13/2016

PRODUCTION ENGINEERING ARCHIVES

PRODUCTION ENGINEERING ARCHIVES

ARCHIWUM INŻYNIERII PRODUKCJI ***PRODUCTION ENGINEERING ARCHIVE,***
Vol. 13, No. 4

Editor' office: Department of Production Engineering nad Safety
Faculty of Management
Czestochowa University of Technology

Publisher: Printing House
The Managers of Quality and Production Association

Existsince 4th quarter 2013

Journal ***PRODUCTION ENGINEERING ARCHIVES*** is the international platform of the scientific exchange within the theory of the production engineering systems organizing and functioning theory. The area of interest focuses onthe following systems: production, quality, total machines maintenance, environmental protection, occupational health and safety, human resources management including elements of innovation and continuous improvement. Published works include technical, economic and social issues.

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ARCHIWUM INŻYNIERII PRODUKCJI
PRODUCTION ENGINEERING ARCHIVES

2016, Vol. 13, No 4, pp 2-6
ISSN 2353-5156 (print version)
ISSN 2353-7779 (online version)

Article history: Received: 22.11.2016 Accepted: 12.12.2016 Online: 30.12.2016

Available online on: http://www.qpij.pl **Exist since 4th quarter 2013**

Employees motivation in two wood industry companies in Croatia

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Abstract. This research analysed the motivating and demotivating factors amongst employees in two wood processing companies in Croatia. Research was conducted over the year 2014 and 2015, during the economic recovery of the companies and Croatian economy in general. Research was conducted with a survey using a questionnaire containing six questions with multiple choice statements. The questions were closed-ended, and respondents used the Likert four-level scale of importance for each statement. A total of 180 employees were surveyed, and results were statistically processed by using the χ^2- test and cluster analysis. This study established that the motivation factors most important to employees between researched companies are significantly different. Employees were most concerned about social needs. Also, employees consider psychological circumstances of work to be very important. Employees' overall motivation can be linked to higher efficiency and higher quality production and business results, and such research should be conducted more often.

Key words – wood processing, furniture manufacturing, employee motivation, demotivating factors

1. Introduction

To achieve a quality production result without the influence of technical-technological factors one of the most important factors to consider is employees' motivation for work. Motivated employees come to work with enthusiasm and a wish to fulfill their daily obligations in the most satisfying way because it guarantees that their business results would be on the level required, satisfaction with their results would be higher, and their salaries would be bigger. Unmotivated employees very seldom fulfill their obligations, so their production and business results are on a much lower level than required by the company or by the market (JELAČIĆ D. ET AL. 2010).

There are two groups of motivating theories: (1) motivation of contents and (2) motivation of the process. The first group of theories researches the factors that motivate towards a certain behaviour, and the second group of theories studies the reasons behind a certain behaviour. Among the contents theories, the most recognized are the Maslow theory of needs, and the Glasser theory of choice. It is assumed that all human behaviour is pointed towards satisfying one's basic needs (LIPIČNIK B. 1998; GLASSER W. 1999, GLASSER W. 1994, KROPIVŠEK J. ET AL. 2011, JELAČIĆ D. ET AL. 2008). Knowing the profile of a person's needs can help form the basis for making the right approach for efficient and successful leadership (KROPIVŠEK J. 2007, JELAČIĆ D. ET AL. 2007). Herzberg gives one of those main theories, which has two main parts, the factors or motivators and the hygienic factors, which help maintain the standard level of satisfaction (MOŽINA S. 1998).

Among the different process theories there is the theory of a problem, which is based on a statement that people are willing to solve problems. A problem automatically initiates some kind of reaction from an employee (LIPIČNIK B., MOŽINA S. 1993). The Hackman-Oldhamer model of enrichment is based on three key psychological circumstances, the importance of work, responsibility and knowing results, which all have an influence on motivation at the workplace (LIPIČNIK B., MOŽINA S. 1993). Fromm (FROMM E. 1996) gives a theory that says people work because they either want to have something or because they want to live up to be somebody/something one day.

Some newer research within companies for wood processing and furniture manufacturing (KROPIVŠEK J. 2003, KROPIVŠEK J., ROZMAN R. 2007) reveals the presence of organizational culture within a workplace, where the main goal is to motivate employees, which can represent an additional problem under certain given circumstances. It can be stated that almost all motivational factors lay in the hands of management. The main question remains: does management know how to use them (MOŽINA S. 1998)? Motivation means that somebody does something because he or she wants to do so, and what management has to do is to motivate and stimulate him or her in such a way (HERZBERG F. 2008, GEORGE J. M., JONES G. R. 1999). Motivation is the process of awakening a person's drive to pursue activities, with attention to certain details and regulation to achieve a certain goal while overcoming obstacles along the way (JELAČIĆ D. AT AL. 2010). It can be said that motivation contains factors such as enthusiasm, wish, intention, persistence, *etc.*, which motivate and point ones behaviour in a certain direction (DAFT L. R. ET AL. 2000). Previous research has shown that human activities are motivated by one or many known and sometimes unknown complicated factors (MOŽINA S. 2002). There are individual factors that influence human activities and they are very often part of human social life. Therefore, some routine motivating approaches may prove to be ineffective, because they are not adapted to each individual person within a company (LIPIČNIK B. 1998). The main goal of these activities aims to satisfy the wishes and expectations of one individual person, which are formed, based on his or her own material and social needs, desire for respect, independence, personal growth and development.

The presented ideas have led to the empirical research in two wood processing companies. The aim was to establish what motivating factors are most important to employees and their level of importance in two different companies.

2. Methodology of research

The research method for collecting the data was a survey conducted by means of a questionnaire for employees consisting of 6 questions. The conditions of key presumptions of different motivational theories were checked within the questionnaire. The questions were closed-ended, and respondents were using a four-level scale of importance for each statement: number 1 meaning never, 2 meaning sometimes, 3 meaning often, and 4 meaning always. A total of 180 employees (n) were surveyed in each of two wood processing companies. The survey was conducted over the years 2014 and 2015.

The differences in the frequency of answers given by employees between two companies were tested by the χ^2-test for each individual question. The hypothesis H_0 was that the distributions of answers to the same question given in both companies were equal. The test showed that there was a statistically significant difference between distribution of all answers given in two different companies (for all tested values $p<0.001$). The study aimed at establishing which answers to the questions given were closer to each other than others. Therefore a cluster analysis was conducted.

The clustering method was used to find distances between the questions. For computing the distances between the questions, the percent disagreement measure distance equation, (x,y) = (number of $x_i \neq y_i)/i$ was used due to the categorical nature of the answers. For the clustering algorithm the hierarchical single linkage known as the nearest neighbor method was used. In this method the distance between two clusters is determined by the distance of the two closest objects within the different clusters $d(C_iUC_j,C_k)=\min.(d(C_i,C_k), d(C_j,C_k))$. All statistical analysis and graphical presentations were conducted using the STATISTICA 10.0 statistical software.

3. Results

Using the χ^2 - test (Pearson's chi-squared test and p-values, where p<= 0.001 meaning that the differences are "very highly significant" (99.9%), where 0.001<p<= 0.01 meaning that the differences are "highly significant" (99.0%), where 0.01 <p<= 0.05 meaning that the differences are "significant" (95.0%), and where p> 0.05 meaning that the difference is "non-significant" (90.0%)), it was established that all the differences for all the questions were highly significant. Therefore, to establish the relationships between answers, the cluster analysis was used. Some of the results of the cluster analysis are given in the following graphs.

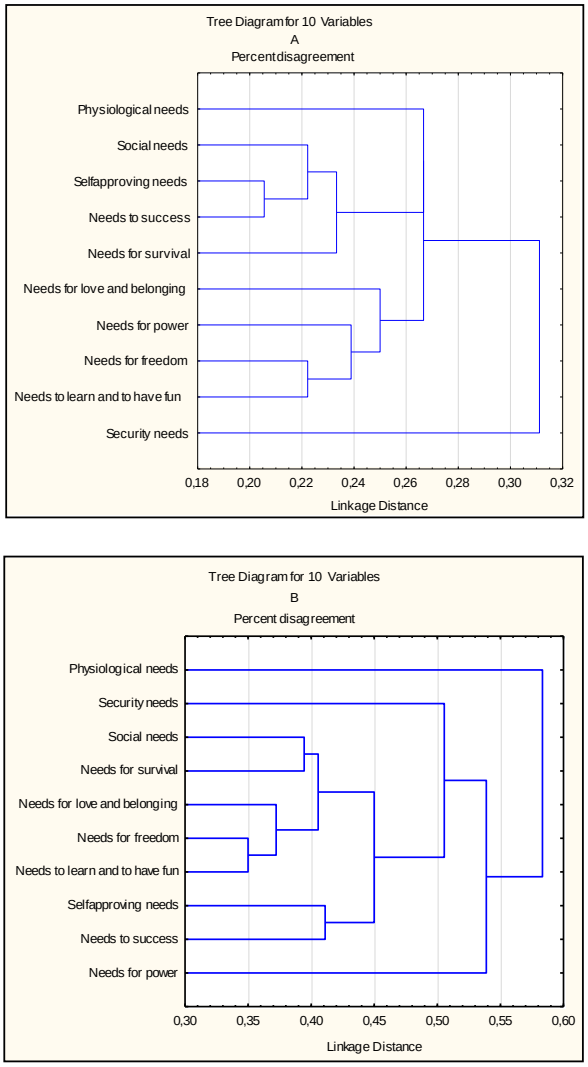

Fig. 1. Tree diagrams for the answers to question 1 (Which employees' needs do managers pay most attention to while managing?) for companies A and B.

Figure 1 shows that there was a strong relationship between self-approving needs and the need for success in company A, while there is a strong connection between the need for freedom and the need to learn and to have fun in company B.

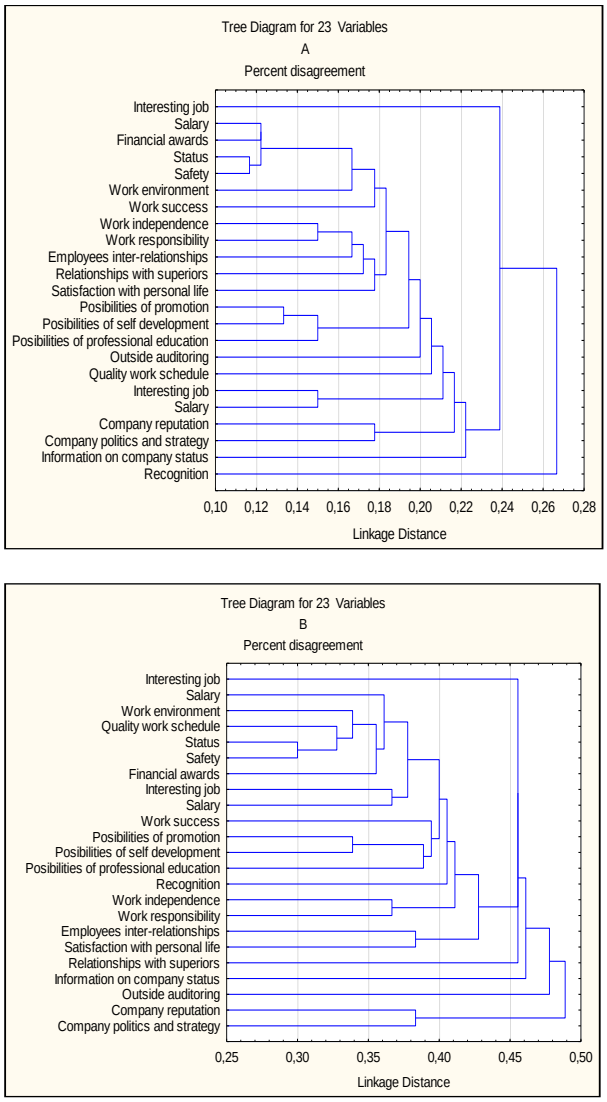

Fig. 2. Tree diagrams for the answers to question 2 (Which of these factors are important in motivation?) for companies A and B.

Figure 2 shows that the strongest relationship in both companies was between needs for status and safety, but the linkage distance is significantly different for each of the companies in the research. Also, in company A the next two needs in strongest relationship with status and safety are salary and financial gratification. In company B the in strongest relationship with status and safety is a need for quality work schedule. It

means that in company A employees are more interested in physiological needs while in company B they are more interested in social needs.

Answers to question 3 (Can a Problem Increase Your Activity (Motivate You)?) show the way that employees think about a problem as a motivator, and in both companies employees strongly connected a problem as a motivator and special conditions required to solve the problem. Again, the significant difference between two companies is the linkage distance between two answers (in company A the distance was 0.344, while in company B it was 0.530).

The linkage distance between two answers to the question 4, "Why do people work?," was significantly different between two companies. While employees in company A marked “having something” with higher average grade than employees in company B (3.68 comparing to 3.54), for “recognition” the average grade in company B was higher than in company A (2.85 comparing to 2.61).

Results of the cluster analysis for the question, “How psychological circumstances influence work (question 5),” show that employees in both companies consider sense of responsibility and work importance very important, but again the significant difference between two companies in the linkage difference between answers (the average grade of answers).

The last question, can be summarized by the following results in Fig. 3. Regarding demotivating factors and their presence in the company, employees considered different factors as more present in company A than those in company B. The strongest correlation is between the reprehending of employees and use of punishment in managing process, followed by a connection between less work to do and shortening of work hours in company A. In company B the strongest connection was between the use of punishment in managing and the creation of tension amongst employees, followed by less freedom at work.

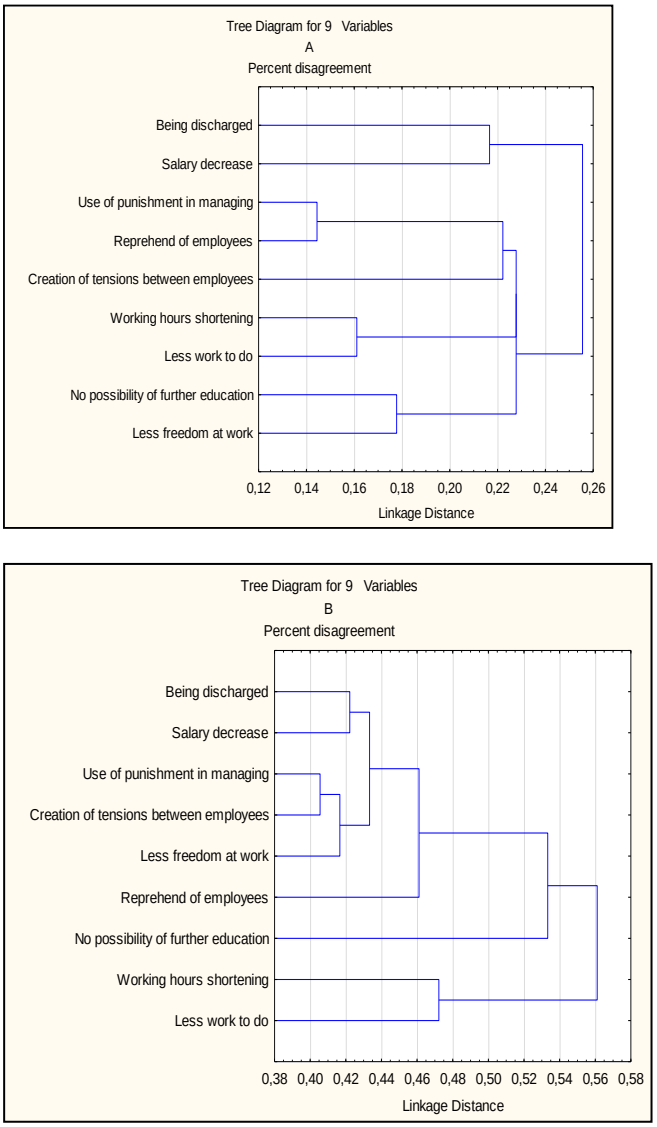

Fig. 3. Tree diagrams for the answers to question 6 (At what level do you notice demotivating factors in your company?) for companies A and B.

4. Conclusion

The aim of this research was to establish the differences between the motivation of employees in two wood processing companies. Research discovered that the differences between all given questions and answers were statistically significantly different, so the cluster analysis was conducted to establish the linkage distance between answers to all the questions separately for both companies in research.

The study discovered that employees consider different motivation factors as important in different companies. Which motivating factors are more impor-

tant to employees in different companies mostly depends on fulfilling of social and physiological needs, meaning that grading on importance of particular motivating factor depends on the work environment, managing skills of superiors, interrelationships between employees, work responsibilities, as well as on salaries and security of the job.

Demotivating factors and their presence in companies also have a significant influence on employees' satisfaction and motivation to work harder. Among demotivating factors employees mostly refer to managing skills of superiors, meaning they consider use of punishment in managing process the most important demotivating factor.

The next research of this type should be conducted in a year or two years from now, to investigate if a changed and improved work environment or some different managing skills among superiors, have a better or any different influence on motivating and demotivating factors in companies in research.

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ARCHIWUM INŻYNIERII PRODUKCJI
PRODUCTION ENGINEERING ARCHIVES

2016, Vol. 13, No. 4, pp 7-10
ISSN 2353-5156 (print version)
ISSN 2353-7779 (online version)

Article history: Received: 21.11.2016 Accepted: 11.12.2016 Online: 30.12.2016

Available online on: http://www.qpij.pl **Exist since 4th quarter 2013**

The assessment of castings quality using selected quantitative methods

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Abstract. Aluminium alloys represent an important category of materials due to their high technological value and wide range of applications. The alloys of the Al-Si-Cu system have become increasingly important in recent years, mainly in automotive industry that uses secondary aluminium (recycled) in the form of various motor mounts, pistons, cylinder heads, heat exchangers, air conditioners due to their high strength at room and high temperature. This work deals with possibilities of quick and correct assessment of aluminium castings microstructure, especially focused on volume, size and shape of structural parameters – eutectic Si and intermetallic phases different chemical compositions. These structural parameters affect the properties of castings and it is important to study their features. The features were studied by using image analyser software NIS Elements.

Key words – aluminium castings, image analyser software, quantitative analysis, structural parameters of aluminium cast alloys

1. Introduction

The castings quality has been evaluated with different methods of quantitative metallography. In the past (the evaluation of microstructure by etalons, measurement of structural parameters by coherent test grids, and so on.). Nowadays automatic image analysis is mostly used (SKOČOVSKÝ P. 1994)

The automatic image analysis comes from the same principles as the measurement of structural parameters by coherent test grids but this method makes use of the possibilities of a computer for the evaluation of the microstructure. The aim of image analysis is to reduce a considerable amount of data represented by a picture to several significant quantitative values. The image analysis enables the evaluation of different structural parameters, for example the evaluation of volume (area) ratio of phases and structural components, shape of particles, size of particles, count of particles per unit of area or volume, the measurement of distance between particles, length, width, diameter, angle, area or perimeter of particles, orientation of structure etc. in different materials (TILLOVÁ E. 2009, TILLOVÁ E. 2010, KONEČNÁ R. 2008, VAŠKO A. ET AL. 2007, VAŠKO A. 2006).

Inspection and testing of castings encompasses five main categories: casting finishing, dimensional accuracy, mechanical properties, chemical composition and casting soundness. Chemical composition markedly affect the formation of structural parameters in aluminium alloys and these parameters markedly affect the mechanical and fatigue properties. Based on the Al-Si system, the main alloying elements are copper (Cu) or magnesium (Mg) and a certain amount of iron

(Fe), manganese (Mn) and more that are present either accidentally, or they are added deliberately to provide special material properties. These elements partly go into solid solution in the matrix and partly form intermetallic particles during solidification. The size, volume and morphology of intermetallic phases are functions of chemistry, solidification conditions and heat treatment (DOBRZAŃSKI L. A. 2006a, DOBRZAŃSKI L. A. 2006b, DOBRZAŃSKI L. A. 2008, MANIARA R., TILLOVÁ E. 2009, TILLOVÁ E. 2010).

Whereas the quality of recycled Al-Si casting alloys is considered to be the key factor in selecting an alloy casting for a particular engineering application, the quantitative analysis with using software NIS Elements (VAŠKO A. ET AL. 2007, VAŠKO A. 2006, MARTINKOVIČ M. 2010, ULEWICZ R. 2014) was used for control of structural parameters in AlSi6Cu4 cast alloy.

2. Experimental material and method

Experiments were performed on AlSi6Cu4 cast alloy which was in three states: (a) as-cast without modification or grain refining; (b) after modification with optimal amount of antimony; and (c) after optimal heat treatment.

The experimental alloy was received in the form of 12.5 kg ingots. Ingots were casted in the foundry laboratory of Technological Engineering Department University of Žilina. The melting process and the modification were carried out in a graphite melting crucible in a resistance oven. For the grain refinement process refining salt AlCuAB6 for experimental material AlSi6Cu4 was used, and the process was carried out while overheating the metal bath to 730°C ± 5°C. Antimony was added to the melt in the form of AlSb10 master in the amount 0.1 wt. % (marked as 0.1% Sb). The optimum heat treatment consist of solution heat treatment at 505°C/6 hours and artificial aging at 170°C/8 hours – marked as T6 (HURTALOVÁ L. 2014). Chemical composition of experimental material is given in Table 1.

Experimental material AlSi6Cu4 alloy has a lower corrosion resistance and is suitable for high-temperature (up to max. 250°C) applications (dynamically exposed casts): pistons, cylinder heat, water-jacket, gearbox and so on (NÁPRSTKOVÁ N. 2013a, NÁPRSTKOVÁ N. 2013b, HANSEN S. C. 2000).

Table 1. The chemical composition of the AlSi6Cu4, wt. %.

Si	***Cu***	***Fe***	***Mn***	***Mg***	***Cr***
6.52	*3.88*	*0.43*	*0.45*	*0.29*	*0.01*
Ni	***Zn***	***Ti***	***Al***		
0.01	*0.46*	*0.15*	*base*		

The samples for metallographic observations (1.5 cm x 1.5 cm) were prepared (wet ground, polished with diamond pastes, finally polished with commercial fine silica slurry (STRUERS OP-U) by standards metallographic procedures. The microstructures were studied using an optical microscope Neophot 32. Samples were etched by standard reagent Dix-Keller, and HF.

Quantitative metallography was carried out on an Image Analyzer NIS - Elements to quantify eutectic Si and intermetallic phases at magnification 500 x.

3. Experimental results

Morphology (shape), distribution, volume and size of Si particles markedly affect mechanical properties.

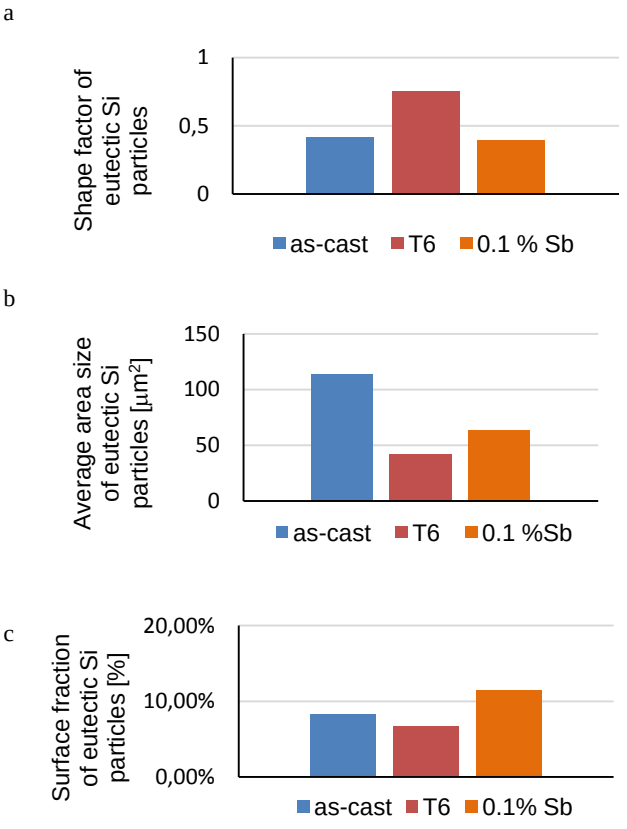

Fig. 1. Quantitative analysis of eutectic Si particles. (a) shape factor; (b) average area size; (c) surface fraction.

The experimental quantitative analysis focused on study the area size, surface fraction (volume) and shape factor (morphology) of these particles in order to evaluation the effect of heat treatment and modification (Fig. 1).

The best value of shape factor, which represents perfectly round particles is 1. The experimental results show that the nearest value to 1 has the state after heat treatment of experimental material (0.75 - Fig. 1a). The state after modification (0.39) is comparable with an as-cast state (0.41 - Fig. 1a). The evaluation of area size shows that the minimum area size have the experimental material after heat treatment (42 μm^2 – Fig. 1b), than after modification (63 μm^2 – Fig. 1b) and in as-cast state the area size was the highest – 113 μm^2 (Fig. 1b).

The evaluation of surface fraction shows that the highest is in state after modification (11%) and the lowest is in state after heat treatment (6.7%). The quantitative assessment shows that the best morphology and size of eutectic Si particles is achieved in state after heat treatment, and it is expected that in this state it would have the best mechanical properties, but the morphology and size of intermetallic phases are very important, too.

From intermetallic phases two types were evaluated: Cu-rich – ternary eutectic and Fe-rich – skeleton like. These two types of intermetallic phases were observed in microstructure of experimental material (HURTALOVÁ L. 2015, TILLOVÁ E. 2009, TILLOVÁ E. 2010).

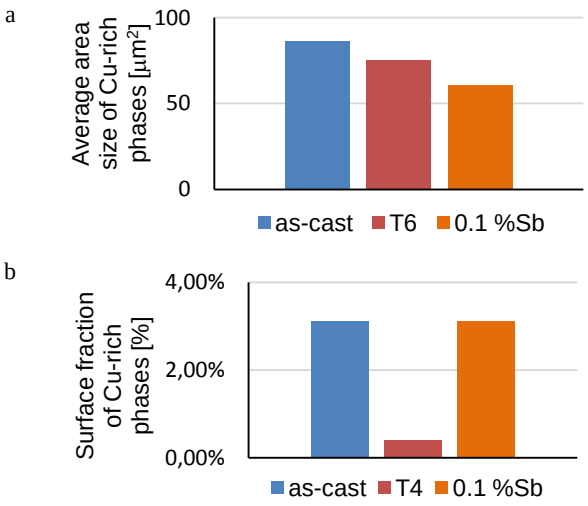

Fig. 2. Quantitative analysis of Cu-rich intermetallic phases. (a) average area size; (b) surface fraction.

The evaluation of intermetallic phases ~~was~~ focused on study their area size and surface fraction (volume) in order to evaluation the effect of heat treatment and modification (Fig. 2, 3).

The quantitative assessment of Cu-rich phases shows that minimum average area size was after modification 60.5 μm^2 (Fig. 2a). In state after heat treatment area size was 75.4 μm^2 and in as-cast state 82 μm^2. The surface fraction was minimum after heat treatment 0.4% and in as-cast state and state after modification was the same 3.1% (Fig. 2b). The assessment of Cu-rich phases shows that Cu-rich phases were fragmented and dissolved in to the matrix in the state after heat treatment the most and, therefore, it is supposed that a material in this state would have the best mechanical properties (TILLOVÁ E. ET AL. 2009).

The quantitative assessment of Fe-rich phases shows that the minimum average area size was after modification 35 μm^2 (Fig. 3a). In state after heat treatment was area size 72 μm^2 an in as-cast state 106 μm^2. The modification caused a significant changes of Fe-rich intermetallic phase's size. The surface fraction was minimum after modification (2.9%) an in as-cast state (2.7%) (Fig. 3b). The maximum surface fraction of Fe-rich phases was after heat treatment (4.4%). The assessment of Fe-rich phases shows that these phases were fragmented and coarsened in state after modification the most (TILLOVÁ E. ET AL. 2010).

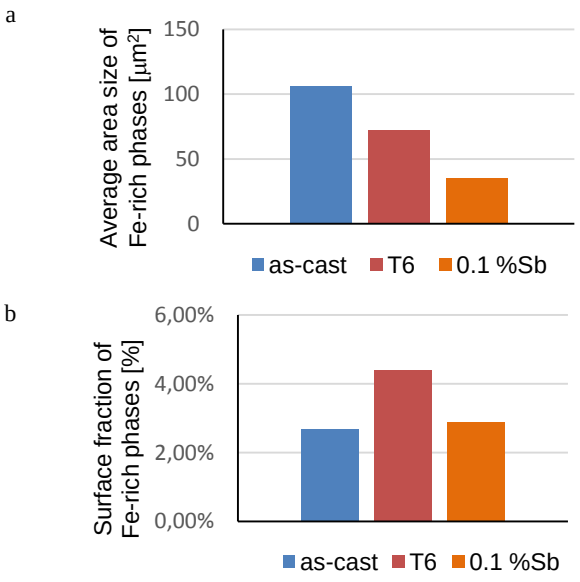

Fig. 3. Quantitative analysis of Fe-rich intermetallic phases. (a) average area size; (b) surface fraction.

9. Summary and conclusions

The quantitative assessment by using image analyser software NIS Elements was used for study the size, volume and morphology (shape) of structural parameters (Si particles, Fe-rich and Cu-rich intermetallic phases) in experimental material AlSi6Cu4.

The evaluations shows that this material has the large eutectic Si particles, Cu-rich and Fe-rich intermetallic phase in as-cast state. This morphology is insufficient because the mechanical properties affect these particles, therefore material was heat treated or modified.

The average area size of all particles was decreasing while using heat treatment and modification. The results shows that heat treatment has a greater effect on area size of eutectic Si particles and modification on intermetallic phases. Therefore, it is best when these methods are used together.

Acknowledgements

This work has been supported by Scientific Grant Agency of Ministry of Education of Slovak Republic and Slovak Academy of Sciences, No1/0533/15, No 044ŽU-4/2014.

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ARCHIWUM INŻYNIERII PRODUKCJI
PRODUCTION ENGINEERING ARCHIVES

2016, Vol. 13, No. 4, pp 11-15
ISSN 2353-5156 (print version)
ISSN 2353-7779 (online version)

Article history: Received: 18.11.2016 Accepted: 15.12.2016 Online: 30.12.2016

Available online on: http://www.qpij.pl **Exist since 4th quarter 2013**

Employing various metallography methods at high temperature alloy fatigue tests evaluation

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Abstract. Microstructures of superalloys have dramatically changed throughout the years, as modern technology of its casting or forging has become more sophisticated. The first superalloys have polyedric microstructure consisting of gamma solid solution, some fraction of gamma prime and of course grain boundaries. As demands on higher performance of aero jet engine increases, the changes in superalloys microstructure become more significant. A further step in microstructure evolution was directionally solidified alloys with columnar gamma prime particles. The latest microstructures are mostly monocrystalline, oriented in [001] direction of FCC gamma matrix. All microstructure changes bring necessity of proper preparation and evaluation of microstructure. Except for the already mentioned structures have gamma double prime and various carbides form can be seen. These structural parameters have mainly positive influence on important mechanical properties of superalloys. The paper deals with a microstructural evaluation of both groups of alloys – cast and as well as wrought. Microstructure evaluation helps to describe mechanism at various loading and failure of progressive superalloys. Such an example where microstructure evaluation is employed is fractography of failure surfaces after fatigue tests, which are examples of metallography evaluation described in this paper as a secondary objective.

Key words – Ni-base casting and wrought alloys, gamma prime, gamma double prime, gamma solid solution, light microscopy, scanning electron microscopy (SEM)

1. Introduction

The prime objective of metallography is to understand the relationship of composition, processing, and mechanical behaviour to the microstructure (RADAVICH J. F. 1997).

Superalloys are complex alloys of Fe-Ni, Ni-, and Co-base compositions. Their microstructure can be quite complex due to the potential for a variety of phases that can form in heat-treatment or service exposure conditions.

Preparation of superalloys for microstructural examination is not exceptionally difficult. The procedures are similar to those used to prepare stainless steels. Because they are face centred cubic (FCC) "austenitic" alloys with exceptionally good toughness, their machinability is poorer than for steel, and the age hardened alloys, especially the cast alloys, can be more difficult to section than most steel–when it has a very high γ'- phase content (VANDER VOORT G., MANILOVA E. P. 2004).

The whole metallography specimen preparation process consists of a few fundamental steps. The first

step is cutting-off a specimen with proper dimensions (average surface size is 1 cm^2). Then the preparation is followed with a specimen mounting.

After mounting, preparation continues with grinding and polishing of specimens. Polishing usually commences with either 6 μm or 3 μm diamond abrasive, as a paste, slurry, or aerosol with the appropriate liquid extender/lubricant on a cloth pad. The first polishing step is followed with a second diamond abrasive step, generally 3 or 1 μm in size, or they used one or two steps with aqueous aluminium oxide slurries (www.georgevandervoort.com).

Numerous etchants are used to reveal the structure of superalloys. Some minor second-phase particles can be easily observed in the as-polished condition using bright field illumination. Obviously, non-metallic inclusions can be best observed in the as-polished condition.

However, even when such amount of etchant for superalloys is available, the use of the proper one depends on specific superalloy type (wrought or cast superalloy, differences in chemical composition, heat-treatment and so). It has been found that conventional mechanical polishing and immersion etching does not reveal equally well the various phases that can be present in alloy 718. In many cases depending on the thermal treatments, the corrosion behaviour of the alloy can necessitate stronger acid solutions or longer etching times or both (RADAVICH J. F. 1988). There are slightly different approaches for metallography of cast and wrought superalloys. For cast superalloys it is significant to reveal a dendritic microstructure to help evaluate the secondary dendrite arm spacing. On the other hand, wrought superalloys metallography evaluates the grain boundary and deformation, as well as crystallization twins.

The colour etching (SKOČOVSKÝ P., PODRÁBSKY T. 2001) is a quite novel method to reveal microstructure of superalloys and adds an interesting dimension into microstructure evaluation. Anyway, colour etching is not only way how to add some colour to microstructure. Using of DIC (Differential Interference Contrast) or Nomarski polarisers work well and gives satisfied results.

2. Experimental material and methods

The Ni-base superalloys in cast and wrought form were used as experimental materials. From cast superalloys group is alloy ŽS6K (which is former USSR cast superalloy) and the second group of wrought superalloys is Inconel's Alloy 718. The chemical composition of experimental materials is listed in Table 1.

Metallography specimens were prepared by cutting on MTH Micron 3000 precise saw, and mounting into bakelite mixture in Struers Cito-Press 1 and, finally, they were grinded and polished with of Struers Tegra-System (TegraPol-15 and TegraForce-1).

Table 1. The chemical composition of experimental superalloys (in wt. %)

Alloy	C	Co	Nb	Ti	Cr	Al	W	Mo	Fe	Mn
ŽS6K	0.2	5.5	-	3.2	12	6	5.5	4.8	2	0.4
Alloy 718	0.026	0.14	5.3	0.96	19.31	0.57	-	2.99	11.15	0.07

*Ni content is balance, Source: own study

Grinding and polishing consist of a few steps; grinding with SiC sand paper No. 320, followed by medium polishing with MD-Allegro and fine polishing with OP-S lubricant.

All the mentioned procedures for cast and wrought superalloys were used while preparing metallographic specimens after high frequency, and high cycle fatigue test via push-pull loading of IN 718 superalloy, as well as low frequency fatigue testing of three point bending load for the same superalloy.

Fatigue test at push-pull loading was done at frequency of f = 20 000 kHz at R = -1 and three point bending test was done at frequency f = 150 Hz with R = 0.11. For all fatigue tests number of cycles $N_f = 10^7$ were considered as fatigue lifetime limit σ_c. After tests also SEM fractography of fracture surfaces was performed.

3. Results of experiments

Microstructure of Ni-base superalloys is formed in dependence of chemical composition as follows:

Chromium, *Cobalt*, and *Ferrum* creates the substitution solid solution called γ- phase (also known as

matrix). This phase has austenitic FCC lattice. Solid solution provides fundamental strength characteristics of superalloys (BELAN J. 2012).

Aluminium and *Titanium* are considered as main elements responsible for hardening of solid solution via precipitation mechanism when forms γ'-phase ($Ni_3Al(Ti)$ gamma prime). Gamma prime phase is coherent to solid solution FCC matrix γ and has $L1_2$ lattice. Unique properties of superalloys are closely related to fraction of γ'-phase. Its optimum size for high-temperature application is 0.35 μm - 0.45 μm where superalloys combine satisfactory creep rupture strength and yield strength Rp0.2 (DONACHIE M. J., DONACHIE S. J. 2002).

Niobium and *Tantalum* when presented in superalloy at higher amount, may form hardening phase γ" (Ni_3Nb gamma double prime), which is considered as main precipitation hardening phase in Alloy 718 type. Gamma double prime crystalizes in DO_{22} lattice and is characterized by disk-like shape with the small dimension aligned along the three [001] directions. In addition, there are some γ′ precipitates present on which the particles γ′′ have been shown to precipitate (PINEAU A., ANTOLOVICH S. D. 2009).

Molybdenum and *Tungsten* form carbides when the amount of Carbon is sufficient. While carbon addition is beneficial for grain boundary ductility, the large carbides that form can adversely affect fatigue life (length greater than 0.005 mm) (CETEL A. D., DUHL D. N. 1988).

Cast superalloys microstructure is characterized by dendritic segregation, Fig. 1. Dendritic segregation is formed due to a significant chemical heterogeneity and secondary dendrite arm spacing (SDAS - factor) is very often evaluated as typical for cast superalloys. The colour metallography may help to identify carbide particles formed in inter-dendritic areas (Fig. 1).

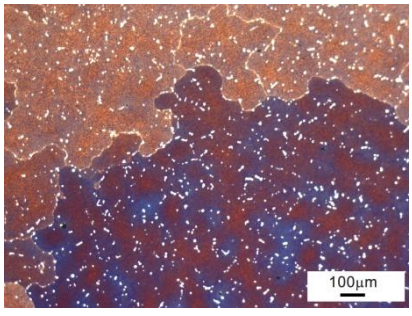


Fig. 1. A dendritic segregation in cast superalloys, ŽS6K; etch. Beraha III.

Microstructure of wrought superalloys consist of polyedric grains of various size, and depends on mechanical working. Due to mechanical history of microstructure, the deformation twins is presented in such a microstructure very often, Fig. 2.

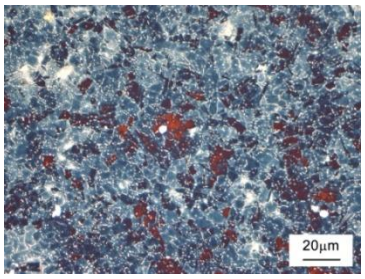


Fig. 2. A typical microstructure of wrought superalloys with polyedric grains and deformation twins, Alloy 718; etch. Beraha III.

SEM (Scanning Electron Microscopy) is employed for more detailed microstructure observation for a metallography process. At higher magnification it is possible evaluate morphology of γ'-phase and in some cases is possible to observe a γ/γ' eutectic cells formed especially in cast superalloys, Fig. 3.

From experimental fatigue data, S-N curves were plotted.

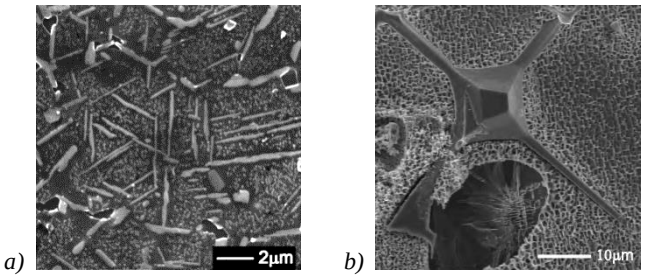
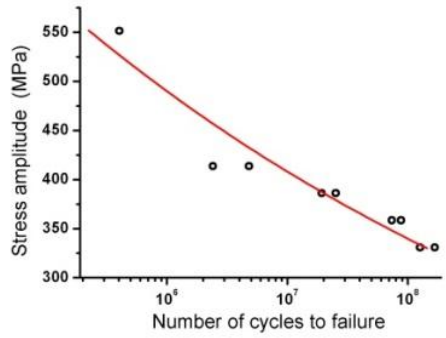


Fig. 3. SEM micrographs of a) alloy 718, electrolyte etching, CrO_3+H_2O (2V, 1s, 90 mA/cm^2) to reveal γ'-phase and δ-phase after annealing at 800 °C/72 hrs b) γ/γ' eutectic cells, morphology of $M_{23}C_6$ carbides is also visible, ŽS6K superalloy; etch. Marble.

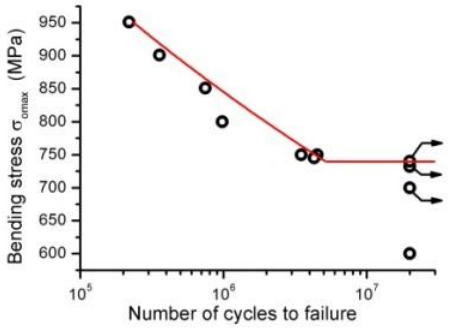
Results can be seen at Fig. 4 where Fig. 4a reports fatigue lifetime curve for push-pull loading and Fig. 4b reports fatigue lifetime curve for three point bending loading (BELAN J. ET AL. 2014, UHRÍČIK M. ET. AL. 2016, KOPAS P. ET. AL. 2014, BOKŮVKA O. ET. AL. 2012). It is obvious that loading mechanism has an important influence on fatigue lifetime limit σ_c. While at push-pull high frequency is σ_c = 330 MPa at N_f = 1.68 .10^8 at three point flexure low frequency loading

was σ_c = 700 MPa (almost twice as high as push-pull loading) at $N_f = 2.01 .10^7$. SEM observation of fatigue fracture surfaces is shown at Fig. 5.

At higher volume of loading ~~a~~ multiple initiation sites can be seen in both cases, push-pull as well as three point flexure loading (Fig. 5a,b). After fatigue crack initiation, the major crack propagates at perpendicular direction to main loading and creates the so called "striation". It was characterised by transcrystalline mechanism of propagation (Fig. 5c, d).

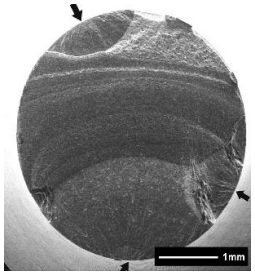


a)

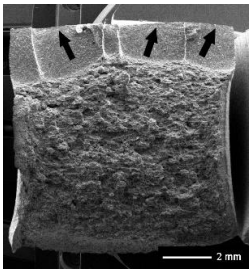


b)

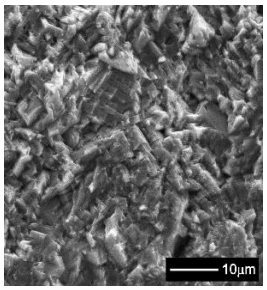
Fig. 4. Fatigue lifetime S-N curves for a) push-pull, high frequency loading, and b) three point bending, low frequency loading.



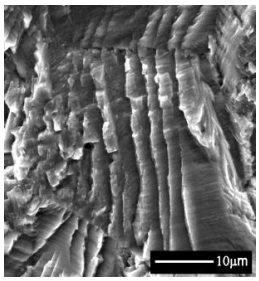
a)



b)



c)



d)

Fig. 5. SEM observation of fracture surfaces after fatigue tests; a-b) initiation site at higher cyclic loading, note three initiation points for push-pull (a) and three point flexure (b); (c-d) stable fatigue crack propagation characterised by striation (c is for push-pull; d for three point flexure).

4. Conclusions

The metallography of cast and wrought Ni-base superalloys is discussed in this paper. After preparation metallography specimens are etched with various reagent (chemically or electrolytic) which provide different results. Also colour etching for better identification of structural characteristics is successfully used at superalloys.

Metallography of cast superalloys has its own specifications because of significant dendritic segregation and its main task is to reveal dendritic structure of cast superalloys to help calculate and evaluate SDAS-factor.

On the other hand, wrought superalloys are prepared with the aim to reveal grain boundary and grain size. Its further objective is to evaluate deformation history of wrought superalloys such as the presence of deformation twins in structure.

No matter whether cast or wrought superalloys are taken into consideration, SEM is powerful tool to evaluate morphology of γ'-phase, and observe morphology of primary and secondary carbides. For example, coarse γ'-phase means decreasing of mechanical properties due to easier slip of dislocations. To achieve this aim are deep etching or electrolyte etching employed to reveal microstructure.

All described metallography techniques were employed to evaluate samples where the fatigue tests were applied. Metallography is a powerful tool for fatigue failure mechanism description and provides information how microstructure is related to mechanical properties. SEM observation reveals e. g. initiation

sites of fatigue cracks, mechanism of crack propagation (striations and transcrystalline ductile mechanism of propagation), to static ductile dimple failure.

Acknowledgment

The authors acknowledge the financial support of the projects VEGA No. 1/0533/15, KEGA No. 044ŽU-4/2014.

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ARCHIWUM INŻYNIERII PRODUKCJI
PRODUCTION ENGINEERING ARCHIVES

2016, Vol. 13, No 4, pp 16-19
ISSN 2353-5156 (print version)
ISSN 2353-7779 (online version)

Article history: Received: 20.11.2016 Accepted: 14.12.2016 Online: 30.12.2016

Available online on: http://www.qpij.pl **Exist since 4th quarter 2013**

Significance of factor describing visual control in the second management principle of Toyota in the automotive supply industry

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Abstract: The article presents research results in a scope of evaluation importance in visual control usage in the production processes of enterprises from automotive industry. The significance of visual control in a production process was characterized. An innovative BOST questionnaire survey was described as a tool for transformation of Toyota's management principles into questions. The survey questions from BOST study were described, which is used in evaluation of the visual control importance with reference to the second Toyota's management principle (question E3). The analysis of respondents preference in ranging factors of the second Toyota's management principle was conducted using comparative evaluation of Thurstone's method, as well as the degree of similarity between these factors was indicated. A subjective factor was assessed by employees of automotive industry as one of less significant in the production process.

Key words – visual control, statistical analysis, BOST method, automotive supply industry

1. Significance of visual control in production process

Visual control is known as well as visibility management, management by visibility or management by sight. Visual control is a lean technique; a way of communicating; a type of control; a system; a type of workplace management; a method of problems visualization. The concept of visual controls is the major part of a Lean manufacturing system, which focuses on waste reduction (ORTIZ CH. O., PARK M. R. 2011)

Visual control is a system that helps organizations create and sustain a competitive advantage in two significant ways. First, it ensures that an organization's internal structure, management systems, work environment, and culture are aligned with its mission and values. Second, it focuses employees' attention on critical performance goals, making sure that employees know what is expected of them at all times and are committed to the organization's success (LIFF S., POSEY P. A. 2007). Visual control is the type of control that will enable even person such as the company president, or other upper-level executives who know very little about the plant, to apprehend a certain amount of important information about the plant (namely, the progress status of the manufacturing processes, the amount of raw materials and work-in-progress being held in inventories, the number of defects generated, which machines and equipment are out

of production and why, and the like) merely by walking through the plant and observing it; which, in turn, will allow these executives to point out problems and make suggestions concerning how to deal with them.

Visual control is any communication device used in a work environment that shows how work should be done and whether it is deviating from the standard (LIKER J. K. 2005). Visual control includes measures, instruments or mechanisms, which were designed for the sake of management or operation of control (process) in order to fulfil the defined objectives. It is an important element in 5S practice. Visual workplace is self-ordering, self-explanatory, self-regulating and self-improving work environment – where, whatever is supposed to happen, will invariably happen, a result of visual solutions. Visual control includes different approaches, which cause that the state of process is visible at first glance (MANN D. 2005).

Jeffrey K. Liker, an expert on the Toyota's production system, points at the basic aim of visual control, i.e. visual control, above all, is supposed to help to identify problems and to show divergences between objectives and the current situation. When deviations from standards are visible and obvious for everyone, there is a possibility of immediate corrective actions in order for these problems to be solved. According to Liker, the visual aspect of this control consists in the fact that it is possible to examine a process, a machine, an element of supplies, information or an employee performing a task, and to notice immediately a standard adopted for them along with possible deviation from it.

Masaki Imai, the world-famous kaizen expert, distinguished three basic objectives (principles) of visual control: first – indication of problems. If deviation from the norm cannot be detected, nobody can manage the process; second – help both employees and supervisors in staying alert as far as reality in the workplace is concerned (gemba). Visualization of deviations from the norm for all employees – managers, supervisors and linear employees – enables immediate corrective actions; third – show and explain the purpose of improvements. The existence and visualization of purpose are a basic motivator for people, as Imai states, *"numbers aren't enough…, without purpose numbers are dead"* .

Based on literature analysis in the content of visual control (HIRANO H. 1995) it is possible to specify the following specific objectives of visual control: organization of workspace so that all people (even those from the outside) could state whether everything is going well or badly, without expert assistance; allowing an employee orientation in the new environment that is described, identified and ordered; simplification of determined events perception, and owing to that shortened response time of the operator to existing incident; showing the operation or work status in an easy to see format; providing instruction; providing information; causing that problems, irregularities, or deviation from standards are visible for everyone, i.e. corrective actions can be performed immediately; ensure immediate response from people.

2. Idea of the second management principle of Toyota

A survey and research method determined as BOST - the name of the is an acronym created from the first two letters of the name and surname of its creator, Stanislaw Borkowski, a professor of technical and economic sciences. The acronym, which is legally protected (BORKOWSKI S. 2012A), was formed as a result of the author's fascination in Toyota Motor Company, in its management and production system, enhanced after reading a book by Jeffrey Liker "The Toyota Way: 14 Management Principles from the World's Greatest Manufacturer".

BOST studies are aimed to prove that in enterprises operating in Poland, irrespective of conducted activity, the employees unconsciously use management principles about which perhaps they never heard. These are principles of Toyota's management principles (BORKOWSKI S. 2012B). In relation to BOST study over 50 publications presenting practical results of the use of this method in various organizations were used (BORKOWSKI S., KNOP K., RUTKOWSKI T. 2011). An issue of visual control evaluation in BOST questionnaire form appears in question E3. The content of question E3 is "a response" to the second Toyota's management principle, ordering "to create continuous process flow to bring problems to the surface". Area marked as E3 is described a set of six factors, among which is the factor of *visual control usage* (SW). The

content of question E3 is: what is the most important factor in the production process? In the box write 1, 2, 3, 4, 5, 6 (6 the most important element) (BORKOWSKI S. 2012C).

CP		Continuous system of disclosuring problems
PE		Production interruption after detecting quality problem
SZ		Standard tasks, processes, documents
EU		Delegate authority down
ST		Applying exclusively a reliable technology
SW		Usage of visual control

BOST questionnaire survey – Toyota's management principles in questions were conducted amongst 10 enterprises from the automotive industry. A research area included companies from the area of Silesian province in Poland. The research objects were direct suppliers (Tier 1) and companies from the second in the chain of subcontractors (Tier 2). A preliminary condition for classification of the companies to BOST study was confirmed information about implementation of visual control system in the workstations in the analysed company.

3. Creation of significance series of discussed factors

The analysis of the importance of visual control use in the production process of automotive industry was carried out. For that purpose, answers to question E3 were analyzed from BOST questionnaire form, which is a reply to the second Toyota's management principle. As a part of analysis in the obtained replies the structure of evaluations to subjective factor was presented. Analysis results were presented in Fig. 1.

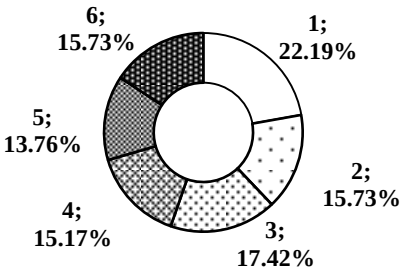

Fig. 1. Percentage ratings structure for the use of visual control (SW) factor.

Rating most often granted by respondents to subjective factor was "1" (22.19% of readings), and most rarely – "5" (13.42% of readings). Analysis of ratings distribution indicates intermodality, no consensus as to the importance of this factor in cross-section of all examined enterprises from the automotive industry.

Average rating to examine factor was 3.29 ± 1.76. The most frequently occurring value was 1. Calculation results of such positional statistical parameters as median, quartiles and range were presented using box plot with reference to all factors of the production process (Fig. 2).

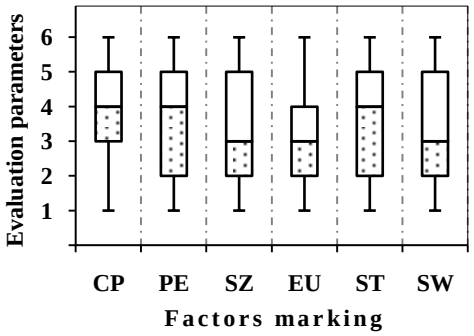

Fig. 2. Box plot diagrams for the factors of the second Toyota's management principle.

Box plot provided a lot of valuable information about rating distribution to the examined factor. Values of interquartile range shows that half of respondent replies were between the value of "2" and "5". Median rating was "3", i.e. half of polled employees pointed at lower than "3" and half at higher than "3". Median value, which is closer to the first quartile Q_1, indicates right-handed asymmetry of distribution in 50% central ratings. Identical height of tendrils and central location of box points at the symmetrical distribution of all ratings. A similarity in distribution of positional statistical parameters was recorded between the subjective factor and factor of standard processes, tasks and documents (SZ). In the following part of the article it was verified whether this relation is statistically significant. A place of subjective factor was analyzed amongst the remaining factors of the second Toyota's management principles in ranks of importance for individual ratings 1-6 (Table 1). Subjective factor SW was assessed as one of the most important in case of "1" and "3" rating and as one of the least important in case of "4", "5" and "6" rating.

Table 1. Analysis of the causes and consequences of errors in the calculation of the bearing capacity of the slewing bearings

Ranking	1	2	3	4	5	6
1	EU	**SW**	SZ	CP	ST	PE
2	SZ	EU	PE	ST	**SW**	CP
3	EU	**SW**	ST	SZ	PE	CP
4	SZ	PE	ST	**SW**	CP	EU
5	CP	ST	PE	**SW**	SZ	EU
6	CP	PE	ST	**SW**	SZ	EU

The analysis showed that SW factor was more preferred by respondents over only two factors of the production process i.e. delegate authority down (EU) and standard tasks, processes and documents (SZ). In other cases it is a less preferred factor of the production process. A graphical compartment of one-dimensional marking scale of comparative assessments was created (Fig. 3).

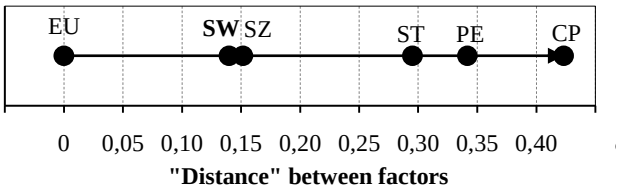

Fig. 3. One-dimensional marking scale of comparative assessments of second Toyota's management principle factors.

From Fig. 3 results that are possible to distinguish four groups of preferred factors in the structure of factors of the second Toyota's management principle in the analyzed industry. The least preferred factor (the first on the left) is delegate authority down (EU), rank among the second group of preferred factors are two factors i.e. standard tasks, processes and documents (SZ) and a subjective factor SW (degree of similarity between these factors is the greatest), the third group of factors includes production interruption after detecting quality problem (PE) and applying exclusively a reliable technology (ST), and the most preferred factor among all examined industry turned out to be continuous system of discloursing problems (CP).

4. Conclusions

An analysis of collected responses from employees of 10 companies from the automotive industry was carried out. Percentage structure of votes to the factor of visual control used in the production process was described. Statistical analysis of a reply to examined factor was carried out using statistical parameters of position and box-tendrils graphs. A place of subjective factor was analyzed amongst factors of the second Toyota's management principle in ranges of the importance for individual evaluations. Comparative evaluation of the Thurstone's method was used in order to create a scale of factor preferences of the second Toyota's management principle. The analysis showed that subjective factor was the most similar in evaluations to the factor of standard tasks, processes and documents (SZ). The subjective factor SW is preferred only by 0.28% from the SZ factor. The SW factor was the one of least significant in the production process factors of analysed companies from automotive industry.

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PRODUCTION ENGINEERING ARCHIVES

2016, Vol. 13, No. 4, pp 20-25
ISSN 2353-5156 (print version)
ISSN 2353-7779 (online version)

Article history: Received: 05.12.2016 Accepted: 16.12.2016 Online: 30.12.2016

Available online on: http://www.qpij.pl **Exist since 4th quarter 2013**

Fractography analysis of Inconel 718 fatigued at 700°C

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Abstract. This work deals with the fractography analysis of nickel-base superalloy Inconel 718 fatigued at 700°C in air atmosphere in the high cycle region. During cyclic loading of this alloy at high temperatures some different mechanisms compared to cyclic loading at ambient temperature take place. Cyclic plastic deformation at high temperatures causes some structural changes, which could have some influence on the fatigue process.

Key words – Inconel 718, high temperature fatigue, fractography analysis

1. Introduction

Inconel 718 is precipitation hardenable nickel-base superalloy characterized by excellent mechanical properties in wide range of working temperatures (from -250°C up to 700°C), good corrosion resistance and good weldability. These properties are a result of specific microstructure consisting of gamma matrix (substitution solid solution of alloying elements in nickel), strong coherent precipitates gamma double prime (Ni_3Nb) and gamma prime (Ni_3Al,Ti), delta phase (non-coherent, stabile form of Ni_3Nb with orthorhombic lattice) which is located along grain boundaries. In structure there are also carbidic and carbonitridic particles, which even their considerably small content, and have significant influence on the fatigue process, especially in the high temperature loading regime. The characteristics of the individual structural components are well described in the works of BELAN J. 2015, KALLURI S. ET AL. 1994, DARECKÝ J. 2001, and many others. Cyclic plastic deformation in synergy with high testing temperature can cause a phase transformation in the structure of Inconel 718, which might have significant influence on the fatigue process and its stages. Field of the high cycle fatigue of In 718 at ambient temperature is well described by many authors (BELAN J. ET AL. 2016, DONACHIE M. J. 2002). In this type of loading usually crystallographic initiation takes place in the suitable oriented grain at the surface region. Fatigue crack propagation is transcrystalline through facets of individual grains. High cycle fatigue at high temperature of this alloy is usually investigated up to 650°C, even the highest possible operating temperature for In 718 is 700°C according to manufacturers and published TTT diagrams (RADAVICH J. F. 1989) etc. Therefore, the fatigue

process of Inconel 718 loaded at 700°C is not well explored. Another important factor is that most published papers about high temperature fatigue of In 718 were carried out by considerably low frequency testing machines where the effect of environment (oxidation at high temperatures) has strong impact on the fatigue test. According to the study of (ABIKHI M. ET AL. 2013), during high temperature cyclic loading significant changes in the initiation mechanisms can occur. During the high temperature cyclic loading at small frequencies initiation on the carbidic and carbonitridic particles was observed, which is caused by a phenomenon called oxidation assisted crack initiation which is well described in the study of (ABIKHI M. ET AL. 2013). In very special cases, when the oxidation attack on the grain boundaries is large enough, the change of the fatigue crack propagation can occur, and the intercrystalline crack propagation could be seen in the fracture surfaces. The aim of this study is to describe fatigue process of alloy Inconel 718 in terms fractography of the fracture surfaces after cyclic loading at 700°C, at an average frequency of 87Hz, which is according to published papers, high enough to eliminate the influence of the environment.

2. Experiment

To perform fatigue process nickel-based alloy Inconel 718 in form of rods was used, from which specimens were machined. Material was heat treated solution annealed at 980°C/1h and aged at 720°C/8h and subsequent cooled to 620°C and hold 8h at this temperature. Chemical composition and the mechanical properties are shown in the Table 1 and Table 2.

Table 1. Chemical composition of tested material

In 718	**Ni**	**Cr**	**Fe**	**Nb**	**Mo**	**Ti**	**Al**	**Co**
wt%	53.2	18.5	Bal	5.3	3.04	1	0.52	0.13
	C	**Mn**	**Si**	**P**	**S**	**B**	**Cu**	
wt%	0.03	0.04	0,06	0.008	<0.001	0.004	0.03	

Table 2. Mechanical properties of In 718

Temperature	**Ultimate tensile strength [MPa]**	**Yield strength [MPa]**	**Elongation [%]**	**Hardness HBW**
20°C	1238	1474	26	450
650°C	1030	1211	13,5	-

Fatigue test was performed with using electromagnetic pulsator, ZWICK ROELL AMSLER HFP 5100. Specimens was cyclically loaded by symmetric tension-compression loading (R=-1), at 700°C, in air atmosphere. Fatigue test has been conducted at stress-controlled regime.

From the broken specimens a specimen for microstructure observation was manufactured. The aim of this observation was to compare the microstructure of the initial state with the microstructure after cyclic loading at 700°C. Specimens for the light and electron microscopy observations were prepared by standard process for metallographic samples preparation and were electrolytic etched in the solution of 10g CrO_3 in 100ml H_2O.

Fracture surfaces of the specimens broken by the cyclic loading at 700°C were evaluated by SEM, with the aim of describing mechanisms of stages of the fatigue process (crack initiation, crack propagation and final rupture). Fracture profiles were also evaluated by the light microscopy, the dependence of the roughness on the length of the crack (and thus on the K_α) was evaluated.

3. Results and discussions

The high temperature, at which fatigue test was performed caused significant changes in the fatigue process. At fracture surfaces of the broken specimens was clearly visible changes in the fatigue crack initiation and propagation. During cyclic loading of In 718 at 700°C, multiply initiation of fatigue crack was observed. While the number of initiation sites depends on the valued of loading stress, when at the specimens loaded at higher stress level higher number of initiation sites was observed. On the fracture surface a great number of secondary cracks was present, while the value of these cracks depends on the loading stress, same as the number of initiation sites. On the fracture surfaces there was no visible macroscopic clear border between the fatigue crack propagation area and the area of the final fracture.

Initiation of the fatigue crack takes place solely on the carbidic or carbonitridic particles at surfaces or subsurface area (Fig. 1 and 2), which is in clear contrast with the crystallographic initiation observed at fracture surfaces of specimens fatigued at ambient temperatures. In the study of (ABIKHI M. ET AL. 2013)

was well described mechanism of crack initiation of carbide particles at specimens cyclically loaded at high temperature at small frequencies of loading (oxidation and subsequent volume expansion of carbide particles caused internal stresses in the matrix, which serves as a preferred initiation places). Implementation of this mechanism in the study is questionable, and it needs some more research to confirm or reject this claim, but in general, for example, the specimen broken after $N_f = 3.6x10^6$ cycles, had quite sufficient time to oxidation of carbide particles, because in the high cycle fatigue, initiation stage consume more than 90% of the whole time of the fatigue test and duration of test was 7.5 hours.

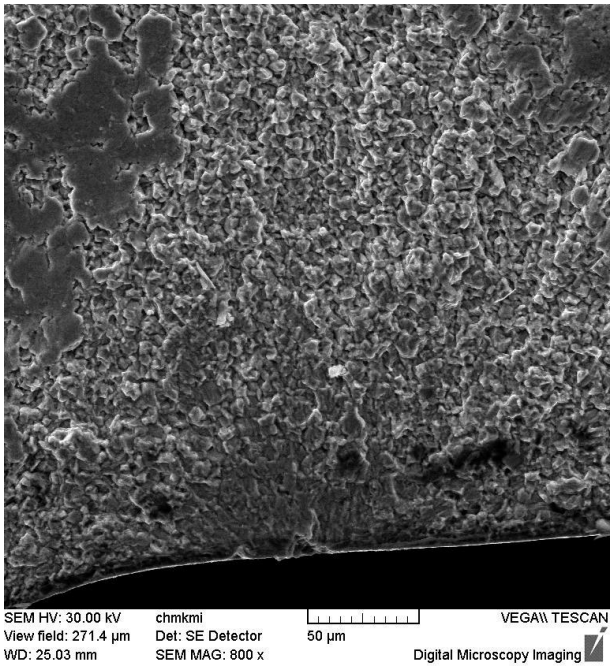

Fig. 1. Typical initiation site, In 718 cyclically loaded at 700°C, REM.

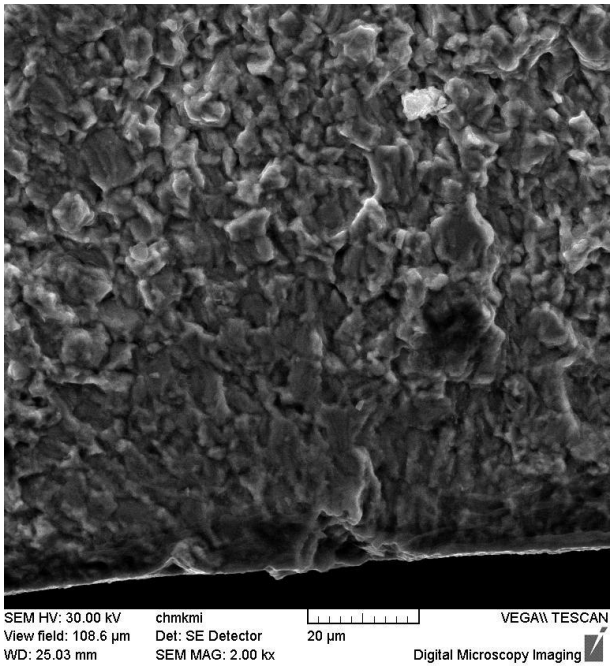

Fig. 2. Detail of the initiation place, there is clearly visible that initiation of fatigue crack took place on the carbonitridic particle, REM .

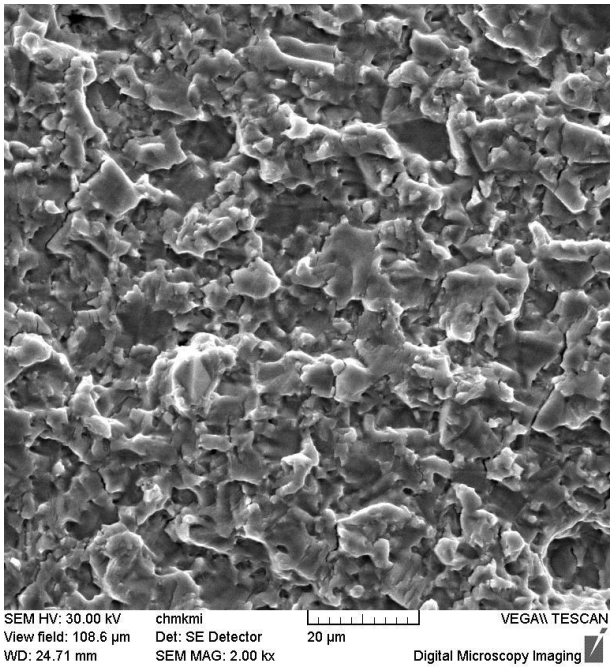

Fig. 3. Area of fatigue crack propagation, there is visible rough character of fracture surface, REM.

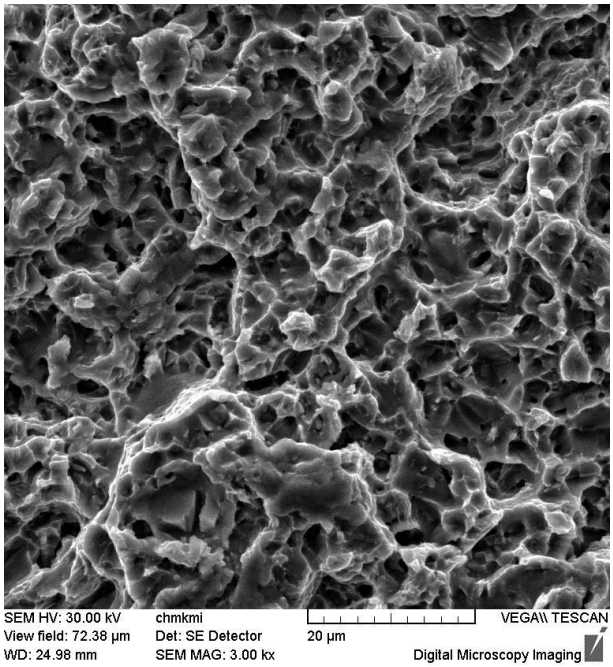

Fig. 4. Final rupture, transcrystalline ductile mechanism with strong dimple morphology, REM.

Fatigue crack propagation occurs by the transcrystalline ductile mechanism (Fig. 3), while on the fracture surface a great number of the secondary cracks was observed. Facets of intercrystalline fatigue crack propagation weren´t observed in neither case. Formation of intercrystalline fracture is in the case of In 718 is conditional on the present the high content of laves phase (which is not possible in the wrought material) or by very high level of oxidation of the grain boundaries region, but this case is possible only when specimens are loaded at very low frequencies. On the fracture surfaces, in the crack propagation area striations could be observed, but they were hard to detect due to a certain degree of oxidation at the surface and a significant roughness topography of the fracture surfaces. Fracture profiles observations, showed, that by increasing length of the crack (and thus K_{α}), the fracture profiles had higher roughness, which is well documented on Fig. 5 and 6.

Final rupture took places by the transcrystalline ductile mechanism with very strong dimple morphology (Fig. 4), which was caused increased ductility in testing temperature. Facets of intercrystalline fracture were not observed in the final rupture region, and it shows a good state of microstructure, even some structural changes caused by cyclic plastic deformation at 700°C, which are described in the next part.

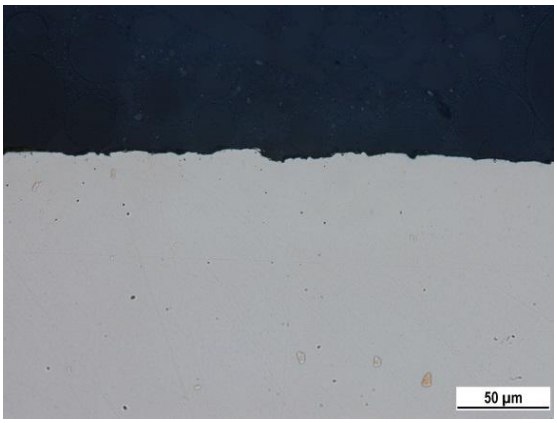

Fig. 5. Crack profile at crack lenght 2.5 mm.

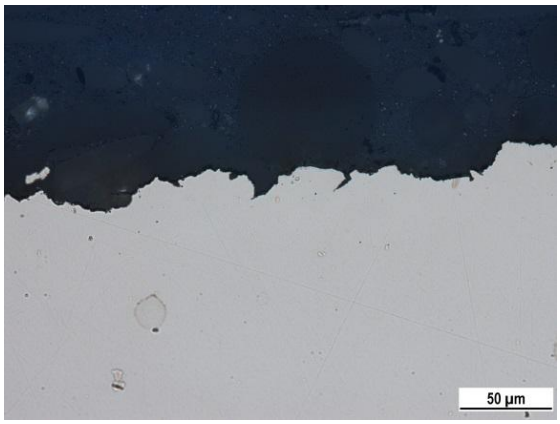

Fig. 6. Crack profile at crack lenght 7.5 mm.

Microstructural observation showed that the cyclic plastic deformation at high temperature (700°C) caused significant microstructural changes. Microstructure of the initial state (Fig. 7) consists of the fine grains of gamma matrix, delta phase particles at grain boundaries and with a primary carbides Nb(Ti)C and carbonitridic particles TiNC. In structure there are also fine precipitates gamma prime and gamma double prime, but these are not detectable by this kind of observation due their small dimensions and the strong coherency with the matrix. In the microstructure of the specimen cyclically loaded at 700°C (Fig. 8) were observed significant changes, especially in the form and the amount of the delta phase particles. Cyclic plastic deformation caused mechanical dissolving of gamma double prime particles (this mechanism is described in the work (WORTHEM D.W. ET AL. 1990), which leads to faster transformation of gamma double

prime to the intragranular delta phase (delta precipitate as a plates – in the cross section needles). Despite the fact that the volume of delta phase in the structure dramatically increased, it could be stated that it has no effect of the fatigue process in the Inconel 718 superalloy.

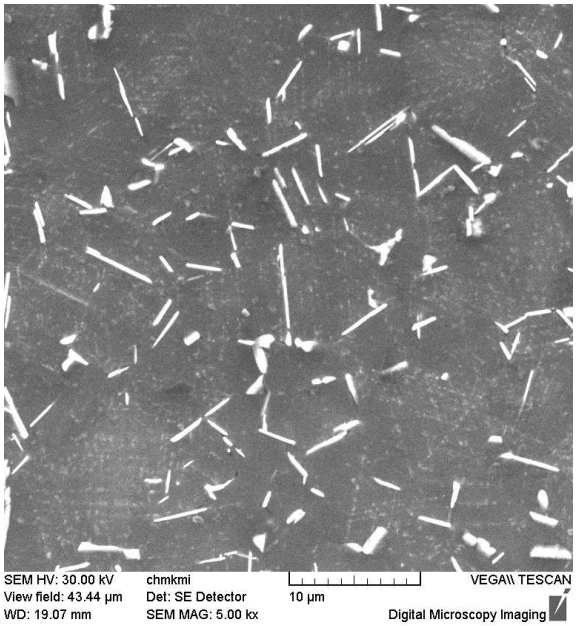

Fig. 7 . Microstructure of In 718 of initial state, electrolytically etched in CrO_3 water solution, REM.

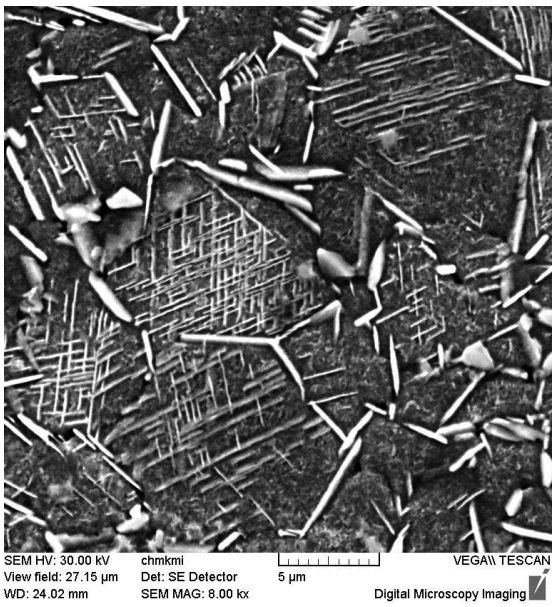

Fig. 8. Microstructure of In 718 after cyclic loading at 700°C, sample from fracture subsurface, great increase of intragranullar delta phase, electrolytically etched in CrO_3 water solution, REM.

4. Conclusions

Based on the carried out fatigue test and subsequent observation of Inconel 718 cyclically loaded at 700°C following conclusions can be drawn:

- Initiation of the fatigue crack in Inconel 718 fatigued at 700°C occurs on the carbidic/carbonitridic particles at the surface or near the surface.
- On the specimens was observed to multiply initiation, when the higher loading stress result in more initiation sites.
- Fatigue crack propagation occurs by the transcrystalline ductile mechanism, while on the fracture surfaces no facets of intercrystalline crack propagation were recorded.
- Fracture surface contains a large amount of secondary crack, when the higher loading stress results in higher number of such crack.
- There were recorded significant changes in the microstructure caused by cyclic plastic deformation at high temperature (increase of the amount of the delta particles), but no effect of this changes on the fatigue process was observed.

Acknowledgements

The research was supported by Scientific Grand Agency of Ministry of Education, Science and Sport of Slovak Republic and Slovak Academy of Sciences, grants VEGA No. 1/0123/15 and VEGA No. 1/0533/15.

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PRODUCTION ENGINEERING ARCHIVES

2016, Vol. 13, No 4, pp 26-30
ISSN (print version)
ISSN (online version)

Article history: Received: 30.11.2016 Accepted: 12.12.2016 Online: 30.12.2016

Available online on: http://www.qpij.pl **Exist since 4th quarter 2013**

Draft questions of 5S pre-audit with regard to health and safety standards for tires retreating plant

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Abstract. A continuous technological progress forces an improvement of the production process. The article describes the sole beginning of changes in the process of tires retreading on the 5S management method with regard to health and safety standards. The authors point out that the process of the production of retreaded tires is associated with the relationship between a man and a machine. The process improvement can dispense only by improving the machines but it should also pay attention to the man. The improvement of the production process must precede the audit, which can show areas that require intervention. Any such change in the production process cannot be performed without the participation of health and safety inspector, because his knowledge, skills and competence are able to determine whether the proposed changes interfere with the level of safety at the workplace. The authors emphasize that the process of production improvement production should be compatible with the process of improving the health and safety of workers involved in the production process. The combination of 5S audit with health and safety standards results in a holistic approach to the improvement process.

Key words – audit, 5S method, occupational health and safety standards

1. Introduction

A continuous improvement is one of the most important tasks for management and production engineers in a company. Whether it is a large factory or a small factory, the owner will strive to improve the process, to lean production, or to increase the level of safety and health at work. It is very difficult to achieve such desirable elements without the participation of employees in the improvement process. Meeting the requirements of improvement requires the interest of the whole company resources (owners, managers, workers, etc.) as this allows the efficient conduct of the process (ANTOSZ K., PACANA A., STADNICKA D., ZIELECKI W. 2015, PACANA A. BEDNÁROVÁ L. 2009).

2. Improvement of production processes in the context of occupational health and safety standards

According to the art. 207 § 1 of the Labour Code it is an employer who is responsible for the condition of occupational safety. In the following section, namely art. 207 § 2, 3 and 4, the employer is obliged to respond to the needs of health and safety standards in the workplace and to adapt the measures taken to improve the level of safety. The employer has a duty to ensure the implementation of a policy to prevent accidents at work and occupational diseases, with particular emphasis on:

• the technical conditions,
• organization of work,
• working conditions,
• social relations at work,
• the impact of environmental factors at work (Journal of Law of 2016 item. 1666 later amended).

The right employer's approach to the issues of occupational health and safety in a company (and especially in a manufacturing company) should be systemic. The employers should care about the right protection of workers as the quality of the production process depends on them to a large extent. Thus, it is reasonable when an employer takes care of it, so that the likelihood of an adverse event causing the loss will be small. Adverse events are associated with the condition of safety, but also with unwarranted interruption of the production process (PACANA A. 2010).

The research described inter alia by (DOBOSZ M., SAJA P., PACANA A., WOŹNY A. 2016) indicate that it is difficult for management to approve grassroots activities of employees without the support of people from managerial staff. Therefore, the actions in the field of organization of production and safety should be carried out spinning the whole crew, i.e. management and employees.

3. Method 5S with regard to occupational health and safety

The 5S method consists of five guidelines to streamline the organization of the processes in the workplace:
• seiri (selection);
• seiton (scheme);
• seiso (cleaning);
• seiketsu (standardization);
• shitsuke (discipline).

The result of the application of the 5S method is reducing waste and production time and improving safety in the work environment.

The five elements that make up the 5S method should be implemented in the company in the right order and the right time. The first three "S" elements concern an introduction of the method, and the last two are connected with the standardization and maintenance (SELEJDAK J., KLIMECKA-TATAR D., KNOP K. 2012).

A proper process improvement, which refers to the production, can take place without the active participation of health and safety inspector. The leader, who is planning the implementation of 5S properly, should implement a safety inspector, because he has the knowledge and competence relevant to the assessment of health and safety at the workplace where the 5S method will be launched. His experience can help to change the concept of improving the organization of production at the position where the 5S method exists. This procedure takes place, and in literature it is called 6S, where the 6th S (safety) concerns safety in the workplace. However, such a solution is not always the most appropriate. The use of knowledge and competences of the safety inspector for only the so-called sixth S seems to be inefficient. Therefore, it is advisable that the safety inspector should work at every stage of the implementation of the 5S method. He ought to take part in the selection, systematics and so on. This method could be described as 5S in occupational and safety standards. Such an action may actually increase safety and at the same time the position of the organization as the result of the implementation of the 5S method (PETERSON J., SMIT R. 1998).

4. 5S safety and health audit in tires retreating plant

5S safety and health audit was applied in a tires retreating plant which deals with storage, sale and retreading of tires for various vehicles. So far in the plant no elements improving work organization have been introduced. The results of the audit have caused the need to introduce changes that sparked the decision to merge the implementation of the 5S method with occupational safety and health standards.

Tab. 1 shows a set of control questions which allowed diagnosing organizational and safety problems in the context of implementing the various phases of 5S safety and health standards.

Table 1. Control questions of 5S safety and health standards for the tires retreating plant

5s	CONTROL QUESTION	CONDITION ASSESSMENT		REMARKS
		ACCE-PTABLE	UNACCE-PTABLE	
1s SEIRI	Are the machines and devices to retread tires necessary for the work?	•		In the retreating hall there are machines and tools necessary only to the process.
	Do the machinery and equipment needed for the retreading of tires have a valid maintenance (service) and their moving parts are adequately covered?		•	Machines to shear the old tread is not enclosed on one side. This can cause a seizure.
	Are there any elements unnecessary after the preceding steps of retreading?		•	In the hall there are scraps tread, damaged tires unsuitable for retreading, empty containers, etc.
	Do the elements of the previous stages of the retreading reduce visibility and can cause a stumble, fall on a surface, fire or explosion?	•		
	Are there specific storage sites for the waste after the process of retreading tires?		•	In the hall there is no clearly defined storage location for redundancies.
	Is there any place where redundancies are stored and properly secured?		•	Redundancies are not stored according to any scheme.
	Do workers have an easy access to the machines and equipment in retreating plant?	•		
	Do workers have an easy access to semi-finished products used for retreading?	•		
	Are machinery, equipment and semi-finished products available in a convenient way for the employee (while following the principles of ergonomics)?		•	Some of half-finished products are stored on the floor forcing the workers to bend down and lift heavy items.
	Is the manner of storage elements before and after the retreaded correct?		•	Some employees throw the remaining products into a collecting container - they do not segregate waste
2s SEITON	Is the place of storage marked in the same way before tires retreading, when retreading etc.?	•		
	Do you have a separate area tire storage (yellow-black belt)?		•	
	Is it possible to easily find the tools needed for the retreading process?		•	On the table the tire disassembly lack of standardization, the employees forget to deposit the tools
	Do workers store tools in place designed for this purpose, and in a certain way?		•	
	Are the distance and height of tools and components used for retreading appropriate?	•		
	Do the distance and height of the tool meet the requirements of ergonomics?	•		
	Are communication paths marked in an appropriate manner?		•	Traffic routes clear, but marked with a white color which is constantly dirty
	Are communication paths marked with signs and evacuation warnings as required by PN or EN?		•	There are no signs that comply with standards.
3s SEISO	Do workers clean up their workplace?	•		
	Do the employees care about the cleanliness of machines and tools used in the retreading process?		•	It is difficult to keep machine clean during the process
	Is the division of responsibility for the cleanliness of the retreating plant right?	•		
	Is cleaning systematic and compulsory?		•	Employees sometimes forget about cleaning
	Is cleaning an element of safety control safety of retreating plant?	•		

4s SEIKETSU	Are the instructions available, current and complete?		•	No current instruction for machinery and equipment and the occupational health and safety instructions.
	Are there visible in the workplace the elements of the selection, cleaning and standardization during the retreading process?		•	Employees do not carry out selection, cleaning and standardization systematically.
	Does the staff treat the elements of selection, cleaning and standardization as daily responsibilities?		•	
	Do workers have defined responsibilities in the plant?	•		
	Do employees have personal protective equipment at the selection, cleaning and standardization process?	•		
5s SHITSUKE	Are there any improvement methods applied in the tires retreating plant?			The changes introduced were not accepted by all employees
	Do the employees properly store their personal belongings	•		
	Do employees accept changes made in the plant	•		
	Audit questions concerning the improvement of the process of tires retreading			
	Audit questions concerning the improvement of the process of tires retreading with regard to health and safety			

5. Conclusions

Improvement of the production process using the 5S method cannot take place without the participation of health and safety inspector, because he cares about the safety of employees. The essence of the improvement process is the quality and efficiency of production, but it seems necessary to take into account health and safety standards at every stage of the implementation of the 5S method. The right approach to health and safety issues can increase the quality and productivity of employees.

The measures taken by the leader of process improvement and safety inspector resulted in a detailed analysis of the condition of occupational safety and health in the tires retreating plant. An analysis of 5S safety audit caused that according to the inspector the probability of an adverse event associated with work in the plant can be reduced at every stage of the implementation of 5S.

This may result in the fact that the result of occupational risk assessment may fall for such hazardous situations as:

- stumble and fall on the surface,
- fire or explosion,
- overload the musculoskeletal system,
- impact of inanimate objects,
- rapture by moving parts of machines and equipment.

Another element that from the point of view of safety will improve is the visibility of all the safety instructions in the manual describing each of the elements of the retreading process, which will be mounted on any device and at any stage of tire retreading.

However, it should be noted that the most important role in the audit played the employees themselves, who honestly answered the questions posed by auditors. The presence of the safety inspector has helped in the interpretation of different employee behavior during the observation of the tire retreading. The knowledge, skills and competences of the safety inspector were very helpful and reinforced the belief that the synergistic combination of 5S safety and health audit can bring higher efficiency of the implementation process to improve the process of retreading tires.

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ARCHIWUM INŻYNIERII PRODUKCJI
PRODUCTION ENGINEERING ARCHIVES

2016, Vol. 13, No. 4, pp 31-34
ISSN 2353-5156 (print version)
ISSN 2353-7779 (online version)

Article history: Received: 01.12.2016 Accepted: 15.12.2016 Online: 30.12.2016

Available online on: http://www.qpij.pl **Exist since 4th quarter 2013**

Methods of measuring the effectiveness of Lean Management

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Abstract. Invalid organisation of the production environment in an enterprise is the cause of many disruptions during the implementation of production processes. Lean Management is aimed at improving processes and eliminating interference in accordance with the Kaizen principle. A significant element of management constantly analyses and measures the improved results. The article presents the results of the literature research from the scope of observation methods and measuring the effects of the use of Lean Management instruments in manufacturing companies.

Key words – Lean Management, production efficiency, Kaizen

1. The origin of Lean Management

Lean Management belongs to the family of modern management concepts. It is used in many diverse sectors of the global economy. It has been observed that more and more implementation ways of Lean Management concept resulted in success.

A diverse terminology in accordance with the concept of lean management can be found in literature. Lean is formulated as a slender approach that "[...] shows the way of producing more volume using less - minimising human labour, reducing the number of devices, as well as saving time and space - all at increased level of meeting the customers' needs [...] it also allows to achieve a greater level of job satisfaction [...]" (WOMACK J. P., JONES D. T. 2012). Liker explains the issue of "lean management" as an aspiration to efficiently manage the resources, and as a result of that to reduce expenses, quality orientation and minimising the waiting time of implementation of orders (LIKER J. K. 2005). Lean Management is defined as a set of concepts, principles, procedures and tools adapted to improve of the production process by reducing waste (TAJ S. 2008).

Lean is sometimes referred to as a system of waste elimination, or cost reduction. These terms are too simplistic, therefore, they do not show the essence of the system built up over the decades (since around 1950) at Toyota. It is also sometimes mistakenly associated by Polish workers with only audits controlling keeping an order of work stations, drawing lines in the production hall and the ubiquitous hanging instructions and symbols, or measuring work time and increasing standards. Wrong picture about Lean is often a result of inadequate management attitude (MASSAKI I. 2006). It is often the cause of the unfortunate use of financial measures to assess the effectiveness of lean tools.

The need for continuous improvement of the company derived from the Toyota Production System re-

quired elaboration certain methods (5S, PDCA, Andon, standardized work, define the main waste in the company, etc.), which helped to improve processes. These methods are often referred to just as Lean tools. Kaizen, that is continuous improvement, should be treated as a foundation of Lean Management, without which the company will only have randomly selected elements of lean management (ULEWICZ R., KUCĘBA R. 2016). Saakichi Toyoda introduced the first pillar of the Structure of Toyota Production House (WOMACK J. P., JONES D. T., ROOS D. 2008). It is based on respect in relations to other people and self-improvement of skills. The main elements in this scheme are stability, 5S rule, reduction of volatility and limitation of production machines breakdowns. Jidoka relied on the quality built-in work station. Whereas Kichiro, who visited Ford factory in the USA, implemented mass production and the second pillar of which was the principle of just in time - speaking about delivery timeliness. The purpose of this system was to reduce the cost but keep an appropriate level of quality, minimizing products delivery time by limiting waste during the operation of production processes (OHNO T. 2008). At the same time the leader was appointed what has became the Toyota Motor Production. This phenomenon was called Lean Manufacturing. Simultaneously, the authors of Lean Thinking have extended the approach beyond the motor industry to business processes (MANN D. 2014).

2. Instruments of Lean Management

Lean Management has instruments which by functioning improve implementation of modern management concepts. The presented tools are implemented in companies that are at a similar level. As a rule, after a year of progress with the Lean Management project they are at 80% in Poland and Mexico (BEDNAREK M., 2015):

- 5S,
- TPM,
- SMED.

During the implementation of 5S practices the human factor should be taken into account. This method has become a recovery plan, by affecting the company financial result has become a way of action. At the same time the relationship between the employees and the organisation they work in every day has been taken care of. The first element was the training of the management team, who should adapt to the new working conditions by using innovative organizational techniques. Workshops include planning tasks and tight control of the progress that employees performed on every work station. It the use of the implementation of a cyclic system results review was also scrutinized. Each unit in an organization should identify with the organizational aim with particular emphasis on quality, work efficiency, cost reduction, delivery on time, safety of staff and product, clean and tidy workplace, reduce wastage (CZERSKA J. 2014).

Total Productive Maintenance this is all company's activities, which purpose is to prevent errors of qualitative nature of the products, the occurrence of equipment failure and the condition required in terms of frequent adjustment (BORKOWSKI S., ULEWICZ R. 2009). The purpose of the TPM is to accelerate the work of machine operators. At the same time focusing on work safety and ease of operation. The assumption of the overriding aim of TPM is a zero failures, zero defects arising during machine operation. Referring to the elementary principles of Lean is to minimize waste and improve the level of improvement of the organization, so the purpose of TPM, one of the pillars of Lean is also to minimize losses. Presented below are 6 great losses (CZERSKA J. 2014):

- Failure of equipment.
- Set-up and establishment of workstations.
- Short Term downtime during operation.
- Loss of speed.
- Defects in the quality and a need to correct defective parts.
- Low material utilization and losses at start-up of the machine.

Then listed the five elements of TPM (KUNIO S. 1992):

- Improvements to eliminate the causes of 6 big losses.
- Antonomous maintenance.
- Scheduled system maintenance.
- Training.
- Purchasing and design reliable and easy to maintenance equipment.

The SMED (Single Minute Exchange of Die), an one digit exchange form. The technique of performing

of retooling of machines and devices in less than 10 minutes was formulated. Retooling is defined as the time measured from the last good product produced on the old machine setting to the first good product produced on a new setting of the machine, which should start a mass production (SHINGO S. 1985).

3. Measurements and metrics of Lean Management

The message of Lean is to avoid any kind of waste, reducing the internal functions of a company to what is necessary, and in relation to the manufacturing process, eliminating steps not adding value to a product. Unnecessary actions lengthen production time and often are results of an organizational mess, causing an additional low quality production. According to the principles of Lean Management company should be reorganized so that customers orders were carried out in the shortest possible time and with minimal employees effort. This also allows shortening production cycles, improving product quality, reducing production costs, improving morale and commitment of staff. In literature you can meet with different types of measures used in Lean Management. A common feature of these measures is defined aim and measurable parameters that define it. An important element is the designation of measurements that are needed and feasible to implement. In an interview for the Lean Enterprise Institute Poland Orest Company - Chief Financial Officer WIREMOLD, warns against using financial measures.

In a production company, that only begin to implement Lean, the financial results of the first two years almost always deteriorate. A more beneficial is to use metrics related to time and exactly the ratio of release time, which was consumed for operations not giving added value. The meter associated with the release of additional production capacity in the company can also be used.

Productivity is also often used to define the effects of lean management. Productivity is the ratio of the result or effect of which is achieved by certain process, to the resources consumed to achieve this effect. By resources the following is meant: materials, human labour and the individual elements of the overall costs. On the list of measures in the literature (ULEWICZ R., MAZUR M. 2015) can be found inter alia:

- inventory turnover ratio,
- reduction of shortages,
- reduction of retooling time,
- reduced manufacturing costs
- lead time,
- cycle time,
- reduction of overtime,
- reduction of waste,
- increasing the number of sales of products,
- increase the efficiency of use of the new fund crush-time work,
- increasing the efficiency of machinery and equipment,
- freeing resources - time, effort and materials
- stabilize and standardize processes (re-flow materials, line work, line balancing),
- levelling of production, the organization of the assembly work station/production,
- improving health and safety.

Data for indicators should come from automated records or forms filled by operators. The choice of measures should depend on what a company wants to achieve and on type of Lean tools, which is implemented in a company. Do not use all measures at once. When introducing Lean tools the metrics should be chosen to most accurately assess the effect of changes resulting from the new tool (eg. 5S, Kazien, Just in Time, Kanban, VSM, TPM collocation of equipment, etc.).

4. Summary

The concept of Lean is aimed at improving and increasing the efficiency of operating processes in an enterprise. The assessment of activities included in the process because of their desirability and usefulness should be done during its implementation. The motto of the introduction of Lean could be a statement of P. Drucker: There is nothing quite so useless as doing with great efficiency, something that should not be done at all.

A question why to measure and analyse efficiency of inefficient things may further be posed.

A common mistake when performing measurements to determine the metrix is complicated analysis

and the time needed to carry it out, which can be wasteful in itself.

Every company wants to do the best to achieve the purposes, and strive to fulfil the company's vision. A company should set as well as to measure key performance indicators. The key performance indicators are important part of the assessment of the organization, as they allow clearly decide whether their aims are all implemented and at what stage they are at. When a company does not implement the set targets, you can quickly counteract it, find the problem and then find a solution. Incredible advantage given by the use of efficiency measures is that they influence the organizational culture very well, which prevails in a company, and their use contributes to the fact that employees know exactly what is expected of them and what the rules of assessing their work are.

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ARCHIWUM INŻYNIERII PRODUKCJI
PRODUCTION ENGINEERING ARCHIVES

2016, Vol. 13, No. 4, pp 35-40
ISSN 2353-5156 (print version)
ISSN 2353-7779 (online version)

Article history: Received: 05.12.2016 Accepted: 11.12.2016 Online: 30.12.2016

Available online on: http://www.qpij.pl **Exist since 4th quarter 2013**

Integration management system – new of requirements of ISO 9001:2015 and ISO 14001:2015 standards

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Abstract. Organizations are becoming more aware of the importance of integrated management systems (IMS). Interest in this subject indicates that IMS are seen as "management systems of the future". The problem is that the methodology of integration of management systems does not exist. There are specification for example PAS 66 that tell only about requirements standards. standards Both ISO 9001:2015 and ISO 14001:2015 standards were revised in 2015. Based on this, the aim of this article is to characterize the possibility of creation of IMS through the identification of common elements and specific requirements in accordance with professional references ISO 9001:2015 and ISO 14001:2015.

Key words – Integrated management system, environmental management system, quality management system

1. General requirements

According to the Chartered Quality Institute, UK, integration means a combination; that is putting all the internal management practices into one system in such a way that the components of the system are not separated but linked to form one integral part of the company's management system. In simple words, an integrated management system (IMS) is a management system which combines all components of a business into one coherent system so as to enable the achievement of it purpose and mission (OLARU M., MAIER D., NICOARA D., MAIER A. 2013).

The most common integrated international standards include are: Quality Management Systems (QMS) according to ISO 9001, Environmental Management Systems (EMS) according to ISO14001or EMAS III, and Occupational health and safety management systems according to OHSAS 18001. Integration of three management systems is possible because ISO 9001 and ISO 14001 standards are compatible and OHSAS 18001 specification was modelled on ISO 14001; all of them have a process oriented approach based on the concept PDCA (Plan - Do - Check - Act). Effective management is based on maintaining and improving standards. The first task should be to maintain management standards based on the cycle of SDCA (standardize - do - check - act). When standards are adhered

to by employees, the next task should be to improve the standards based on the PDCA cycle (plan - do - check - act) (JAGUSIAK-KOCIK M. 2014, KNOP K., MIELCZAREK K. 2015).

The ultimate focus of ISO 9001 is profit intended to improve customer satisfaction. EMS, according to ISO 14001, is focused on how the company cares about the environment (standard towards the outside). An important term which relates to EMS is sustainability. Sustainability is broadly defined as meeting the needs of the present generation without compromising the ability of future generations to meet their own needs (INGALDI M., 2015 STASIAK-BETLEJEWSKA 2015). OHSAS is focused on how management manages their employees (standard towards inside). These can also integrate other standards such as: ISO 27001 (Information security), ISO 26000 (Social responsibility), ISO 31000 (Risk management), or different industry standards ISO 50001 (Energy management), ISO 22000 (Food safety management systems), ISO 13485 (Medical devices), ISO/TS 16949 (Automotive quality management), etc., as well as internal standards developed by the company itself and valid within (IKEA, SONY, Slovnaft). ISO/TS 16949 together with ISO 9001 demonstrate guidelines for the implementation and maintenance of quality management systems in the whole chain of production processes and the production of spare parts in the automotive industry (ROSAK-SZYROCKA J. 2014).

Integrating two or more management systems into an integrated management system can have much advantages: alignment of objectives, processes, resources in different areas, reducing of paper work, eliminating of duplications between procedures of the systems, reduction in external certification costs over single certification audits, a holistic approach to managing business risks, improvement of internal and external communication, increase of management efficiency by merging three functional departments into one, time saving, better structured processes and clearer responsibilities, improved operational performance, cross-functional team work and integrated audits. It is a time consuming and costly process. The integration of systems arise to certain risks. One of them is giving different importance to each aspect, for example more attention is paid to aspects of quality at the expense of environmental aspects. It is important to remember that integration of systems does not mean that these systems will exist next to each other but have to be connected with each other and to form a complete unit. For integration is therefore not use the software package documentation administering the systems, or the inclusion of managers for QMS, EMS and OHSAS per one department.

2. Requirements of ISO 9001:2015 and ISO 14001 standards

In the year 2015 the new international standards ISO 9001:2015 and ISO 14001:2015 were published. In the year 2017 standard for Occupational Health and Safety Management Systems (ISO 45001) will be published. The similarities or the generic processes in a management system are: top management commitment, definition of a policy, planning of objectives and targets, procedures for training of employees, communication procedures, audits, documentation and records control, control of non-compliance, corrective and preventive actions, and management review. In the Table 1 similarities and specifications in management are presented. There are several approaches which can be taken, depending on the current position of an organisation.

Conversion: If an organisation has a certificated QMS, it can build upon it by adding the necessary processes to cater for health, safety, environment, and other requirements of management system standards.

Merging systems: If an organisation has more than one formal system, e.g. a quality management system and an environmental management system, it can merge these two systems and proceed to integrate other systems as it begins their formalisation. With this method the organisation can merge documentation where it supports the same process. However, they will remain two separate systems unless the labels are removed, and quality, safety and environment are no longer separated at the detail level.

System engineering approach: Whether an organisation has an existing formal system or no formal system, it can adopt the system engineering approach to management system development, i.e. design a system top-down to fulfil a specific objective. The benefits are that one coherent system can be built which serves business needs and does not tie the organisation to a particular standard (DOUGLAS A., GLEN D. 2000).

Table 1. Overview of similarities of standards ISO 9001:2015 and ISO 14001:2015

SIMILARITIES OF MANAGEMENT SYSTEMS (QMS, EMS)	
Context of the organization	The organization: – should determine external and internal issues, monitor and review information about that issues. – should determine interested parties and requirements of the interested parties to the quality management system (QMS) and environmental management system (EMS). The organization shall monitor and review information about interested parties. – should determine the scope of QMS and EMS. It means that the organization shall determine the boundaries of applicability of QMS and EMS (free choice, throughout the organization or in selected parts of the organization). – should not exclude from the scope of activities the ones that have a significant impact on strategy or environment. – should determine the applicability of QMS/EMS. When the applicable requirements of the standard an organization must substantiate this decision. – should determine the processes for QMS/EMS, determine the inputs and outputs from these processes, determine the interaction of these processes, evaluate the performance, determine the resources and ensure their availability, assign the responsibilities and authorities for processes and address the risk and improve the processes.

Leadership	Top management should:
	– demonstrate leadership.
	– take responsibility for the effectiveness of QMS/EMS.
	– establish, implement and maintain an policy and objectives for QMS/EMS. The policy shall be available to relevant interested parties, shall be maintained and communicated.
	– provide the resources needed for QMS/EMS.
	– ensure the requirement of QMS/EMS integration into the organization´s business processes.
	– assign the responsibility and authority for the following:
	  – ensuring that QMS/EMS conform to the requirements of standards ISO 9001:2015/ISO 14001:2015.
	  – reporting on the performance of QMS/EMS.
	– ensure that people are engaged in order to contribute to the effectiveness of QMS/EMS.

Planning	The organization should: – determine the risk and opportunities related to intended results of QMS and environmental aspects. – plan and implement actions to address of risks and opportunities and evaluate the effectiveness of these actions. – establish quality and environmental objective at relevant functions, levels and processes. The objectives should be consistent with the policy, shall be measurable, communicated and update. – plan changes in QMS/EMS and review the consequences of change. It means defining the purpose of the change, the availability of resources, reallocation of responsibilities and authorities, etc.. – determine and provide the resources needed for QMS/EMS.
Support and operation	The organization should: – determine and provide the resources needed for QMS/EMS. – determine the competence that is necessary in terms of people, take actions to acquire the competence and evaluate the effectiveness of the action taken. – ensure that person doing work under the organization´s control is aware of the environmental and qualitative policy, the quality objectives, the significant environmental aspects and their contribution to the effectiveness of QMS/EMS. – establish the process needed for internal and external communications relevant to QMS/EMS. – control the processes and determine the requirement for the processes, the products and services and establish criteria for the processes. – control outsourced processes.
Performance evaluation	The organization should: – evaluate the effectiveness of QMS/EMS. The organization ought to determine what needs to be monitored and measured, the methods for measurement, time of measurement and shall evaluate the performance QMS/EMS. – conduct internal audits at planned intervals. – review the organization´s quality management system and environmental management systems at planned intervals.
Improvement	The organization is supposed to determine and select opportunities for improvement. When nonconformity occurs, the organization ought to react to it, by reviewing and analysing, as well as determining its causes. It should also undertake any actions needed, review the effectiveness of any corrective action taken and update risks

Table 2. Overview of specifications of standards ISO 9001:2015 and ISO 14001:2015

SPECIFICITIES OF MANAGEMENT SYSTEMS (QMS, EMS)		
Leadership	**QMS**	Top management should determine, understand and meet customer requirements, and determine regulatory and contractual requirements.
	EMS	
Planning	**QMS**	The organization should: – determine and provide people for operation and control of processes and implementation of QMS, – determine, provide and maintain the infrastructure necessary for the operation of processes, – determine, provide and maintain the environment necessary for the operation of its processes (e.g. calm, non-confrontational, stress-reducing, temperature, heat, light, noise, etc.), – determine and provide the resource needed for monitoring or measuring, – ensure the measurement traceability (measuring equipment shall be identified, calibrated and safeguarded form damage), – determine knowledge necessary for the operation of processes.
	EMS	The organization should: – determine the environmental aspects of activities, products and services and determine the environmental impact, – determine significant environmental aspects by using established criteria, – communicate its significant environmental aspect among the various levels and functions of the organization, – determine the compliance obligations related to environmental aspects and determine how these compliance obligations apply to the organization, – plan to take actions to address its significant environmental aspects, compliance obligations and risks and opportunities, – plan how to implement the action into its environmental management system processes, – plan how to evaluate the effectiveness of these actions, Within the scope of EMS, the organization shall determine potential emergency situation, including those that can have an environmental impact.
Support and operation	**QMS**	The organization should: – communicate with customers, obtain customer feedback and provide information relating to products and services, – conduct a review of the customers requirement, regulation requirements and contract requirement before committing to supply products and services to a customer, – determine the required process stage, the control activities, the activities of verification and validation, the responsibilities and authorities, the requirement for products, the resource needed for the design and development of products and services, – identify, review and control change of design and development, – ensure that externally provided processes, products and services, which determine and apply the controls, monitoring, verification and validation of the external providers performance, do not adversely affect the organization's ability to consistently deliver conforming products and services to its customers, – communicate with external provider the requirement for the processes, products and services, the requirements on the approval and release of products and services, competence person, control and monitoring of the external providers performance, verification and validation, etc., – implement production and service provision under controlled conditions, – ensure identification and traceability of outputs, – identify and protect customer or external providers property, – meet requirements for post-delivery activities relating to warranty provisions, recycling, etc., – control change relating to production and service provision, – implement planned arrangements in order to release of products and services. The release of products and services to the customer should not proceed until the planned arrangements have been satisfactorily completed, – ensure identification of nonconforming outputs, apply appropriate action and verify outputs after repair.
	EMS	The organization should: – respond to relevant communications on its EMS, – establish the processes needed to prepare a response to potential emergency situations, – take action to prevent or mitigate the consequences of emergency situations and periodically test response actions.

Performance evaluation	**QMS**	The organization should: – monitored of customer satisfaction, – analyse and evaluate appropriate data from monitoring and measurement.
	EMS	The organization should: – monitor, measure, analyse and evaluate its environmental performance and determine the criteria of evaluate, – communicate relevant environmental performance information both internally and externally, – establish, implement and maintain the process needed to evaluate fulfilment of its compliance obligation.
Improvement	**QMS**	
	EMS	

Table 3. Overview of requirements on documentation information (ISO 9001:2015, ISO 14001:2015)

DOCUMENTED INFORMATION		
Similar requirements		The organization should retain documented information in terms of: – the scope of the quality management systems (QMS) and environmental management system (EMS), – the quality policy and environmental policy, – the objectives for QMS/EMS (the organization shall determine: what will be done, what resources will be required, who will be responsible, when it will be completed, how the results will be evaluated), – the risk and opportunities, – the processes of QMS/EMS (inputs, outputs, performance evaluation, resource, responsibility and authority, etc.), – necessary competence of people doing work under the control that affect the performance of QMS/EMS, – the documented information that demonstrate that processes have been carried out as planned, – performance evaluation of QMS/EMS, – the audit programme, – the management review, – the control of nonconformity.
Specific requirements	**QMS**	The organization should retain documented information on the following: – the resources of monitoring and measurement, – the necessary knowledge, – the control of externally provided processes, products and services, – demonstrating fraceability, – lost or damaged property of a customer or an external provider, – the results of the review of change, – the release of products and services, – the control of nonconforming outputs, – the documented information needed to demonstrate that design and development requirements have been met (documented information on design and development inputs, controls, outputs and change).
	EMS	The organization should retain documented information on: – the environmental aspects, and environmental impact, – the significant environmental aspects and criteria used to determine its. significant environmental aspects, – the compliance obligations related to environmental aspects, – communications, – emergency preparedness and response, – the evaluation of compliance.

3. Conclusion

Integration of management systems into a single IMS brings many benefits to the organization. It is important to recognize, that IMS is a single structure used by organizations to manage their processes or activities that transform input of resources into a product or service which meet the organization's objectives and equitably satisfy the stakeholders quality, health, safety, environmental, security, ethical or any other identified requirement. If this conditions not met, for example in favouring one system over another may develop risk. The results of several international studies show that the most companies implemented ISO 9001:2000 first, followed by ISO 14001: 2004, and then OHSAS 18001:1999.

In Slovakia such a study has not been conducted. Studies have also shown the problems with integration have a small and medium-sized enterprises (SMEs) (DOUGLAS A., GLEN D. 2000). SMEs referred the lack of time, human and financial resources, and the perception that that management systems are too bureaucratic. In general, SMEs are not aware that the adoption of IMS not only improves their management and their internal efficiency, but also results in cost reduction.

Acknowledgment

This paper was written with the financial support of the granting agency KEGA of The Ministry of Education, Science, Research and Sport of the Slovak Republic as a part of the project No. 074TUKE - 4/2015 - An innovative approach to legislative coordination of environmental protection through the visualization on the basis of the phenomenon Small World Networks.

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ARCHIWUM INŻYNIERII PRODUKCJI
PRODUCTION ENGINEERING ARCHIVES

2016, Vol. 13, No. 4, pp 41-43
ISSN 2353-5156 (print version)
ISSN 2353-7779 (online version)

Article history: Received: 22.11.2016 Accepted: 01.12.2016 Online: 30.12.2016

Available online on: http://www.qpij.pl **Exist since 4th quarter 2013**

Assumptions concept of LEAN processes in the organization of the work on example the production of building components

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Abstract. The following paper discusses how to use of a company's assets efficiently by the identification of value stream and the elimination of all the processes that do not contribute to a company's added value. The identification of critical points of value stream by means of a map illustrating these processes helps to indicate the area where the selected elements of LEAN concept aiming at eliminating waste in domestic transport should be implemented. The article contains the analysis of the state of the current stream, and suggestions concerning its improvement.

Key words – LEAN Management, Value Stream Mapping (VSM), production of short series

1. Introduction

Lean Management (LM) is an instrument of strategic enterprise management which aims at achieving market success. The idea, which has been implemented and constantly improved by TPS (Toyota Production System), is primarily based upon the elimination of waste and muda. Muda ("futility; uselessness; wastefulness") refers to all the wastage caused by all the actions that do not contribute to a product's value, but, which, at the same time, consume its resources.

The aim of LM implementation is to use of the resources available and production potential in the most efficient way, and to shorten the process of fulfilling orders.

LEAN is a farfetched philosophy based on a long-range concept which sometimes works regardless of the fact that it does not produce financial results, at least the short-term ones. It also includes a commitment to long-term economic development of an organization over a longer period of time. Enterprises which attempt to implement LEAN concept make use of the most essential instrument intended to identify and minimize wastefulness, i.e., Value Stream Mapping (VSM) (INGALDI M. JAGUSIAK-KOCIK M. 2014).

2. Streamlining of processes

LEAN concept which uses of a variety of tools is a solution that makes it possible to create a flexible system which, at the same time, will be able to react quickly to any changes happening within and organization and its surroundings. The implementation of the concept in a company structure requires a constant improvement of such an organization through training

designed for both, staff and employees. It also demands a division of duties and responsibilities by appointing small organizational units, or teams working on one particular task (CZERSKA J. 2009).

The improvement process of the whole enterprise in accordance with the premises of LEAN requires the use of all available tools and methods which are offered by management science. A necessary condition under which a proper transformation process will occur is their correct grouping, setting mutual connections, and utilising analysis results. Primary tools which facilitate creation of an efficient organization by using LEAN management concept include:

- Deming cycle (P-D-C-A) – a systematic series of actions occurring in a logical sequence which work in accordance with a basic concept of continual improvement of an enterprise functioning.
- Value Stream Mapping (VSM), whose aim is to collect data concerning the flow of goods and information.
- 5S – a tool for systematic learning of discipline, standardization, and striving for perfection.
- TPM - Total Productive Maintenance – a method aiming to provide a maximum number of mission critical production equipment. At the same time, it is a system which mitigates failures and improves quality due to involvement of all employees.
- SMED - Single Minute Exchange of Die – a method referring to changeover time reduction. It has a great significance in organizing manufacturing process and it guarantees system flexibility.
- KAIZEN philosophy – a tool jest that allows individual workers to organize and manage their work. It leads to devising standards for constantly improved processes.

3. Process mapping in practice

The presented analysis was conducted in a manufacturing and service company dealing with goods for construction industry and automotive industry working in SME and SMB sectors. The approach how to enhance efficiency of the company was developed according to its employees' experience and the premises of LEAN concept. The measures offered focused on waste elimination, which, according to Kaizen method, were supposed to be low-budget actions. Following Toyota, in order to retain the morale in the research entity, one of the basic ideas before proceeding with the research was to leave the headcount intact (ULEWICZ R., KUCĘBA R., 2016).

In order to implement lean management rules in terms of materials, mapping was performed so as to identify the status quo. The aim of this is to analyse the flow of goods according to "door to door" rule.

The analysis of a given value stream involves all the actions connected with a product undergoing a process form a basic feedstock to final recipients. The attempts to optimise material flow on an assembly line producing valves which are representative for the assortment. Figure 1 shows the current material flow.

Resulting from the effort of the staff and the analysis of the map illustrating the status quo, the main causes of waste were identified, i.e., excessive transport, redundant inventory, expendable movements, demurrage, improper manufacturing methods, as well as overproduction which leads to excessive strain (MURA). As based on prior experience, reasonable goals for lean manufacturing were defined:

- increasing the rate of inventory turnover,
- limiting the surface area of the production hall where spare parts inventory is located,
- limiting the number of workers engaged in the activity of moving materials within the area of the production hall,
- increasing the tact time of supplying stock parts to manufacturing cells,
- eliminating a need for engaging operators to move elements within the area of a production hall,
- reaching the level of 100% of planned production per shift as compared to the average production rate,
- eliminating the movement of forklift trucks supplying parts in the production hall.

In order to achieve the intended goals it was suggested that the size of product lot and flow units should be decreased between specific workstations which, consequently, will result in:

- increased flexibility, (the production time of one element is extremely short, the production of small series enables the system to react to customers' needs in a more flexible way and produce items which meet their expectations),

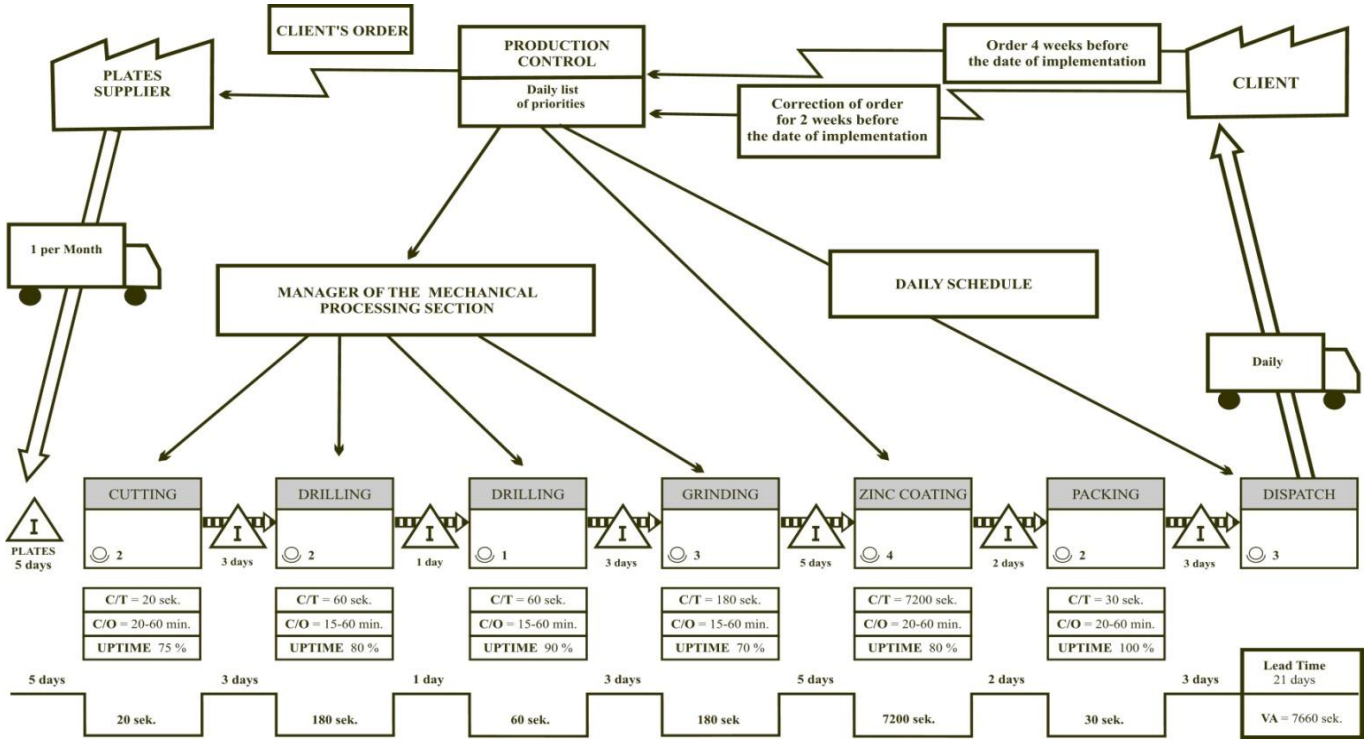

Fig. 1. The map of the current state of stream value for valve production.

- increased productivity (in case of short series flow cell, activities which do not add value are subjected to very definite standards),
- improved quality (incorporating quality within the flow of short series is much more efficient),
- creating additional production area (in a cell everything is situated in proximity and inventory occupies only a small space),
- safety improvement (smaller batches of elements are moved across the production hall, fork-lift trucks, which are the main cause of accidents, are eliminated),
- decrease in inventory costs.

4. Results and discussions

The methods of internal transport were thoroughly analysed. A fork-lift truck was eliminated due to its cost and the cost of its use, as well as the necessity of building wide paths along which it could move. A further argument for eliminating FLT in transportation process within a production hall is the fact that it carries full load boards, while parts in excessive number generate abundant inventory in the production process. Therefore, more cost-effective and more frequent supplies to manufacturing cells were suggested. There were new manufacturing paths were designated (according to a rule which states that the width of one-way path is supposed to be 1.8m, while a two-way one 3.6m). For internal transport trucks with double steering axle were used. A crucial element is setting the manufacturing tact time enabling uninterrupted material flow through all the production processes avoiding the so called bottleneck.

The implemented suggestions concerning improvement and optimization of transport conditions within a company greatly contribute to a decrease in the risk level on the company premises which are linked to the elimination of fork-lift trucks from the production hall.

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ARCHIWUM INŻYNIERII PRODUKCJI
PRODUCTION ENGINEERING ARCHIVES

2016, Vol. 13, No. 4, pp 44-48
ISSN 2353-5156 (print version)
ISSN 2353-7779 (online version)

Article history: Received: 03.12.2016 Accepted: 16.12.2016 Online: 30.12.2016

Available online on: http://www.qpij.pl **Exist since 4th quarter 2016**

Production of heterogeneous surfaces by ESD and LBM

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Abstract. The paper is concerned with testing Cu-Mo coatings deposited over carbon steel C45 which were then eroded with a laser beam. The properties were assessed by analyzing the effects of laser eroded, texturing methodology and wear tests. The tests were conducted for Mo and Cu coatings (the anode) which were electro-spark deposited over the C45 steel substrate (the cathode) and melted with a laser beam. The coatings were deposited by means of an ELFA-541. The laser processing was performed with an Nd:YAG laser. The coatings after laser processing are still distinguished by very good performance properties which make them suitable for use in sliding friction pairs.

Key words – heterogeneous surfaces, electro-spark deposition (ESD), laser beam machining (LBM), texturing, properties

1. Introduction

During tribological investigations it was found that employing heterogeneous surfaces models into boundary interaction of solid surfaces could make significant improvement (ANTOSZEWSKI B. 1999). Surfaces described as heterogeneous consist of areas which are different one from another in geometrical, physicomechanical or physicochemical properties. The heterogeneity of surfaces is frequently the result of the application of more than one technology, and can be constituted by (GYK G., ETSION I. 2006, WAN YI, XIONG DANG-SHENG 2008):

- shaped surface features such as grooves, pits or channels resulting from milling, eroding, etching, laser-beam forming, etc.,
- areas with different physicochemical and physicomechanical properties, e.g. areas with varying hardness and mechanical strength accomplished by local surfacing or selective surface hardening (e.g. electron-beam machining, laser-beam forming or thermochemical treatment),
- areas with diversified surface microgeometry, e.g. areas eroded at the points of focus (laser treatment or electro-spark deposition), or areas with formed surface microgeometry, for instance, in terms of desired microroughness directivity or load capacity (LBM and ESD technologies).

Heterogeneous surfaces can be obtained by different methods, and the laser treatment of electro-spark deposited coatings is one of them.

2. Texture impact on contact issues

Frictional resistance between slide rings of the end-face seal depend on interrelations between elementary processes that occur in the gap (ANTOSZEWSKI B. 2010. ANTOSZEWSKI B. 2009). The processes include the following: hydrostatic and hydrodynamic action of the medium, the medium adhesion to the substrate, change in the gap geometry resulting from thermal and mechanical deformation, carrying away of heat, changes of phase and rheological properties of the liquid in the gap. Those interrelations, in turn, cannot be considered without referring to the physical properties of the medium, and of the surfaces that enclose the gap (e.g. viscosity, wettability), or to kinematic and dynamic relations between the above-mentioned factors (ARNOLD J., MULLER G., SCHNEIDER H., MULLER H.K., HUGEL H. 1993). It should be understood that, depending on the factors, those elementary interrelations can produce either synergistic or antagonistic effect on the minimisation of frictional resistances in the seal gap. Bearing that in mind, the role of macro- and micro-geometry of the surfaces that constitute the gap needs to be taken into account. Departure from smooth and flat surface, if regular in character and properly designed, can bring about synergistic effect on the desirable properties of a sliding pair, such as bearing, durability and reliability. In view of all the arguments above, an important role for surface engineering technologies in producing sliding friction pairs should be emphasised. Those technologies, which once contributed to the manufacturing of flat and smooth surfaces, are currently employed to make heterogeneous and textured surfaces (YU X.Q., HE S. 2002, KOVALCHENKO A., AJAYI A., ERDEMIR A., FENSKE G., ETISON I. 2005).

Figures 1 and 2 show examples of heterogeneous surfaces. Generally, the real contact surface is smaller than the nominal one and contact load onto real contact surfaces are higher than the corresponding nominal values. In particular, while analysing the real geometries of contact of geometrically textured surfaces, it is necessary to have data on the real contact surface (PIETRASZEK J., RADEK N., BARTKOWIAK K. 2013).

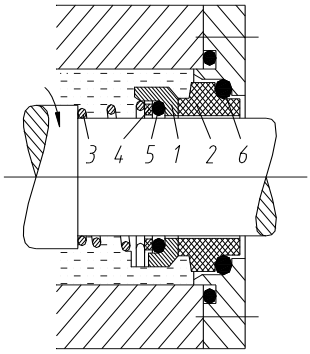

Fig. 1. Schematic diagram of the face seal: 1 – axially shifted sliding ring, 2 – anti-ring, 3 – spring, 4 – clamping ring, 5, 6 – secondary seals.

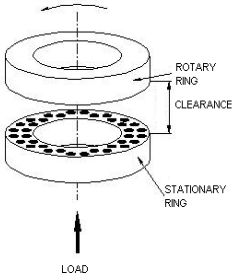

Fig. 2. Model of sliding pair with textured surface.

Depending on load, and also due to wear, the surface bearing profile undergoes changes. The analysis of changes in the bearing surface for the shape profile with spherical dimples is presented above (Fig. 3 and 4).

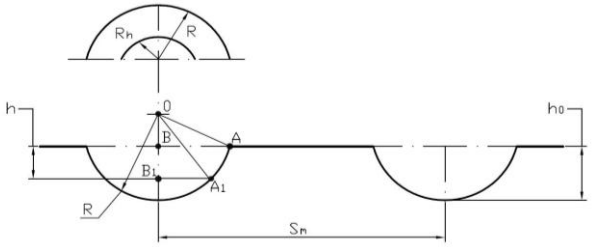

Fig. 3. Diagram of a geometric texture with spherical dimples.

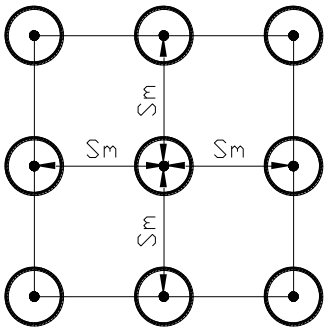

Fig. 4. Dimple spacing in the surface with uniform texture.

As a result of deformations caused by load or wear, the depth of dimples of h values is reduced in service, which also produces a reduction in the dimple radius to the value of R_h.

$$R_h = A_1B_1 = \sqrt{R^2 - (R - h_0 + h)} = \sqrt{(h_0 - h)(2R - h_0 + h)} \quad (1)$$

For $2R >> h$ $$R_h = A_1B_2 = (R - h_0)^{\frac{1}{2}}(h_0 - h)^{\frac{1}{2}} \quad (2)$$

Because of exploitation, the bearing surface α (the ratio of the surface without dimples to the nominal surface) will be changed to the value of α_h:

$$\alpha = \frac{A_n}{A_0}, \quad \alpha_h = \frac{A_h}{A_0} \quad (3)$$

where: $A_n = A_0 - k\pi R^2$, $A_h = A_0 - k\pi R_h^2$ (k – number of dimples on the surface A_0).

If loading with F force is assumed, the following dependence for the value of pressure on the surface is received:

$$\sigma_h = \frac{F}{A_h}, \quad \sigma_0 = \frac{F}{A_0} \quad (4)$$

After substituting dependences (2) and (3), the following is obtained:

$$\sigma_h = \left(\frac{A_0}{A_0 - k\pi(R - h_0)(h_0 - h)} \right) \sigma_0 \quad (5)$$

The amount of lubricant, its distribution and properties create various situations in the sliding pair. Those generate processes in the contact zone, which are different qualitatively and quantitatively. If only the amount and wetting properties of the lubricant are taken into account, four cases should be differentiated (Fig. 5).

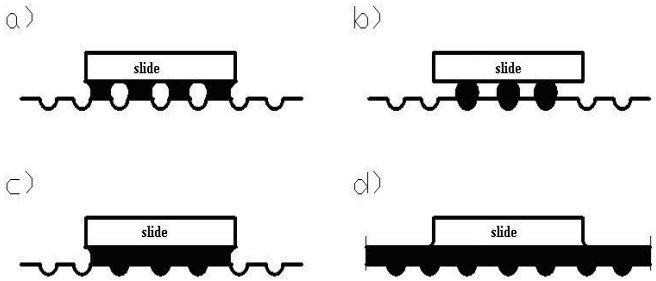

Fig. 5. The interaction of the lubricant and the textured surface in the sliding pair: a) lean lubrication with a weak wetting agent, b) lean lubrication with a good wetting agent, c) sufficient lubrication of the slide with a good wetting agent, d) abundant and continuous lubrication of the textured surface.

Texture is described by geometric relations for a single texture element, and also by relations that refer to their spacing on the friction surface. As regards a texture composed of uniformly distributed dimples having the form of spherical bowls, it is possible to state relations between a degree of blackening, diameter and depth of dimples and their volume.

3. Texturing methodology and wear tests

Laser surface texturing is one of the most common and promising methods of surface roughening. Categorized as a metal removal process, laser texturing is usually performed at a power density of 10^6-10^9 W/cm^2. At present, it accounts for about 2% of all laser-based material processing processes used in the world.

In laser surface texturing, a pulsed laser beam is focused on a material to melt a hole. The hole depth is dependent mainly on the power density and the pulse duration. The drilling debris is removed from a hole being drilled using compressed air or another inert gas.

The tests were conducted for Cu-Mo coatings produced by electro-spark deposition onto rings made of carbon steel C45.

The electro-spark deposition of Cu and Mo wires with a diameter of 1 mm was performed by means of an ELFA-541, a modernized device made by a Bulgarian manufacturer.

The parameters of the electro-spark deposition established during the experiment include:

- current intensity, I = 16 A (for Cu I = 8A),
- table shift rate, v = 0.5 mm/s,

– rotational speed of the head with electrode, n = 4200 rev/min,
– number of coating passes, L = 2 (for Cu L = 1),
– capacity of the condenser system, C = 0.47 μF,
– pulse duration, t_i = 8 μs,
– interpulse period, t_p = 32 μs,
– frequency, f = 25 kHz.

The texturing was performed using an Nd:YAG laser (impulse mode), model BLS 720, and operating in the pulse mode under the following conditions:

– laser spot diameter, d = 0.7 mm,
– laser power, P = 20 W,
– beam shift rate, v = 1200 mm/min,
– nozzle-sample distance, h = 1 mm,
– pulse duration, t_i = 1.2 ms,
– frequency, f = 8 Hz.

A Joel JSM-5400 scanning electron microscope was used to study the effects of laser surface texturing. Selected SEM images are presented in Figure 6. As can be seen, the surface structure after laser surface texturing is regular. The surface is covered by bumps and dimples resulting from phase and structural modifications and the accompanying specific volume changes in the laser affected zones. Lapping and super finish are used to obtain hard flat areas transferring normal loads and areas of pores where the hydrodynamic forces are generated during fluid lubrication. Surfaces with such a texture can be applied, for instance, to sliding friction systems. The microscopic analysis showed that the removal of the drilling debris was not complete when the laser beam was focused locally. This was probably due to insufficient power density. The action of the thermocapillary forces and the convective motion resulted in the formation of rims, whose structure consisted of molten and then crystallized Cu-Mo.

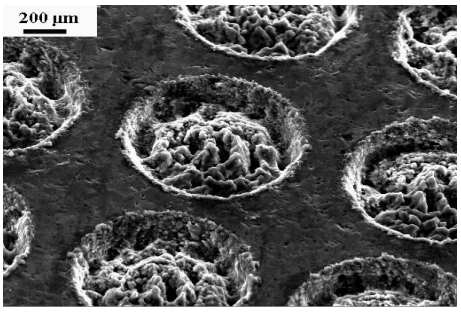

Fig. 6. A system of microcavities on the ring.

Detailed parameters of geometric texture can be identified by examining it on a profiler Talysurf FORM-120L Taylor-Hobson Limited. Figure 7 shows an example of the profile of the surface in a 3D view with the isometric map.

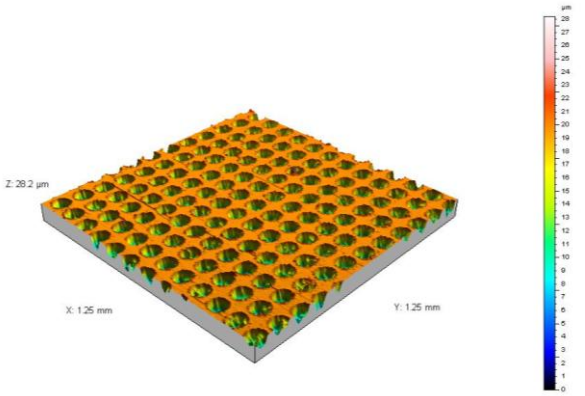

Fig. 7. Geometrical structure textured surface - 3D view.

The wear tests of the Cu-Mo electro-spark deposited coatings before and after laser surface texturing were carried out using the pin-on-disc tester T-01M.

The tester makes it possible to measure the friction force for a predetermined load. The pin ϕ 4 x 20 mm was made of tool steel. The samples and anti-samples were prepared in accordance with the instruction. The tests were conducted at the following parameters of friction:

– linear velocity, v = 0.8 m/s,
– test duration, t = 3600 s,
– sliding distance, S = 2880 m.
– range of load changes: 5, 10, 15 N.

A drop of lubricant – paraffin oil was applied on the ring raceway only once.

It was necessary to measure the time after which the value of the friction coefficient increased.

The wear test results for the electro-spark deposited Cu-Mo coating before and after laser surface texturing are shown in Tables 1 and 2.

Table 1. Results of the wear test for the Cu-Mo coating after laser surface texturing

Load, N	**Mass loss, mg**			
	not lubricated		lubricated oil	
	pin	disc	pin	disc
5	5.44	6.88	3.35	4.26
10	10.24	12.16	7.11	8.63
15	14.88	20.16	10.29	15.72

Table 2. Results of the wear test for the Cu-Mo coating before laser surface texturing

Load, N	Mass loss, mg			
	not lubricated		lubricated oil	
	pin	disc	pin	disc
5	6.16	9.64	4.89	6.33
10	13.05	16.84	9.06	11.54
15	19.41	23.28	13.14	18.67

Table 3 shows the values of the friction coefficient for the Cu-Mo coating before and after laser surface texturing.

Table 3. Results of the friction coefficient for the Cu-Mo coating before and after laser surface texturing

Load, N	Friction coefficient			
	not lubricated		lubricated oil	
	Cu-Mo	CuMo+laser	Cu-Mo	Cu-Mo+laser
5	0.39	0.40	0.21	0.14
10	0.54	0.46	0.35	0.23
15	0.67	0.48	0.43	0.32

4. Summary

1. It is possible to diversify the surface of electro-spark deposited coatings, i.e. to obtain heterogeneous surfaces. The laser-affected areas are characterized by the occurrence of regular cavities, hardened areas and varied roughness.
2. The surface heterogeneity (i.e. the cavities) is desirable in sliding friction pairs. They may be used as reservoirs of lubricants as well as sources of hydrodynamic forces increasing the capacity of a sliding pair.
3. Laser texturing of Cu-Mo coatings provides increased resistance to wear and reducing of friction coefficient.
4. A concentrated laser beam can effectively modify the state of the surface layer, i.e. the functional properties of electro-spark coatings can be achieved.
5. In the next phase of the research it is essential to determine the phase composition and porosity of the coatings before and after laser treatment.

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PRODUCTION ENGINEERING ARCHIVES

2016, Vol. 13, No. 4, pp 49-52
ISSN 2353-5156 (print version)
ISSN 2353-7779 (online version)

Article history: Received: 21.11.2016 Accepted: 01.12.2016 Online: 30.12.2016

Available online on: http://www.qpij.pl **Exist since 4th quarter 2013**

The OHS management system in the "small-sized" production company

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Abstract. In the article the problem with systemic management of safety in the smallest production entities has been shown. The effect of health and safety management system and the benefits resulting from it for the most numerous economic entities in Poland - micro-enterprises have been discussed. Moreover, the results of questionnaire examination conducted in several Polish production companies have been presented. Surveys were completed in companies in which the number of employees does not exceed 49 people (micro enterprise - from 1 to 9 employees and small enterprises - from 10 to 49 employees).

Key words – health and safety management system, micro enterprises 'small size', a manufacturing company

1. Introduction

The Occupational Health and Safety Management System is an autonomous part of the overall enterprise management system. It consists of the following elements: the organizational structure, planning, responsibilities, policies, procedures, processes and resources needed for development, review of health and safety policy etc. (pkt. 3.2. PN-N 18001:2004). These are all elements that are used to establish the policies and objectives of the company in the field of occupational safety and health and also tools which are used to achieve those objectives.

Basic requirements for the occupational health and safety management system's in the company resulting from legal regulations under which it is necessary to carry out a risk assessment and resulting from this assessment protection measurement, as well as employees training (KORADECKA D. 2008).

In Poland, among entrepreneurs the most popular consistently is PN-N18001 Standard. Continuous improvement of working conditions, which is the overarching objective of health and safety management system ensures to the employee, that the employer cares about his safety in the performance of professional duties (ULEWICZ R. ET AL. 2015).

Implementation of OHS management system according to PN-N-18001 can not only help to meet the requirements of applicable law, but also enable the achievement of measurable benefits associated with the improvement of the level of occupational health and safety (PODGÓRSKI D. 2015).

An effective occupational health and safety management system allows to (EJDYS J. ET AL. 2013):

- reduce the number of accidents at work as well as the number of occupational diseases and related losses,
- reduce employees' absenteeism,
- increase productivity,

– improve the quality of work.

According to literature, there are sufficient five steps to build the company effective health and safety management system complying with the requirements of PN-N-18001. It is also possible in 'small size' companies, which are considered to be a actuating medium of economic growth and supporting innovation in Europe.

3. Methodology of research

This article contains brief reviews of some literature, as well as results from available reports about the importance of occupational health and safety management system in small businesses, especially manufacturing companies. The operation of safety management system in "small size" enterprises producing furniture using the original questionnaire has also been evaluated.

4. Results and discussions

The SME sector in the EU employs the average of 4.22 people, which decisive majority (92.4%) of enterprises in the EU is classified as a micro-enterprise. These micro-enterprises represent 67.4% of all jobs in Europe. Therefore, their importance for the European economy is significant. The data shows that workers in small-sized businesses are more at risk than employees of larger businesses and smaller enterprises confronted with more problems in risk control.

Various studies, including those carried out by EU-OSHA's - European Survey of Enterprises on New and Emerging Risks (ESENER), show that difficulties in meeting the requirements of occupational health and safety are particularly important in smaller entities (www.osha.europa.eu of 10.10.2016).

The relatively low level of occupational health and safety can result from certain characteristics - typical of small businesses, such as structural and organizational characteristics of work and employment in such entities, their economic situation and economic relations, diversity and flexibility of business, small regulatory oversight of these companies, attitudes and competence of owners and employees in small entities or their short-term operations. These features make it difficult for micro-businesses and small-businesses to create and maintain a safe and healthy work environment. Among other factors that have an impact on the management of occupational health and safety in these companies (compared to larger companies) are the following (www.osha.europa.eu of 10.10.2016):

– difficulties with regulation, since they are generally not uniform, geographically dispersed and without coherent representation,
– budget constraints, often resulting in the lack of resources to implement initiatives and interventions in the field of occupational health and safety related to getting of paid advice and information on occupational health and safety, as well as use of specialized tools and controls,
– inadequate resources make it impossible to implement of preventive measures,
– less time and energy is devoted to the task "non-core activities", and as such are sometimes considered the activities in the field of safety and health. Appropriate level of occupational health and safety is not considered as a priority,
– risk assessment is sometimes expensive and inconvenient, especially if the company does not have the resources or knowledge in the field of occupational health and safety, which enable it to effectively carry out,
– organizations promoting or enforcing appropriate level of occupational health and safety is sometimes difficult to immediately reach out to micro and small enterprises.

While a "small size" company actually has a lot of difficulties in the application of health and safety management system in their structures, it certainly has many benefits. As the most important and most frequently mentioned by employee the lack of employee awareness of the importance of the health and safety management system and conviction of the lack of financial resources for the implementation of the system principles are listed. In addition, employees of "small size" enterprises, especially micro-enterprises, do not indicate safety as the most important value. It is for them secondary. As the most important considered for the enterprise are maintaining in the market and be competitive. However, there are enterprises (employing 10 to 49 employees - small enterprises), for which their company's success sis the safety system management. They indicate the following benefits of occupational health and safety management system:

– increase the compliance of the legal requirements,
– increase employee awareness of the rules and safety regulations,
– minimization of the accidents' incidence.

A very important and fundamental goal of health and safety management system in the enterprise is the

principle of continuous improvement based on the Deming Cycle (Fig. 1).

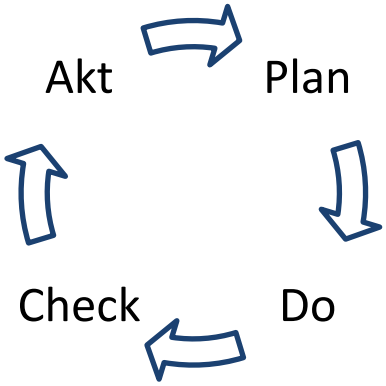

Fig. 1. Deming cycle model (LIKER J. K., FRANZ J. K. 2013).

These four basic steps - plan, do, check, act – are the strategic elements of the work security policy. Contrary to the opinions of the respondents, it can be easily implemented, even in the smallest entities, especially productive. The company should always plan for all its activities on the market, then realize the planned activities, then check the validity of objectives made and correct everything that needs correcting. It is very important that the workers in of this type of action considered the norm, and they saw the sense in continuous improvement.

To ensure a comprehensive system, organizations introducing a health and safety management system can (and should) use the guidelines at international, national and industry levels. The structure of the system structure has been shown in Fig. 2.

The implementation and operation of the OSH management system is closely related to workers' knowledge on the security and management system. While employees of small businesses (10 to 49 employees) declared in the questionnaire the knowledge of basic health and safety regulations. They also respect safe behavior at work. Conversely, the employees of micro-enterprises (up to 9 employees)did not declare such knowledge. Most respondents perceive the lack of knowledge about safe work as "boring" and irrelevant as they usually did not participate in training or participated with constraint.

It should be remembered that every employer (manager represented often micro enterprises) is responsible for the initial training carried out; periodic as well as instructional. Moreover, the owner is liable for any problems resulting from their low level training, or even its absence, regardless of the extent of accidents; whether they are minor or produce fatal consequences.

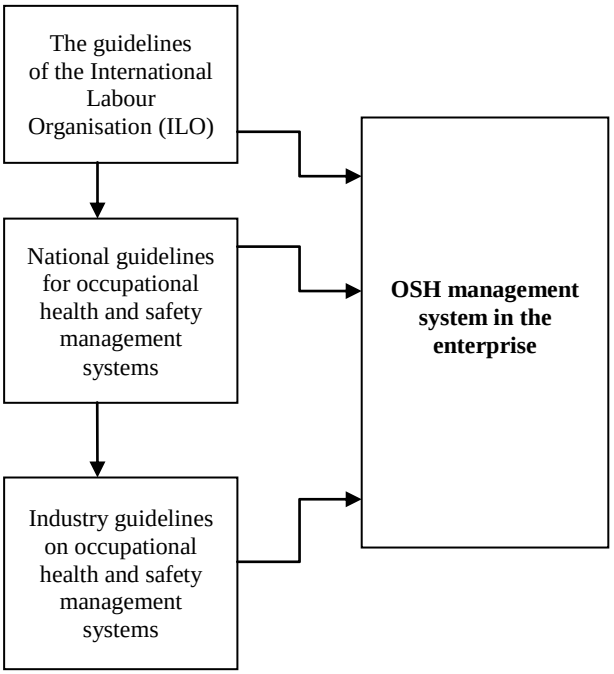

Fig. 2. The structures element of Occupational Health and Safety Management System (GAŁUSZA M. 2014).

5. Summary

System management of health and safety in "small size" enterprises is difficult but not impossible. In medium and large business entities, there are health and safety departments that care about all the elements of health and safety management system that shape the consciousness of their employees in terms of safe and accident-free work, pointing to the benefits of a comprehensive and systematic approach to managing health and safety. In small entities, especially micro-enterprises, there is the lack of supervisors' knowledge and awareness that the system management of health and safety is not complicated and expensive, and brings many benefits. Literature and safety experts suggest that the most neglected element that are responsible for the functioning of the OHS management system are "training, awareness, competence and motivation" (LEWANDOWSKI J., GÓRSKA E. 2010). A human being, as the most important element in any organization, and the most valuable capital should be adequately trained, his awareness should be shaped, competence raised and motivation for safe and accident-free operation is still activated.

Responsibility for all the above mentioned elements shall be borne by supervisor, who in micro enterprises, which is usually also the owner of the company. It also builds on relationships in the enterprise, as the employees perceive their mentor and leader. Regardless of the size of the economic entity and the (AAMIR ALI CHUGHTAI 2015). Nature of the business, one of the most important elements that determine the effectiveness of the OHS management system is the human factor.

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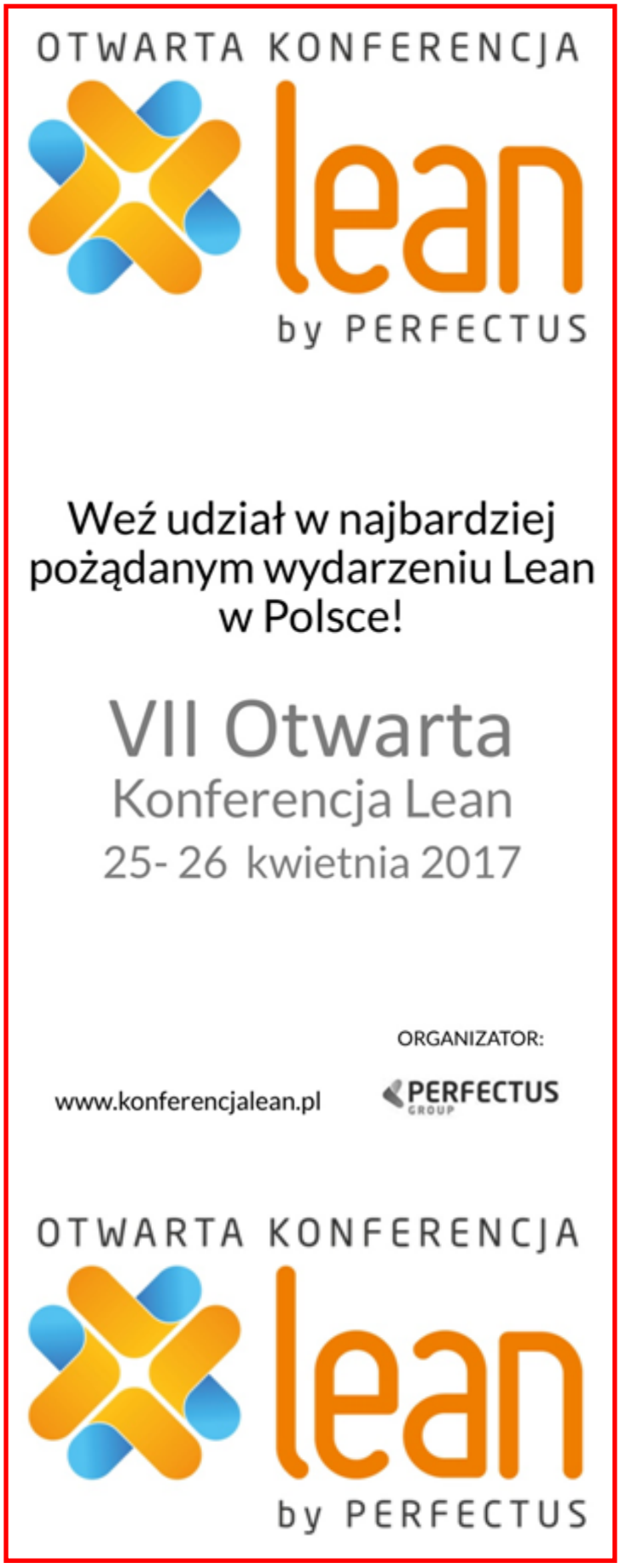

ABSTRACTS:

Denis Jelačić, Josip Faletar

This research analysed the motivating and demotivating factors amongst employees in two wood processing companies in Croatia. Research was conducted over the year 2014 and 2015, during the economic recovery of the companies and Croatian economy in general. Research was conducted with a survey using a questionnaire containing six questions with multiple choice statements. The questions were closed-ended, and respondents used the Likert four-level scale of importance for each statement. A total of 180 employees were surveyed, and results were statistically processed by using the $\chi 2$- test and cluster analysis. This study established that the motivation factors most important to employees between researched companies are significantly different. Employees were most concerned about social needs. Also, employees consider psychological circumstances of work to be very important. Employees' overall motivation can be linked to higher efficiency and higher quality production and business results, and such research should be conducted more often.

Lenka Kuchariková, Eva Tillová, Denisa Závodská

Aluminium alloys represent an important category of materials due to their high technological value and wide range of applications. The alloys of the Al-Si-Cu system have become increasingly important in recent years, mainly in automotive industry that uses secondary aluminium (recycled) in the form of various motor mounts, pistons, cylinder heads, heat exchangers, air conditioners due to their high strength at room and high temperature. This work deals with possibilities of quick and correct assessment of aluminium castings microstructure, especially focused on volume, size and shape of structural parameters – eutectic Si and intermetallic phases different chemical compositions. These structural parameters affect the properties of castings and it is important to study their features. The features were studied by using image analyser software NIS Elements.

Juraj Belan, Lenka Kuchariková, Alan Vaško, Mária Chalupová, Ivana Švecová

Microstructures of superalloys have dramatically changed throughout the years, as modern technology of its casting or forging has become more sophisticated. The first superalloys have polyedric microstructure consisting of gamma solid solution, some fraction of gamma prime and of course grain boundaries. As demands on higher performance of aero jet engine increases, the changes in superalloys microstructure become more significant. A further step in microstructure evolution was directionally solidified alloys with columnar gamma prime particles. The latest microstructures are mostly monocrystalline, oriented in [001] direction of FCC gamma matrix. All microstructure changes bring necessity of proper preparation and evaluation of microstructure. Except for the already mentioned structures have gamma double prime and various carbides form can be seen. These structural parameters have mainly positive influence on important mechanical properties of superalloys. The paper deals with a microstructural evaluation of both groups of alloys – cast and as well as wrought. Microstructure evaluation helps to describe mechanism at various loading and failure of progressive superalloys. Such an example where microstructure evaluation is employed is fractography of failure surfaces after fatigue tests, which are examples of metallography evaluation described in this paper as a secondary objective.

Krzysztof Mielczarek, Krzysztof Knop

The article presents research results in a scope of evaluation importance in visual control usage in the production processes of enterprises from automotive industry. The significance of visual control in a production process was characterized. An innovative BOST questionnaire survey was described as a tool for transformation of Toyota's management principles into questions. The survey questions from BOST study were described, which is used in evaluation of the visual control importance with reference to the second Toyota's management principle (question E3). The analysis of respondents preference in ranging factors of the second Toyota's management principle was conducted using comparative evaluation of Thurstone's method, as well as the degree of similarity between these factors was indicated. A subjective factor was assessed by employees of automotive industry as one of less significant in the production process.

Michal Jambor, Juraj Belan, Otakar Bokůvka, František Nový

This work deals with the fractography analysis of nickel-base superalloy Inconel 718 fatigued at 700°C in air atmosphere in the high cycle region. During cyclic loading of this alloy at high temperatures some different mechanisms compared to cyclic loading at ambient temperature take place. Cyclic plastic deformation at high temperatures causes some structural changes, which could have some influence on the fatigue process.

Andrzej Pacana, Artur Woźny

A continuous technological progress forces an improvement of the production process. The article describes the sole beginning of changes in the process of tires retreading on the 5S management method with regard to health and safety standards. The authors point out that the process of the production of retreaded tires is associated with the relationship between a man and a machine. The process improvement can dispense only by improving the machines but it should also pay attention to the man. The improvement of the production process must precede the audit, which can show areas that require intervention. Any such change in the production process cannot be performed without the participation of health and safety inspector, because his knowledge, skills and competence are able to determine whether the proposed changes interfere with the level of safety at the workplace. The authors emphasize that the process of production improvement production should be compatible with the process of improving the health and safety of workers involved in the production process. The combination of 5S audit with health and safety standards results in a holistic approach to the improvement process.

Marcel Lizak

Invalid organisation of the production environment in an enterprise is the cause of many disruptions during the implementation of production processes. Lean Management is aimed at improving processes and eliminating interference in accordance with the Kaizen principle. A significant element of management constantly analyses and measures the improved results. The article presents the results of the literature research from the scope of observation methods and measuring the effects of the use of Lean Management instruments in manufacturing companies.

Renata Nováková, Katarína Čekanová, Alena Pauliková

Organizations are becoming more aware of the importance of integrated management systems (IMS). Interest in this subject indicates that IMS are seen as "management systems of the future". The problem is that the methodology of integration of management systems does not exist. There are specification for example PAS 66 that tell only about requirements standards. standards Both ISO 9001:2015 and ISO 14001:2015 standards were revised in 2015. Based on this, the aim of this article is to characterize the possibility of creation of IMS through the identification of common elements and specific requirements in accordance with professional references ISO 9001:2015 and ISO 14001:2015.

Magdalena Mazur

The following paper discusses how to use of a company's assets efficiently by the identification of value stream and the elimination of all the processes that do not contribute to a company's added value. The identification of critical points of value stream by means of a map illustrating these processes helps to indicate the area where the selected elements of LEAN concept aiming at eliminating waste in domestic transport should be implemented. The article contains the analysis of the state of the current stream, and suggestions concerning its improvement.

Norbert Radek, Izabela Pliszka, Bogdan Antoszewski, Jacek Świderski, Jacek Pietraszek

The paper is concerned with testing Cu-Mo coatings deposited over carbon steel C45 which were then eroded with a laser beam. The properties were assessed by analyzing the effects of laser eroded, texturing methodology and wear tests. The tests were conducted for Mo and Cu coatings (the anode) which were electro-spark deposited over the C45 steel substrate (the cathode) and melted with a laser beam. The coatings were deposited by means of an ELFA-541. The laser processing was performed with an Nd:YAG laser. The coatings after laser processing are still distinguished by very good performance properties which make them suitable for use in sliding friction pairs.

Dorota Klimecka-Tatar, Marta Niciejewska
In the article the problem with systemic management of safety in the smallest production entities has been shown. The effect of health and safety management system and the benefits resulting from it for the most numerous economic entities in Poland - micro-enterprises have been discussed. Moreover, the results of questionnaire examination conducted in several Polish production companies have been presented. Surveys were completed in companies in which the number of employees does not exceed 49 people (micro enterprise - from 1 to 9 employees and small enterprises - from 10 to 49 employees).

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2016, Vol. 13, No 4, pp 1-3 or 4
ISSN 2353-5156 (print version)
ISSN 2353-7779 (online version)

Article history: Received: dd.mm.rrrr Accepted: dd.mm.rrrr Online: dd.mm.rrrr

Available online on: http://www.qpij.pl **Exist since 4th quarter 2013**

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