 to a number of 285 spotted injuries in the year 2016) while the number of employees in the several years in Bitola's region is higher and higher. But the fact that although the numbers are smaller and smaller, the total amount of lost working days is still large. So several future steps (from which several are already active ones) were predicted and the same ones together with a cooperation with the health and safety resposibile persons from the entities should give results in the next period. At the end knowing that this was only a small segment from an ongoing extensive research, and knowing that there are planty of gathered data to present, several future publication of papers are expected.

REFERENCES

[1] Silvana Angelevska, Ivo Kuzmanov, *INJURIES INTO THE LARGEST INDUSTRIAL ENTITY FROM BITOLA – part from an extensive research considering the OSHAS systems into the biggest power plant in R. Macedonia*, 5th Electronic International Conference EIIC, August 2016

[2[Ivo Kuzmanov, Roberto Pasic, Svetlana Mijakovska, *Analysing the injuries in Large industrial entities from Bitola – Segments of extensive research regarding the Control of Quality Assurance and Implementation of Integrated Management Systems*, International Journal of Scientific Research , Volume 7, Issue March 1 2016, pages 271-274, ISSN 2229-5518

[3] Ivo Kuzmanov, Roberto Pasic, *Evaluating the Integrated Management Systems into Bitola's region with a special accent on injuries spotted in larger Industrial Capacities*, International Journal of Engineering Research and General Cience, November –December, 2015, Issue 6

[4] Ivo Kuzmanov, Silvana Angelevska, Zore Angelevski, Stojance Nusev, Vasko Stojanovski, *Injuries as everyday element into industrial entities from Bitola*, International Conference OSH Bon – Ton, Ohrid, Proceedings, October 2015, Ohrid

[5] Ivo Kuzmanov, Silvana Angelevska, Zore Angelevski, *Education and economic factors as elements for implementing and improving the OSH systems*, 10th International Conference – October 2013, Tara, R. Serbia

[6] Ivo Kuzmanov, Silvana Angelevska, Zore Angelevski, *Analysisng the injuries in three industrial systems from Macedonia with emphasis on future steps for continuous improvements*, 10th International Conference – October 2013, Tara, R. Serbia

[7] Ivo Kuzmanov, Silvana Angelevska, Zore Angelevski, *Analyzing the number and the nature of the injuries in a industrial system from Bitola, R. Macedonia*, International Scientific Conference on Information, Communication and Energy Systems and Technologies, June 2013, Ohrid, ISBN 978-9989-786-90-7

[8] Ivo Kuzmanov, Silvana Angelevska, Zore Angelevski, Vasko Stojanovski, *Evaluating the injuries into Bitola's region in 2012, real enterprises experience and ways for improving the safety systems into real enterprises*, 11th International Conference on accomplishment in Electrical and Mechanical Engineering and Information Technology, DEMI 2013, May – June 2013, ISBN 978-99938-39-46-0

[9] Zore Angelevski, Ivo Kuzmanov, SIlvana Angelevska, *Analyzing the number of injuries into the business entities from Bitola*, International Conference – Safety engineering in function of improvement of the working conditions, Ohrid May 2013

[10] Ivo Kuzmanov, PhD., *Case study of the number of injuries (considering several key indicators) in 2012 in real enterprises in Bitola region, Republic of Macedonia*, International Journal of Innovation and Applied Studies, Vol. 3, No. 1 May 2013, pp. 92-97, ISSN 2028-932

AUSTEMPERING OF ALLOY SPHEROIDAL GRAPHITE CAST IRONS

Julieta Kaleicheva

Abstract: *The paper presents the results of the study on some peculiarities of structure formation in the bainite range of alloy spheroidal graphite cast irons. The austempering is done at a temperature of 420 ^{o}C from 5 to 300 min. An optical metallographic analysis, an electron-microscope analysis, a X-Ray phase analysis and testing of Vickers hardness have been done. The influence of the chemical composition and the austempering regime on the phase composition, microstructure and hardness of alloy spheroidal graphite cast irons have been examined.*

Key words *Alloy spheroidal graphite cast irons, austempering, bainite transformation, upper bainie, α-phase, retained austenite, martensite, carbides.*

1. INTRODUCTION

The spheroidal graphite cast irons are an efficient material of construction, combining good technological features with high physical-and-mechanical properties. Their mechanical properties can be improved by alloying with different elements in certain concentrations and proportions and by different heat treatments. A considerable improving of the strength and plastic properties can be achieved by austempering, with which the bainitic spheroidal graphite cast irons (Austempered Ductile Iron ADI) with a tensile strength of R_m > 1000 MPa and relative extension of A > 10 % are obtained [1,2]. The spheroidal graphite cast irons with a bainitic metal basis have high wear-resistance with friction by sliding and rolling and with abrasive wear-out [3-5]. Depending on the austempering regime, cast irons with a structure of lower bainite or upper bainite are obtained. The lower bainite structure (220-280°C) is characterized with high strength and wear-resistance and the structure of upper bainite (350-450°C) increases plasticity and durability. These materials are used successfully for manufacturing of gears, cast crankshafts and other parts of transport equipment [1,5,6]. The study of austempered ductile irons with new compositions, including also with added nanosized particles to the melt before austempering, expands the possibility of a wider application of these materials [7-9].

The aim of the examination carried out is to study the structure formation in the bainite range of non-alloy and alloy with Mo and Cu spheroidal graphite cast irons.

2. METHODOLOGY OF INVESTIGATION

The paper presents the results of the study on the bainite transformation in three groups of spheroidal graphite cast irons with different chemical composition: non-alloy, alloy with 0,22 % Mo and alloy with 0,22 % Mo + 0,50 % Cu (Table 1).

All samples examined after casting have been subjected to normalizing at 900 ^{o}C, 2 h. The austempering is done after heating at 900 ^{o}C, 1h, in a salty bath at a temperature of 420°C from 5 to 300 min (Fig.1).

Corresponding author: Prof. Dr. Julieta Kaleicheva, Technical University of Sofia, e-mail: jkaleich@tu-sofia.bg

Table 1. Chemical composition

Group of irons	Chemical composition,wt. %						
	C	Si	Mn	P	Ni	Mo	Cu
1	3,43	2,60	0,30	0,05	0,01	0,01	0,02
2	3,59	2,58	0,31	0,05	0,01	0,22	0,02
3	3,53	2,69	0,30	0,05	0,01	0,22	0,50
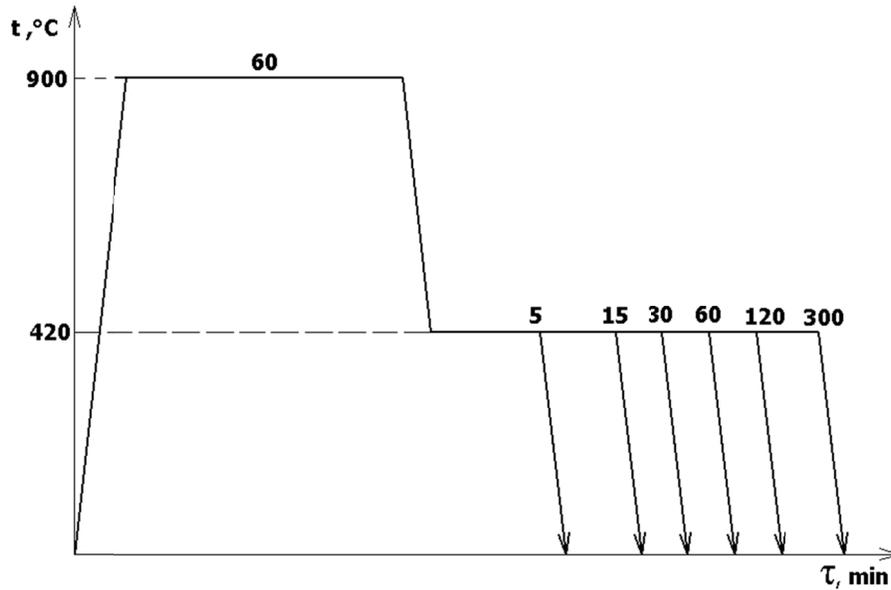
Fig. 1. Diagram of austempering regimes.

The microstructure has been examined using an optical metallographic analysis (on an optical microscope Neofot 32) and an electron-microscope analysis (on a scanning electron microscope РЭММА 101-A). The samples are treated with 2% $HNO_3 - C_2H_5OH$ solution. The quantity of the retained austenite has been determined through a X-Ray phase analysis. X-Ray analysis is made by means of a diffractometer TUR M61. The test of Vickers hardness has been done with a load of 500g.

3. EXPERIMENTAL RESULTS AND ANALYSIS

In the most common case with the bainitic transformation, the structure formed consists of a martensite α-phase supersaturated with carbon (bainitic ferrite), retained austenite with a carbon concentration different from the average one, carbides formed both directly from the austenite and with the decay of the α-phase as a result of self-tempering. Under certain conditions, some products of pearlitic and martensitic transformation can also exist together with the products of bailitic transformation [1,2].
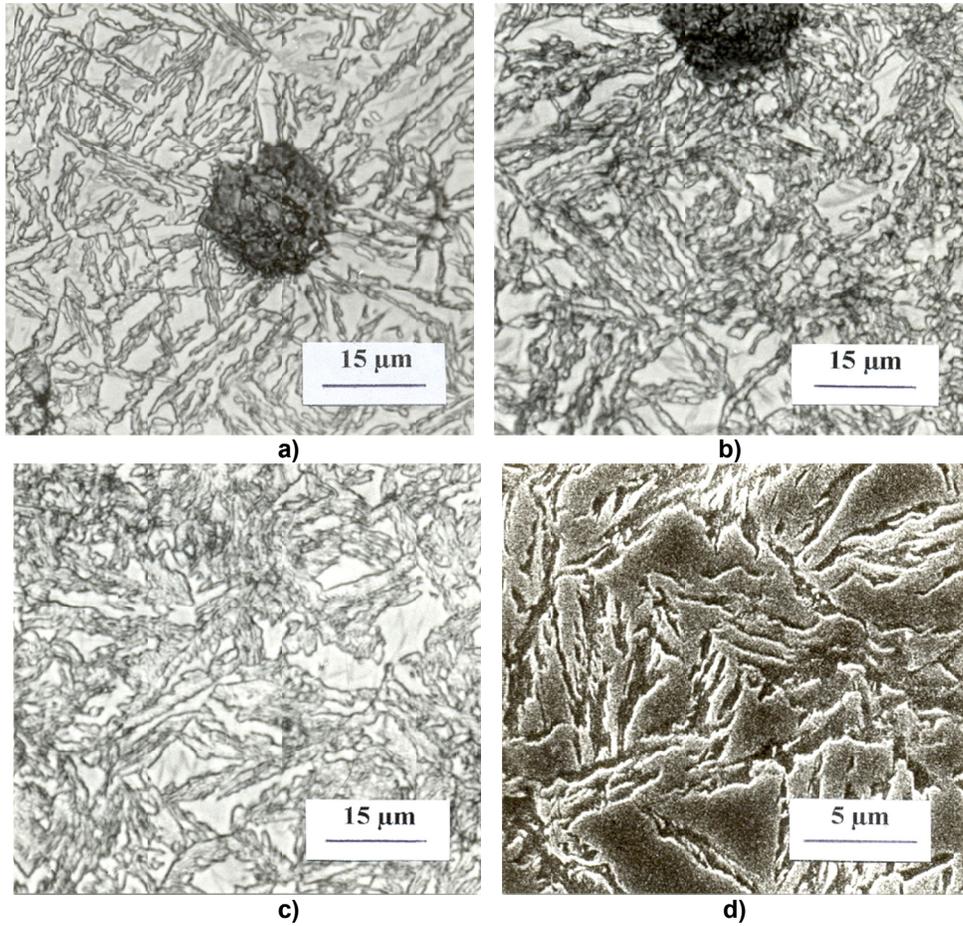
Fig. 2. Microstructure of non-alloy spheroidal graphite cast irons after austempering at 420 oC, 15 min (a), 1 h (b), 2 h (c) and 5 h (d).
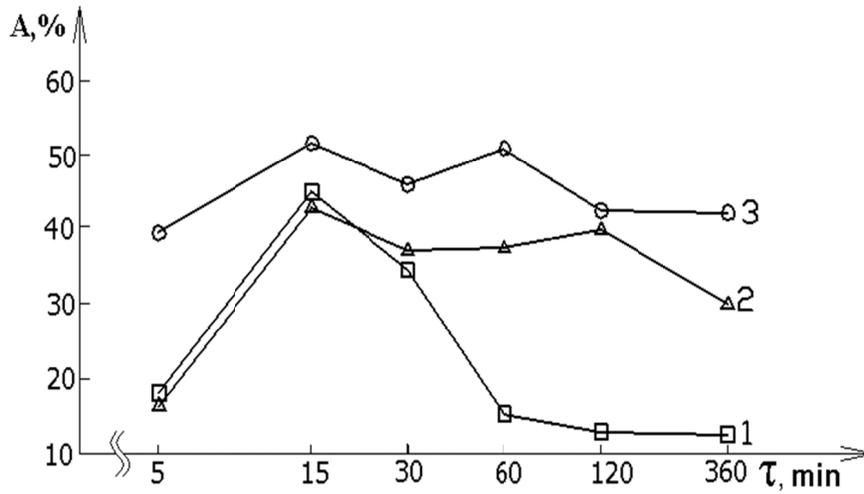
Fig. 3. Change of the quantity of retained austenite A according to the time of isothermal transformation at 420^oC in non-alloy (1), alloy with 0,22 % Mo (2) and alloy with 0,22 % Mo + 0,50 % Cu (3) spheroidal graphite cast irons.

As a result of the austenite austempering in the cast irons examined at a temperature of 420°C, an upper bainitic structure is obtained. At the beginning of transformation the upper bainitic structure in the non-alloy spheroidal graphite cast irons consists of oriented α-phase plates, retained austenite and martensite formed from the untransformed austenite with cooling to the room temperature. Packets of α-phase plates and untransformed austenite following each other are formed (Fig. 2 a, d). With the development of transformation the α-phase plates grow laterally and lose their orientation (Fig. 2 b, c). During the first 15 minutes the retained austenite A increases and reaches 45 %, then decreases sharply and after the isothermal transformation from 60 до 300 min, it changes inconsiderably, from 15 to 12,5 % (Fig. 3).

The cast irons examined contain silicon of 2,6 – 2,7 % (Table 1). It is known that the bainitic transformation in the iron-carbon alloys with silicon results in considerable enriching of the non-transformed austenite with carbon even at an initial carbon concentration of about 1 %. Silicon makes the direct emission of carbides from the austenite difficult due to the decrease of the thermodynamic activity of iron. However, on a certain stage of the bainitic transformation development at temperatures of 400-450 ^{o}C the carbide phase in the iron-and-carbon alloys containing silicon is either directly separated from the austenite enriched with carbon or this austenite decades to a ferrite-and-carbide mixture [1,2]. In the non-alloy cast iron examined, with the transformation development, after 15 min a ferrite-and-carbide mixture is probably formed (Fig. 2 b, c), which is the reason for the sharp decrease of the quantity of retained austenite A (Fig. 3). The hardness is changed from 305 to 335 HV$_{0,5}$, which is the biggest one after the isothermal transformation at 420 ^{o}C, 30 min (Fig. 4).

The alloying with 0,22 % Mo influences on the kinematics of the bailitic transformation at 420 ^{o}C. The bailitic structure is more disperse and the α-phase plates, unlike those in non-alloy cast iron, keep their orientation even after 60 min of isothermal transformation (Fig. 5a). The quantity of the retained austenite A increases to 43 % during the first 15 min, then it stabilizes and remains unchanged up to 120 min at 420°C (Fig. 3). After 300 minutes of isothermal retaining, with which the retained austenite A decreases to 30%, it is possible to form ferrite-carbide mixture of the austenite enriched with carbon. Hardness changes from 320 to 350 HV$_{0,5}$ and is higher than those in the non-alloy cast iron (Fig.4).

The influence of Mo (beginning with 0,2 %) appears in improving the cast iron strength properties. Molybdenum makes the metal basis stronger dissolving in the hard solution and forming disperse carbides stabilizing the grain boundaries [2]. The complex alloying with Mo and Cu allows obtaining of cast irons with a bainitic structure possessing high strength and plasticity at the same time. The alloying with Cu improves the strength properties, neutralizes the carbide-forming activity of Mo and increases the cast iron corrosion resistance [1].

After austempering at 420 ^{o}C the hardness of the cast irons alloyed with 0,22 % Mo + 0,50 % Cu changes from 330 to 370 HV$_{0,5}$ and is greater than that of the non-alloy or alloy cast iron with 0,22 % Mo (Fig. 4). The simultaneous alloying with 0,22 % Mo and 0,50 % Cu changes the morphology of the upper bainitic structure (Fig. 6). With the development of the transformation, the α-phase preserves the characteristic martensite orientation of the plate without expressed lateral increasing (Fig. 6 b). The quantity of the retained austenite A increases during the first 15 minutes (51,5 %), after which it remains a constant up to 60 min and then, after 300 minutes, it decreases to 42 % at 420 ^{o}C (Fig. 3). The quantity of the retained austenite A in the cast irons alloyed simultaneously with Mo and Cu is bigger in comparison with that in the non-alloy cast irons and cast irons alloyed with Mo for all times of isothermal retaining. That is explained with the fact that the additional alloying with 0,5 % Cu decreases point M$_s$ with cooling the untransformed austenite from 420 ^{o}C to the room temperature influencing the kinetics and degree of austenite transformation in the bainite range.
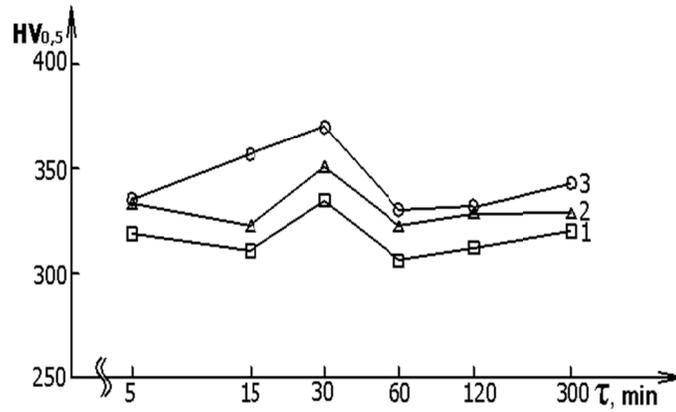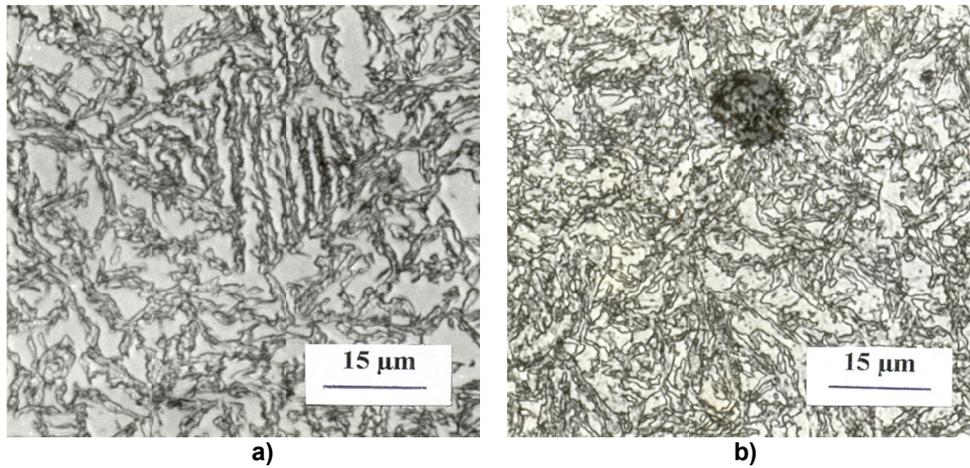
Fig. 4. Change of hardness HV$_{0,5}$ according to the time of isothermal transformation at 420 ^{o}C in non-alloy (1), alloy with 0,22 % Mo (2) and alloy with 0,22 % Mo + 0,50 % Cu (3) spheroidal graphite cast irons.

a)   b)

Fig.5. Microstructure of alloy spheroidal graphite cast irons with 0,22 % Mo after austempering at 420 ^{o}C, 1 h (a) и 5 h (b).
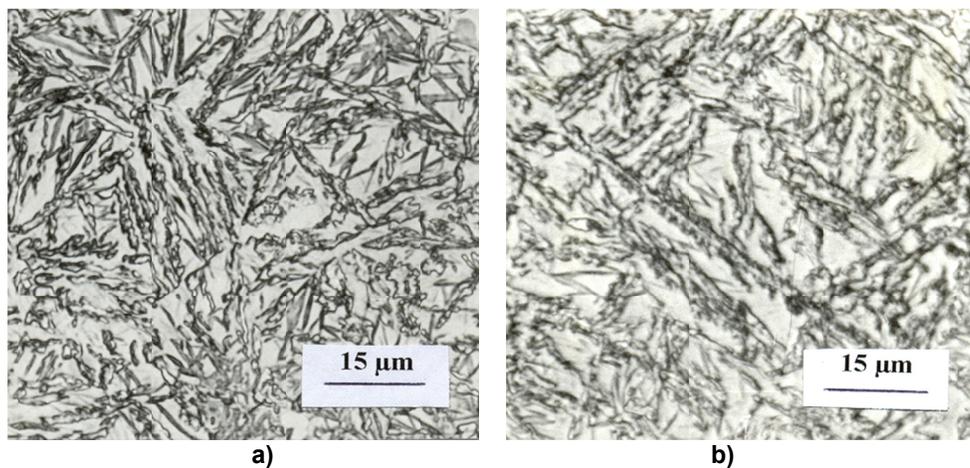

a)   b)

Fig.6. Microstructure of alloy spheroidal graphite cast irons with 0,22 % Mo + 0,50 % Cu after austempering at 420 ^{o}C, 1 h (a) и 5 h (b).

4. CONCLUSION

The microstructure of the austempering spheroidal graphite cast irons with different chemical compositions has been studied at 420 $^{\circ}$ C from 5 to 300 minutes. The alloying with 0,22 % Mo and the complex alloying with 0,22 % Mo and 0,5 % Cu influence on the kinematics of the bailitic transformation, on the disperse character of structure ingredient, on the degree of the austenite decay and on the morphology of the bainitic structure. The alloying with 0,22 % Mo and with 0,22 % Mo + 0,50 % Cu increases the hardness and the quantity of the retained austenite in the structure of the examined austempering cast irons.

REFERENCES

[1] Dorasil E. (1985). *High-strenght Bainitic Nodular Cast Iron*. Academia, Prague.

[2] Bhadeshia, H.K.D.H. (2001). *Bainite in Steels*, 2st ed., Inst. of Materials, Cambridge, London.

[3] Sahin, Y., Durak O. (2007).Abrasive Wear Behavior of Austempered Ductile Iron. *Materials & Design,* Vol. 28, No 6, p. 1844-1850.

[4] Sahin, Y., Erdogan, M., Kilicli, V. (2007). Wear Behavior of Austempered Ductile Irons with Dual Matrix Structures. *Materials Science and Engineering* A, Vol. 444, No 1-2, p.31–38.

[5] Myszka, D., Wieczorec, A. (2013). An Assessment of the Applicability of Austempered Ductile Iron Containing Mo and Ni for Mining Machines Parts. *Polish Academy of Sciences - Archives of Metallurgy and Materials*, Vol. 58, No 3, p. 953-956.

[6] Zimba, J., Simbi, D. J., Navara, E.(2003). Austempered Ductile Iron: an Alternativ material for earth moving components. *Cement and Concrete Composites,* Vol. 25.No 6, p. 643-649.

[7] Kaleicheva, J. (2014). Wear Behavior of Austempered Ductile Iron with Nanosized Additives. *Tribology in Industry*, Vol. 36, No 1, p. 74-78.

[8] Kaleicheva, J., Mishev, V., Avdeev, G., Karaguiozova, Z. and Dineva, B. (2014) Influence of Nanoadditives on the Structure and Properties of Austempered Ductile Irons. *European Conference on Heat Treatment and 21st IFHTSE Congress, Munich 2014, Conference Proceedings*, p. 537-543.

[9] Kaleicheva, J., Mishev, V., Karaguiozova, Z., Nikolcheva, G. (2017). Structure and Mechanical Propertes of Spheroidal Graphite Cast Iron with Nanosized Additives. *11thInternacional Scientific and Practical Conference : Environment, Technology, Resources, Rezekne 2017, Conference Proceedings*, Vol. III*, p. 122-128.

TEMEL-ij

AUSTEMPERED DUCTILE IRONS WITH *TiN* NANOSIZED ADDITIVES

Julieta Kaleicheva

Abstract: *The microstructure and mechanical properties of austempered ductile irons (ADI) with nanoadditives of titanium nitride TiN (50nm) are investigated within this paper. For improvement of the particles wetting and distribution into the melt volume the electorless method for plating of the additives is applied using EFTTOM-NICKEL method. The spheroidal graphite cast iron samples are undergone an austempering, including heating at 900°C for an hour, after that isothermal retention at 280°C, 0,5÷6 h and at 380°C, 0,5÷6 h. The microstructure of the austempered ductile iron samples is observed using optical metallography and X-Ray analysis. Test for hardness is carried out. The influence of the nanosized particles of titanium nitride TiN on the bainitic transformation, as well as on the morphology of the lower and upper bainitic structure and on the hardness is studied.*

Key words: *Titanium nitride, austempered ductile irons, nanoadditives, hardness, bainite, retained austenite.*

1. INTRODUCTION

Austempering of the iron-carbon alloys in the bainitic area is widely used in the treatment of structural steels and ductile cast iron [1,2]. Austempered ductile irons (ADI) are characterized with high strength, toughness and wear resistance, which is related to the features of their structure [1]. The graphite present in cast iron provides resistance to mechanical wear and improves workability. The bainitic structure of the cast iron metal base provides high strength combined with increased toughness and plasticity. In fact, the structures resulting from bainitic transformation and subsequent cooling to ambient temperature are too complex. They consist of bainitic ferrite, carbides, martensite and retained austenite. Combined in a certain way with each other, these phases can provide a complex of properties that are becoming more and more interesting.

By alloying, heat treatment, or by combining these two processes, the morphology of graphite and the structure of the metal base can be influenced to produce cast iron with optimal properties. The study of cast irons with new compositions, including also with additions of nanosized particles to the melt, after casting or after heat treatment, expands the possibility of a wider application of these materials [3-8].

Nanosized particles added to the casting of cast iron in small quantities can alter the graphite morphology from laminated to vermicular [3], also increase the amount of graphite and reduce the size of the graphite sphere [4], alter the structure of the metal matrix of cast irons and austempered ductile irons (ADI), which increases the mechanical and tribological properties of the cast irons [3-8].

The aim of this study is to investigate the peculiarities of the structure formation in the bainitic area of spheroidal graphite cast irons containing additives of nanosized particles - titanium nitride TiN.

2. MATERIALS AND INVESTIGATION METHODS

The composition of the spheroidal graphite iron samples is: Fe-3,55C-2,67Si-0,31Mn-0,009S-0,027P-0,040Cu-0,025Cr-0,08Ni-0,06Mg wt%. The samples without and with nanoadditives of *TiN* are tested (Table 1). The nanosized particles of *TiN* are coated by electroless nickel coating EFTTOM-NICKEL prior to the edition to the melt [9]. The nickel coating improves the particles wetting into the melt and their uniformity distribution into the casting volume.

Corresponding author: Prof. Dr. Julieta Kaleicheva, Technical University of Sofia, e-mail: jkaleich@tu-sofia.bg

Table 1. Retained austenite quantity A and hardness HV10 of ADI.

Number of the sample	Nanosized additives	Time of isothermal retention									
		0,5 h		1 h		2 h		4 h		6 h	
		A,%	HV10	A,%	HV10	A,%	HV10	A,%	HV10	A,%	HV10
Lower bainite											
1. 1÷ 1.5	-	17,8	410	23,1	396	30,6	405	16,7	397	16,0	391
2.1 ÷ 2.5	TiN	17,0	390	17,8	400	24,4	394	18,4	401	18,1	395
Upper bainite											
1.1 ÷ 1.5	-	25,1	297	29,3	306	40,4	320	23,1	313	20,0	321
2.1 ÷ 2.5	TiN	25,3	294	26,0	292	31,8	312	19,3	317	19,4	311

The spheroidal graphite cast iron samples are undergone to austempering, including heating at 900 ^{o}C for an hour, after that isothermal retention at 280 ^{o}C, 0,5 h, 1 h, 2 h, 4 h, 6 h and at 380°C, 0,5 h, 1 h, 2 h, 4 h, 6 h. The austempered ductile iron samples' microstructure is observed by means of an optical metallographic microscope GX41 OLIMPUS. The samples surface is treated with 2 vol. % solution of HNO$_3$ in ethanol. The hardness testing is performed by Vickers method.

The austempered ductile iron samples are tested by X-Ray diffraction analysis the retained austenite quantity in the structure to be defined. X-Ray powder diffraction patterns for phase identification are recorded in the angle interval 22÷104° (2θ), on a Philips PW 1050 diffractometer, equipped with Cu Kα tube and scintillation detector. Data for cell refinements and quantitative analysis is collected in θ-2θ, step-scan mode in the angle interval from 22 to 104° (2θ), at steps of 0.03^o (2θ) and counting time of 3 s/step. Quantitative analysis is carried out by BRASS - Bremen Rietveld Analysis and Structure Suite [10].

3. EXPERIMENTAL RESULTS AND ANALYSIS

The samples of ductile cast iron without nanoadditives and these with nanoadditives have a ferrite-pearlite structure of the metal base.

The quantitative metallographic analysis performed to assess the impact of nanosized additives on the graphite phase characteristics show that *TiN* nanoparticles do not change the shape of the graphite in ductile cast irons. They reduce the average diameter of the graphite spheres *Dmid* from 11.00 to 10.64 µm and increase the amount of the graphite phase by 36 % compared to this one in the cast irons without nanoparticles additions. Nanosized additives also change the quantity ratio between pearlite and ferrite in the cast iron structure [4].

SEM analysis in the fracture of the impact destructed ductile cast iron sample with nanoparticles additives and EDX analysis of the graphite phase are performed and the nanoparticles presence in the graphite is observed [11]. The SEM and EDX analysis together with the quantitative metallographic analysis demonstrate that nanoparticles have a "modifying" effect on the size and shape of the graphite phase. This affects the mechanical and tribological properties of the studied cast irons [4,6,7,8].
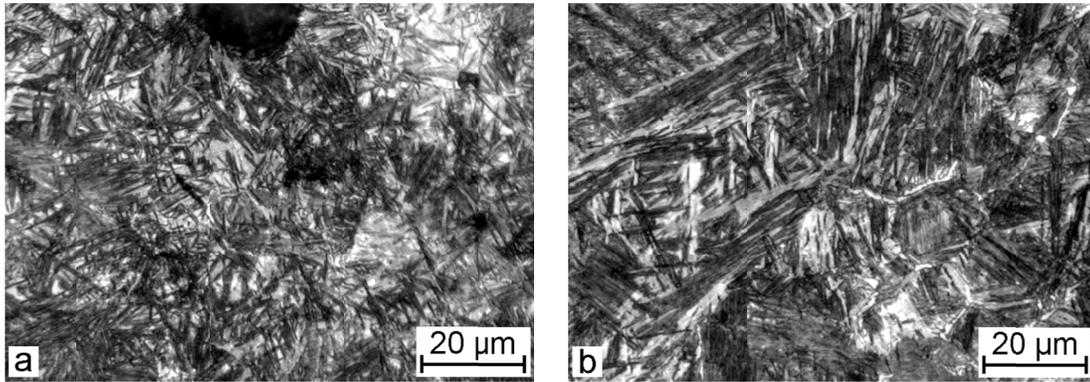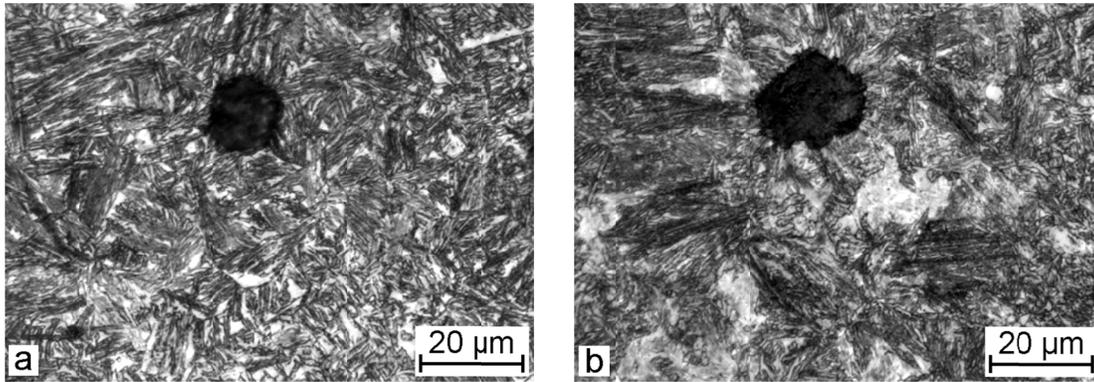
Figure 1. Lower bainite structure in ADI samples without nanoadditives after isothermal retention for 30 minutes (a) and for 4 h (b).
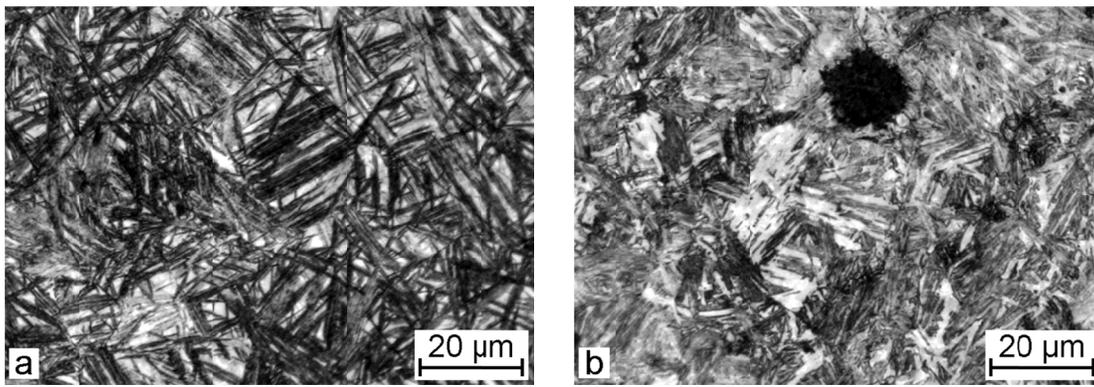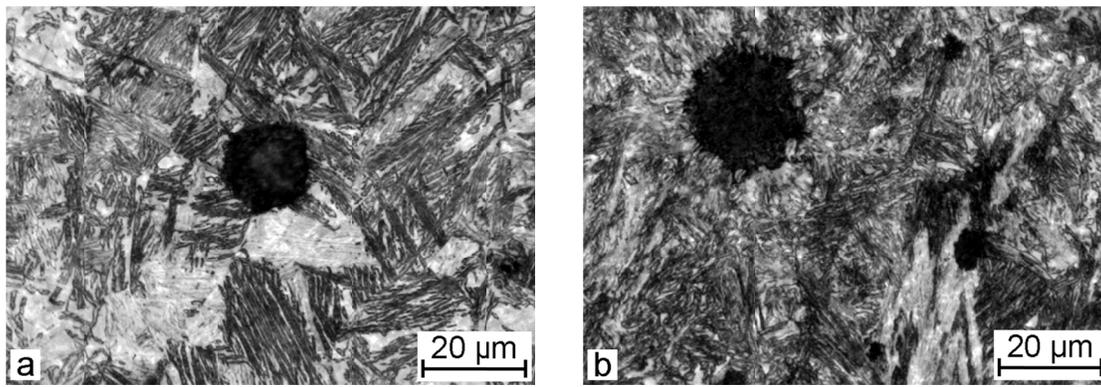

Figure 2. Lower bainite structure in ADI samples with nanoadditives of TiN after isothermal retention for 30 min (a) and for 4 h (b).

The spheroidal graphite cast irons with and without nano-sized additives are subjected to austempering in order to obtain a bainitic structure of the metal base. The austempering regimens include austenitization at 900°C, 1 h and subsequent isothermal retention at 280 ° C, 0.5 h, 1 h, 2 h, 4 h and 6 h and at 380°C, 0.5 h, 1 h, 2 h, 4 h and 6 h. As a result of this heat treatment, the cast iron is given a lower bainitic structure (Figures 1 and 2) or an upper bainitic structure (Figures 3 and 4).

The bainite is an oriented structure consisting of α-phase needles (bainitic ferrite), carbides and non-converted austenite. The α-phase is formed by a martensitic mechanism from the austenitic regions of low carbon content [1,2]. During cooling from the temperature of the isotherm to room temperature, part of the non-converted austenite undergoes martensitic transformation, and another part remains in the structure as retained austenite A. The bainitic transformation of the austenite begins with the formation of separate α-phase needles (bainitic ferrite) and develops with the formation of new oriented needles placed close to each other and forming a package of alternating α-phase plates and non-converted austenite enriched with carbon A (c) [1,2,7,8].

Figure 3. Upper bainitic structure in ADI samples without nanoadditives after isothermal retention for 30 min (a) and for 4 h (b).

Figure 4. Upper bainitic structure in ADI samples with nanoadditives of TiN after isothermal retention for 30 min (a) and for 4 h (b).

In an optical metallographic analysis, this package appears as a separate needle in the lower bainitic structure. In the upper bainitic structure α-phase and A (c) in the package are perceived as separate phases. The carbide phase is formed as a result of self-tempering of the α-phase or directly from A (c). Silicon in ductile cast iron (2 ÷ 3%) hinders the process of a carbide formation. Isothermal retention up to 2÷4 hours produces a formation of a bainitic ferrite structure and carbon-enriched non-converted austenite $A_{(c)}$ which is characterized by high mechanical properties. At austempering modes over 4÷6 hours, it is possible to observe carbides separation directly from A (c) or decomposition of the carbon-enriched austenite A (c) to the ferrite-carbide mixture (α+carbide), which reduces the mechanical properties of the cast iron and it is not actually carried out in practice.

The amount of the retained austenite in the samples with the upper bainitic structure is greater than in the samples with a lower bainitic structure, which is related to the peculiarities of the bainitic transformation mechanism in the upper and lower part of the bainitic area (Figures 5 and 6). With the increasing of the bainitic transformation to 2 hours, the amount of retained austenite rises to 24.4 ÷ 30.6% for the samples with a lower bainitic structure and up to 31.8 ÷ 40.4% for the samples with upper bainitic structure (Table 1). After 4 hours of isothermal retention at 280 ° C and 380 ° C, the amount of retained austenite in all of the tested samples decreases, which is due to the removal of the carbide phase from the carbon-enriched non-converted austenite $A_{(c)}$.

Nano-sized particles of *TiN* accelerate the transformation of the austenite to bainite. The amount of the retained austenite in the samples without nanoparticles additives for 2 hours isothermal retention at 280 °C is 30.6% and at 380 °C - 40.4%. In the samples with nanoadditives of *TiN*, the amount of the retained austenite decreases to 24.4% for 2 hours of isothermal retention at 280 ° C and up to 31.8% for 2 hours of isothermal retention at 380 °C (Table 1).
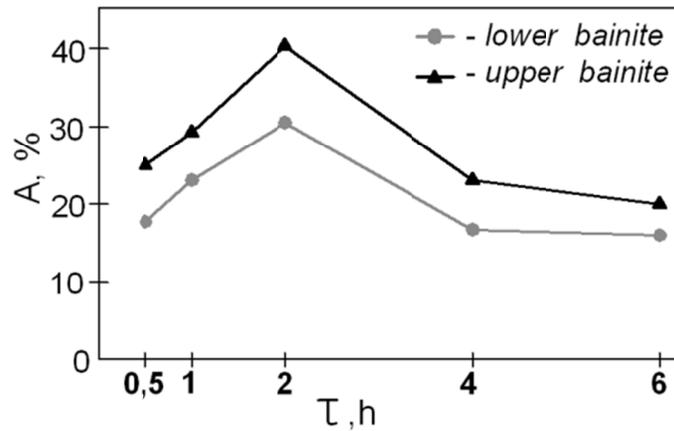
Figure 5. Dependance of the retained austenite quantity A on the izothermal retention time τ at 280°C (lower bainite) and at 380°C (upper bainite) for ADI without nanoadditives.
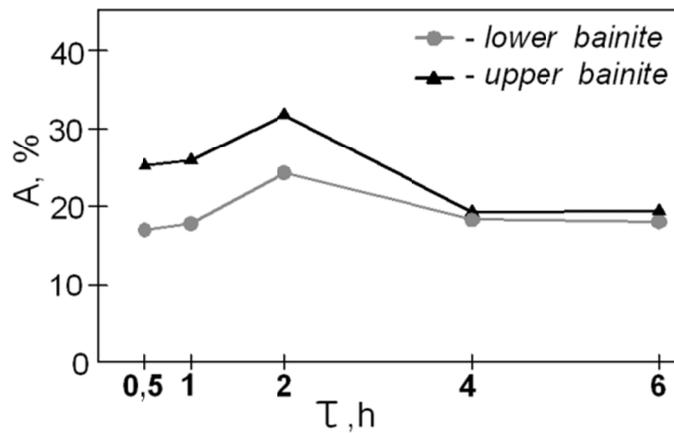
Figure 6. Dependance of the retained austenite quantity A on the izothermal retention time τ at 280°C (lower bainite) and at 380°C (upper bainite) for ADI with nanoadditives of TiN.
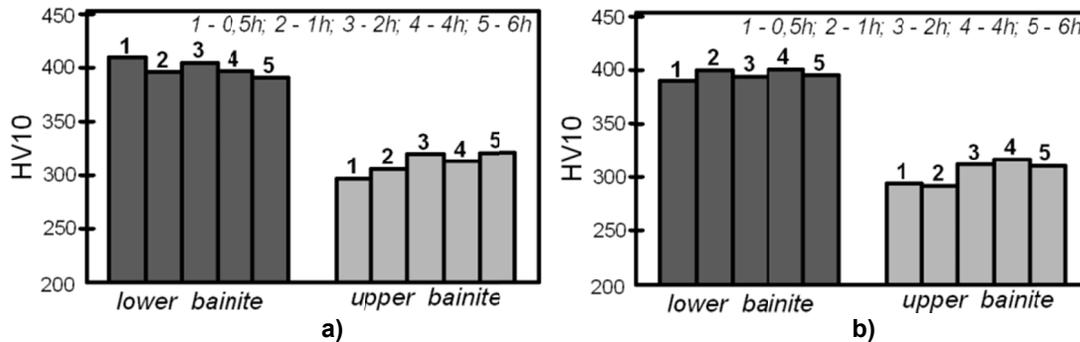
Figure 7. Hardness HV10 for ADI samples without nanoadditives (a) and with nanoadditives of TiN. (b), with lower and upper bainitic structure, obtained after izothermal retention for 0,5 to 6 hours.

The hardness HV10 of the lower bainitic structure is in the range 390÷410 HV10, and the upper bainite have 292÷321 HV10 (Table 1, Figures 7). The higher hardness of the lower bainite compared to this one of the upper bainite is associated with the higher carbon saturation of the α-phase and with the greater degree of transformation of the undercooled austenite to the bainite in the lower temperature range of the bainitic area.

4. CONCLUSION

- Nanosized particles in the ductile cast irons have a modifying effect on the graphite phase. Nanosized additives do not alter the graphite shape. They decrease the average diameter of the graphite spheres and increase the quantity of the graphite phase in structure of ductile cast irons. This changes the austenite composition that is formed during heating before austempering. This affects the characteristics of the bainitic transformation during austempering;
- In the case of austempering of ductile cast iron, nanosized additives of *TiN* influence on the structure formation in the temperature range of the bainitic area. They alter the kinetics of the bainitic transformation and accelerate the transformation of the undercooled austenite into bainite.

REFERENCES

[1] Dorasil E. (1985). High-strenght Bainitic Nodular Cast Iron. Academia, Prague.

[2] Bhadeshia, H.K.D.H. (2001). Bainite in Steels, 2st ed., Inst. of Materials, Cambridge, London.

[3] Wang, Y., Pan, Z., Wang, Z., Sun, X., Wang, L. (2011). Sliding wear behavior of Cr–Mo–Cu alloy cast irons with and without nanoadditives, Wear 271, p. 2953–2962.

[4] Kaleicheva, J., Mishev, V., Lasarova, R., Karaguiozova, Z. (2015). Study of Spheroidal Graphite Cast Irons with Nanosized Additives. Nanoscience & Nanotechnology'15, eds. E. Balabanova, E. Mileva, BAS, Sofia, Vol. 15, No 1, p. 40-43.

[5] Li, J., Chen, M., Gao, H., Zhao, Y. (2007). Structures and Properties of Cast Irons Reinforced by Trace Addition of Modified SiC Nanopowders. Chinese Journal of Chemical Physics, Vol.20, No 6, p. 625- 631.

[6] Kaleicheva J., Kandeva, M., Mishev, V., Karaguiozova, Z. (2013). Wear Behavior of Ductile Cast Irons with Nanoparticle Additives. J. Chem. Chem. Eng.,Vol. 7, No 11, p. 1044–1049.

[7] Kaleicheva, J., Mishev, V., Avdeev, G., Karaguiozova, Z., Dineva, B. (2014). Influence of Nanoadditives on the Structure and Properties of Austempered Ductile Irons. European Conference on Heat Treatment and 21st IFHTSE Congress, Munich 2014, Conference Proceedings, p. 537-543.

[8] Kaleicheva, J. (2014). Wear Behavior of Austempered Ductile Iron with Nanosized Additives. Tribology in Industry, Vol. 36, No 1, p. 74-78.

[9] G. Gavrilov, Nicolov, C. (1985). Electroless Nickel and Composite Coatings. Tehnika, Sofia.

[10] Birkenstock, J., Fischer, R. X., T. Messner, T. (2003). BRASS 2003: The Bremen Rietveld Analysis and Structure Suite. Ber. DMG, Beih. z. Eur. J. Mineral. 15(1), 21.

[11] Kaleicheva, J., Mishev, V., Karaguiozova, Z., Nikolcheva, G. (2017). Structure and Mechanical Propertes of Spheroidal Graphite Cast Iron with Nanosized Additives. 11[th]Internacional Scientific and Practical Conference : Environment, Technology, Resources, Rezekne 2017, Conference Proceedings, Vol. III, p. 122-128.

STUDY OF PHYSICAL PROCESSES IN OPTICAL SYSTEM FOR ELECTRON BEAM WELDING

Assoc. Prof. PhD M. Tongov[1], Prof. Dr.Sc PhD Peter Petrov[2]

Abstract: *This study represents results from mathematical modelling of the electron beam formation into electrostatic field, created by electron optic system (EOS) of the electron beam welding (EBW) gun. Using Finite Element Method (FEM), electrical, thermal and electrostatic tasks are solved. Because of the numerical simulation, the dependences between input (cathode heating current, anode and wehnelt voltage) and beam parameters (current magnitude, spatial arrangement of the crossover and the area of the electron beam) are calculated.*
The structure of the electrostatic field is presented according to the voltage of the anode and wehnelt. The shape and dimensions of the electron beam are determined in the various sections of the electrostatic optic system.

Key words: *EBW, Electron Beam Welding, Electron Optic System, modelling, numerical simulation*

1. INTRODUCTION

Welding of metals and their alloys takes place because of the introduction and thermodynamic irreversible transformation of one kind of energy into another [1, 2]. In the case of electron beam welding (EBW), the kinetic energy of accelerated electrons into beam is transformed to thermal.

The main advantage of EBW over conventional methods (MMA, MIG/MAG, TIG and plasma welding) is that the thermal source is a highly concentrated energy stream (CES) with high density of power flux into interaction zone between the focused electron beam and the welding sample. This causes a few times the smaller energy, which is introduced into the welding zone, and, consequently, significantly lower influence into heat affected zone (HAZ) and the weld. In welds with large thickness a "dagger" shape is obtained. The processes of EBW and laser welding are highly automated and typically with high welding speed. The ratio between the width **b** and the weld penetration (**h**) reaches 1:30 and above (Fig.1). The power density **q** [W/cm^2] and the welding speed **v** [cm/s] determine the shape and dimensions of the welds.

Power density is a basic parameter defined as the maximum value of the beam power in a XY plane perpendicular to its axis. The process of electron beam welding with the key-hole formation into the liquid weld pool is possible when power density is greater than it's critical power value P_{cr}, [3,4]. The electron beam area with the power density greater than P_{cr} is defined in [4] as the active zone. For an axisymmetric electron beam, the active zone dimensions (electron beam diameter d_1 and length L_a) are determined by the conditions:

---

[1] Assoc. Prof. M. Tongov, PhD, Deputy Dean of Faculty of Industrial Technology – TU-Sofia, email: tongov@tu-sofia.bg
[2] Prof. Peter Petrov, Dr.Sc, PhD, Deputy Director Head Laboratory "Physical Technologies, Sliven" Institute of Electronics, BAS, email: peterpitiv@gmail.com
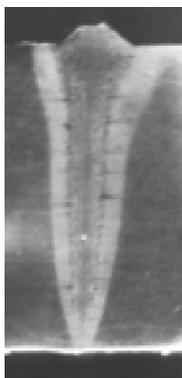
$$P(r,0,z) \geq P_{cr} \tag{1}$$

$$P(0,0,z) = P_{cr} \tag{2}$$

In [5] has been shown that the quality of the weld is determined by the shape and position of the active zone relative to the welded sample. The parameters of the electron beam active zone are dependent on the design of the electron beam gun (EBG) electrostatic part and characteristics (current density, electron flow density and electron velocity field) formed into it.

In this study, using the numerical modelling methods, the processes in the electrostatic part of the EBG and the formation of the electron beam are described.

Fig.1. Cross section of the weld (U_a=60[kV]; q=3[kW] and v=1[cm/s]

2. ELECTRON BEAM GUN

For the numerical experiments an EBG with electrostatic part shown in Fig.2 (cathode node, control electrode (wehnelt) and anode) is considered [6,7]. In ours study, geometry of a real-life EBG is used which has a different configuration and dimensions of the wehnelt and anode (Fig. 3)[8]. The cathode is a band with thickness of 0.1 [mm] and active surface size of 2x2 [mm].

a)   **b)**   **c)**
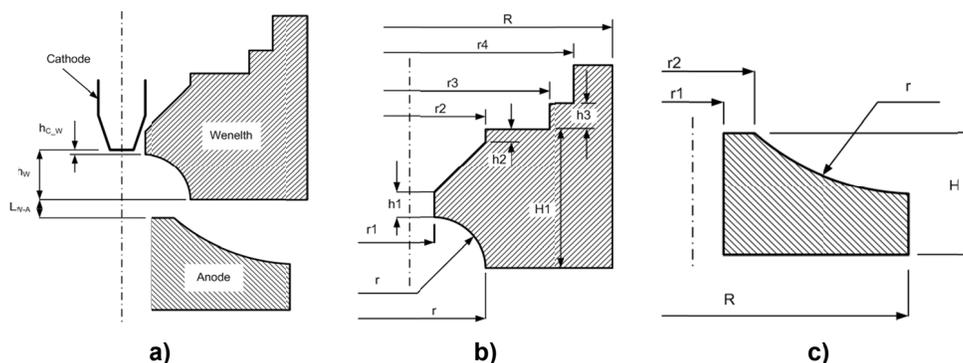
Fig.2. Common schematic (a), wehnelt (b) and anode (c) parameterized dimensions.

3. SIMULATION MODELLING

Electrons are emitted from the cathode surface. The Richardson law describes the thermionic emission process. According to this equation, the current density of the emission is defined as:
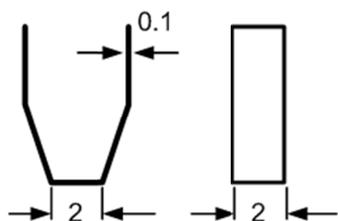
Fig.3. Cathode dimensions

$$j_R = \beta A T^2 \exp\left(-\frac{\varphi}{kT}\right) \tag{3}$$

where β is the material coefficient (for pure tungsten – 0.5 [12]); T - thermodynamic temperature; k - Boltzmann constant; φ - work function (for tungsten φ=4.3[eV]); A - quantum coefficient defined as $A = \left(4\pi m_e k^2 e\right)/h^3$. Here m_e and e are electron mass and charge respectively; h - Plank constant. Under the EBW conditions, the electric field E in front of the cathode may have significant values. Therefore, in this case it is necessary to take into account the Schottky effect. According of this effect the electric field component, normal to surface (E_n) leads to a reduction in the work function with a magnitude:

$$\Delta\varphi = \sqrt{\frac{e^3 E_n}{4\pi\varepsilon_0}}$$

and equation (3) can be written as follows

$$j_{R-S} = \beta A T^2 \exp\left(-\frac{\varphi}{kT}\right).\exp\left(\frac{1}{kT}\sqrt{\frac{e^3 E_n}{4\pi\varepsilon_0}}\right) \tag{4}$$
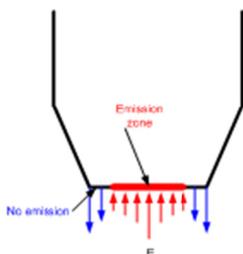
Fig.4. Emission zone on the cathode active surface

The electric field in front of the cathode surface depends on the geometry of the electrostatic part, anode and wehnelt voltage. The anode voltage is positive with respect to the cathode and contributes to the emission and the wehnelt voltage is negative with respect to the cathode and prevents this emission. In the formation of the electron beam, electrons are emitted only those areas of the cathode for which the component of the electric field on the normal to the cathode surface is directed to the cathode (Fig. 4).

It is also possible to emit from other parts of the cathode, but these electrons fall into an electrostatic field, which returns them to the cathode. In fact, some of these electrons, which are emitted near the equipotent surface $E_n = 0$ and have an appropriate orientation of the velocity vector, can enter the field with an anode-accelerating electric field. We do not take this into account. At the same time, we do not take into account the volumetric charge of the electrons in the beam. Its influence is greatest in this area. Thus, the two phenomena are partly offset.

Once the electrons fall into the space between the cathode and the anode they are accelerated by the electrostatic field. The velocity vector has three components - axial, radial and orbital, the latter being the result of the axisymmetric deviation. The radial component leads to the formation of the electrostatic focus (crossover), and the axial one has the main merit of electron energy at the anode outlet. Thus, for the simulation modelling of beam formation, it is necessary to determine the surface temperature of the cathode and the electric field in the space between the cathode, wehnelt and anode.

In the case in question, the cathode is directly heated (by running current). To model these processes the tasks to be solved are: electrical and thermal into the cathode and cathode node; electrostatic and motion (of electrons) into the space between the cathode and the anode. To solve the thermal task in the cathode node (Fig. 5), the differential equation of the heat conduction is used, and for the electric one the equations for the potential and the density of the current in the conducting medium. Since the parameters defining the process do not change over time, the task is resolved as a stationary one. The system of equations is as follows:
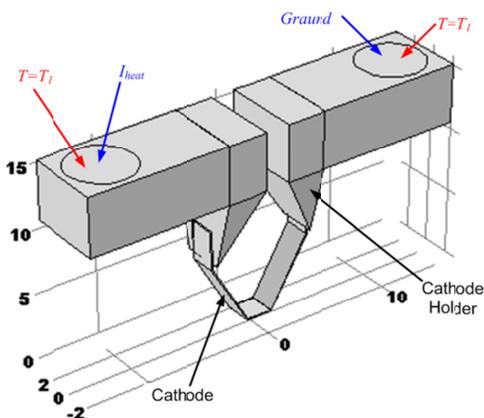

Fig.5

$$\nabla.(\lambda\nabla T)+\frac{j^2}{\sigma}=0$$

$$\nabla.(\sigma\nabla V_1)=0 \tag{5}$$

$$\mathbf{j}=\sigma\mathbf{E}_1 \quad \mathbf{E}_1=-\nabla V_1$$

Here T is the temperature; λ - thermal conductivity (Fig.6); V_1 and $\mathbf{E_1}$ - respectively the potential and electric field; σ - the electrical conductivity (Fig.7) and $\mathbf{j}$ - the current density.

For the electrical task, the boundary conditions define a zero potential of one of the two current-carrying surfaces, and the other - the heating current. All other surfaces are electrically insulated. The thermal task of these two surfaces is set to the temperature (80°C) because all the current-carrying elements are water-cooled. Part of the cathode carrier is flooded

with polymer. These surfaces that fall into the polymer are set as adiabatic boundaries. For the remaining surfaces, heat removal is prescribed by Stefan-Boltzmann's law. The data used for the emissivity are given in Fig. 8. In addition, the cathode's active surface is assigned a heat output because of the emission of electrons with a heat flux density:

$$q_{emi} = (\varphi - \Delta\varphi).j_{R-S} \tag{6}$$

and

$$j_{R-S} = \begin{cases} \beta A T^2 \exp\left(-\dfrac{\varphi}{kT}\right).\exp\left(\dfrac{1}{kT}\sqrt{\dfrac{e^3 E_n}{4\pi\varepsilon_0}}\right) & E_n \geq 0 \\ 0 & E_n < 0 \end{cases} \tag{7}$$
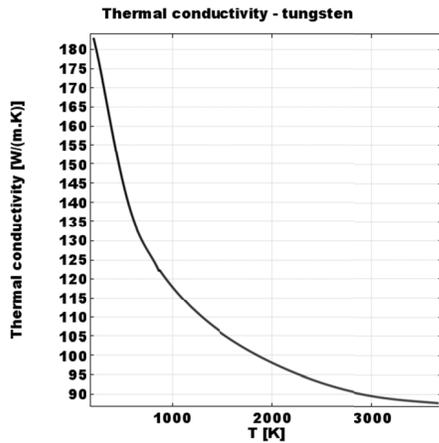
Fig.6
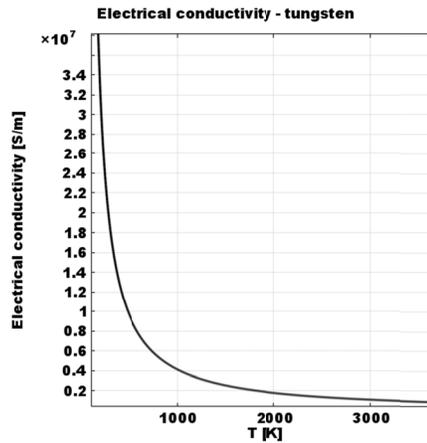
Fig.7
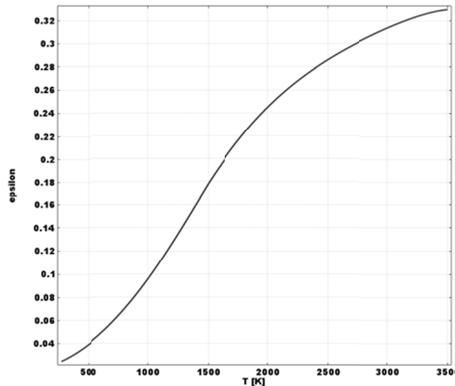
Fig.8. Emissivity of tungsten vs. temperature

In the cathode-cathode carrier contact areas are defined electrical and thermal contact resistors. They are specified for roughness of the contact surfaces 10 μm and the force and the pressing area are determined depending on the actual screw M2. They are defined because they lead to a more even distribution of the temperature on the active surface - the heat removal from the cathode decreases as a result of the heat resistance and the release of heat in the contact electrical resistance.

In the space outside the cathode node, wehnelt and anode (vacuum), the electrostatic field is determined and a task for electron's trajectories is solved. The electrostatic task is solved as a stationary and in fact comes down to a potential task. The equations used are as follows:

$$\nabla^2 V = 0 \quad \mathbf{E} = -\nabla V \tag{8}$$

under the following boundary conditions: all surfaces electrically connected to the cathode have zero potential; the outer surface of the anode and the control electrode have potentials U_a and U_w respectively ($U_w < 0$), with V and $\mathbf{E}$ are the potential and electrostatic field respectively.

To model the electron movement in the electrostatic field, a time dependant task is solved and the following equation is used for each electron in the electron beam:

$$\frac{d(m_{er}\mathbf{v}_i)}{dt} = \mathbf{F}_i$$

$$m_{er} = \frac{m_e}{\sqrt{1 - \mathbf{v}_i . \mathbf{v}_i / c^2}}$$

(9)

Here m_{er} is the relativistic mass of the electron, $\mathbf{F}_i$ is the force it acts on, v_i is electron speed and c is the light speed. This force has two components - one is the result of the interaction with the electrostatic field and the second as a result of the electron - electron interaction under Coulomb's law. This is how it gets

$$\mathbf{F}_i = -e\mathbf{E} - \frac{e^2}{4\pi\varepsilon_0}\sum_{\substack{j=1 \\ j\neq i}}^{N}\frac{\mathbf{r_i} - \mathbf{r_j}}{|\mathbf{r_i} - \mathbf{r_j}|^3}$$

(10)

In solving this task, the emission of electron portions from the cathode is generated. Their initial spatial distribution is obtained by dividing the surface of the cathode into a number of areas of approximately the same area (e.g., through the generated finite elements mesh). The number of electrons generated in each area is proportional to the density of the emitted current.

4. RESULTS AND DISCUSSION

The factors that influence the quality of the beam in terms of physical processes are: the temperature distribution on the cathode active surface; the shape and dimensions of the spot in which the electrons are emitted; the structure of the electrostatic field that defines the beam section in the electrostatic focus and the anode outlet; the electron velocity components (axial, radial and orbital) of the anode outlet. In addition, the EBG control characteristic data is important - the beam's current dependence on the wehnelt voltage at different values of the heating current and the anode voltage. For the temperature uniformity of the cathode active surface, the maximum and average temperature graphs can be judged (Fig. 9). It is seen that they practically coincide, which speaks of an even distribution of temperature on this surface. With a given geometry and anode voltage, the emission spot is determined by the voltage of the control electrode. For L_{W-A} = 7 [mm] and U_A = 50 [kV] it is shown in Fig. 10 (at U_W = -1150 [V] the cathode does not emit). From the result shown, it can be concluded that the voltage of the control electrode must be in the range (-1150, 750) [V]. By lowering this voltage, the shape of the emission spot strives for a circle.
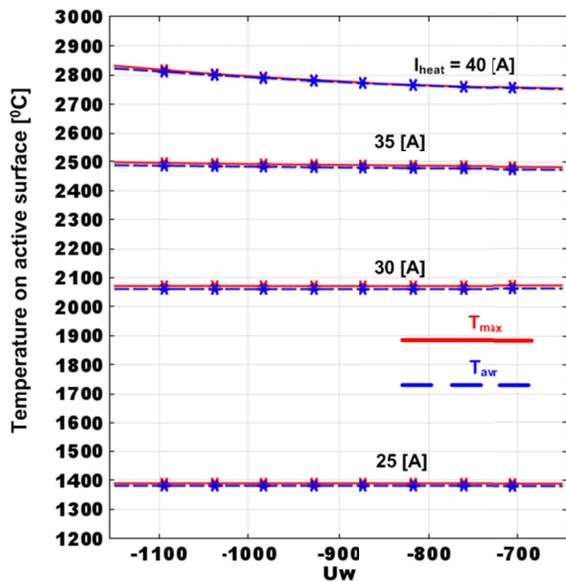

Fig.9. Maximum and average temperature of the active surface depending on the wehnelt voltage at different heating currents and anode voltage 50 [KV].

The axial component of the electrostatic field is responsible for electron accelerating. Fig.11 shows how it changes from the cathode to anode along the symmetry axis and at a distance of 1 [mm] from it (at the end of the active region) (Fig.12) for different control voltage values. These graphs show that a field difference is about the maximum that is located directly in front of the anode and in the cathode region (Fig.13). The last figure shows that U_w = -1150 [V] is the voltage at which the cathode clogs. The distribution of the intensity of the electrostatic field (axial component) in the cathode region is shown in Fig.14. It also shows here that the emitting spot does not cover the entire active surface of the cathode.

Besides the axial strength of the electrostatic field, there are radial and orbital components. Due to the axisymmetric anode and control electrode, the orbital component has no significant value in the electron beam area. At the same time, the radial component is crucial to crossover formation. It can be determined in

the following way (Fig. 15):

$$E_r = E_x \cos(\alpha) + E_y \sin(\alpha) \qquad (11)$$
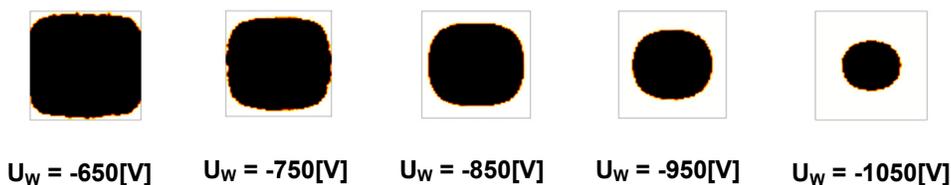

| U_W = -650[V] | U_W = -750[V] | U_W = -850[V] | U_W = -950[V] | U_W = -1050[V] |

Fig.10. Shape and dimensions of the emission spot on the active surface (2x2[mm]).
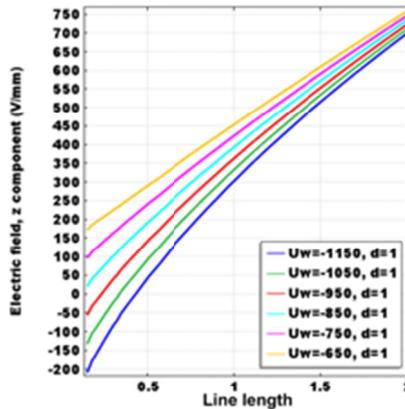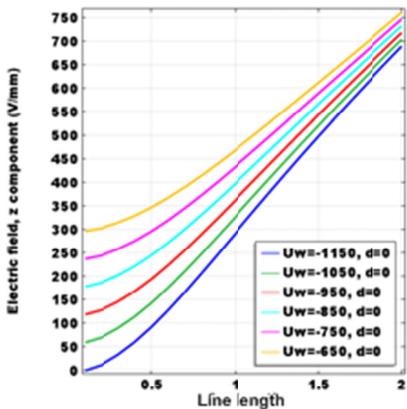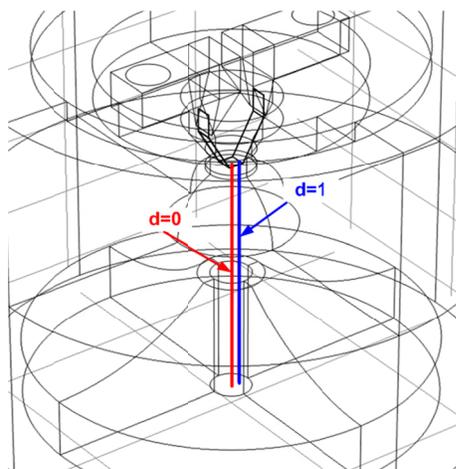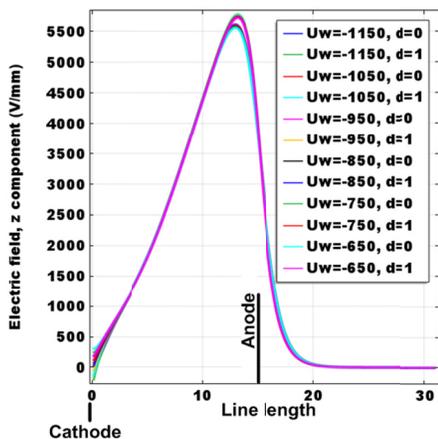

Fig.11

Fig.12.

Fig.13. Electric field in front of cathode

The result of the calculation is shown in Fig.16. At positive values of the radial component of the electrostatic field, the forces acting on the electrons are centripetal. Thus, the structure of the electrostatic field in this case is such that when the electrons approach the anode, conditions are created to increase the beam diameter. This type of structure is preserved at all control voltage values.

The magnitude of the electron beam current depends on the heating current, the control electrode voltage and the anode voltage (Fig.17). It is determined by integrating the emitted current density on the cathode active surface:

$$I_{beam} = \int_{S_{active}} j_{R-S}(T, E_n) dS \qquad (12)$$

In calculating this integral, the current density is determined in accordance with equation (7). This graph shows that beam current over a wide range can be set in the 35 to 40 [A] range for the heater current.
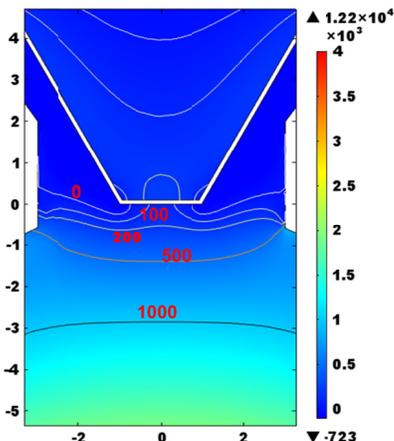
Fig.14. Electric field (electrostatic task)
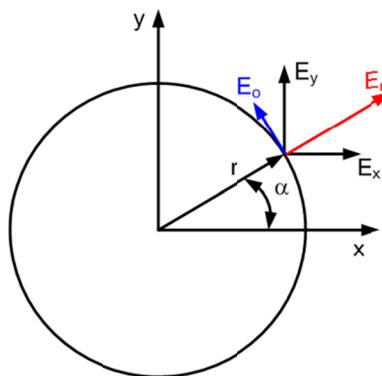
Fig.15. Determination of the radial component of the electric field
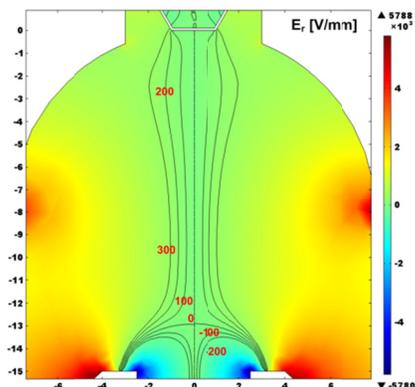
Fig.16. Structure of the electrostatic field
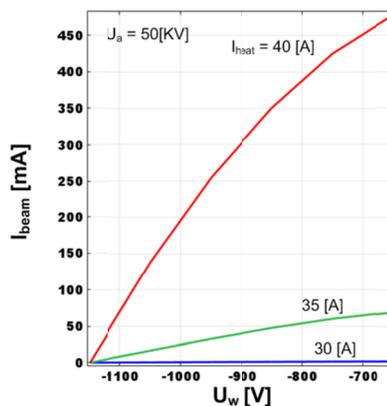
Fig.17. Beam current dependence of the control voltage at different values of the heating current

Beam formation is only tracked for heating current 35 [A]. The overall shape of the beam at the control voltage -650 [V] is shown in Fig.18. The electrostatic focus is visible and in the section of the anode outlet, the shape of the beam is not a circle. In Table 1 and Fig. 18 are given the results for the position of the crossover and its distance from the cathode (δ) for different control voltages. The shape of the beam is represented by the areas through which it passes into three sections: the cathode active surface (black) in the crossover (blue) and the anode outlet (red). By increasing the absolute value of the wehnelt voltage, the crossover approaches the cathode and the beam cross section is retained in the crossover and decreases in the other two considered planes. When the control voltage becomes less than -950 [V], the beam section at the exit of the anode is less than the emission spot on the cathode active surface.
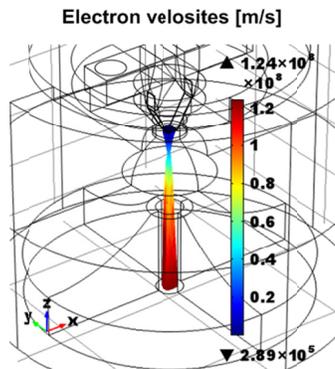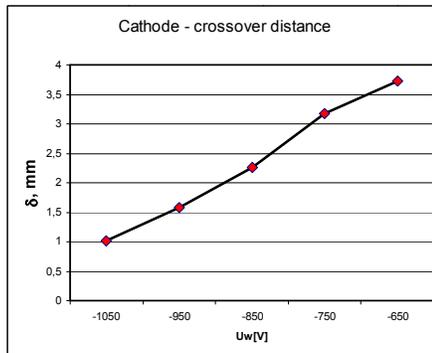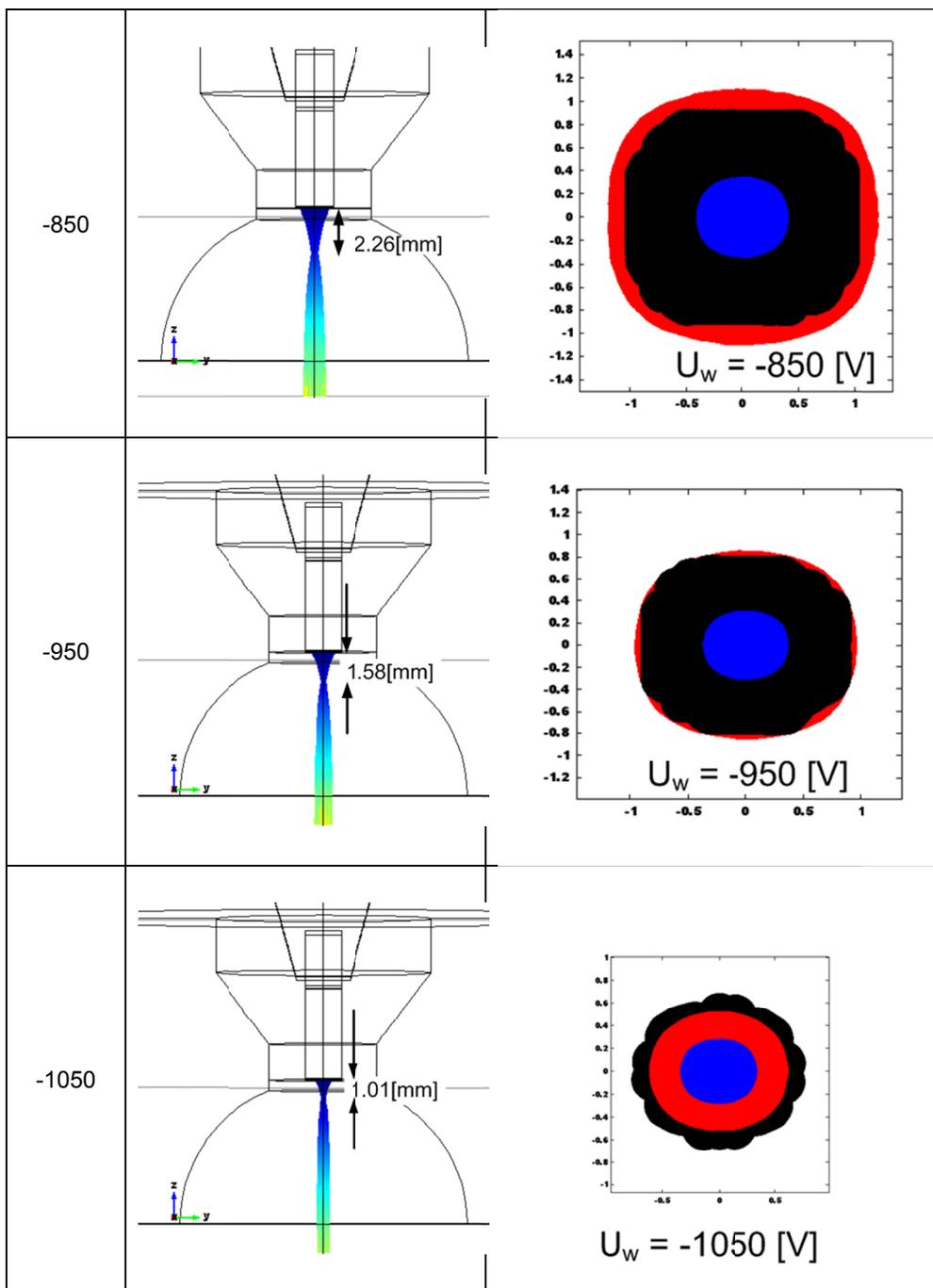
Fig.18. The overall shape of the beam.

Fig.19. Distance between cathode and crossover.

Table 1.

Crossover position and beam form for different wehnelt voltage.

U_W, [V]	Crossover position	Beam form
-650		
-750		

The conclusions reached relate only to the case under consideration and cannot be said to be of a universal nature that is geometrically attached to a particular installation for EBW. The main conclusions that can be drawn are the following.

1. A simulation model of the physical processes in the electrostatic part of the EBG was developed, including the solving of electrical and thermal tasks in the cathode node and electrostatic and the task of moving the electrons in the space between the cathode, wehnelt and anode.

2. By solving the model, using FEM, it was found that the temperature of the active surface is constant at a given heating current (the temperature gradients are negligible). The main reason for this is the cooling effect of the emitted electrons - as the temperature increases, the emission increases as a result of which the heat dissipation increases (there is a self-regulating effect).

3. In the electron emission model the Richardson equation with Schottky correction and material factor for tungsten was used.

4. It has been found that the intensity of the electrostatic field in the axial direction passes through a maximum that is located near the anode. This magnitude is slightly dependent on the control voltage, and only in the area of the maximum and in the immediate vicinity of the cathode.

5. The radial component of the electrostatic field is positive from the surface of the cathode to the maximum indicated, and in this area creates a force aimed at focusing the beam, and in the vicinity of the anode the sign is changed and the force acts defocusing.

6. Adjustment characteristics are shown - the beam current depends on the heating current and the control voltage.

7. It has been found that by increasing the absolute value of the control voltage the distance between the cathode and the crossover decreases. It also reduces the beam section at the anode outlet, this reduction being greater than the reduction of the spot through which the electron emission is realized. This indicates that the reason is not only reducing the magnitude of the beam current. At the same time, the beam size in the crossover does not change.

REFERENCES

[1] S. David, T. Debroy, Science, Vol.257(1992)497.

[2] S. Kou "Welding Metallurgy" A John Wiley&Sons, Inc.Publication,(2002)460p.

[3] Н. Н. Рикалин, А. А. Углов, А. Г. Зуев "Основы электроннолучевой обработки материалов", Москва, Машиностроене, (1978)238с.

[4] Y.Arata "Plasma, Electron and Laser Beam Technology" American Society for Metals,(1986)630p.

[5] Y. Arata, K. Terai, S. Matsuda, Trans. of JWRI, Vol. 2, n.1(1973)103.

[6] S. Shiller U. Heisig, S. Panzer "Elektronenstrahltechnologie" Forschungsinstitut Manfred von Ardene, Dresden, VEB Verlag Technik, (1972)528p

[7] Adam, V. et al.: Elektronenstrahlschweißen. pro-beam AG & Co. KgaA, München (2011).

[8] Petrov P., Sabchevski S. " Parameters used for electron beam welding - A comparative study"
Proc. 8th Int. Conf. Beam Technology, Halle, pp. 92-94, (2010).

[9] M. Dulău, L. David, Modeling and simulation of electron's trajectory inside of electron beam gun, CEAI, Vol. 9, No. 1, pp. 27-32, 2007

[10[A. V. Shcherbakov, M. V. Ivashchenko, A. S. Kozhechenko, and M. S. Gribkov, Parametric Analysis in the Design of Technological Electron Beam Guns, ISSN 10683712, Russian Electrical Engineering, 2016, Vol. 87, No. 1, pp. 41–45. © Allerton Press, Inc., 2016.

[11] E. Lassner, W. Schubert, Tungsten Properties, Chemistry, Jechnology of the Element, Alloys, and Chemical Compaunds, ISBN 978-1-4613-7225-7, Springer Science+Business Media New York, 1999

[12] Кузнецов М. С., Технология получения высокоэмиссионных материалов на основе гексаборида лантана в режиме самораспространяющегося высокотемпературного синтеза при механоактивации шихты, Диссертация на соискание ученой степени кандидата технических наук, 2016

OPERATIONS MANAGEMENT IN THE REPUBLIC OF MACEDONIA

Toni Soklevski[1], Mirjana Soklevska[2]

Abstract: *This scientific paper provides a complete picture of the operations management in the Republic of Macedonia and the need for professional introduction in any organization regardless of type and size. The survey has been carried out over the last few years in more than 200 organizations in the service and manufacturing industry. The research analyzed the views and opinions of the top, operations and line managers and employees in the organizations. Based on the experience, the direct monitoring of the positions of the operations managers, the interviews with all levels of management and employees were assessed the necessary characteristics in the scope of work and the requirements that are set in the operation of the operations management. Accordingly, this research offers several basic practical recommendations: to indicate to the top management the importance of the operations management and the implications for the success of the organizations; to build professionalism in organizations at the operations level of management; to invest in operations managers because it will result in a high turnover on invested capital; in the process of providing, developing, activating and maintaining human resources, and to take into account the proposed model of competences. This research defines the model of competences (common and special competences) of the operations managers in the Republic of Macedonia, which is the basis for the establishment of national standards for operations managers.*

Key words: *operations management, organizations, national standards.*

1. INTRODUCTION

In everyday speech competent is considered certain someone who can perform certain work properly (work task, work activity, procedure). Therefore, in the professional literature competence of the individual relates to his performance. More specifically, Mansfild in 1999 states that competence is "basic characteristic of a person which results in effective or superior performance", while in 2002, Rankin said: "Competencies represent the language of performance. They can articulate the expected results of individual effort and the way (manner) in which these activities are conducted. " From the previous two definitions can be derived primary meaning of the above mentioned terms:
- competence as a term based on personality characteristics and
- competence as a feature derived from work , i.e. looking for a job position for which the person is competent.

"Competency is a set of defined behaviors that provide a structured guide that allows the identification, evaluation and development of the behavior of individual employees." (Craig C. Lundberg, 1970). It is this definition the term "competence" first appeared in an article by the author Craig C. Lundberg in 1970 titled "Planning Executive Development Program". The term has become attractive when in 1973, Dr. David McClelland, wrote crucial article titled "Testing for Competence rather than Intelligence. Since then it has been popularized by a colleague of Richard Boyatzis McBer & Company (currently "Hay Group") and many other researchers.Competence is the ability to perform some specific task, action or activity and simple to operate successfully. Competence in the management of human resources represents a standardized request of an individual properly to perform a specific work. (Spencer Jr.et al.,1994). Some scholars see the "competence" as a combination of knowledge, skills and behaviors that are used to improve performance, or quality and adequate qualification, which aims to successfully performing a specific job. In urgent cases, competent people can react in a given situation, according to previous experience behavior to succeed. To be competent, people should be able to see the situation in a given context and to have a range of possible actions, but to qualified for them. Competence is enhanced through experience

---

Corresponding author:[1] Toni Soklevski, PhD, Professor, Business Academy Smilevski-BAS in Bitola, sokle2000@yahoo.com

and ability of individuals to learn and adapt. Competencies are the characteristics that lead extraordinary performance in a particular job, role or function. The model of competence refers to a group of competencies that are required in certain task and they are usually 7-9 in total. The number and type of competencies in the model will depend on the nature and complexity of work, along with the culture and values of the organization they work for.

Operations functions in organizations are processes through which resources transfer in the process of transformation and are shipped to customers as finished products and services. Each organization has operations functions for producing a special type of products or services. But, however, not all types of organizations in their structures have designated types of operations functions. (Nigel Slack et al., 2004)

Operations managers are mid-level managers who have responsibilities for the entire process of input, manufacturing and output. Operations managers in organizations can be called by other names such as "Production manager", "administrative managers" in hospital "commercial manager" in the supermarket. Operations management is a term used for actions, decisions and responsibilities of the operating manager.

Each activity or group of activities that takes certain inputs, transforms and delivers output information about its customers can be called a process.[2] The two most important processes are services and manufacturing. Service processes are prevailing in the business world. Statistics from major industrialized countries show that more than 80 percent of occupations in the business world are in the sphere of services. Without production processes, products that we enjoy as part of our daily life would not exist. Also, production raises the development of services.

2. METHODOLOGY

In order to realize our research, which aims to assess the common and specific competencies of managers operating in the Republic of Macedonia, 224 respondents were surveyed, 40 top managers, 104 operations managers and 80 line-managers (supervisors, controllers) who are directly responsible and competent to respond to their superiors (operations managers) and are potential neutralizers of the possible occurrence of socially desirable answers / responses biased by top management.

Object, which is treated in the survey is to define common and specific competencies of operations managers, i.e impact of competence as an important factor for successful and professional execution of operations functions in the manufacturing and service organizations.

Hypothetical framework

General hypothesis
Operations managers in various manufacturing and service organizations have common and specific competencies required for successful and professional performance in the workplace.

Special hypothesis 1
In the different types of manufacturing and service organizations there are common competencies of operations managers.
Single hypothesis 1.1.
In the different types of manufacturing and service organizations there are common competencies of operations managers who are necessary to perform their tasks**.**
Single hypothesis 1.2.
In the different types of manufacturing and service organizationsthere are joint competencies required to perform work activities.
Single hypothesis 1.3.
In the different types of manufacturing and service organizations there are joint competencies required in the context of work.

Special Hypothesis 2
In the different types of manufacturing and service organizations there are required level of requirements to be fulfilled in front of operating managers to perform their job successfully.
Single hypothesis 2.1.
The different types of manufacturing and service organizations i front of operating managers there are requirements in terms of their **knowledge and education** to meet the successful in completing their work.

Single hypothesis 2.2.
In the different types of manufacturing and service organizations in front of operating managers there are requirements in terms of their **skills** to meet for successfully performing their job.
Single hypothesis 2.3.
In the different types of manufacturing and service organizations in front of operating managers there are requirements in terms on their **abilities** to meet for successful execution of their work.
Single hypothesis 2.4.
In the different types of manufacturing and service organizations in front of operating managers there are requirements in terms on their **working style** to meet for successful execution of their work.

Special Hypothesis 3
Specific competencies of operations managers are specific to each type of manufacturing and service organizations.
Single hypothesis 3.1.
Specific competencies of operations managers are specific to each type of manufacturing organizations.
Single hypothesis 3.2.
Specific competencies of operations managers are specific to each type of service organizations.

3. RESEARCH RESULTS AND ANALYSIS

All data were processed with statistical program SPSS, which through numerical indicators in the best manner we give answers to what in the methodology is defined as an indicator of a phenomenon. The questions were practically divided into two parts one of which refers to the competencies that need to have managers and the second concerning the requirements that operations managers have to meet, to carry out their duties.
The first part is divided into the competencies required to execute the tasks, competencies to complete the work activities, competencies needed in their work.
In some of the issues that appear to respond at least three possibilities, because it is expected that the possible answers to the always-often and seldom-never make a significant difference, the responses are divided into two groups: always and often go as the first group, and rarely and never a second.
In some of the issues that appear to respond at least three possibilities, because it is expected that the possible answers to crucial - necessary and useful -irrelevant to make a significant difference, the responses are divided into two groups: crucial and necessary first go as a group, useful and irrelevant as the second.
The competencies required to execute the task, examined the following:
-   Managing and coordinating the activities of business or department relating to production, pricing, sale or distribution of products.
-   Managing staff, preparing work schedules and assigning specific duties.
-   Reading and understanding financial and sales reports, review of activities and data related to performance in order to measure productivity and achievement of objectives, identification of areas where it is necessary to decrease the costs.
-   Determining the needs of staff, conducting interviews, hiring and training new employees and monitoring these processes associated with staff.
-   Monitoring businesses and agencies to ensure that they efficiently and effectively provide needed services within budgetary constraints.
-   Monitoring activities directly related to production and provision of services. Managing and coordinating the financial and budgetary activities of the organization in order to fund operations, maximize investments and increase efficiency.
-   Determining which goods or services you are selling, pricing and credit terms based on forecasts of demand from customers.
-   Managing over the goods to and from manufacturing / service facilities.
Sample were processed as all competences:
For competency Management and coordination of activities of business or department relating to production, pricing, sale or distribution of products the following frequencies are obtained: 100 operations managers responded always and 4 often; 36 managers responded always and 4 often and 70 line managers answered always, 4 and 6 are often answered rarely.

In order to determine whether there is a statistically significant difference in opinion between functional managers, top managers and line managers in terms of how this competency is necessary for realization of tasks.

Table 1: Gender of respondents

		Frequency	Valid Percent
Valid	male	156	69,6
	femalei	68	30,4
	Total	224	100,0
Missing	System	2	
Total		226	

Table 2: Age of respondents

		Frequency	Valid Percent
Valid	20-30	11	.,ی
	31-40	70	31,3
	41-50	104	46,4
	51-60	34	15,2
	61-70	5	2,2
	Total	224	100,0
Missing	System	2	
Total		226	

Table 3: Vocational preparation of respondents

		Frequency	Valid Percent
Valid	secondary	58	25,9
	faculty	159	71,0
	m-r	5	2,2
	d-r	2	,9
	Total	224	100,0
Missing	System	2	
Total		226	

Table 4: Work experience in the organization

		Frequency	Valid Percent
Valid	0-5	24	10,7
	6-10	68	30,4
	11-15	47	21,0
	16-20	44	19,6
	more 20	41	18,3
	Total	224	100,0
Missing	System	2	
Total		226	

Table 5: Arithmetic differences in levels of management

COMPETENCES	N	Subset for alpha = 0.05		
		1	2	3
1.TOP	40	3,63		
3. LINE	80		3,79	
2. OPERATIONS MANAGERS	104			3,92

Table 6: Relationship between competencies and requirements for operations managers

Oprations mangers	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
knowledge	0.055	0.081	0.116	0.680	0.501
Skills	0.021	0.079	0.046	0.266	0.792
abilities	-0.056	0.060	-0.158	-0.931	0.358
work style.	0.004	0.097	0.008	0.046	0.963

R	R Square	Adjusted R Square	Std. Error of the Estimate	Sig.
0.198	0.039	-0.068	0.096	0.830

Table 7: Defining correlations (Pierson's ratio) of the competences between operations with top managers and line managers

	Correlations		Operations managers			Top managers			Line managers		
			VAR01	VAR02	VAR03	VAR01	VAR02	VAR03	VAR01	VAR02	VAR03
Operations managers competences	VAR01	Pearson Correlation	1	0.021	-0.157	0.273	-0.010	-0.433	0.013	0.066	-0.239
		Sig. (2-tailed)		0.833	0.112	0.088	0.953	0.005	0.908	0.559	0.033
		N		104	104	40	40	40	80	80	80
	VAR02	Pearson Correlation		1	-0.117	-0.224	-0.094	-0.140	0.226	0.203	-0.147
		Sig. (2-tailed)			0.238	0.165	0.562	0.390	0.044	0.071	0.192
		N			104	40	40	40	80	80	80
	VAR03	Pearson Correlation			1	0.158	0.336	0.273	-0.008	0.080	0.414
		Sig. (2-tailed)				0.329	0.034	0.089	0.947	0.483	0.000
		N				40	40	40	80	80	80
Top managers competences	VAR01	Pearson Correlation				1	0.591	0.081	0.090	0.368	0.405
		Sig. (2-tailed)					0.000	0.619	0.580	0.019	0.010
		N					40	40	40	40	40
	VAR02	Pearson Correlation					1	0.342	0.079	0.303	0.439
		Sig. (2-tailed)						0.031	0.630	0.057	0.005
		N						40	40	40	40
	VAR03	Pearson Correlation						1	-0.098	0.015	0.286
		Sig. (2-tailed)							0.548	0.928	0.074
		N							40	40	40
Line managers competences	VAR01	Pearson Correlation							1	0.122	0.003
		Sig. (2-tailed)								0.280	0.976

	Correlations		Operations managers			Top managers			Line managers		
			VAR01	VAR02	VAR03	VAR01	VAR02	VAR03	VAR01	VAR02	VAR03
		N								80	80
	VAR02	Pearson Correlation								1	0.208
		Sig. (2-tailed)									0.064
		N									80
	VAR03	Pearson Correlation									1
		Sig. (2-tailed)									
		N									

Of all analyzed competencies that answered the three groups of respondents, it can be concluded that the majority of responses received difference is statistically significant. This means that the three groups managers have the same opinion about the importance of the proposed competencies.

4. CONCLUSION

Knowledge/education

Requirements to meet operations managers for successfully performing their work, we practically divided into several parts by: knowledge/education, skills, abilities, work style. For requirements pertaining to knowledge / education in mind, we took the following:
- Knowledge of the principles of business and management involved in strategic planning, resource allocation, human resources modeling, leadership techniques, production methods and coordination of people and resources
- Knowledge of principles and processes serving. This includes assessment of customer needs, meeting the standards of service quality and evaluation of customer satisfaction.
- Knowledge of laws, legal codes, court procedures, precedents, government regulations, decrees, agency rules and democratic political processes.
- Knowledge of principles and procedures for recruitment, selection, training, compensation and benefits of employees, labor relations and negotiation, and personnel information systems
- Knowledge of principles and methods for showing, promoting and selling products. This includes marketing strategy and tactics, product demonstration, sales techniques and control systems sales.
- Knowledge of arithmetic, algebra, geometry, calculus, statistics and their application
- Knowledge of economic and accounting principles and practices, financial markets, banking, and analysis of financial data and preparing reports.
- Knowledge of raw materials, production processes, quality control, costs and other techniques for maximizing the effective manufacture and distribution of goods

Skills
The skills related to knowledge / education in mind, we took the following:
- Active Listening - Giving full attention to what the speaker says, understanding what is said, asking questions for clarification where necessary, not interrupting when someone is speaking.
- Management of staff - Motivating, developing and managing people in their work, identifying the right people for the right job.
- Organizing time - Organize your time and others'
- Making judgments and decisions - Taking into account the relative costs and benefits of potential actions to choose the most appropriate
- Tracking (Monitoring) -¬ monitoring / self-assessment, assessment or other organization to introduce improvements or take corrective actions
- Understanding of read - Understanding written sentences and paragraphs in work related documents
- Speaking - Effective oral transmission of information to others
- Managing Financial Resources - Determining how to spend money to complete the work and accountability for such spending

- Active Learning - Understanding the implications of new information on current and future situations of problem solving and decision making
- Persuasion - Convincing others to change their thinking or behavior

Working style

In terms of working style of managers, opinion isptanicite received in relation to:
- Addiction - The work requires Reliability, responsibility and fulfillment of obligations.
- Leadership - Work requires willingness to lead, to take the lead and offer opinions and guidance
- Integrity - Work requires being honest and ethical
- Attention to detail - The work requires attention to detail and thoroughness in completing tasks
- Initiative – Work requires willingness to take responsibilities and challenges
- Self-control - The work requires¬ maintaining restraint, the rule of emotions, controlling anger and avoiding aggressive behavior, even in very difficult situations
- Collaboration - Work requires being pleasant with others in the workplace and to manifest cooperative
- Caring for others - work required to be sensitive to the needs and feelings of others, to show understanding and offer assistance in working
- Analytical thinking - Work requires analyzing information and using logic approach to issues and problems related to work
- Independence - The work requires developing their own ways of doing things, self-management with little or no supervision and relying on yourself to complete things.

From the above parameters of the survey form following profile of an operations manager in RM is:
- Male- in production activities
- Female – in accounting, finance, hospitality, education (services)
- Age: 41-50 years
- Work Experience: 11-15 years
- Work experience as an operating manager: 6- 10 years
- Education: University degree, 26% SSS (21 of 80 respondents)
- Competences: common and special
- Requirements: knowledge, skills, abilities and work style.
- Operations managers are encountered in most organization with over 30 employees.

REFERENCES

[1] Lee J. Krajewski and Larry P. Ritzman (1999). Operations Management, Strategy and Analysis. Massachusetts: Addison-Wesley Publishing Company.

[2] Spencer Jr., L. M., McClelland, D. C., Spencer, S. M. (1994). Competency Assessment Methods: History and State of the Art.

[3] Shippmann, J. S., Ash, R. A., Battista, M., Carr, L., Eyde, L. D., Hesketh, B., Kehoe, J., Pearlman, K., and Sanchez, J. I. (2000). The practice of competency modeling. Personnel Psychology, pp.703-740.

[4]Soklevski, T. (2014). The common and special competences of operations managers in Republic of Macedonia, Skopje: ISPPI.

STUDY OF PHYSICAL PROCESSES IN THE CATHODE REGION OF A WELDING ARC

Manahil Tongov[1], Alexander Gechev[2]

Abstract: *The study presents results from mathematical modelling of the physical processes in the cathode area of an electric welding arc with tungsten cathode. Finite Element Method (FEM) is used to solve electrical, thermal and fluid tasks. When solving the equations, the characteristics of the materials involved in the process are set as temperature functions. As a result of simulation modelling the cathode voltage drop, temperature fields, electric potential, and current density close to the cathode have been obtained. The methods of reading the heat balance in the cathode region are discussed and the role of plasma cooling for concentrating the current lines through the electrode tip is shown.*

Key words*: FEM, TIG, Thermal Plasma, Thermal Processes, Electrical Processes*

1. INTRODUCTION.
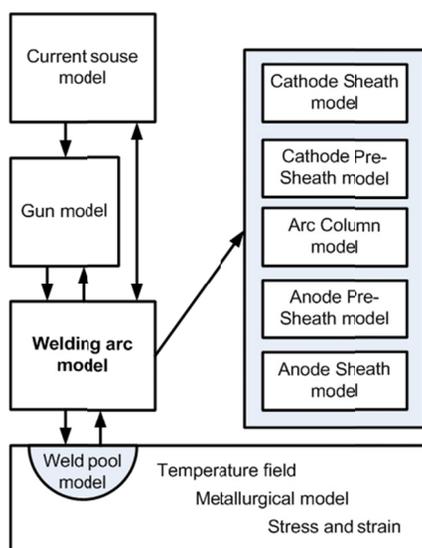
Fig.1. General scheme of modeling the process of arc welding

The mathematical modelling of the processes during welding with non-consumable electrode (TIG and plasma arc welding) is an exceptionally complicated process associated with solving a number of tasks (fig.1). It is usually assumed that the welding power source maintains a stable current or changes it according to a certain program during pulsed arc processes. The same applies to the flow rate of the used gases. In the welded workpiece, a thermal and/or deformation equations are typically solved to determine the thermal cycles, temporary and residual stresses. Usually, the influence of the welding arc on the workpiece is reduced to the usage of a specific heat source distributed over the surface of the workpiece (Gaussian distribution is commonly used) or in a specific volume (fig.2). Also, in some studies the welding arc and the weld pool are modelled simultaneously, and usually data is given about the depth and shape of the penetration [1, 2].

Modelling the processes in the welding arc is done in three different ways. The first approach is to examine the movement of plasma particles and the reactions between them [3]. The second is to model the processes by solving thermal, electric and fluid equations [4 ÷ 9] and also electromagnetic equations [4 ÷ 7, 9]. In this case, in addition to the differential equations, analytical dependencies on the concentration, temperature, and electron and ion velocities necessary to determine the electron and ionic currents are often used. The third approach involves solving the differential equations used in the previous two cases [10].

---

[1] M. Tongov, Assoc. Prof. PhD, Faculty of Industrial Technology, Technical University – Sofia
(tongov@tu-sofia.bg)
[2] A. Gechev, Ass., Faculty of Industrial Technology, Technical University – Sofia
(a_gechev@tu-sofia.bg)
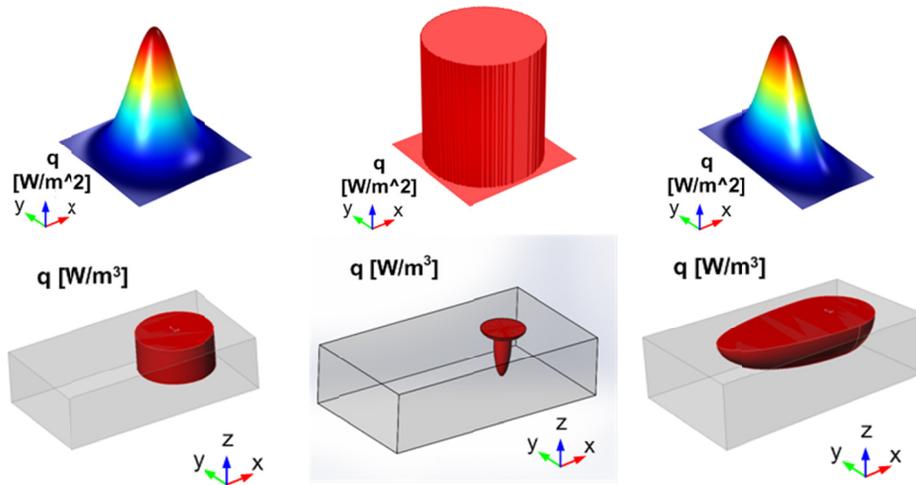
Fig.2. Examples of thermal sources used to model the interactions between the welding arc and the workpiece
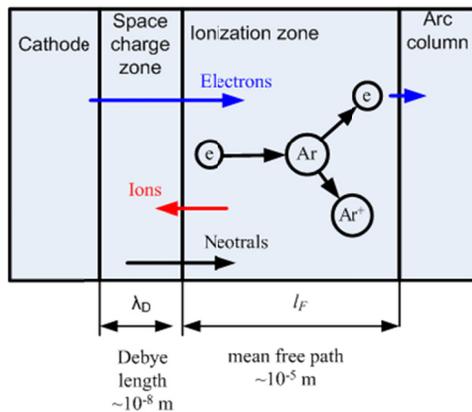
Fig.3. Subarreas in cathode region

When modelling the processes in the cathode region, it is often divided into two sub areas (fig. 3). The first one, which is in direct contact with the cathode, has a small size (in the order of the Debby length) and inside, interactions between the particles does not happen. The second is between the first and the arc column and is an ionization zone (the size is from several micrometers to 0.1 [mm]) and there are considered mainly the processes between charged particles. For these interactions, cross section data about the reactions in the argon plasma are used [3, 11 ÷ 13].

2. MODEL DESCRIPTION.

The diagram shown in Figure 4 is used to realize the model. In the framework of this study, the following equations were solved: thermal for determining the temperatures in the electrode and the plasma; Fluid for determining the gas phase velocities that affect the temperature distribution; electrical to determine the current density and, respectively, the power of the volumetric heat source. All material characteristics are set as temperature functions and the equations are solved for a cylindrical coordinate system[3].

To solve the fluid problem, the continuity and the Navier-Stokes equations for compressible fluid are used:

$$\frac{\partial \rho_{Ar}}{\partial t} + \nabla.\left(\rho \mathbf{u}\right) = 0 \qquad (1)$$

$$\rho_{Ar}\frac{\partial \mathbf{u}}{\partial t} + \rho_{Ar}\mathbf{u}.\nabla \mathbf{u} = -\nabla p + \nabla.\left(\mu\left(\nabla \mathbf{u} + \left(\nabla \mathbf{u}\right)^{T}\right) - \frac{2}{3}\mu(\nabla.\mathbf{u})\mathbf{I}\right) \qquad (2)$$

Here ρ_{Ar} is the argon density, [kg/m³]; μ - the dynamic viscosity, [Pa.s], $\mathbf{I}$ - the single tensor and $\mathbf{u}$ is the velocity vector, [m/s]. The boundary conditions are shown in figure 4.

Calculating the temperature is reduced to solving the solving the differential equations:

In the electrode

---

[3] The coupled problem is stationary but time dependant solution is used as a first stet because of highly nonlinearity of the equations used to find consistent initial values for second stationary step.

$$\rho_W C_{pW} \frac{\partial T}{\partial t} = \nabla.(\nabla T) + q_e \qquad (3)$$

In argon

$$\rho_{Ar} C_{pAr} \frac{\partial T}{\partial t} + \rho_{Ar} C_{pAr} \mathbf{u}.\nabla T = \nabla.(\nabla T) + q_e - q_{rad} \qquad (4)$$

where ρ_W and ρ_{Ar} are respectively the densities of the tungsten and argon, [kg/m³]; C_{pW} and C_{pAr} - specific heat capacities at constant pressure, [J/(kg.K)]; q_e and q_{rad} respectively are the heat output emitted as a result of current flow and plasma radiation, [W/m³].

The boundary conditions are shown in figure 5, the plasma interaction with the cathode being discussed below.

The following equations are used to solve the electrical task:

$$-\nabla.(\sigma \nabla V) = Q \qquad (5)$$

$$\mathbf{E} = \nabla V \qquad (6)$$

$$\mathbf{J} = \sigma \mathbf{E} \qquad (7)$$
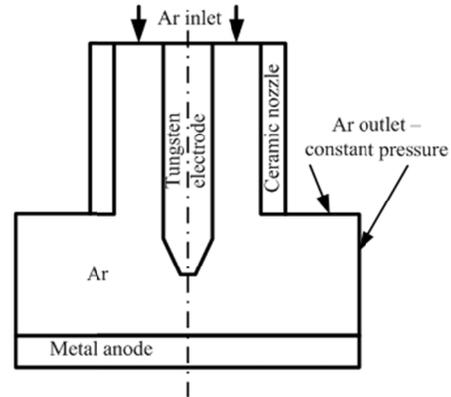
Fig. 4. Geometry schematic and fluid flow boundary conditions.

Here σ is the argon electrical conductivity [S/m]; Q - the space charge density, [C/m³]; V - electric potential [V]; $\mathbf{E}$ - the electrical field vector, [V/m]; $\mathbf{J}$ -the current density vector, [A/m²]. The boundary conditions are shown in Figure 5 (the remaining surfaces are electrically insulated).

The modeling of the processes in the cathode region is carried out as follows. Depending on the cathode temperature, the emission of electrons is limited according to Richardson's equation, [A/m²]

Fig.5. Thermal boundary conditions

$$j_R = \beta A T^2 \exp\left(-\frac{\varphi}{kT}\right) \qquad (8)$$

where β is a material-dependent coefficient (for tungsten according to [14] it's valued 0.5); T - the absolute temperature of the cathode surface; k – Boltzmann's constant; φ - work function (for tungsten alloyed with thorium φ = 2.65 [eV]) and A - quantum coefficient, defined as $A = (4\pi m_e k^2 e)/h^3$. Here m_e and e are the mass and charge of the electron, and h is the Planck's constant.

The strength of the electric field in front of the cathode affects the emitted current (Schottky effect). This influence is accounted for by the reduction of the work function for the electron emission with the value

$$\Delta\varphi = \sqrt{\frac{e^3 E_n}{4\pi\varepsilon_r\varepsilon_0}} \qquad (9)$$

where ε_r is the relative dielectric permeability of argon (for argon $\varepsilon_r \approx 1$); ε_0 - the dielectric permeability of the vacuum; E_n - the electric field strength component on the normal to the cathode surface (fig. 6) and

$$AB \Rightarrow \quad E_n = E_z$$
$$BC \Rightarrow \quad E_n = -E_r \cos(\alpha) + E_z \sin(\alpha) \quad (10)$$
$$CD \Rightarrow \quad E_n = -E_r$$

The effective value of the work function is defined as $\varphi_{eff} = \varphi - \Delta\varphi$. From equations (6) and (7) we obtain the limit for the emission current with the Schottky effect
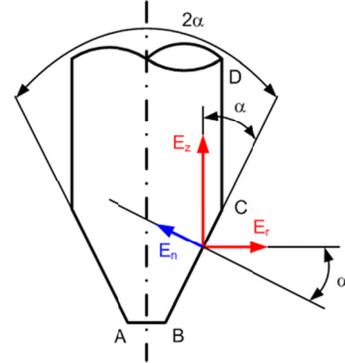
Fig.6. Determination of the normal component of the electric field strength

$$j_{R-S} = \beta A T^2 \exp\left(-\frac{\varphi}{kT}\right) \cdot \exp\left(\frac{1}{kT}\sqrt{\frac{e^3 E_n}{4\pi\varepsilon_0}}\right)$$

$$(11)$$

The current density across the cathode surface is j_n. It can be determined in a way similar to the determination of the electric field strength:

$$AB \Rightarrow \quad j_n = j_z$$
$$BC \Rightarrow \quad j_n = -j_r \cos(\alpha) + j_z \sin(\alpha) \qquad (12)$$
$$CD \Rightarrow \quad j_n = -j_r$$

In the cathode region there is an electron (j_e) and an ion (j_i) current. In [4] it is quoted by [15] dependence derived from the energy balance in the cathode region connecting these two currents, the ionization potential (U_i) and the cathode voltage drop (U_C). Using this dependence it is obtained that $j_i = j_e(U_C/U_i)$. When we consider that $j_n = j_e + j_i$, and also the limitation for the electron current we get

$$j_e = j_n \frac{U_i}{U_i + U_C} \qquad j_i = j_n \frac{U_C}{U_i + U_C} \qquad (13)$$
$$j_e \le j_{R-S}$$

The cooling effect of electron emission is determined by the effective work function and the emission current. When the ions reach the surface of the cathode they recombine. This process also requires the emission of an electron. Therefore, the cooling effect should also take into account this process. This means that the total cooling flow resulting from the electron emission is

$$q_{C-e} = j_n \frac{(\varphi - \Delta\varphi)}{e} \qquad (14)$$

The electrons that enter the plasma bring energy into it. The heat flux to the plasma can be determined by the emission current and the temperature of the cathode T_C (the electrons that interact with the ions are not accounted for) as [4]:

$$q_{p-e} = j_e \frac{2kT_C}{e} \qquad (15)$$

The latter equation is based on the fact that electrons obey Maxwell's distribution. But in the cathode (temperature does not exceed 3500 [K]) the distribution of Fermi - Dirac is in effect. In addition, the electron emission is from the Fermi level but we will be not discus this problem now.

When ions reach the surface of the cathode, they recombine and energy is released eU_i. This energy is released by γ quantum and the plasma is actually transparent to it. This means that the plasma loses this energy. In equation (4), we measure the radiation of the plasma through the heat flux q_{rad} and it should not be duplicated. At the same time, the probability that this photon is directed to the cathode surface is 50%. Part of the photons are reflected - we account for it with a reflection

coefficient (ε_m). In the first approximation, this coefficient is equal to the degree of cathode surface emissivity. In this case, the surface of the cathode will be heated and the density of this heat flux is

$$q_{C-emi} = \frac{1}{2}\varepsilon_m j_i U_i \tag{17}$$

The ions reaching the cathode interact with it, and some of their kinetic energy is transmitted to the cathode surface. Under the cathode voltage drop U_C within the cathode region the ions acquire additional kinetic energy equal to eU_C (assuming that only primary ionization is observed). Part of this energy (taken into account by the coefficient ε_k, as we have assumed $\varepsilon_k = 1$ in this study) they give to the cathode

$$q_{C-U_C} = \varepsilon_k j_i U_C \tag{18}$$

The rest of the energy increases the energy state of plasma in the cathode region. Thus, the thermal flux cooling the surface of the plasma in the contact area is

$$q_{p-U_C} = \varepsilon_k j_i U_C - (1-\varepsilon_k) j_i U_C = (2\varepsilon_k - 1) j_i U_C \tag{19}$$

Neutral atoms are also heating the cathode. This process can be described as convection with a heat flow q_{conv}. For the heat flux that is heating the surface of the cathode we obtain:

$$q_C = -q_{C-e} + q_{C-emi} + q_{C-U_C} + q_{conv}$$

and for the heat flux to the plasma

$$q_p = q_{p-e} - q_{p-U_C} - q_{conv}$$

By replacing the heat fluxes in these equations we obtain:

$$q_C = -j_n \frac{\varphi - \Delta\varphi}{e} + \frac{1}{2}\varepsilon_m j_i U_i + \varepsilon_k j_i U_C + \alpha(T_{Ar} - T_s) \tag{20}$$

$$q_p = j_e \frac{2kT_C}{e} - (2\varepsilon_k - 1) j_i U_C - \alpha(T_{Ar} - T_C) \tag{21}$$

where α is the coefficient of surface heat transfer, [W/(m^2.K)].

In order for the equations (17) and (18) to be used as boundary conditions, the cathode voltage drop must be determined. This can be done by any of the formulas known in the literature or by the potential field obtained by solving the electrical task. When using the second method, it is necessary to know the size of the cathode region. We assume that it is equal to the ion mean free path (l_F), depending on local temperature and density. We determine it by the number of particles in unit volume (n_0) and the cross section of the interaction (S) $l_F = (n_0 S)^{-1}$. The number of particles in a unit volume is determined by the argon density (ρ_{Ar}), depending on pressure and temperature, and the atomic mass (m_{Ar} = 39.95 [g/mol]) $n_0 = \rho_{Ar} N_A m_{Ar}^{-1}$. The cross section of the interaction is calculated as $S = \pi(r_i + r_{eff})^2$, where r_i = 154 [pm] is the effective radius of the ion, and r_{eff} is the mean radius of the surrounding particles $r_{eff} = ((1-\chi)r_{Ar} + \chi.r_i)$. Here χ is the degree of ionization in the cathode region, and r_{Ar} = 71 [pm] is the radius of the atom of argon.

That's how we obtain

$$l_F = \frac{m_{Ar}}{\pi \rho_{Ar} N_A ((1-\chi)r_{Ar} + (1+\chi)r_i)^2} \tag{22}$$

For every point of the boundary between the cathode and the plasma, the cathode voltage drop (fig. 7), which is used in the equations (11, 17 and 18), is determined

To solve the equations included in the model it is necessary to specify the characteristics of the materials. They are shown in Fig. 8 - Fig.18 [16÷24].
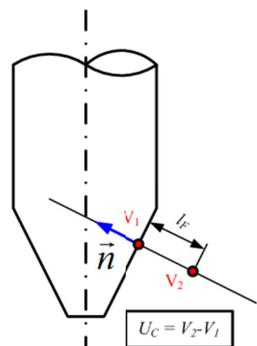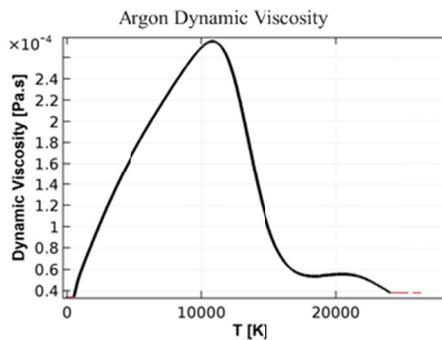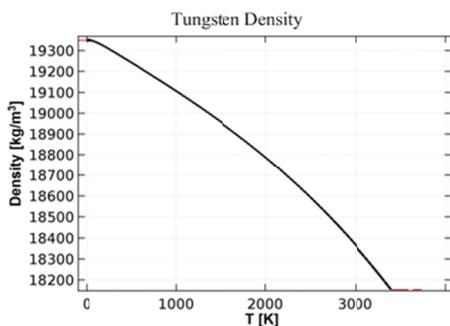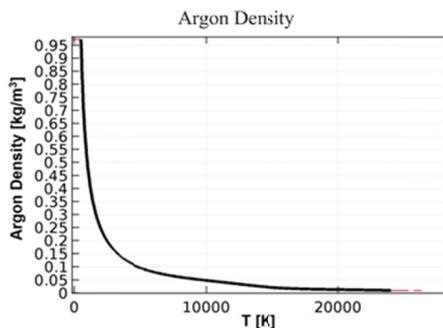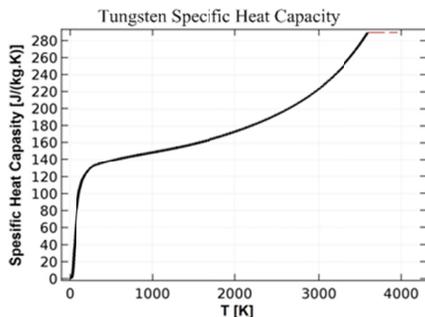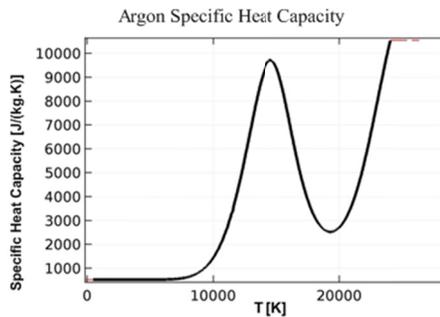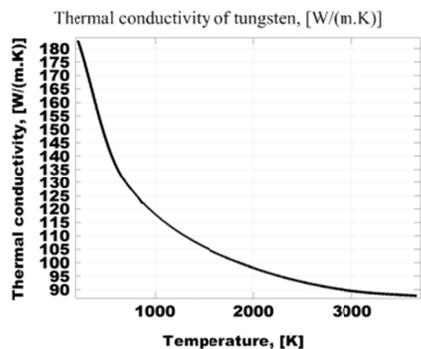
Fig.7. Cathode drop determination
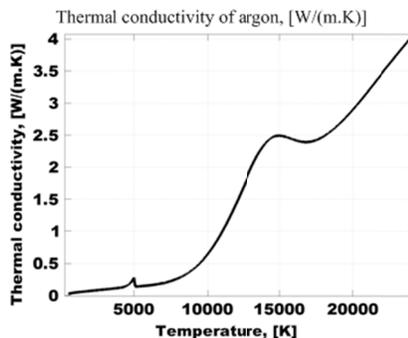

Fig.8.

Fig.9.

Fig.10.

Fig.11.

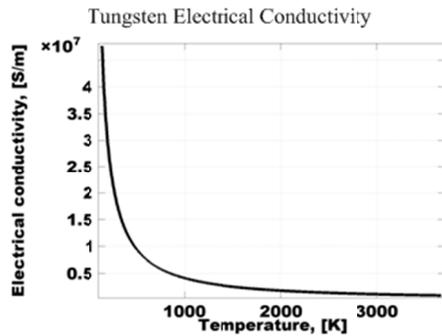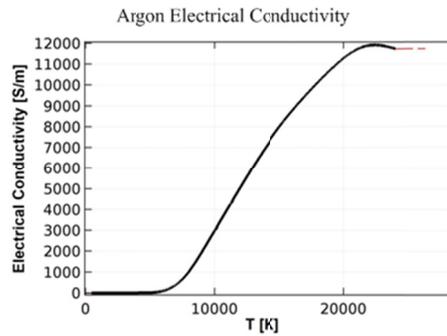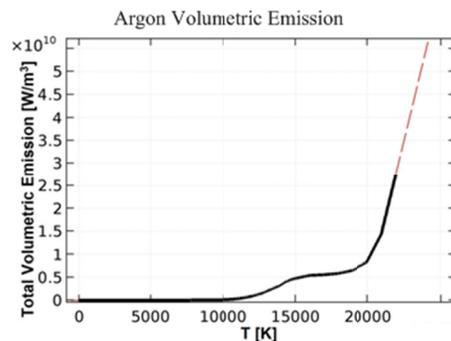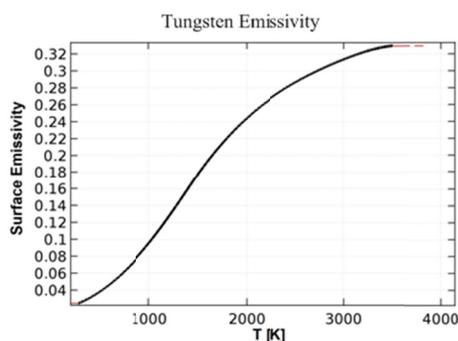

Fig.12

Fig.13

Fig.14

Fig.15

Fig.16

Fig.17

Fig.18

3. DISCUSSION AND ANALYSIS

When solving the model, an electrode with a diameter of 4 [mm], a sharpening angle of $2\alpha=30^0$ and a radius of the area AB 0.2[mm] is used. The flow rate of argon is 6 [l/min] and the inside diameter of the gas nozzle 16 [mm]. The length of the arc is 2[mm] and the length of the electrode with respect to the gas nozzle is 8 [mm]. The welding current is 125 [A].

Figure 19 shows the temperature field in the argon near the tungsten electrode. The maximum plasma temperature is in the range of 13500 [K], with the maximum values located along the arc axis but distant from the end of the electrode. Throughout the contact area between the electrode and the plasma, large temperature gradients are observed. This can be judged by the temperature along the arc axis (fig.20). In addition, the temperature goes through a maximum, due to cooling, because of fluid movement. On the surface of the cathode, the plasma temperature is 6000 [K], but we must point out that it is different for different points on the surface of the cathode. The curve indicating the velocity of the fluid along the arc axis also passes through a maximum (fig.21) and reaches a value of 0.52 [m/s]. By comparing the last two figures, it can be concluded that the range of maximum temperatures is limited by the fluid flow. At the same time, the speeds directly below the electrode are negligible - of the order of 25 [mm/s].

Fig.19. Temperature field.
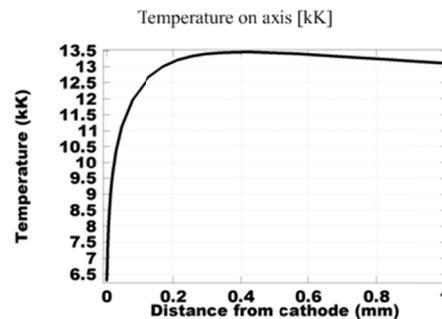
Fig.20. Temperature fn arc axis.
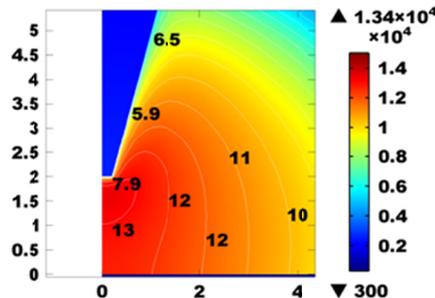
108
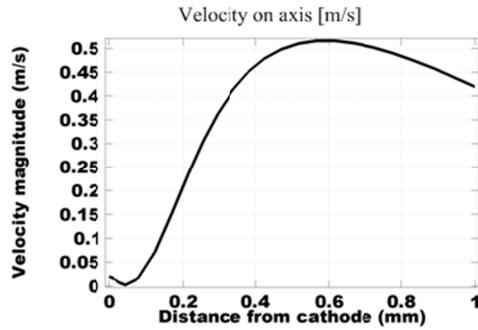
Fig.21. Gas velocity on arc axis.

The surface temperature of the cathode and the plasma temperature along the cathode border are shown in Figure 22. By moving away from the end of the electrode along the cathode surface the temperatures decrease and at some point the protective gas already has a cooling effect on it. In the area of low cathode temperatures and protective gas there is no current flowing from the electrode to the plasma because of its low emissivity and the high resistance of the gas phase due to the extremely low degree of ionization.

The electric field is illustrated in fig. 23, showing the distribution of the potential and the equipotential lines for the current density. As expected, the maximum current density is obtained at the tip of the electrode. Fig. 24 shows the variation of the electric field strength along the arc axis.
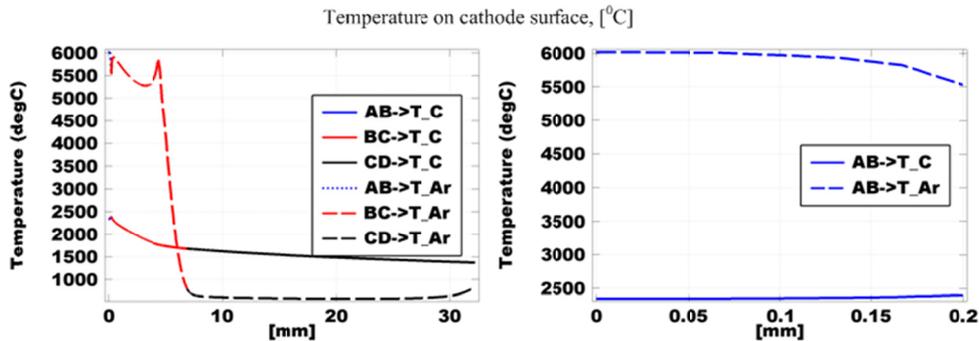
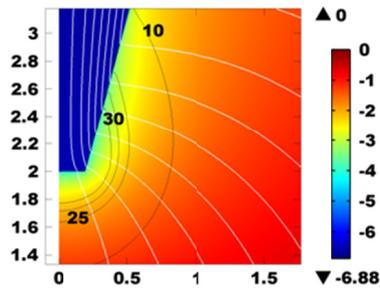*Fig.22. Temperatures on tungsten – argon boundary*

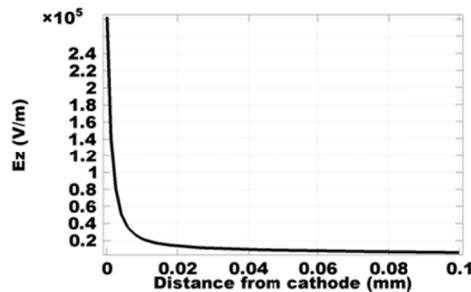*Fig.23. Electric field*

Fig.24. Electric field strength along the arc axis (axial component)

The change in the electric field strength is most significant in the immediate vicinity of the cathode surface. Then, going further into the ionization zone, it decreases, which corresponds to the volumetric charge. This zone is less than the length of ion mean free path and is smaller than the size of the cathode area. The approximate size of this area is 10 [μm] and is considerably larger than λ_D. Here we have to point out that no conclusions can be made regarding the ionization zone with the model that we are considering. To analyze the processes in this zone, a detailed model based on particle motion and their interactions is required. Fig. 25 shows how the electric potential changes along the arc axis, and in fig. 26 the graphs for the variations of the potential in front of the tip of the tungsten electrode are shown.
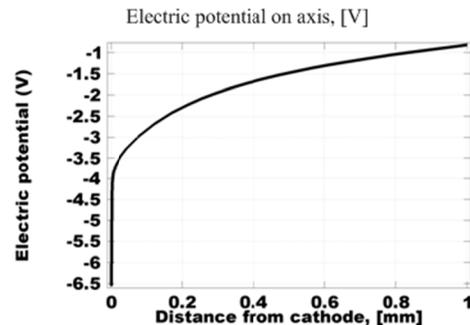

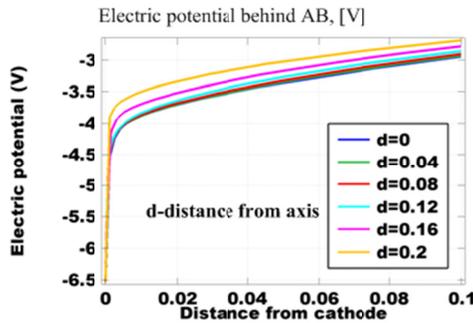*Fig.25. Electric potential changes along the arc axis*

Fig.26. Electric potential in front of the tip of the tungsten electrode

In accordance with the change in field strength, the electrical potential also changes sharply in the proximity of the cathode. From fig. 24 and fig. 25 it can be concluded that there is no change of the characteristics of the said graphs, which clearly shows the size of the cathode region – it means that the transition from the zone of ionization to the arc column is smooth. Also, in front of the face of the cathode, which has a radius of 0.2 [mm] in the case in question, there is no significant difference in the change in electrical potential. Immediately beneath the tungsten electrode, the current flow conditions are practically the same, and the cathode voltage drop in this area is the same.

Significantly different is the situation on the inclined surface of the electrode (fig.27). By moving away from point B to 2 [mm], the potential increases at a constant distance from the surface of the electrode, and then decreases. When this decrease begins, the field strength along the electrode surface normal changes and the area with a sharp change of electric potential disappears.
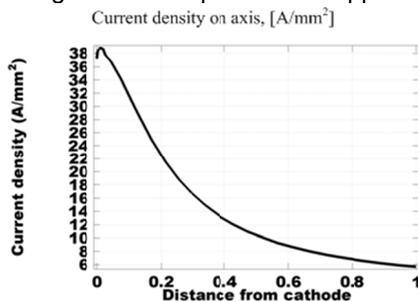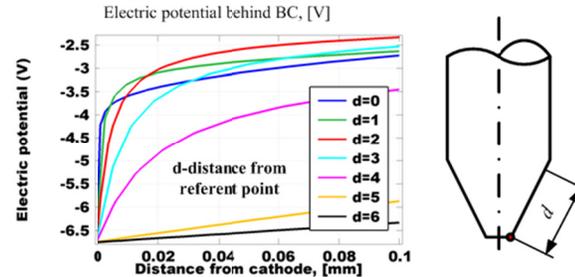

Fig.27. Electric potential in front of conic surface of the tungsten electrode

Fig.28. Current density along the arc axis

The current density along the arc axis is shown in Fig.28. It is largest immediately below the electrode and decreases with distancing from its surface due to the current dissipation because of the conductivity of the argon and the influence of the anode.

4. CONCLUSIONS

The results obtained by this computer simulation of the processes in the cathode region during welding with a tungsten electrode are relevant to this case, but the approach used is applicable to solving a wider range of TIG and plasma arc welding models. The main conclusions that can be drawn are:

1. A model is proposed, involving simultaneous solving of electrical, thermal and fluid tasks in welding conditions concerning a non-consumable electrode.

2. At the boundary between the cathode and the plasma, heat flows are used as boundary conditions, taking into account the interactions between the charged particles and the surface of the cathode, and the plasma.

3. Results for the temperature and electric field near the cathode surface are presented.

4. The cathode voltage drop along the surface of the electrode is presented.

5. REFERENCES

[1] Lu F., X. Tang, H. Yu, S. Yao, Numerical simulation on interaction between TIG welding arc and weld pool, Computational Materials Science 35 (2006) 458–465p.

[2] Mochizuki M., M. Tanaka, S. Okano, Integrated simulation model between arc plasma process and weld mechanics toward accurate distortion analysis, Transactions of JWRI, Special Issue on WSE 2011(2011), 123-128p.

[3] Dowdent J., P. Kapadiat and B. Fenn, Space charge in plasma arc welding and cutting, J. Phys. D Appl. Phys. 26 (1993) 1215-1223

[4] Wendelstorf J., Ab inito modelling of thermal plasma gas discarges (elecric arc), Disertation, 2000

[5] Meng J., X. Dong, Numerical Simulation and Analysis on Jet Characteristics of Combined Plasma Arc, The Open Mechanical Engineering Journal, 2011, 5, 78-86

[6] Choquet I., H. Nilsson, M. Sass-Tisovskaya, Modeling and simulation of a heat source in electric arc welding.

[7] Murphy A., M. Tanaka, K. Yamamoto, S. Tashiro, J. Lowke, CFD modelling of arc welding –the importance of the arc plasma, Seventh International Conference on CFD in the Minerals and Process Industries CSIRO, Melbourne, Australia, 9-11 December 2009

[8] Traidia A., F. Roger, A. Chidley, J. Schroeder and T. Marlaud, Effect of Helium-Argon Mixtures on the Heat Transfer and Fluid Flow in Gas Tungsten Arc Welding, J. Chem. Chem. Eng. 5 (2011) 854-861p.

[9] Bauchire J., E. Langlois-Bertrand1, C. Izarra, Numerical Modelling of a Free-Burning Arc in Argon. A Tool for Understanding the Optical Mirage Effect in a TIG Welding Device, Proceedings of the COMSOL Conference 2009 Milan

[10] Aithala S. M., V. Subramaniam, Numerical model of a transferred plasma arc, Journal of Applied Physics, Volume 84, Number 7, 1998

[11] Uhrlandt D., M. Baeva, A. V. Pipa, R. Kozakov, G. Gött, Cathode fall voltage of TIG arcs from a non-equilibrium arc model, Weld World (2015) 59:127–135

[12] Jose Luis Tapia Fabela, Joel Osbaldo Pacheco-Sotelo, Marquidia Pacheco Pacheco, Jorge Samuel Bentez-Read, Regulo Lopez-Callejas, et al.. Modeling the Voltage Drop Across the Cathode Sheath in HPS. IEEE Transactions on Plasma Science, Institute of Electrical and Electronics Engineers, 2007, 35 (4), pp.1104-1110. <10.1109/TPS.2007.902125>. <hal-00188969>

[13] A. Boutaghane, K. Bouhadef, F. Valensi, S. Pellerin, Y. Benkedda. Theoretical model and experimental investigation of current density boundary condition for welding arc study. The European Physical Journal Applied Physics, 2011, 54 (1), <10.1051/epjap/2011100146>. <hal-00687330>

[14] Кузнецов М. С., Технология получения высокоэмиссионных материалов на основе гексаборида лантана в режиме самораспространяющегося высокотемпературного синтеза при механоактивации шихты, Диссертация на соискание ученой степени кандидата технических наук, 2016

[15] Benilov M.S., A. Marota, A model of cathode region of atmospheric pressure arcs, J. Phis. D: Appl. 28 (1995), 1869-1822.

[16] Shanping Lu, Wenchao Dong, Dianzhong Li, Yiyi Li, Numerical study and comparisons of gas tungsten arc properties between argon and nitrogen,Computational Materials Science 45 (2009) 327–335

[17] Зиновьев В. Е., Теплофизические свойства металлов и сплаввов при высоких температурах. Справочник, М. Металургия, 1989,

[18] E. W. Lemmon and R. T Jacobsenp Viscosity and Thermal Conductivity Equations for Nitrogen, Oxygen, Argon, and Air, International Journal of Thermophysics, Vol. 25, No. 1, January 2004 (© 2004)

[19] H. N. Olsen, Thermal and Electrical Properties of an Argon Plasma, Physics of Fluids 2, 614 (1959); doi: http://dx.doi.org/10.1063/1.1705962

[20] V. A. Baturin, Electrical conductivity of an argon plasma in a stabilized arc, Journal of Applied Mechanics and Technical Physics March 1970, Volume 11, Issue 2, pp 338–346

[21] G.J. Dunn and T.W. Eagar, Calculation of Electrical and Thermal Conductivities of Metalurgical Plasmas, WRC Bulletin 357

https://hypertextbook.com/facts/2004/DeannaStewart.shtml
http://www-ferp.ucsd.edu/LIB/PROPS/PANOS/w.html
http://thermalinfo.ru

ACKNOWLEDGEMENTS