10/2016

PRODUCTION ENGINEERING ARCHIVES

PRODUCTION ENGINEERING ARCHIVES

ARCHIWUM INŻYNIERII PRODUKCJI ***PRODUCTION ENGINEERING ARCHIVE,***
Vol. 10, No. 1

Editor' office: Institute of Production Engineering
Faculty of Management
Czestochowa University of Technology

Publisher: Printing House
The Managers of Quality and Production
Association

Exist since 4rd 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 on the 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.

Editor:

Editor's address:	Instytut Inżynierii Produkcji, Wydział Zarządzania, Politechnika Częstochowska, Al. Armii Krajowej 19B, Poland, tel. +48 34 3250 333
Editor's e-mail:	journalarchive@qpij.pl Published: 300 pcs
Indexed on:	https://baztech.icm.edu.pl/ http://www.indexcopernicus.com/

The press and the cover:
Publishing and Advertising Agency Edytor Ltd.
ul. Gałeczki 61, 41 – 506 Chorzów, Poland
e-mail: office@edytor.pl

Perfect Gaul i wspólnicy sp.j.
ul. Świerzawska 1, 60-321 Poznań
http://www.perfekt.pl/

CONTENTS:

ARCHIWUM INŻYNIERII PRODUKCJI
PRODUCTION ENGINEERING ARCHIVES

2016, Vol. 10, No 1, pp 2-4
ISSN 2353-5156 (print version)
ISSN 2353-7779 (online version)

Article history: Received: 04.01.2016 Accepted: 25.01.2016 Online: 31.03.2016

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

Use of statistical acceptance of products in the automotive industry

Agata Dudek[1]

[1] *Czestochowa University of Technology, Institute for Material Engineering, Faculty of Production Engineering and Materials Technology, Czestochowa, Dabrowskiego 69, Poland, phone 48343250721, dudek@wip.pcz.pl*

Abstract: The article presents the results of studies on the implementation of statistical acceptance of products with the example of a styrene-rubber plastic connector, while considering particular stages of production. The characterization of factors determining the transition from normal inspection to relaxed or tightened inspection for products made of styrene-rubber plastic materials has been made. The effect of the type of inspection on the level of non-conformance of products has been determined.

Key words quality, SCP, automotive, control

1. Rules of the statistical acceptance of styrene-rubber plastic connector

The principles of the statistical inspection of a styrene-rubber plastic connector have been developed and implemented on the basis of the PN-ISO 2859+AC1 standards. Sampling plans based on the acceptable quality level (AQL) were used during lot-by-lot inspection [PN-ISO 2859-1:2003]. The following two inspection systems have been implemented in the enterprise:

- normal inspection (recommended as initial inspection); and
- tightened inspection –in situations of enhanced requirements or the necessity of tightening the inspection for other reasons.

These activities are applicable to the evaluation of connectors transferred between particular phases of production (ULEWICZ R. 2003, ŠURINOVÁ Y., LESTYÁNSZKA ŠKŮRKOVÁ K. 2013, SOŃTA G., DUDEK A., SELEJDAK J., ULEWICZ R. 2015).

For the assessment of the quality of transportable lots with normal inspection, a single-stage sampling plan, the general inspection level II, and the acceptable quality level, AQL = 2.5%, were taken. A schematic diagram of the procedure is shown in Fig. 1.

In order to determine the conformance of a transportable lot to the specification, it is necessary to:

- establish the number of pieces in the transportable lot,
- take a random sample of products of the size as specified in the sampling plan,
- examine each piece taken for conformance with the established acceptance criteria and determine whether it is good or bad, then count bad pieces in the sample and compare their number with the qualifying and disqualifying numbers – isolate the rejects and mark them with the card "Rejects";

- consider the lot as conforming to the requirements, if the number of bad pieces in the sample is equal or less than the qualifying number;
- consider the lot as non-conforming to the requirements, if the number of bad pieces in the sample is equal or greater than the qualifying number;
- consider the lot as non-conforming to the requirements, if the number of bad pieces in the sample is equal or greater than the qualifying number, and mark it with the card "To be sorted / reworked".

The procedure for the assessment of a transportable lot with tightened inspection is similar to that for normal inspection, except for the number of acceptable nonconformities in the sample, which is different. Figure 1 shows the schematic diagram of the statistical control procedure.

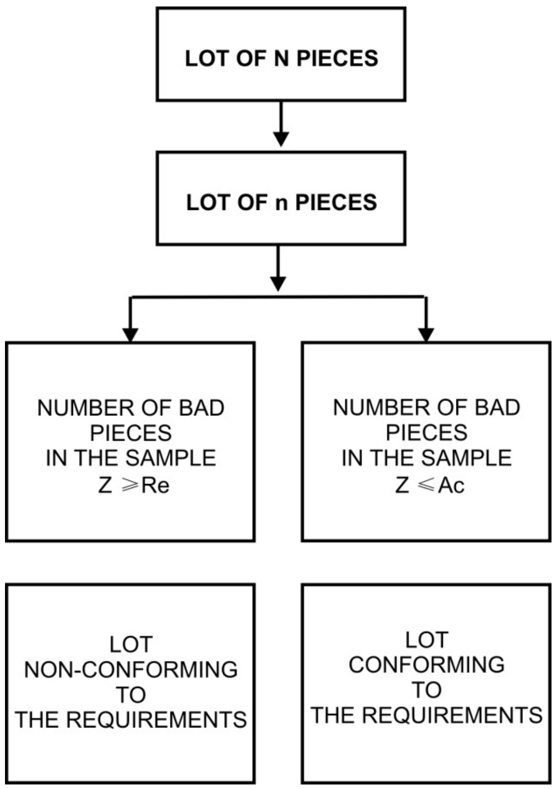


Fig. 1. Schematic diagram of the statistical control procedure: Ac – qualifying number, Re – disqualifying number, N – lot size, n – sample size, Z – number of bad pieces found in the sample.

Source: own study

2. Conditions and procedures of transition

- Transition from normal inspection to tightened inspection. When performing normal inspection, tightened inspection should be introduced, when two of five or less successive lots are found to be non-conforming to the requirements at the first time during inspection, which means that lots resubmitted are not taken into account in this procedure.
- Transition from tightened inspection to normal inspection. When performing tightened inspection, normal inspection should be restored, if five successive lots have been considered conforming to the requirements at the first time during inspection.
- Transition from normal inspection to relaxed inspection. When performing normal inspection, relaxed inspection should be introduced, if all of the following conditions are satisfied:
  - 10 previous lots were submitted to normal inspection and all of them were accepted at the first time during inspection,
  - the total number of non-conforming units in the samples taken from the 10 previous lots is equal or less than the applicable limiting number,
  - production is stable,
  - relaxed inspection has been recognized as advisable by the authorized person.
- Transition from relaxed inspection to normal inspection. When performing relaxed inspection, normal inspection should be restored, if any of the following conditions occurs for the first time during inspection:
  - the lot has not be accepted,
  - the lot has been considered acceptable on the basis of the relaxed inspection procedures,
  - deliveries have become irregular or delayed,
  - other conditions exists, which justify the necessity of restoring normal inspection.

Figure 2 shows a schematic diagram of conditions for transition from normal inspection to relaxed or tightened inspection.

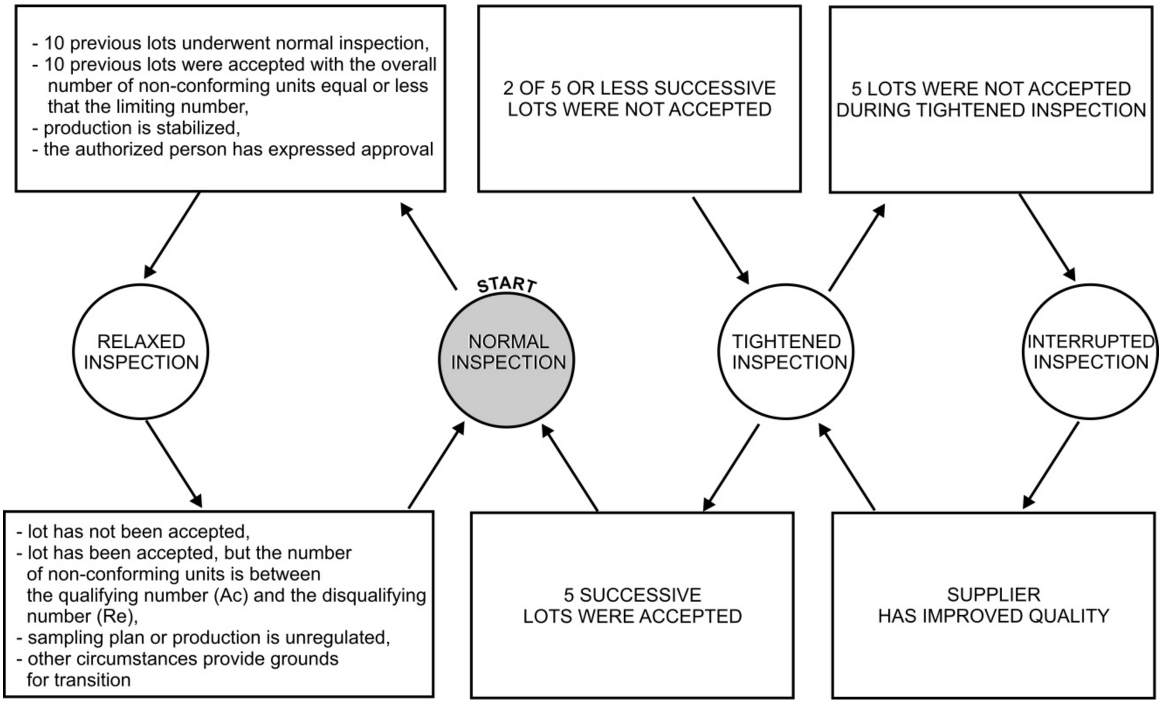


Fig. 2. Schematic diagram of transition from normal inspection to relaxed and tightened inspections.

Source: own study

3. Conclusion

The development and implementation of the statistical acceptance of styrene-rubber plastic connectors for serial manufacturing on particular stages of production have brought about a reduction of non-conforming products and faulty products by 9%. Data coming from inter-operational acceptance are processed by the Quality Control Department and the Production Planning Department. The results of analyses serve for modifying the parameters of the production cycle. By using processed statistical data, new procedures for taking actions at the limiting number of non-conformities have been developed. This has enabled the shortening of time necessary for the identification of the critical points of the production cycle. The large number of factors influencing the quality of produced styrene-rubber plastic connectors requires careful quality control. The use of a variable quality inspection system is quite expensive and is associated with the necessity of engaging larger human and equipment resources. The mechanism of transition from normal inspection to tightened or relaxed inspection requires an immediate change of inspectional and executive procedures [ULEWICZ R., DIMA I.C., GRABARA J. 2013]. The implementation of this form of inspection has proved to be more efficient that the traditional form of quality control, and, in combination with new procedures, shortened the time from the identification of a non-conformance to the initiation of corrective actions.

References

1. ISO 2859-1:2003
2. ŠURINOVÁ Y., LESTYÁNSZKA ŠKŮRKOVÁ K. 2013 Brief Review Of German Standards For Quality Audits In Automotive Production, Production Enginerring Archves Vol.1, pp. 35-37.
3. SOŃTA G., DUDEK A., SELEJDAK J., ULEWICZ R. 2015 Analysis of structure of elements for automotive industry, *Applied Mechanics and Materials*, Vol. 712, pp. 81-86
4. ULEWICZ R. 2003, Quality control system in production of the castings from spheroid cast iron, *Metalurgij*a, Vol. 42, Issue 1, pp. 61-63
5. ULEWICZ R., DIMA I.C., GRABARA J. 2013, Quality Assurance in the Process of Material Selection and Production of Semitrailer Structure Parts. *Metalurgia International,* Vol.18 no 7, pp. 195-199

ARCHIWUM INŻYNIERII PRODUKCJI
PRODUCTION ENGINEERING ARCHIVES

2016, Vol. 10, No 1, pp 5-8
ISSN 2353-5156 (print version)
ISSN 2353-7779 (online version)

Article history: Received: 14.01.2016 Accepted: 05.02.2016 Online: 31.03.2016

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

The assessment of quality of products using selected quality instruments

Edyta Kardas[1]

[1]Czestochowa University of Technology, Faculty of Materials Processing Technology And Applied Physics, Ul. Dabrowskiego 69, 42-201 Czestochowa, Poland, (+48) 34 32 50 753, ekonstan@wip.pcz.pl

Abstract The quality parameters of products should be controlled at every stage of the production process, since it allows detection of any problems even in the initial stages of production processes and removes their causes during manufacturing. Final control of products is intended to capture non-conforming products that did not go to the customers. The results of such controls should constantly be analysed. Such analysis can help to detect the most common problems, determine some dependences or identify the causes of such situations. A lot of different instruments that can support improvement of processes can be used for this kind of analysis. The paper presents the possibility of using some tools which can be utilized to support the analysis and assessment of quality of products at different stages of the production process. The quality analysis of exemplary products using selected quality methods and tolls is carried out. Metal sleeve, that is part of electronic control subassembly of anti-blocking system of ABS, which was the research component being studied.

Key words – quality, quality assessment, methods of quality managements, quality instruments, metal sleeve

1. Introduction

Quality of products is one of the factors determining customer satisfaction and profit for the company. For companies which work in the automotive industry, the quality of products has additional significance for customers. The quality of the produced component affects the quality, comfort and safety of use of vehicles, which has a significant impact on people's health and life. Production of repeatable products (products with the same level of quality parameters), which have the best parameters compatible with the specifications, standards and requirement of the customers, is very important for the companies (TORUŃSKI J. 2012, HAMROL A., MANTURA W. 2009). Continuous analysis of products at each stage of the production process, from assessment of quality of materials, through to the various stages of manufacturing to the control of products in stock, is one on the most important factors relevant to the quality of finished products (BORKOWSKI S., INGALDI M., JAGUSIAK-KOCIK M. 2014, INGALDI M. 2014, SYGUT P. 2015). The analysis of sleeve, that is part of electronic control subassembly of anti-blocking system of ABS, was presented in this paper. This analysis was based on results from a manufacturing company of automotive industry operating in the region of Lodz. The assessment of the quality of the finished product was also presented. The research covers the period of 1 calendar year.

2. Characteristics of the tested object

The quality analysis of metal sleeve is presented in this paper. The appearance of this sleeve is presented in Fig. 1.

Fig. 1. The appearance of the sleeve
Source: [6, 7]

This sleeve is the part of braking system. This is the part of component of electronic control subassembly of anti-block system of ABS, which is presented in Fig. 2.

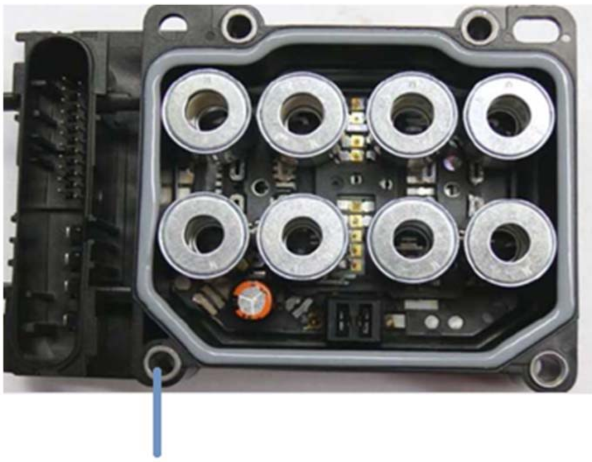


Fig. 2. Control subassembly of anti-block system of ABS
Source: (KOZIEŃ A. 2011)

This sleeve has to be produced with the utmost accuracy and precision due to the fact that the ABS control system effects on safety of vehicle users.

3. Methodology

In order to assess the quality of finished products the following quality tools were used:

1. Pareto chart – quantitative analysis of non-conforming products was made, all defective products were divided into 10 groups and the most frequent non-conformance was identified.
2. Ishikawa's diagram – causes of the most frequent non-conformance were identified and were divided into 5 groups.
3. 5xWHY? method – one of causes of the most frequent non-conformance was analysed deeply.
4. SPC – statistical analysis was made for one of parameters connected with the most frequent non-conformance. Elements of this analysis were following: histogram, basic statistics, three sigma law, process performance indexes (Pp, Ppk), control chart.

4. Pareto chart for non – conforming sleeves

The Pareto chart of finished sleeves was made. Results used in the analysis covered 12 months of 1 calendar year. Ten of the most frequent non - conformances were observed in the research products:

- Dimensional error – wrong dimension, usually too short element,
- Material error – visible joining of mould during casting of material, which cannot be removed during treatment,
- No treatment – untreated product,
- Edge – protruding edge on the lateral surface of the sleeve,
- Notches - corrugated lateral surface inside the sleeve,
- Loose chips – chips inside the sleeve,
- Impressions – damages on the surface caused by tool outside the sleeve,
- Surface – surface defects inside the sleeve,
- Steps – corrugated lateral surface inside the sleeve,
- Damage – defects of the surface caused by inaccurate treatment.

The Pareto chart was made based on the results on the quantitative analysis of non - conformances. Diagram was presented in Fig. 3.

The Pareto chart (Fig. 3) showed that dimensional error was the most frequent non - conformance (almost 22%), than surface (20%) and damages (18%). These three non - conformances in total has an effect in 60% of all non – conforming sleeves. Non - conformances (loose chips, impressions, notches, material error) occurred in small amount of product were insignificant in point of view of production process.

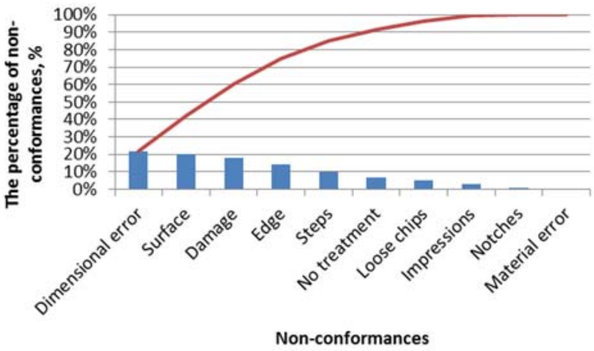


Fig. 3. Pareto chart of non – conformances
Source: Own study based on (KARDAS E. 2013, KARDAS E. 2014)

5. Ishikawa's diagram for causes of appearing of non-conformance of dimension of metal sleeve (short part)

Using Ishikawa's diagram the analysis of causes of appearance of the most common non-conformance was made. It demonstrated all significant relations, which caused the problem of dimension (short part). Groups of the causes of this non-conformance using Ishikawa's diagram is presented in Figure 4.

Ishikawa's diagram presented in Figure 4 shows how the source of failure and malfunctioning of the process can be discovered and identified. In addition, it indicated essential relations among various reasons causing research non-conformance. The application of diagram enabled the identification and classification of causes of the issue and presentation of imperfections of the process.

6. The analysis of selected reason of non-conformance of short part (chipping tool) for metal sleeve using 5xWHY? method

After the Ishikawa's analysis, the method of 5xWHY? should be made in order to further identification of the problem and improving its quality. This analysis is presented in Table 1. The analysis of the causes associated with chipping tool was made.

5xWHY? method showed how the causes of non-conformance – short part can be eliminated. The analysis of cutting tool showed that the roll of cam in the automatic lathe was deformed due to the low hardness of the used material.

Table 1. The analysis of selected reason of non-conformance, dimensional error of sleeve – short element (crushed tool), using method 5x WHY?

Why did the problem occur?	
Why ?	Chipping cutting edge of the tool
Why ?	Vibrations transmitted form the tool post
Why ?	Unstable bringing the tool post to the material
Why ?	Roller of running cam has been deformed
Why ?	Deformation of rolls caused due to the low hardness of used material

Source: Own study based on (KARDAS E. 2013, KARDAS E. 2014)

8. Summary

The assessment of quality of products, especially in automotive industry, has great importance for customers due to their satisfaction and significant impact on people's health and life. Metal sleeve, which is part of braking system, was the product under study.

Based in the analysis, presented in this paper, it can be said that:

- There was no trend or periodical fluctuation in the amount of non – conforming products, only small changes were observed. These changes can be caused mainly by various factors of the production process.
- Pareto chart showed that during study period ten non – conformances appeared. Three of them: dimensional error (almost 22%), surface (20%) and damage (18%) were the most frequent and had the greatest importance for the quality of products.
- The use of Ishikawa's method presented all significant relations among various reasons that caused non-conformance occurring the most frequently - improper dimension of metal sleeve (short part). Diagram enabled the identification and classification of causes of this issue and indication of causes of imperfections of the process.
- 5xWHY? method showed what was the primary cause of non-conformance – short part. During the analysis of cutting tool it turned out that the roll of cam in the automatic lathe was deformed due to the low hardness of the used material.
- Amount of non – conforming products is very low. During research period only 138 pieces of product were detected. Analysis shows that quali-

ty of product is very high and performs requirements of customer. That small amount of non – conforming products is the result of the quality control on every step of production process, what helps to detect even small error and prevent them to appear later.

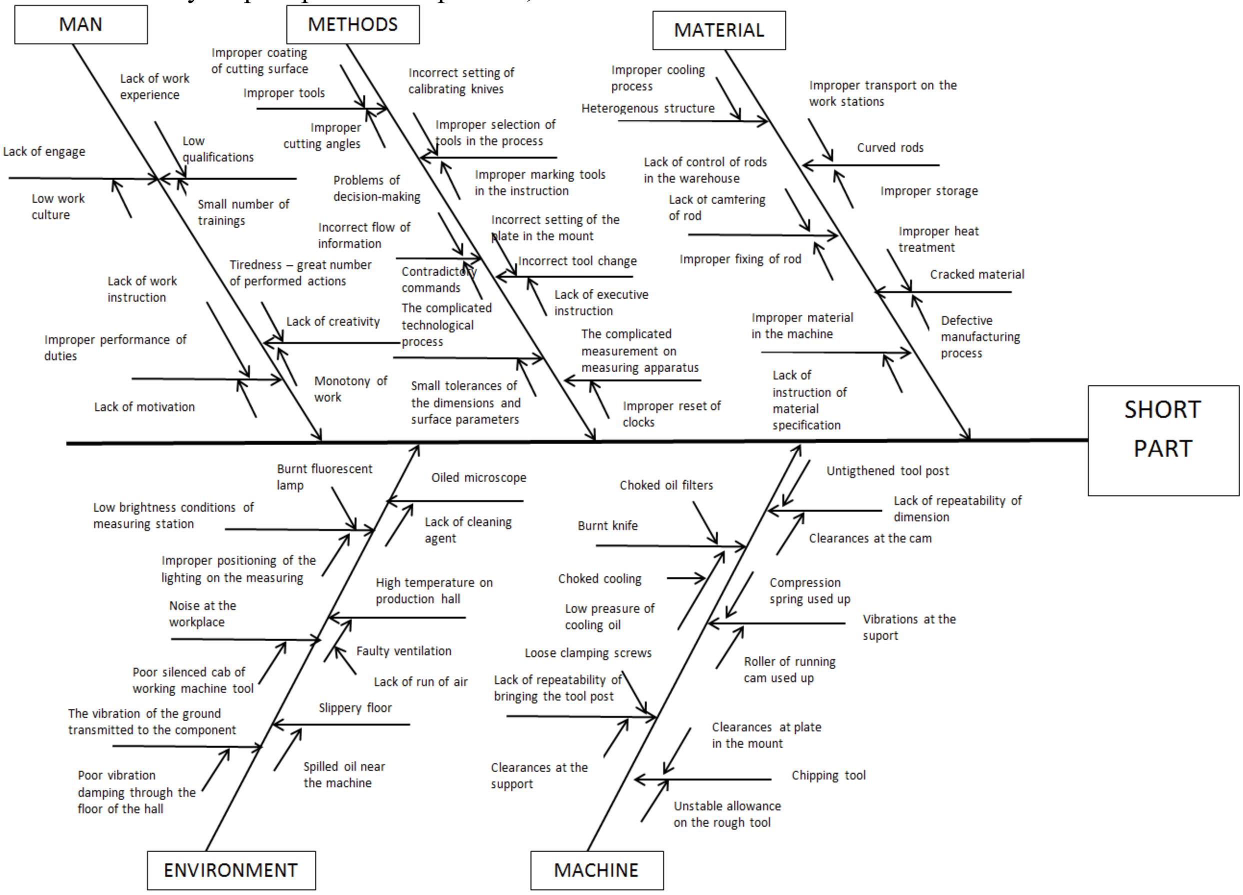


Fig. 4. The analysis of causes of dimensional error of sleeve (short element)
Source: Own study based on (KARDAS E. 2013, KARDAS E. 2014)

REFERENCES

1. TORUŃSKI J. 2012. *Quality management in the automotive industry*, Scientific papers of the University of Natural Science and Humanities in Siedlce, Series: Administration and management, No 92/, pp. 23 – 32.
2. HAMROL A., MANTURA W. 2009. *Quality analysis. Theory and practice*, PWN, Warsaw.
3. BORKOWSKI S., INGALDI M., JAGUSIAK-KOCIK M. 2014. *Quality analysis and technological portfolio in production of the metal screws*, METAL 2014 - 23rd International Conference on Metallurgy and Materials, Conference Proceedings, pp. 1716-1722
4. INGALDI M. 2014. *Analysis of the quality problems during production process of the stud frame of the stretching station*, Production Engineering Archives, Vol. 2, No. 1, pp. 2-5
5. SYGUT P. 2015. Evaluation of paving stone production quality, Production Engineering Archives, Vol. 6, No. 1, pp 14-16
6. INFORMATION MATERIALS COMPANY X
7. KOZIEŃ A. 2011. *The analysis of the effectiveness of the quality management system in the selected production company*, Engineering work under the direction of Edyta Kardas, Czestochowa University of Technology, Czestochowa.
8. KARDAS E. 2013. *The assessment of quality of braking system element using chosen quality tools*, In: Estimation and Operating Improvement, S. Borkowski, M. Krynke (red), Faculty of Logistics, University of Maribor, Celje, pp. 85 – 94.
9. KARDAS E. 2014. *The assessment of quality of metal sleeve using selected quality tools*, Metallurgy – Metal Engineering, 11/2014, pp. 788 – 792

ARCHIWUM INŻYNIERII PRODUKCJI
PRODUCTION ENGINEERING ARCHIVES

2016, Vol. 10, No 1, pp 9-12
ISSN 2353-5156 (print version)
ISSN 2353-7779 (online version)

Article history: Received: 10.01.2016 Accepted: 05.02.2016 Online: 31.03.2016

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

Quality and fatigue characteristics relation

Libor Trško[1], Otakar Bokůvka[2], František Nový[3], Ján Lago[4]

[1]Ing., PhD., Research Centre of the University of Žilina, SK, phone: +421415132607, e-mail: libor.trsko@rc.uniza.sk
[2]Prof. Ing.PhD.,University of Žilina, Department of Materials Engineering, SK, phone: +421415132603, e-mail: otakar.bokuvka@fstroj.uniza.sk
[3]Ing. PhD., University of Žilina, Department of Materials Engineering and Research Centre of University of Žilina, SK, phone: +421415132607, e-mail: frantisek.novy@fstroj.uniza.sk
[4]Ing., University of Žilina, Department of Materials Engineering, SK, phone: +421415132624, e-mail: jan.lago@fstroj.uniza.sk

Abstract. This paper will explore the mutual correlation of fatigue characteristics ((K_{ath}, σ_c, a_c = f (R_m)) of five structural steels tested at high-frequency loading based on tests (f ≈ 20 kHz, T = 20 ± 10 °C, R = -1). Different fatigue resistance parameters have different meanings and misunderstanding can lead to significant quality problems in component operation. Consequently, it is necessary to completely understand the relation between the two most important fatigue characteristics which are fatigue limit σ_c and the threshold value of the stress intensity factor amplitude K_{ath} and how they act with changing of steel ultimate tensile strength.

Key words– structural steels, fatigue, K_{ath}, σ_c, a_c, fatigue parameters relation

1. Introduction

Degradation of structural materials properties caused by fatigue is a serious problem in engineering applications, because more than 90 % of all fractures which occur during the operation of a component are caused by fatigue (BOKŮVKA O. et. al. 2015). Fatigue of structural materials has therefore been studied intensively in the past 170 years (BOKŮVKA O. et. al. 2002, KUNZ L. 2003, ULEWICZ R. 2013).

Fatigue life of a component or a construction (number of cycles N) contains a number of cycles necessary for fatigue crack initiation Ni and a number of cycles necessary for crack propagation N_p. Components or constructions in term of their resistance to fatigue damage can be evaluated using two methods, that is according to total lifetime (number of cycles N where $N = N_i + N_p$) or according to fatigue crack propagation with respect to laws of fracture mechanics (according to number of cycles necessary for crack propagation N_p), (SKOČOVSKÝ P. et. al. 2015, TRŠKO L. et. al. 2013).

When evaluating the material resistance according to total lifetime method, the dependence of stress amplitude σ_a (for high cycle fatigue) on number of cycles to failure or run - out N is evaluated. High cycle fatigue is characterized by Wöhler diagram, σ_a = f (N). From the Wöhler diagram fatigue limit σ_c. Fatigue limit σ_c can be evaluated and is the highest amplitude of alternating stress at a certain mean stress σ_m which can theoretically withstand for an infinite number of cycles. During fatigue tests it is impossible to load the specimen for an infinite number of cycles. In practical usage the material has a good resistance to fatigue if it can withstand the basic number of cycles Nc, which is in standards for steels - $N_c = 10^7$ cycles.

When evaluating the material resistance according to fatigue crack propagation, the dependence of the fatigue crack growth rate da/dN on the stress intensity factor amplitude K_a is evaluated. From the da/dN = f(K_a) the threshold value of the stress intensity factor amplitude K_{ath} can be evaluated which represents the resistance of material against the crack growth. It is determined according to interatomic distance (crystallography lattice parameter). If the crack increase for one cycle is smaller than one interatomic distance, than cyclic loading has no degradation effect from a physical point of view (it does not cause a macroscopic growth of fatigue crack). In application it means that for values $K_a \leq K_{ath}$ cracks don't grow or growth is extremely slow (slower than da/dN = 10^{-10} m.cycle^{-1}) and it does not cause breaking of material by fatigue fracture for expected time of using (KLESNIL M. 1975, SKOČOVSKÝ P. et. al. 2006).

If it is assumed that structural material will be in operation subjected to fatigue cyclic loading, then it is important to evaluate complex fatigue characteristics for the exact kind of working conditions. This means obtaining the exact values of fatigue limit σ_c for given structural material and threshold value of the stress intensity factor amplitude K_{ath}; but is also very important to know the correlation between σ_c and K_{ath}. Knowledge of material constants and their relation is essential for proper design of machine components and their safety and reliability (HURTALOVÁ L. et al. 2013).

In this work the authors, on the basis of these results, discuss the mutual relationship between the threshold value of the stress intensity factor amplitude K_{ath} and fatigue limit σ_c.

2. Experimental

The experimental works, quantitative chemical analysis, tensile tests and fatigue tests were carried out on five structural steels. The tensile tests were carried out on a ZWICK Z050 testing machine at an ambient temperature of T = 20 ± 5 °C, with the loading range in interval F = 0 ÷ 20 kN and the strain velocity range of $\varepsilon_m = 10^{-3}\ s^{-1}$. Round cross-section specimens were used; the shape and dimensions of the test specimens fulfilled the requirements of EN 10002-1 standard. Three specimens of each material were used.

The fatigue crack growth tests were carried out on a KAUP-ŽU resonance testing device, Fig. 1. The resonance fatigue testing device consists of ultrasonic generator, piezoelectric transducer, booster, exponential concentrator and a test specimen. The electric power from ultrasonic generator is transferred to mechanical vibration in the piezo-ceramic converter of the ultrasonic horn. This causes vibration at both ends of the specimen at resonance frequency. The power is increased until requested displacement amplitude is obtained (measured by deformation amplitude reader on the end of the specimen). A resonance fatigue testing machine allows fatigue tests to be performed with symmetrical push-pull loading (R=-1) at a frequency of f ≈ 20 kHz in the temperature interval of T = 20 ± 5 °C.

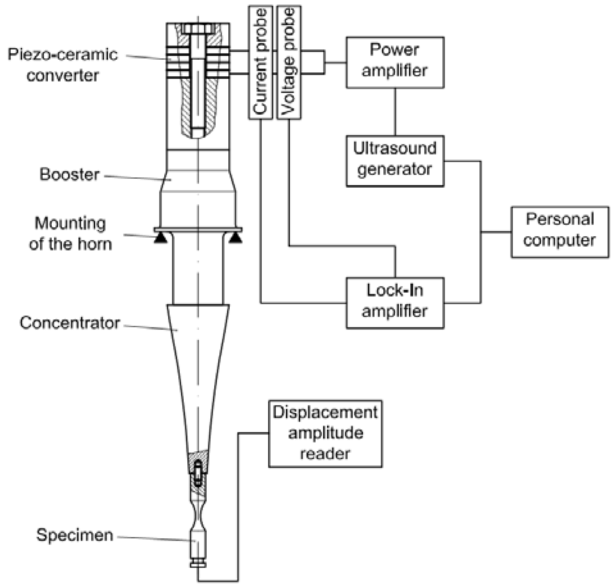


Fig.1. Schematic diagram of the construction of KAUP-ŽU fatigue testing device

Source: own study

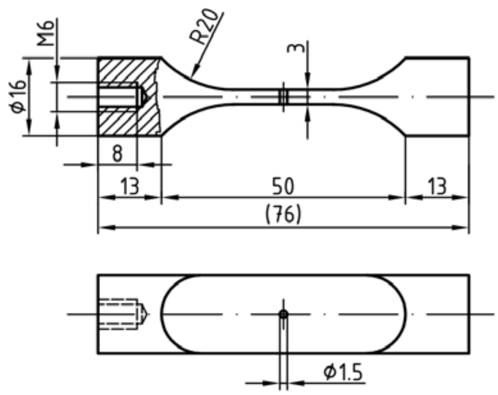


Fig. 2. The shape and dimensions of the fatigue crack growth test specimen

Source: own study

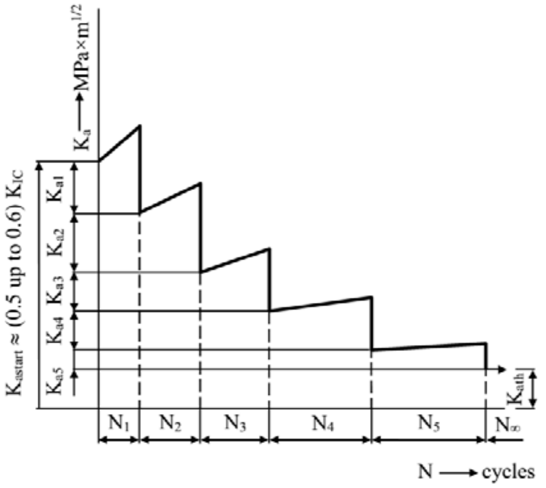


Fig. 3. The method to determine K_{ath} by gradual decreasing of K_a value until the fatigue crack growth is terminated

Source: own study

The shape and dimensions of specimens used in the fatigue crack growth tests are given in Fig. 2. The procedure for evaluation of K_{ath} values result from Fig. 3. This method is based on gradual decreasing of the loading value until the crack stops propagating. The test can be controlled by the decrease of the loading force or by decrease of the K-factor. After each step (each decrease of the loading force or K-factor) the crack has to grow through the plastically deformed zone together with the zone of residual stresses, which were created by the previous loading values. The crack stops its propagation when the threshold value is reached. The applied stress intensity factor amplitude K_a was determined using the following equation:

$$K_a = \sigma_a \cdot \left(w.\tan \right. \quad \text{MPa.m}^{1/2} \qquad (1)$$

in which σ_a is stress amplitude (MPa), a is the half crack length (m) and w is the specimen width (m), (KLESNIL M. 1975, PUŠKÁR A. et. al. 1987). The value of K_{ath} was determined at $da/dN = 10^{-12}$ m.cycle^{-1}; three specimens of each tested material were used.

3. Results and discussion

The results of quantitative chemical analysis (chemical composition) and tensile tests (ultimate tensile strength R_m) of five tested structural steels are in Table 1.

The results of fatigue tests at high-frequency fatigue loading, the threshold values K_{ath}, fatigue limit σ_c and half cracks length a_c of fifth tested structural steels are shown in Table 2.

Tab. 1. Chemical composition (in weight %) and tensile strength R_m of tested steels

Element / Steel	C	Mn	Si	P	S	Cr	Mo	Ni	Cu	V	R_m (MPa)
1	0.26	0.96	0.35	0.019	0.02	0.07	-	0.02	0.05	-	560
2	0.52	0.80	0.40	0.040	0.04	0.3	0.05	0.3	0.3	0.05	841
3	0.78	1.25	0.70	0.015	0.022	1.1	-	-	-	-	1097
4	0.52	0.6	1.44	0.02	0.024	0.57	-	-	-	-	1452
5	0.54	0.61	1.41	0.019	0.004	0.57	-	-	-	-	1532

Source: own study

Tab. 2. Threshold values K_{ath}, fatigue limit σ_c and half cracks length a_c of tested steel

Steel	K_{ath} (MPa.m$^{1/2}$)	σ_c(MPa)	a_c(mm)
1	4.50	196	0.1670
2	3.38	294	0.0420
3	2.80	383	0.0160
4	2.28	508	0.0060
5	2.10	536	0.0048

Source: own study

The approximate fatigue limit σ_c was calculated using the equation $\sigma_c = 0.35\ R_m$ (valid for structural steels with R_m in interval from $R_m = 500$ MPa to $R_m = 1500$ MPa), with regards to the work (ŠIMEK V. 1969). A discussion of the tensile strength R_m vs. threshold K_{ath} and tensile strength R_m vs. fatigue limit σ_c response incl. relation of threshold K_{ath} vs. fatigue limit σ_c behavior was possible to describe by Fig. 4 where the K_{ath} values obtained in structural steels is decreasing with increasing of R_m and on the other hand the σ_c increasing with R_m increase. The same trend was reported by authors (RITCHIE R. O. 1981, BOKŮVKA O. et. al. 1992), retardation effects to fatigue crack propagation have also been found to be highest in low-strength steels (PETRAK G. J. 1974, BOKŮVKA O. et. al. 2012). The microstructural factors (e. g. strength and grain size) indicate that thresholds for crack growth (K_{ath}) is decreased by high strength levels and fine grain sizes whereas thresholds for crack initiations, e. g. fatigue limit (σ_c) are increased by high strength levels and fine grains sizes (RITCHIE R.O. 1981, BOKŮVKA O. et. al. 2015).

This means that with the increase of the ultimate tensile strength of structural material, the critical length of the crack which starts to propagate by fatigue mechanism decreases. This seems to be contrary to the values of the fatigue limit, which is higher for materials with higher tensile strength. It must be understood that the K_{ath} value is a parameter representing only the critical size of a crack or a defect from which the fatigue crack will propagate. If defects in material are smaller than the critical size, other fatigue crack initiation mechanism has to take place during the fatigue degradation process. Materials with higher ultimate tensile strength have higher resistance to fatigue crack initiation, but lower resistance to fatigue crack propagation. Because the fatigue crack initiation period represents more than 90 % of the total number of cycles to fracture (this is related to smooth specimens and components without presence of defects and notches) and just the rest is needed for the fatigue crack propagation. Usually materials (mainly steels) with lower tensile strength are more ductile, thus they are able to create a plastically deformed zone in the surrounding of a crack tip. This deformed zone significantly slows down fatigue crack during its propagation and is the main reason why these materials have higher K_{ath} values. Again in the case of defects smaller than K_{ath} the fatigue crack initiation process depends only on the strength of the material and these materials have a lower fatigue limit σ_c.

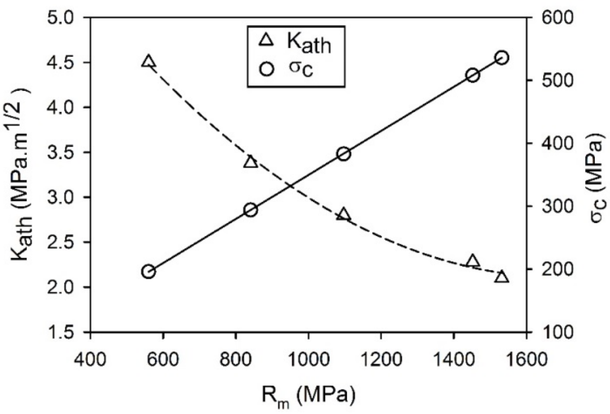


Fig. 4. K_{ath} and $\sigma_c$dependence on ultimate tensile strength R_m
Source: own study

4. Conclusions

Based on fatigue crack growth, test results on five different structural steels with increasing ultimate tensile strength and their relation to approximate fatigue limit, it can be stated that with increasing materials ultimate tensile strength increases the fatigue limit σ_c, and decreases the critical defect size represented by K_{ath} value. In general, materials with higher strength are more resistant to fatigue loading but also more sensitive to various kinds of material defects (pores, inclusions etc.), surface defects (scratches, machining marks etc.) and artificial notches (sharp edges between different diameters, holes, grooves etc.). This means that the stronger the material used to improve the fatigue resistance of the component, the bigger the care necessary to take on the surface quality and construction of the component to avoid sharp notches.

Acknowledgements

The research was supported by Scientific Grand Agency of Ministry of Education, Science and Sport of Slovak Republic and Slovak Academy of Sciences, grant VEGA No. 1/0123/15, by the project APVV-14-0096 and project “Research Centre of the University of Žilina”, ITMS 26220220183.

Bibliography

1. BOKŮVKA O. et al. 2002. *Low and High Frequency Fatigue Testing*. EDIS ŽU v Žiline.
2. BOKŮVKA O. et al. 2015. *Fatigue of Materials at Low and High-frequency Loading.* EDIS, ŽU v Žiline.
3. KUNZ L. 2003. *Experimentálnístanovenínúnavovýchcharakteristikmateriálů.* EDIS ŽU v Žiline (in Czech).
4. ULEWICZ R., MAZUR M. 2013. *Production Engineering Archives*, No. 1, 32.
5. SKOČOVSKÝ P. et al. 2015. *Náuka o materiáli*. EDIS ŽU v Žiline(in Slovak).
6. TRŠKO L. et al. 2013. *Dynamics Strength and Fatigue Lifetime.* EDIS ŽU v Žiline.
7. KLESNIL M., LUKÁŠ P. 1975. *Únavakovovýchmateriálůpřimechanickémnamáhání.* ACADEMIA Praha (in Czech).
8. SKOČOVSKÝ P. et al. 2006. *Náuka o materiáli pre odborystrojnícke*. EDIS ŽU v Žiline (in Slovak).
9. HURTALOVÁ L. et al. 2013. Key Eng. Materials, Vol. 592-593, 433.
10. PUŠKÁR A. et al. 1987. *Strojírenství,* 2, 507 (in Slovak).
11. RITCHIE R.O. 1981. *Application of Fracture Mechanics to Fatigue Crack Propagation.* University of California.
12. BOKŮVKA O. et al. 1992. *In. Procs. Materials Development in Rail, Tire, Wing, Hull Transportation.* AIM Milano, Italy.
13. PETRAK G.J. 1974. *Eng. Fracture Mechanics,* 6, 725.
14. BOKŮVKA O. et al. 2012. *Annals of Faculty Engineering Hunedoara – Int. Journal of Engineering,* Vol. X, No. 2.

ARCHIWUM INŻYNIERII PRODUKCJI

PRODUCTION ENGINEERING ARCHIVES

2016, Vol. 10, No 1, pp 13-16
ISSN 2353-5156 (print version)
ISSN 2353-7779 (online version)

Article history: Received: 18.01.2016 Accepted: 23.02.2016 Online: 31.03.2016

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

Software support for environmental measurement in quality at educational institutions

Alena Pauliková[1], Katarína Čekanová [1], Renata Nováková[1]

[1]SlovakUniversity of Technology in Bratislava, Faculty of Materials Science and Technology in Trnava, Institute of safety, environment and quality, Botanická 49, 917 24 Trnava, Slovakia, phone: 00421/0908646519, e-mail: katarina.cekanova@stuba.skalena.paulikova@stuba.sk,

Abstract. The analysed theme of this article is based on the training of environmental measurements for workplaces. This is very important for sustainable quality in technical educational institutions. Applied kinds of software, which are taught at technical educational institutions, have to offer the professional and methodical knowledge concerning conditions of working ambient for students of selected technical specialisations. This skill is performed in such a way that the graduates, after entering the practical professional life, will be able to participate in solutions for actual problems that are related to environmental protection by means of software support. Nowadays, during the training process it is also obligatory to introduce technical science. Taking into consideration the above-mentioned facts it is possible to say that information technology support for environmental study subjects is a relevant aspect, which should be integrated into the university educational process. There is an effective progress that further highlights the focus on the quality of university education not only for environmental engineers. Actual trends require an increasing number of software/hardware educated engineers who can participate in qualitative university preparation, i.e.IT environmentalists. The Department of Environmental Engineering at the Faculty of Mechanical Engineering, Technical University in Košice, Slovakia is an institution specified and intended for quality objectivisation. This institution introduced into the study programmes ("Environmental Management" and "Technology of Environmental Protection") study subjects with the software support, which are oriented towards outdoor and indoor ambient and in this way the Department of Process and Environmental Engineering is integrated effectively and intensively into the area of measurement training with regard to the requirement of quality educational processes.

Key words –software support, indoor, outdoor, measurement, quality

1. Introduction

Nowadays there is a frequently repeated idea that information technology support has a key role in environmental education as well as skills in measurement performance and expresses an irreplaceable function in the field of sustainable development. At the technical educational institutions there is the important intent of software education to provide the professional and methodical knowledge about IT skills for students. It is presented in such a way that in practice they can participate in seeking a solution for challenging specific problems which are closely related to environmental measurement. At present, in the educational process there is sn obligation to introduce technical development to an increasingly high standard (CHOVANCOVÁ J., HARAUSOVÁ H. 2013).

2. Software support for environmental measurement

The selected institution for environmental objectivisation was the department of Process and Environmental Engineering, Mechanical Engineering Faculty, Technical University in Košice, the Slovak Republic. This institution demonstrates the synergistic effect of information technology skills and environmental education within the framework of the strengthening of quality development (MARKULIK, Š., NAGYOVÁ, A. 2008).

Measuring of noise and vibration

For measurement of noise and vibration the phonometer *Norsonic 121* and *Norsonic 140 (*see Fig. 1) are used.

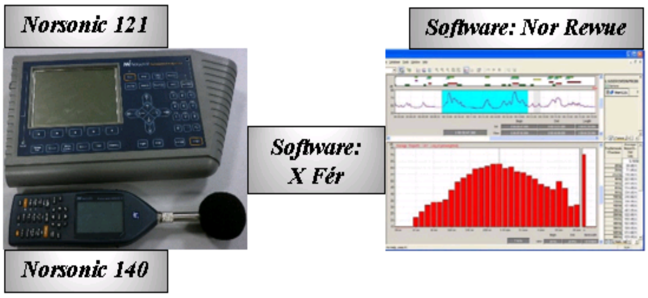


Fig. 1. Scheme of the measured noise data transferring from the phonometer to PC (Source: own study)

Source: own study

Apparatus perform creation of the sound record, evaluation of the structural acoustics, identification of the sound source, creation of the sound maps, noise measuring in outdoor and indoor environments, measuring of the vibrations (with completing of the software evaluated modem). There are characteristics, more detailed descriptions of the apparatus and its purpose of the important elements.

Software X Fér connects the data transfer from the phonometer to the PC. It secures the transfer of the measured data together with necessary explaining data from the phonometer.

Software Nor Rewue is designed for processing of the sound and vibration data. It is used for the creation of simple reports and eventually to the creation of more widening developing and complex projector reports. It serves for evaluation of industry and traffic noise.

The acoustic camera *Array-Ring 32/75* and acoustic camera *Array-Ring 36/48* are other devices which are used for the noise measuring by students during their studies. The acoustic camera is an apparatus designed for the visualisation, localization and analysis of the sources of the noise. It is suitable for the measuring of the vast industry sources of the noise and also for measuring very quiet sounds in the laboratories for purposes of identification and the following quantitative and qualitative analyse. The scheme of the apparatus arrangement represents in Fig.2.

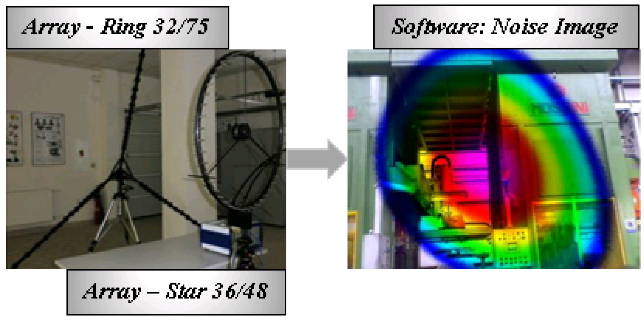


Fig. 2. Scheme of the apparatus arrangement for noise measuring with the acoustic camera (Source: own study)

Source: own study

Software *Noise Image* enables the processing of measured data from the acoustic camera. It enables the transfer into the evaluating equipment, the evaluation of these data, the creation of the acoustic snaps and films shots. *Noise Image* is developed with the purpose of the reaching the interaction among the space, time and frequency. At the model creation there is observed only the equivalent level of the acoustic pressure. In the acoustic picture the values colour differed in such a way that they could be created with the point sources.

The apparatus performs the following operations:

- the spectral analyse of the pictures
- the data edition for individual channel
- the narrow-band filtration
- the utilization of the built-in oscilloscope for the definition of the time and spectral functions
- the linear and the logarithmic A evaluation.

The materials absorption and isolation is measured by means of a device called the *Impedance tube SW 466***,** Fig 3.

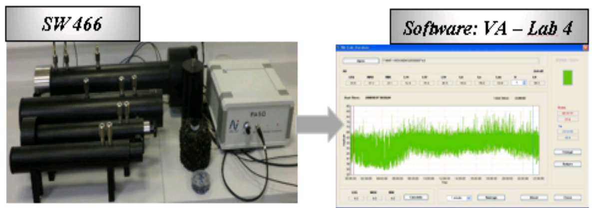


Fig. 3. The set up scheme of an apparatus and outputs of material absorption measurements,(Source: own study)

Source: own study

In the laboratory the psychoacoustic head *HSU III* is used for measuring of psychoacoustic noise. This apparatus analyses the influence of noise on human psychic and operates on the basis of the statistical data. It is able to analyse the noise perceptions as effectively as a human ear. It evaluates the physical and psychoacoustic parameters of the noise for human psychic.

The program *VA-Lab4* performs analysis which is necessary for noise measuring. The obtained values appear in a different time period. The program is effective to create a curve with selected average times (CRYSTAL INSTRUMENTS 2009).

Vibrations are an attendant factor of the noise. These parameters are measured in the laboratory with the apparatus *CoCo 80*, Fig. 4.

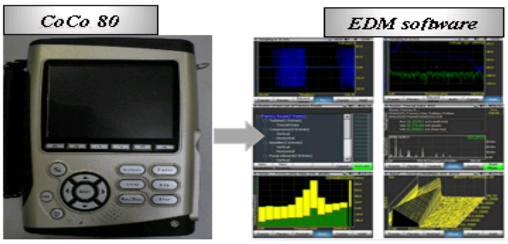


Fig. 4. The set up scheme and software outputs of the vibration measurements (Source: own study)

Source: own study

In principle the device *CoCo 80* is a vibration analyser dedicated to measuring in an industrial environment. *EDM* software creates the protocols and diagrams and their dependences from the device *Crystal Instrument CoCo 80* which supports the registration of measured results (TESTO 400 A 435 2009).

Illumination

The illumination is a further factor which significantly influences the quality of the working environment. The analysis of this factor is also a basic part of the environmental engineers' knowledge. The students learn to operate with *Luxmeter Testo 545* and *Radiolux 111*, Fig.5.

Luxmeter Testo 545 is designed for the measuring of the illumination intensity in the producing workplaces, in the institutions and schools. By means of the program it is possible to report the list of the measuring points and then to generate a graph from consecutive loaded values. In such a way created „light profile" gives a review of the illumination equability of the evaluated environment.

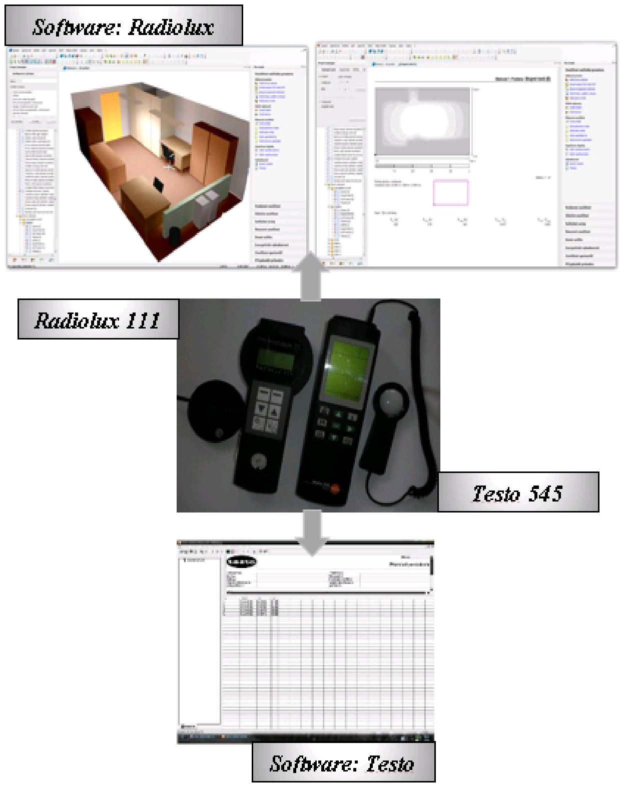


Fig. 5. The scheme and the software outputs for the illumination measurement (Source: own study)

Source: own study

The luxmeter has got the following functions designed for the illumination intensity evaluation:

the determination of the point or time medium value:

- the selection of more than 99 measuring points
- inner memory (3000 values)
- possibility of the rapid documentation by means of the protocol printer *Testo* in place, (optional)

Radio Lux 111 is a manual portable apparatus designed for photometric and radiometric measurement and enables light measuring and the light radiation. It is suitable for external field measurements for accurate laboratory measurement as well. The brightness measurement is a supplementary function which can be accessible with a special adapter.

Software is an integral part of *Luxmeter Testo 545* and *Radiolux 111* and creates the interface for data transferring from the luxmeters to the PC (TESTO 545 2009).

Electromagnetic radiation

Electromagnetic radiation is measured by the apparatus *Efa 200*. The device is an analyzer which is designed for the magnetic and electric field measuring of the indoor and outdoor environment. The apparatus works with the software *Efa tool* and software *NBM-TS*. *Efa tool* is designed for the gathering and transferring of the measured data from devices (control unit of the apparatus *Efa 200/300*) to the PC. It enables the outputs in the rtf format.

Software *NBM-TS* provides the visualisation, analysis of the measured results and their exporting the table calculator MS Excel (NARDA SAFETY TEST SOLUTIONS 2009).

Microclimate conditions

The evaluation of the basic physical environmental factors also represents the measuring of the microclimate conditions. Microclimate is measured by means of the apparatus *Testo 435* and *Testo 400*. The device *Testo 435* enables the measuring of the following parameters of the air and environment:

- temperature
- relative humidity
- illumination
- speed of airflow
- turbulence
- differential pressure
- relative pressure (NARDA SAFETY TEST SOLUTIONS 2009)

The apparatus *Testo 400* is as the reference measuring equipment enabling the large scale measuring of the environment parameters, gas, liquid and rigid matters as well. This device performs measurements for following:

- temperature
- humidity
- pressure
- revolutions
- content of CO/CO_2
- electric values, (NARDA SAFETY TEST SOLUTIONS 2009).

The advantage of these devices is direct reading of the measuring data from a display.

Conclusion

The integrated “Laboratory of the Objectivisation and Evaluation of Environmental Factors” is situated at the Mechanical Engineering Faculty, the department of Process and Environmental Engineering. The laboratory equipment and its instruments and technologies are able to measure the basic physical factors of working indoor and outdoor environments. At present there are 5 environmental factors: noise, vibration, illumination, electromagnetic radiation and micro-climate.

It is necessary to obtain more environmental educated engineers who participated in qualitative academic preparation. But technical science and development can also claim high quality IT skills. It is a challenge for academic educational institutions to build a lot of well equipped laboratories. The establishment of a “Laboratory of the Objectivization and Evaluation of Environmental Factors” undoubtedly contributes to increased quality of studies and preparation for undergraduates.

Affiliation

This article was elaborated within the Project KEGA: 074TUKE-4/2015 An innovative approach to legislative coordination of environmental protection through the visualization on the basis of the phenomenon Small World Networks.

Literature

1. CHOVANCOVÁ J., HARAUSOVÁ H. 2013: Education of the next generation of managers in context of green economy. Journal of economic development, environment and people. Vol.2.
2. MARKULIK, Š., NAGYOVÁ, A. 2008: Quality management system + university = myths or obligation? In: ORP '2008. 6 p. - ISBN 8493425656
3. NORSONIC–PHONOMETERS 2009, [online-cited 4th Decem-ber]. Accessible on www.norsonic.com/index.php?sideID=2431&ledd1=943
4. CRYSTAL INSTRUMENTS 2009 [online-cited 4th December]. Accessible on www.go-ci.com/products.asp
5. TESTO 400 A 435 2009 [online - cited 7th November]. Accessible on www.grimm.sk/testo400 testo435.htm
6. TESTO 545 2009 comfort operating luxmeter [online - cited 7th November]. Accessible on www.grimm.sk/Testo545%20-%20Luxmeter.htm
7. NARDA SAFETY TEST SOLUTIONS 2009 [online - cited 7th November]. Accessible on http://www.narda-sts.us/products lowfreq meters.php

ARCHIWUM INŻYNIERII PRODUKCJI
PRODUCTION ENGINEERING ARCHIVES

2016, Vol. 10, No 1, pp 17-20
ISSN 2353-5156 (print version)
ISSN 2353-7779 (online version)

Article history: Received: 28.01.2016 Accepted: 28.02.2016 Online: 31.03.2016

Available online on: http://www.qpij.pl **Exist since 1th quarter 2013**

Problems concerning product quality enhancement

Marek Krynke[1], Krzysztof Mielczarek[2]

[1]Institute of Production Engineering, Faculty of Management, Czestochowa University of Technology, Armii Krajowej 19B, 42-201 Czestochowa, Poland, e-mail: krynke@zim.pcz.pl
[2]Institute of Production Engineering, Faculty of Management, Czestochowa University of Technology, Armii Krajowej 19B, 42-201 Czestochowa, Poland, e-mail: mielczarek@zim.pcz.pl

Abstract: In the article analysis of the discrepancies in the production process for selected products in a company producing candles was carried out. Using the Pareto-Lorenzdiagram and the FMEA method the most essential areas having influence on the production of candles were shown. Apart from factors connected with the manufacturing side of the process, factors of the labour organization and requirements concerning the quality of material were also noted. An appropriate quality of equipment constitutes one of the essential conditions of production process functioning and this directly influences manufacturing possibilities of the enterprise. A synthesis of immaterial factors that influence the production of the enterprise, taking into consideration conditions of functioning the production system, was also carried out. The set of factors selected for description was the fourteenth Toyota management principle. Respondents were asked to provide answers which could bring the best improvements.

Key words – FMEA method,Pareto-Lorenz diagram, BOST analysis, Toyota Principles, quality, candles production

1. Introduction

Modern technological processes should be characterized by a high rate of production, reproducibility and repeatability and stability of individual technological operations. These features influence the requirements for individual process steps. Careful discernment about the suitable quality of the products is undoubtedly a complex process because of the multiplicity of factors determining it. The basic variables that affect the quality of the product are: (MIELCZAREK K., MAZUR M. 2007):

- quality of the material,
- quality of the process,
- quality of the equipment,
- quality of staff,
- quality of the environment,
- quality of the measurement.

All variables globally create a high quality of the final product, and therefore should be considered together, not forgetting that each of the components is the result of the impact of the following variables in every aspect of production (BORKOWSKI S., KRYNKE M., INGALDI M. 2012).

The quality of the process depends largely on the methods and techniques used to implement the individual technological operations on time. In addition to factors directly linked to the party manufacturing processes are also important factors of work organization and quality requirements of the material. Suitable quality equipment is also significant. It is one of the basic conditions for the functioning of production lines and directly affects the production capacity of the company (VOGT K., KUJAWIŃSKA A.2013).

2. Structure of discrepancies for chosen products

During manufacturing, product deviation causes withdrawal from sale. For the purpose of investigating this situation analysis of the discrepancies was carried out with the use of the Pareto-Lorenzdiagram. The following types of products was analysed: removable tube votive candle.

These products are produced on extruding press and injection moulding machines. Discrepancies that turned up during the production are introduced in table 1.

Table 1. Types of discrepancies in the production of removable tube votive candle

Discrepancy symbol	Name of discrepancy
N_1	cut structure
N_2	too thin
N_3	jagged edges
N_4	too thick
N_5	dirty surface
N_6	wrong color

Source: own study

In Fig. 1 Pareto-Lorenz diagram is presented. The Pareto chart shows, in descending order, the relative share of each element in the overall effect. This method has been applied to demonstrate the participation of each element in the area, and then to arrange all elements according to their level of significance. It shows the structure of the discrepancies and their participation in an analysed 30 day research period. It results from the data analysis that the most often appearing discrepancies there is cut structure produced on extruding press. The discrepancies connected with the inappropriate thickness of the product wall were also often revealed.

In order to prevent the occurrence of the discrepancies in the sheet die, it is necessary to apply the technology of the extruder slit through the use of self-cleaning grid on which dirt settles (for example, grains of sand) present in the granules. Elimination of discrepancy associated with inadequate wall thickness of the tube is possible by adjusting the modernization of the extruder and the exact adjustment of the machine. In the case of the production removable tube votive candle elimination of discrepancies N_1, N_2, N_3 that are caused by the cut structure, too thin structure and jagged edges of the tube, the number of defective products will be reduced by about 71%.

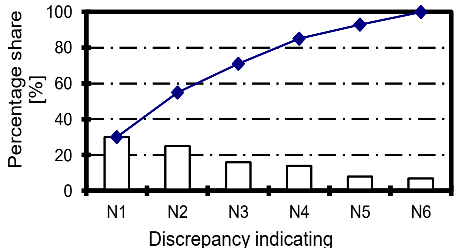


Fig. 1. Pareto-Lorenz diagram for discrepancyof removable tube votive candle

Source: own study

3. Analysis of the causes and consequences of any nonconformity

The analysis of the causes and effects of non-compliance in the selected products was introduced using the FMEA method. Failure modes and effects analysis (FMEA) is a step-by-step approach for identifying all possible failures in a design, a manufacturing or assembly process, or a product or service. A successful FMEA activity helps to identify potential failure modes based on experience with similar products and processes or based on common physics of failure logic. *Effects analysis* refers to studying the consequences of those failures on different system levels (KNOP K., SELEJDAK J. 2009).

Fig.2 presents a summary RPNthat was analyzed for the analyzed product. The results show that the highest value of the risk priority is for discrepancy: cut of element structure. RPN acceptable level exceeds the mismatch caused by jagged edges of the product (ULEWICZ R. 2003). For the customer, such goods are without value that should take corrective action to eliminate these problems. Steps that should be taken in order to reduce the risk of extinction of this discrepancy is the modernization of the extrusion head by mounting the mesh on which the deposit will be getting any contamination with the pellet plasticizing zone. On the other hand, to eliminate the discrepancy caused by the occurrence of jagged edges after cutting the upper waste cutting blades should be replaced or properly sharpened and repeating this step each time the occurrence of the discrepancy.

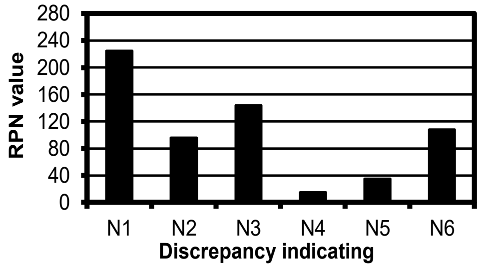


Fig. 2. Summary combination of RPN for discrepancy: removable tube votive candle.

Source: own study.

4. Analysis of areas for improvement of company based on the fourteenth Toyota management principle

The fourteenth principle encourages continual reflection and continuous improvement (BORKOWSKI S. 2012a). According to this principle it is crucial to determine the causes of a problem by solving technical issues. Continuous improvement of the process and production is extremely significant for a company which has been functioning on the market for many years. The study examines the factors that describe the fourteenth Toyota management principle contained in the E8area BOST survey conducted among production workers. Respondents were asked to provide answers to the following question (BORKOWSKI S. 2012b): *Decide with the use of the scale 1-10 (10 the most important factor) which area can bring the best effects after being improved?* Table 2 presents a percentage significance list rates for factors belonging to area E8.

Table 2. Principle 14. Evaluation structure [%] of the factors' importance for E8 area.

Evaluation	Indicating the factors									
	ZT	SM	PT	JK	UM	RE	DA	PN	WS	WD
1	0	25	0	0	0	15	60	0	0	0
2	10	35	0	0	0	15	25	10	5	0
3	45	20	0	0	0	15	10	0	5	5
4	20	20	0	0	0	35	5	5	5	10
5	15	0	5	0	0	15	0	5	10	50
6	5	0	0	5	0	0	0	35	40	15
7	5	0	15	10	0	5	0	30	15	20
8	0	0	35	30	15	0	0	0	20	0
9	0	0	20	25	40	0	0	15	0	0
10	0	0	25	30	45	0	0	0	0	0

where ZT – the employment of workers; SM – incentive system; PT – portfolio of technologies; JK – quality; UM – maintenance of machines; RE –boss-employee relationship; DA – documentation; PN – the flow of information; WS – cooperation with customers; WD – cooperation with suppliers, cooperators.

Source: own study.

Data from table 2 shows the assessment of employees' rates for a particular answer. It allowed for determining a percentage structure of significance rates for particular factors.

To assess the validity of the various factors affecting the areas of improving the company, Pareto-Lorenz diagrams for individual assessments were introduced, which are presented in Fig.3.

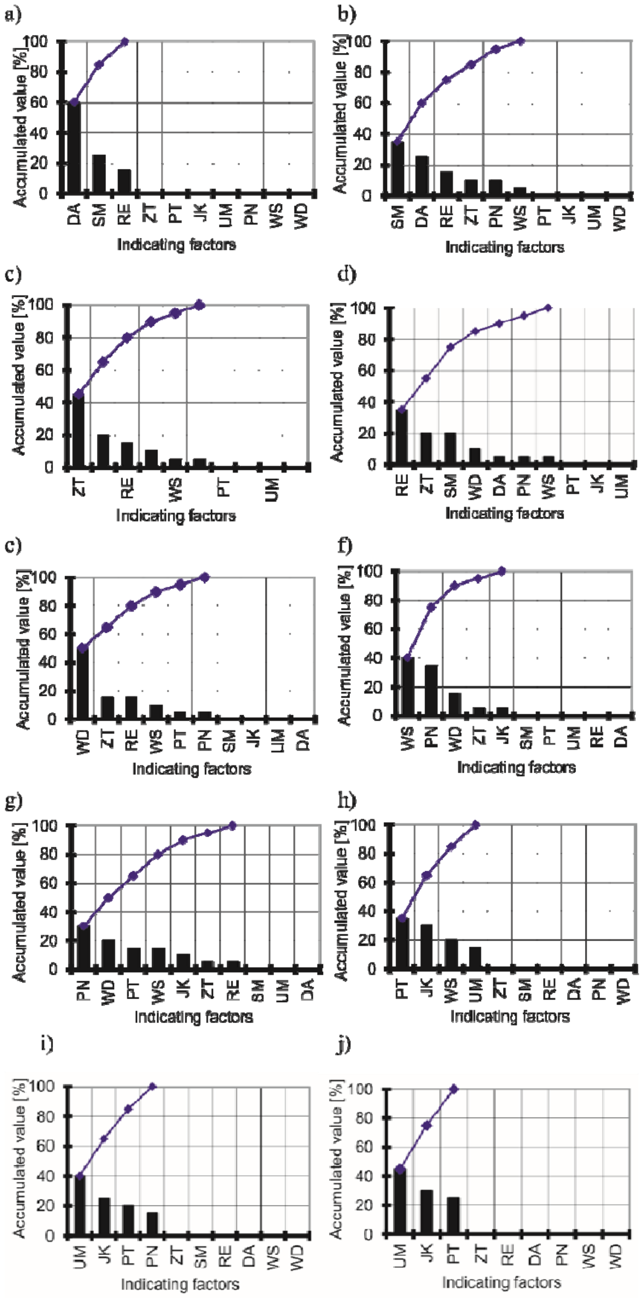


Fig. 3. Principle 14. Pareto-Lorenz diagrams of the factors' importance E8 area for evaluations: a) „1", b) „2", c) „3", d) „4", e) „5", f) „6", g) „7", h) „8", i) „9", j) „10".

Source: own study.

Analyzing data presented in Fig. 3, it is easy to acknowledge that the least important areas in terms of improving the quality of products identified by the employees are areas related to documentation, incentive system and employer-employee relationship. In contrast, the areas that are most important from the point of view of production workers were improvement such as maintenance of machines, the quality and portfolio of technologies.

4. Summary

The study has been subject to a company operating in the plastics processing industry. The analysis of the study shows that the most important area is the economy of machinery equipment and their proper operation. This is due to the fact that the company is implemented mainly in mass production. The study BOST among production workers showed the greatest need for improvement in the area of maintenance of machines. According to people participating in the production process another important aspect of resource technology reduces the risk of non-conforming products. In order to improve the system particular attention should be paid to technological development and modernization, and proper handling of machinery and equipment. It is important to the employees directly involved in the use of machinery to instill an objective to keep machines at the correct level, conducting ongoing inspections and maintenance, not only when the machine shows a decline in efficiency but also when running without charge, because such conduct will bring more benefits in the form of the company's profit. An important factor also indicated by the employees is the quality of manufactured products.

The least important areas that affect the improvement of the products quality and thus, achieve measurable benefits by the company mentioned are documentation, the incentive system and the factor of employee-supervisor relationship. The most important, in terms of production workers is to improve areas such as machine maintenance, quality and portfolio of technologies.

Literature

1. BORKOWSKI S. 2012a. *Dokumenty zawierające wymyślony termin (TOYOTARYZM) oraz zawierające nazwę i strukturę opracowanej metody (BOST)*. Potwierdzenie daty. „AAK" KANCELARIA PATENTOWA s.c. Częstochowa.
2. BORKOWSKI S. 2012b. *Toyotaryzm. Wyniki badań BOST. Wydawnictwo Menedżerskie PTM*. Warszawa.
3. BORKOWSKI S. 2012c. *Zasady zarządzania Toyoty w pytaniach. Wyniki badań BOST*. Wydawnictwo Menedżerskie PTM. Warszawa.
4. BORKOWSKI S., KRYNKE M., INGALDI M. 2012. *Quality of Services from the Scope of Decorative Concrete.* Chapter 5. Toyotarity. Quality of Services Assessment According to BOST Method. Monography. Editing and Scientific Elaboration Stanisław Borkowski, Manuela Ingaldi. Faculty of Logistics, University of Maribor. Celje s. 52-62.
5. BORKOWSKI S., KRYNKE M., KNOP K. 2012. *Evaluation of the Development Concept Factors of a Company from Automotive branch*. Chapter 6. Quality Control as Process Improvement Factor. Monography. Editing and Scientific Elaboration Stanisław Borkowski, Manuela Konstanciak. Ofic. Wydaw. Stowarzyszenia Menedżerów Jakości i Produkcji. Częstochowa. s. 84-99.
6. KNOP K., SELEJDAK J. 2009. *Implementation of FMEA method to improvement of quality food product.* Chapter 12. Quality and Processes Improvement. Monography. Editing and Scientific Elaboration Borkowski S., Czaja P. Endi Miletić. Sisak.
7. MAZUR M., ULEWICZ R. 2007. *Wykorzystanie metody FMEA dla zapewnienia jakości procesu wytwarzania linki sprzęgła samochodowego.* Nowe technologie i osiągnięcia w metalurgii i inżynierii materiałowej. VIII Międzynarodowa Konferencja Naukowa. T.1. Częstochowa.
8. ULEWICZ R. 2003. *Quality control system in production of the castings from spheroid cast iron*, Metalurgija, Volume 42, Issue 1, s. 61-63.
9. VOGT K., KUJAWIŃSKA A.2013. *Analiza wpływu wybranych czynników pracy na skuteczność kontroli wzrokowej*. Inżynieria Maszyn, R. 18, z. 1, s. 40-51

ARCHIWUM INŻYNIERII PRODUKCJI
PRODUCTION ENGINEERING ARCHIVES

2016, Vol. 10, No 1, pp 21-24
ISSN 2353-5156 (print version)
ISSN 2353-7779 (online version)

Article history: Received: 23.01.2016 Accepted: 25.02.2016 Online: 31.03.2016

Available online on: http://www.qpij.pl **Exist since 1th quarter 2013**

QFD – support to higher efficiency of industrial automotive production

Alena Pauliková[1], Katarína Čekanová [1], Melichar Kopas[2]

[1]The Slovak University of Technology, Faculty of Materials Science and Technology in Trnava,Jána Bottu 25, 917 24 Trnava, phone: +421 906 068 465, e-mail:alena.paulikova@stuba.sk, katarina.cekanova@stuba.sk, Technical University in Košice, Faculty of Mechanical Engineering, Letná 9/B, 04200 Košice, Slovakia, phone: +421 55 602 2522, e-mail: melichar.kopas@tuke.sk

Abstract: This paper deals with transformation of the customer's requirements into the specified technical parameters by means of the QFD (Quality Function Deployment) method on condition that the customer disposes of basic technical knowledge. The relevant technical parameters are describing an engineering product, which is chosen from the automotive industry area. The QFD method enables elaboration of the individual functions of quality using a multi-phased mapping process in order to transform efficiently the customer's requirements into the real technical parameters of the given product. The chosen technical product is the petrol engine 1.2 Ecotec® installed in the passenger car and it is working in the functional connection with 5 stage manual gearbox. This article analyses in detail only the first phase of the petrol engine production, taking into consideration the given technical requirements. The following step of this process is the next phase, which is focused on the engine aggregates, further it is the phase of the engine aggregate production and the final phase is the global production.

Key words –QFD, automotive, petrol engine, industrial engineering, industrial management

1. Introduction

The QFD method (Quality Function Deployment) is a multi-phased mapping method developed for elaboration of quality functions. This method consists of several steps and it enables efficient transformation of the customer's requirements into the real technical parameters relating to the given product. This tool, introduced during the 1970s by the Japanese engineer Yoji Akao, is a universal instrument, which can be utilised not only in the phase of proposal and development of a new product, but also for improvement of the individual processes, as well as for projection of the production systems,(RUDY V2009).

The specific methodical procedure, which was developed for a successful application of the QFD method, is illustrated in Fig.1.

2. Methodical Procedure for Creation of the QFD Diagram

The chosen engineering product of automotive industry is the petrol engine 1.2 Ecotec® (51kW/70k), which is installed in passenger car and coupled with 5 stage manual gearbox, (SZENDRO G. 2015), Fig. 2.

Identification of the Customer's Requirements – What the customer wants

The main task of the first step, which is necessary for creation of the QFD diagram, demands definition of a target group of customers and to identify their requirements (concerning the petrol engine) by means of the specific procedures that are applying the tools VOC and CTQ, (JAGUSIAK-KOCIK M. 2014).

Afterwards, the solution team has to analyse these requirements in detail and to arrange them into the set of priority requirements using either the affinity diagram or the Kano model. The given set of requirements, which is prepared in this way, creates a base needed for following assembly of the QFD diagram, (NAGYOVÁ A. 2016).

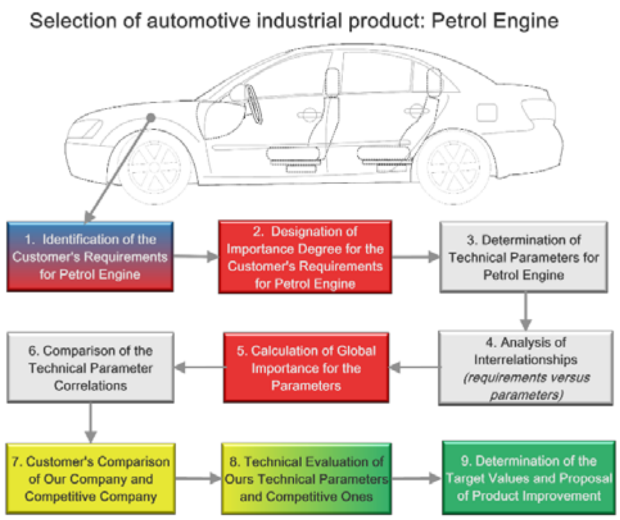


Fig. 1 Procedure developed for application of the QFD method

Source: own study

Fig.2 Petrol Engine 1.2 ECOTEC®

Source: own study

Designation of Importance Degree for the Customer's Requirements – How much the customer needs them

It is necessary to designate a degree of importance to each of the customer's requirements. A suitably selected evaluation scale is based on a collective decision of the solution team, taking into consideration the solution team experiences or it is also possible to use the results obtained from the previous Kano model application. The next evaluation scale was chosen, in this case: 1- the least important requirement, 3 –the most important requirement (SZKLARZYK P. 2014).

Determination of Technical Parameters – Definition of values

This step has to ensure a mutual co-operation between the department of design and the department of technology or production, because the main task of these departments consists of suggestion of technical specifications needed during the design proposal of the petrol engine in accordance with the customer's requirements, whereas there is defined a tendency or direction for a future improvement of the individual technical parameters (KRYNKE M. 2015).

This direction offers information about a necessity to increase or to reduce value of the given parameter in order to reach a higher quality level. Eventually, the given parameter value is defined invariably, (KRYNKE M. 2014).

Analysis of Interrelationships – Looking for interconnections

The functional analyses of the relationships are performed within this step among the customer's requirements and the technical parameters in order to consider whether the given technical parameters of the petrol engine are important with regard to fulfilment of certain customer's requirements. It is necessary to define a proper evaluation range in this step, as well. For example: 3 – strong relationship, 2 – moderate relationship, 1 – weak relationship, 0 – without a relationship (no relationship).

Calculation of Global Importance for the Parameters – Evaluation of technical parameters

The main purpose of this step is identification of such technical parameters, which are the most important with regard to the customer's requirements and therefore the priority of these parameters is the highest during the phase of the petrol engine design. The calculation process creates a sum of the arithmetical products between the degree of dependence and the degree of importance for each of the technical parameters. The parameters with the highest calculated values, obtained within the framework of the performed evaluation process, are the most relevant technical parameters (BIGOŠ P. 2012)

Comparison of the Technical Parameter Correlations – Diagram shelter

It is necessary to compare not only the customer's requirements with the technical parameters, but also to analyse the functional correlations among the individual technical parameters. In the case that a correlation between two technical parameters is positive, i.e. if increasing of one parameter causes an increase of the second parameters, then the parameters are marked with the sign (+). In the case of a negative correlation, i.e. if increasing one parameter reduces the value of the other parameter, the parameters are marked with the sign (-). The third possibility is a variable correlation, i.e. the correlation is either positive or negative. The variable correlation can be reached, for example, by changing another constructional parameter and the sign (∗) is applied in that case. If there is no relevant correlation between two parameters, the corresponding field is without infilling, i.e. this field remains empty, (GIRMANOVÁ L.2009).

Customer's Evaluation – Monitoring of competitors

Before composition of this QFD diagram part it is necessary to choose the competitive engines of the same type or the same price category, which are produced by the most important competitors (A and B). Afterwards it is possible to compare the proposed or the present state of the customer's requirement fulfilments with the situation concerning fulfilment of the customer's requirements by our competition. A suitably defined evaluation scale is a necessity in this step, too. There is chosen, for example: 1 – represents the weakest evaluation, 2 – means a moderate evaluation and 3 – is the best evaluation. The plan for a following improvement of the petrol engine production should be scheduled according to the results obtained from the above-mentioned comparisons (TOPOLŠEK D. 2015)

Technical Evaluation – Monitoring of technical and competitive parameters

The main intention of this step is comparison of the relevant technical parameters with the competition. The used evaluation method is similar to the previous step, however the data collection process is a more complicated task with regard to the fact that the individual companies are protecting their own know-how. From this reason it is possible to apply only the publicly accessible information presented on the web-pages of the companies or in the production catalogues published by the competitive companies (JAGUSIAK-KOCIK M. 2013).

Determination of the Target Values and Proposal of Product Improvement – Finalisation of the First House from QFD method

The project solution team is able to identify possible disadvantages of the petrol engine thanks to the performed technical comparisons and the customer's comparisons (BORKOWSKI S. 2013).

Consequently, this team has to set-up the target parameters for their own petrol engine so that it could be competitive. At the same time it is necessary to consider, which of the target parameters can be ensured and maintained during the long time period by the production company

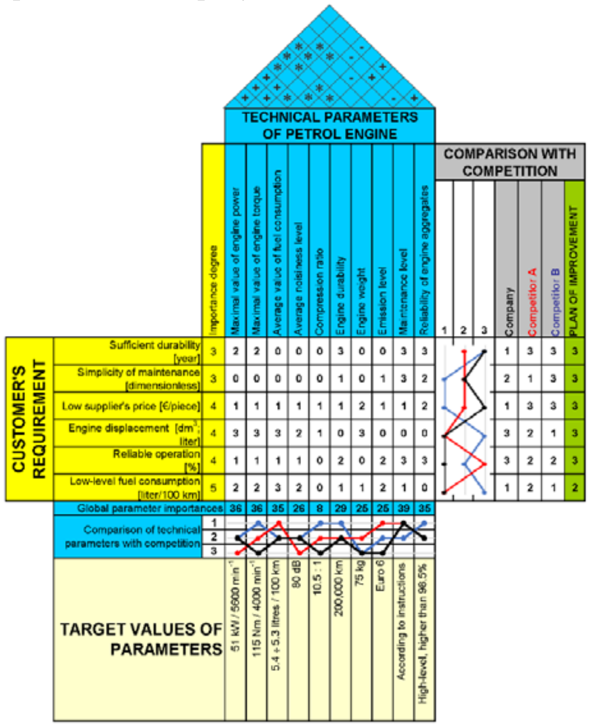


Fig. 3 The final QFD diagram with shelter and with the target values necessary for production of the petrol engine

Source: own study

3. Conclusions

Assembly of the QFD method diagram represents a four-matrix approach. This fact means that after determination of the target parameters of the petrol engine only the first phase from the group of four phases as a whole is complete. The final QFD diagram, created for the first phase, is presented in Fig.3. This diagram includes two shelters and it defines the target values required for intended innovative production of the petrol engine.

The results obtained from the first part of the QFD diagram are necessary for a following development of the second part of the QFD diagram, as well as for the third part and fourth part of this diagram consequently. The results or outputs obtained from the previous parts represent inputs for the following QFD diagram parts at the same time.

The functional differences among the individual matrixes consist in the next characteristics: the second part of the QFD diagram is specified for transformation of the technical parameters (outputs from the first part) into the individual machine design parts or aggregates of the petrol engine.

The third part of the QFD diagram transforms the petrol engine constructional parts or components (outputs from the second part) into the parameters of the petrol engine production process.

Finally, the fourth part of the QFD diagram performs transformation of the production process parameters (outputs from the third part) into the parameters of the whole production system with regard to the global production. It is important to emphasize a fact that this article analysed in detail only the first phase of the petrol engine production, taking into consideration the given technical requirements, (BIGOŠ P. 2011).

Affiliation

This article was elaborated within the Project VEGA: 1/0990/15 "Readiness of industrial companies to implementation of the requirements resulting from the standards of the quality management systems ISO 9001:2015 and to the environmental management systems ISO 14001:2014" as well as within the Project VEGA: 1/0198/15 "Innovative approach to design of driving units and constructions of transport-handling machines, with regard to reduction of emissions and increasing of their reliability".

Literature

1. BIGOŠ P. – FALTINOVÁ E. 2011. *Reliability of Technical Systems*, KošiceTU, SjF. - 171 p. - ISBN 978-80-553-0802-9, (in Slovak: Spoľahlivosť technických systémov)
2. BIGOŠ, P., KUĽKA, J., KOPAS, M., MANTIČ, M.2012. *Theory and Building of Lift and Transport Devices, Košice,* TU - SjF, , 356p; ISBN 978-80-553-1187-6. (In Slovak: Teória a stavba zdvíhacích a dopravných zariadení)
3. BORKOWSKI S. KNOP K. 2013. *Visual Control As a Key Factor in a Production Process of a Company from Automotive Branch*, Production Engineering Archives, Vol. 1, No.1. pp 25-28, ISSN 2353-5156
4. GIRMANOVÁ, L., MIKLOŠ, V., PALFY, P., PETRÍK, J., SÜTŐOVÁ A., ŠOLC M. 2009. *Tools and Methods of Quality Management*, Košice: HF TU - . - 145 s. - ISBN 978-80-553-0144-0. (in Slovak: Nástroje a metódy manažérstva kvality)
5. JAGUSIAK-KOCIK M. 2013. *Quality analysis during production of car counter cases*, Production Engineering Archives, , Vol.3, No.3. pp 22-25, ISSN 2353-5156
6. JAGUSIAK-KOCIK, M. 2014. *Ensuring continuous improvement processes through standardization in the automotive company*, Production Engineering Archives, Vol.2, No.1. pp 12-15, ISSN 2353-5156
7. KRYNKE, M. 2015. *The dynamic state monitoring of bearings system*, Production Engineering Archives, Vol. 6, No.1. pp 35-38, ISSN 2353-5156
8. KRYNKE, M., KNOP K., MIELCZAREK, K. 2014. *Identifying variables that influence manufacturing product quality*, Production Engineering Archives, Vol4, No.3. pp 22-25, ISSN 2353-5156
9. NAGYOVÁ, A.– PALKO, M. 2016. *Analysis of the causes of nonconforming product in supplier-customer chain In: Production Management and Engineering Sciences*. – Leiden: CRC Press/Balkema, , p: 213-218. - ISBN 978-1-138-02856-2
10. RUDY, V. 2009. *Innovation methods in structures of production systems designing*, In: Ovidius University Annual Scientific Journal. Vol. 11, no. 1, p. 15-18. - ISSN 1224-1776
11. SZENDRO, G., HORVATH, E., TOROK, A. 2015. *Wave theory analysis of the Hungarian vehi-cle fleet especially focusing on emission categories*, Production Engineering Archives, Vol. 8, No.3. pp 2-5, ISSN 2353-5156
12. SZKLARZYK, P., KLIMECKA-TATAR, D., SYGUT, P., LIPIŃKI, T. 2014. *Quality analysis of plates for car industry*, Production Engineering Archives, Vol4, No.3. pp 11-13, ISSN 2353-5156
13. TOPOLŠEK,D. JEREB, B. CVAJTE, T. 2015. *Increasing competitiveness with intercompa-ny integration of logistics and marketing functions*, Production Engineering Archives, Vol. 8, No.3. pp 6-9, ISSN 2353-5156

ARCHIWUM INŻYNIERII PRODUKCJI
PRODUCTION ENGINEERING ARCHIVES

2016, Vol. 10, No 1, pp 25-28
ISSN 2353-5156 (print version)
ISSN 2353-7779 (online version)

Article history: Received: 02.02.2016 Accepted: 03.03.2016 Online: 31.03.2016

Available online on: http://www.qpij.pl **Exist since 1th quarter 2013**

Automotive standard ISO/TS 16949 as a quality determinant

Joanna Rosak-Szyrocka[1]

[1]Institute of Production Engineering, Czestochowa University of Technology, Poland, asros@op.pl

Abstract: The main aim of this paper is to present the standard ISO/TS 16949. In the modern world of competition, quality is one of the most important factors. Modern organizations should gamble on quality, regardless of the type of business, because it is the basic form of running a business effectively. It is not only a factor of market success, but also an indication of organizational culture.

Key words – quality, automotive industry, ISO/TS 16949

1. Automotive industry

Thanks to the constant globalisation process and the systematically encountered fierce competition in international markets, change in the location of production processes has become a common practice for entrepreneurs representing the automotive sector all over the world. At the same time, the phenomenon of capital concentration can be observed in the automotive sector (CALADOR D., SILVAM B., SILVABOASORTEOLIVEIRA A., SPAGNOLG S., SARANTOPOULOS A., LIL M. 2014).

The nature of the automotive industry in the era of accelerating technological progress, increasing consumer awareness and the ever changing market demands that global car-makers and their suppliers use and implement systems that are capable of providing the highest quality and safety of their products (BORKOWSKI S., ROSAK-SZYROCKA J. 2009, ROBAK B.,ULEWICZ R. 2013, ROSZAK M., SPILKA M., KANIA A. 2015, ROSZAK M. 2014). Apart from the individual automotive quality management systems characteristic to particular car-companies, the basic standard currently used in the international automotive markets is the quality management system based on the ISO/TS 16949 technical specification.

2. ISO/TS 16949 standard

ISO/TS 16949 together with ISO 9001(BORKOWSKI S., ULEWICZ R. 2000, BORKOWSKI S., ULEWICZ R. 2001) is posing 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.

ISO/TS 16949 was developed by the International Automotive Task Force (IATF) to create common processes and procedures across the automotive industry. IATF members include some of the world's largest car manufacturers, including BMW Group, Chrysler Group and General Motors (HTTP://WWW.KANTNERCOMPANY.COM/AA16949.KC.HTM.).

"Revolutions" car manufacturers in quality management systems, causing difficulties in managing the factory system documentation, which was often carried out for several different independent quality management systems, such as working with Renault, BMW and Ford organization had to have three implemented quality management systems: EAQV(French quality management system), VDA 6.1(Germanquality management system), QS-9000 (U.S. quality management system).

The initiator of this project was the IATF (International Automotive Task Force- International Operations Team Industry Automotive) and national trade associations(AIAG -America, VDA - Germany,SMMT- United Kingdom,ANFIA-Italy, FIEV-France) who were responsible for the design of the technical group International Organization for Standardization ISO TS 176. As result of heated debates a new standard ISO/TS16949"Quality systems was set for suppliers to the automotive market- the specific assumptions for ISO9001:1994." The intention was to harmonize the requirements of the quality management systems of the automotive market: the U.S.(SQ9000), Italian (AYSOJ, French(EAQV) and German(VDA6.1)with ISO9001:1994. Message of ISO/TS16949:1994was to ensure continuous improvement, prevent defects, reduction of volatility and losses in the supply chain.

Top tips for implementing ISO/TS 16949 are following:

1. Make sure your whole business and supply chain are committed.
2. Engage your business and supply chain with good communication.
3. Compare existing quality management with ISO/TS 16949 requirements.
4. Get supply chain and stakeholder feedback on current quality processes.
5. Establish an implementation team to get the best results.
6. Map out and share roles, responsibilities and timescales.
7. Adapt the basic principles of the ISO/TS 16949 standard to your business.
8. Motivate staff and supply chain involvement with training.
9. Encourage your supply chain to become ISO/TS 16949 certified.
10. Regularly review your ISO/TS 16949 system to make sure it remains effective and that you are continually improving it.

According to the investors, the factors which make the automotive sector particularly attractive include:

- the convenient location of Poland in the centre of Europe and the proximity of approximately 40 large automotive industry plants:
- the developed network of sub-suppliers and cooperators which exceeds 900 plants of which over 500 companies hold ISO/TS 16949 quality certificates,
- the availability of a highly skilled labor force,
- an attractive system of investment incentives, including non-reimbursable grants and tax exemptions.

Poland is being increasingly chosen by investors operating in the automotive industry. Among approximately 40 automotive plants located in Central and Eastern Europe and operating in 16 are located in Poland (Table 1).

In 2014, 578.4 thousand passenger cars and commercial vehicles were produced, an increase of 0.6% against the previous year. Further increases in production is expected due to the commissioning of a plant manufacturing VW Crafter in Września in 2016 (maximum production capacity will amount to 100 thousand vehicles). Large production plants also operate in Tychy, Gliwice and in Wałbrzych. Toyota plants manufacture engines for themselves, Peugeot and Citroen; Fiat produces engines for their own needs and for Ford. The Volkswagen factory in Polkowice is a producer of engines for passenger cars and commercial vehicles for VW, as well as for Audi, Seat and Skoda. The Toyota Motor Manufacturing Poland in Wałbrzych manufacture engines and gearboxes for itself, Citroen and Peugeot. Also, General Motors' decision to launch production of the latest generation of Opel Astra is another significant investment. The production in the Gliwice plant commenced in September 2015. The investment outlays related to the implementation of the project amounted to approximately EUR 150 million(WWW.PAIZ.GOV.PL, HTTP://WWW.STANDARDS.ORG/STANDARDS/LISTING/ISO_TS_16949)

Table 1. Engines and cars producers in Poland

Localization area of the company	Name and kind of the company
Słupsk	SCANIA (coaches) KAPENA (coaches)
Poznań	VW Poznań (cars) Solaris (coaches) Solbus (coaches) WolkswagenWrześnia (cars factory from 2016)
Wrocław	Wałbrzych Toyota (engines)
Katowice Kraków	JelczLaskowice Toyota (engines) Polkowice VW (engines) General Motors MP Tychy Engines factory (from 2017) Bielsko-Biała FPT Diesel/Gasoline (engines) AndrychówAndoria (engines) Tychy Fiat/Ford (cars) Gliwice GM Opel (cars) Tychy GM MP (engines)

Source own study basis on: www.paiz.gov.pldostęp: 23.04.2016

3. Meaning ISO/TS 16949 in the company

The benefits of being certified to ISO/TS 16949 Standard includes are but not limited to:
- Quality improvement in product & process,
- Additional confidence to the customers,
- Common approach for managing Quality Management System,
- Reassignment of resources to quality improvement and
- Reduction in the multiple 3rd party registrations.

Implementation of ISO/TS 16949 management system is by no means an easy task. Organizations that have chosen the DIY (Do-It-Yourself) approach may find it confusing when upgrading their ISO 9001 management system to ISO/TS 16949 which includes additional automotive industry requirements and customer-specific requirements. For a company of around 100 staff, it will probably take close to a year to ready itself for the certification process. Even though ISO 9001 is not a pre-requisite for ISO/TS 16949, it is recommended to be implemented first.To be effective, a project team that consists of a team leaders and members from the key processes should be formed to spearhead for the project. Usually, in the initial phase, the team will spend almost 50% of their working time devoted to this purpose. Additional costs could come from the additional staff employed to temporarily take over the duties of the team members assigned.The costs of certification for ISO/TS 16949 depend on the scope of certification, size of the organization, number of manufacturing sites and remote locations. IATF through its "Rules for Achieving Recognition" states the audit man-day requirement be based on the number of employees in the organization. Most of the certification bodies follow the rule quite closely in quoting audit man-days for the organization. Certification bodies usually charge a certain day rate for the audit performed and the rate can be quite different among different countries and different certification bodies(BEVILACQUA M., CIARAPICA F.E., GIACCHETTA G., MARCHETTI B. 2011, CALADOR D.,SILVAM B., SILVABOASORTEOLIVEIRA A., SPAGNOLG S., SARANTOPOULOS A., LIL M. 2014).

4. Summary and conclusions

Requirement for the production of the product with the highest standards of quality beyond the use of the most modern technological methods is the implementation of quality management systems and their continuous improvement in organizations using qualitative methods.

In Poland, the first quality systems began to be implemented in the 90's. The first companies that have decided to change the approach to quality have been exporting companies their products to EU countries. Boards of these companies wanted above all to enter new markets. So it was the main, and often only goal. However, after a few years, a large group of companies began to implement quality systems in accordance with ISO9000 with a view to acting in the Polish market. Their goals were similar to those of the leading European companies: reduce costs, increase competitiveness and internal benefits. Soon, however, entrepreneurs looking for a shorter route through the purchase documentation or even purchase a certificate became common. These, however, are not enough, most of the management decided to implement the system consciously aware of the benefits to be gained.At the end of June 2010, a total of 42,189 certificates were issued to ISO/TS 16949(ŁYSAK D. 2013). Asia Pacific region accounted for the biggest number of certificates issued - 16,585 (47%). Among all the countries, China was the fastest growing country which itself accounted for 13,031 (31%) certificates.

The fact that a given company has a certificate being in accordance with ISO/TS16949 is an important argument in business talks. This standard introduces a common ground for all participants of the supply chain(HYS K. 2015.).

Literature

1. BORKOWSKI S., ROSAK-SZYROCKA J. 2009. *Procedury uzyskiwania znaków jakości*, Wydawnictwo Politechniki Częstochowskiej, Częstochowa.
2. Borkowski S., Rosak-Szyrocka J.: Jakość usług medycznych w Polsce. Wydawnictwo PTM Warszawa 2010.
3. BORKOWSKI S., ULEWICZ R. 2000. *The application of analytical methods in solving quality issues and quality improvement in the automotive industry*, Advanced Manufacturing and Repair Technologies in Vehicle Industry.17th International Colloquium.ZielonaGóra-Łagów.
4. BORKOWSKI S., ULEWICZ R. 2001. *The Quality System According to the Norm QS-9000*,MT'01.The Third International Conference. Mechanical Engineering Technologies. Sofia.
5. http://www.kantnercompany.com/aa16949.kc.htm.
6. http://www.standards.org/standards/listing/iso_ts_16949.
7. HYS K. 2015. ISO/TS 16949 analysis of the current trends. ZarządzanieiFinanse Journal of Management and Finance Vol. 13, No. 2/2015.
8. ŁYSAK D. 2013. *Specyfikacja techniczna ISO/TS 16949*, Problemy Jakości 10.
9. ROBAK B.,ULEWICZ R. 2013. *Use of selected instruments to solve quality problems in the automotive industry*. Chapter 16. Product Quality Improvement and Companies' Competitiveness. Monography. Editing and Scientific Elaboration StanisławBorkowski, Manuela Ingaldi, Faculty of Logistics, University of Maribor, Celje.
10. ROSAK-SZYROCKA J. 2015.*Systemy jakości w aspekcie jakości usług medycznych szpitali w Polsce.* ABC Jakości, 3/2015.
11. ROSAK-SZYROCKA J., BORKOWSKI S. 2012.*Procedure for Implementation Systems of Quality Management in Hospital* [in:] ResearchMethodsImprovement, Borkowski S., Jasiński J. Yurii V. Makovetsky (eds.):, Dnipropetrovsk 2012.
12. ROSZAKM., SPILKAM., KANIAA. 2015.*Environmentalfailuremode and effectsanalysis (FMEA)–a newapproach to methodology.* HrvatskoMetalurskoDruštvo (HMD). Metalurgija. T. 54, Wyd 2, p. 449-451, 2015.
13. ROSZAKM.T. 2014.*The synergy of the interaction of methods and tools of management on the technologies of materialprocesses.*Archives of Materials Science. T. 82, p. 82.
14. WWW.PAIZ.GOV.PL.
15. BEVILACQUA M., CIARAPICA F.E., GIACCHETTA G., MARCHETTI B. 2011.*Implementation of a quality procedure based on Delphi method and the ISO/TS 16949: 2009 in the production ofstainlesssteeltubes forautomotiveexhaust systems,* "International JournalofQuality&ReliabilityManagement", Vol. 28, No. 8.
16. CALADORD.,SILVAMB.,SILVABOASORTEOLIVEIRA A.,SPAGNOLGS.,SARANTOPOULOSA., LIL M. 2014. *Defining quality and maturity level applying the grey system and the method for automotive enterprises diagnosis*, AmericanJournalof Theoretical and Applied Statistics,Vol.3,No.6–1.

ARCHIWUM INŻYNIERII PRODUKCJI
PRODUCTION ENGINEERING ARCHIVES

2016, Vol. 10, No 1, pp 29-32
ISSN 2353-5156 (print version)
ISSN 2353-7779 (online version)

Article history: Received: 17.01.2016 Accepted: 28.02.2016 Online: 31.03.2016

Available online on: http://www.qpij.pl **Exist since 1th quarter 2013**

Increasing competitiveness with intercompany integration of logistics and marketing functions

Darja Topolšek[1], Borut Jereb[2], Tina Cvahte[3]

[1]Assistant professor, University of Maribor, Faculty of Logistics, Mariborska 7, SI-3000 Celje, Slovenia, darja.topolsek@um.si
[2]Associate professor, University of Maribor, Faculty of Logistics, Mariborska 7, SI-3000 Celje, Slovenia, borut.jereb@um.si
[3]Teaching assistant, University of Maribor, Faculty of Logistics, Mariborska 7, SI-3000 Celje, Slovenia, tina.cvahte@um.si

Abstract. Researchers of different scientific disciplines, such as management strategies, organizational theories and marketing, have in the past explored relations of mutual influences and the importance of cooperation between different functions in a company. The increased focus on the logistics function has potential to increase competitiveness. This is especially true for globally aimed production companies. In any company, logistics functions cooperate with various related functions such as production, marketing, procurement, engineering or developing new products as well as with financial functions. Each of the aforementioned connections or cooperation among logistics and its complementary functions can have a decisive effect on the company's competitiveness. Using a survey, we determined which activities in the surveyed companies are performed by the logistical function together with the marketing function and which activities they suggest should be performed together but are currently not, meaning they are co-dependent. Since interfunctional integration between logistics and marketing increases the success of a company, we also examined the connection between the current joint performance of activities and the suggested joint performance of activities among the before mentioned sectors, connected to the effectiveness of the company. To examine the mentioned connections among the logistical and marketing functions, Explanatory Factor Analysis (EFA), Confirmatory Factor Analysis (CFA) and Structural Equation Modelling (SEM) were performed.
Key words – Integration, Logistics, Marketing, SEM

1. Introduction

Logistical functions cooperate (are connected) with different interconnected functions such as production, marketing, procurement (GUSTIN C. M. 1991), engineering or new product development (GUSTIN C. M., 1991) and with financial functions as well (COYLE J. J., BARDI E. J.& LANGLEY J. C. 2003).

Traditionally, many companies are organized around marketing and production functions. This is not unusual, since marketing means selling something, while manufacturing or production represents the production of something; nonetheless, it is necessary to look at a company on a higher level (BALLOUR. H.2004).

Logistics must be closely connected to production and marketing, as only as such it can plan, coordinate and integrate their cross-functional activities (MORASH E. A., DRÖGE C.&VICKERY S. 1997).

Marketing is thus basically responsible for market research, promotion, sales management and product availability. Production/operations refer to the creation of a product or a service which creates value of the product because of its shape. Logistics is hidden in these activities and gives the product or service the value of time and place. This separation of activities into three groups, and not into two, is not always necessary or even advisable. Logistical activities may in fact be coordinated otherwise. Marketing and production systems/operations may successfully carry out logistics activities without creating additional organizational entities.

Various authors differently interpret the integration and cooperation between functions in a company. The integration of logistics and marketing function is a process of interaction and collaboration, in which logistics and marketing functions work together in a cooperative mode to achieve mutually acceptable results for the company.

Logistics and marketing functions are now already integrated to a certain level in many companies, but BOWERSOX D. J., CLOSS D. J. andSTANK T. P.(2008) show two catalysts or initiators for the classification of logistics into a system of key strategic resources. These two catalysts are time and competition, based on quality, efficiency and effectiveness. These factors seek to eliminate wastage of time, effort, incomplete units and supplies in the production-distribution system (SCHULTZ D. P.1985). The most common concepts, which are based on time and quality, are Just in time – JIT and Quick response - QR. Typically, positive effects from such concepts are fully utilized only if the logistic function is internally integrated with marketing.

Recently, researchers have highlighted the need to increase the level of cross-functional collaboration between logistics and marketing, whereas the latter increases the performance of the company (KAHN K. B. &MENTZERJ. T. 1998; MORASH E. A., DRÖGE C.& VICKERY S.1997). BOWERSOX D. J., CLOSS D. J., and STANK T. P.(2000) made an initiative claiming that the improvement of integration between logistics and marketing function is crucial to the success of companies in the 21st century. The success of the company is to be understood as the sum of performance of teams, departments and individuals. That is why companies recently place great emphasis on assessing work performance, staff motivation, development of human and intellectual capital.

Based on the given facts, it can be concluded that the integration of logistics and marketing functions is crucial to the success of the company. On this basis, this study focuses on which activities of logistics and marketing functions are actually carried out jointly, and which activities should be carried out together and interdependently. Because of that, the main research field of this research is focused on the implementation of joint actions and the impact there of on the performance of the company.

2. Methodology of research

To determine the relation between the current state of implementation of the activities, the proposed state of implementation of the activities, and performance of the company, an anonymous survey was carried out among Slovenian companies. The sample of enterprises was based on a predetermined scope, represented by companies whose business is defined as Retail trade, except for motor vehicles.

In the analysis, we dealt with 78 correctly completed questionnaires. The questionnaire is comprised of two main sets of questions that relate to the implementation of the activities and performance of the company. All questions were answered by employees in the logistics sector as well as in the sector of marketing.

Respondents evaluated the existing state of implementation of activities and the proposed status of implementation of activities on a Likert scale (1 Never, 5 Always). We also evaluated the performance of the company from the perspective of four items on a Likert scale (1 Very Low, 5 Very High).

Table 1: Variable names

Which activities are performed together (left side) and which activities should be performed together (right side)		
Variable – current state	Description	**Variable-suggestedstate**
CURR_1	Transport	SUGG_1
CURR_2	Warehousing and storage of goods	SUGG_2
CURR_3	Industrial packaging	SUGG_3
CURR_4	Goods manipulations	SUGG_4
CURR_5	Maintenance of stock	SUGG_5
CURR_6	Order processing	SUGG_6
CURR_7	Demand predictions	SUGG_7
CURR_8	Production planning	SUGG_8
CURR_9	Procurement	SUGG_9
CURR_10	Consumer support	SUGG_10

CURR_11	Location of production and storage facilities	SUGG_11
CURR_12	Handling of returned goods	SUGG_12
CURR_13	Support to service activities and supply of spare parts	SUGG_13
CURR_14	Solving problems with waste and their disposal or recycling	SUGG_14
CURR_15	Designing specific characteristics of the product or service from the view of usefulness, quality or design	SUGG_15
CURR_16	Packaging design	SUGG_16
Assessment of performance of the company		
Variable		
PERF_1	My company has achieved a reduction in the costs services that we have in order to meet the specific requirements of a certain consumer	
PERF_2	My company has achieved a reduction in costs in transporting certain goods to certain consumers	
PERF_3	My company has achieved a reduction in costs in the processing of certain orders of certain consumers	
PERF_4	My company has achieved a reduction in outgoing stocks of a given product for a given consumer	
PERF_5	My company has achieved a reduction in the delivery time for a given consumer	

To explore the problem defined, a statistical analysis was carried out, which included exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) as well as structural equation modelling (SEM).

3. Results

With the help of a questionnaire we measured what activities respondents from both sectors (logistics and marketing) actually carried out jointly and which activities the respondents proposed to be carried out jointly or interdependently between sectors.

Basic developed insights suggest that the perception of the implementation of interdependent activities among employees in complementary functions varies considerably. We note the continuing differences in the responses of employees in the marketing function in comparison to the answers of employees in the logistics function, from which we detect some non-compliance and poor understanding of the actual implementation of activities.

EFA and CFA

Exploratory factor analysis (EFA) is designed for situations where the links between the observed and latent variables are unknown or uncertain. Based on a normality test we can conclude that the distribution is normal, which allows for the use of Maximum Likelihood estimation. To determine reliability, the Bartlett's test of sphericity (BTS) and the Kaiser-Meyer-Olkin(KMO) test were also conducted. The BTS value was highly significant (=2798.229 with df=276 and $p<0.001$), while the value of KMO was 0.736 > 0.05. Therefore we can claim that factor analysis is reliable. Item loadings on factors were significant, since they reached the value 0.40 or more.

The EFA resulted in 3 factors – see Figure 1 for details. It is evident that the variables concerning the current state (CURR), suggested activities (SUGG) and company's performance (PERF) are significantly loaded on the corresponding factors. Loading factors resulting from EFA were assigned to confirmatory factor analysis (CFA). Based on the assumption of multivariate normality, the maximum likelihood (ML) method was used.

Structural equation model

Six steps of SEM modelling were performed as recommended by Kline (2005). In SEM the maximum likelihood (ML) estimation method was used.

Figure 1 shows SEM results, where the estimated path coefficients are significant at $p\leq0.10$ level among the variables.

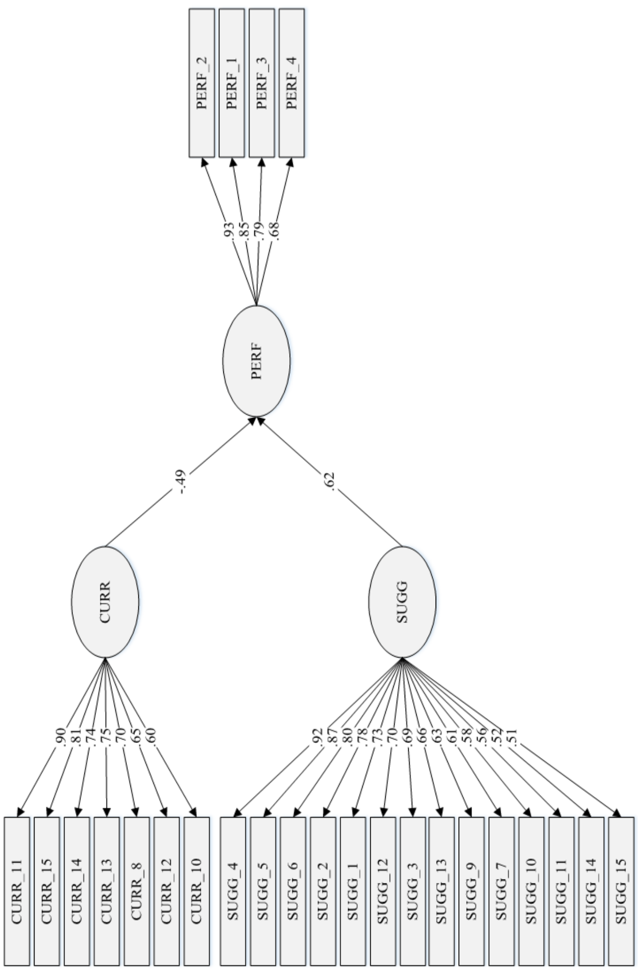
The latent variable CURR for currently jointly performed activities was constructed with 7 measured variables. From the path coefficient, it is obvious that the maximum value is that of the CURR 14 (Solving problems with waste and their disposal or recycling) and of CURR15 (Designing specific characteristics of the product or service from the view of usefulness, quality or design). This means that these two variables are most commonly presented and are most commonly performed together with a complementary business function.

The latent variable SUGG is comprised of 14 measured variables, among which SUGG_4 (Goods manipulation) in SUGG_5 (Maintenance of stock) stand out, meaning that they are the most important activities for cooperation.

For PERF variables, the EFA and CFA revealed 4 latent variables, among which PERF_2 (Reduction in transport costs) has the largest coefficient and is therefore the most important factor in a company's performance and success.

The SEM results also identified 3 significant relations among the latent variables. First negative relation is between current performance of activities and effectiveness. This shows that current joint performance of activities is not at a satisfactory level and even has a negative effect on the company's performance. On the other side, results show an important positive relation between the suggested performance of activities together with other functions and the company's performance. This leads to the conclusion that such companies are on the path towards economical success.

Figure 1: Results of the SEM model and coefficients of relations



All indices of model fit are inside the allowed limits or surpass the given minimal values (Chi-Square = 2411.883; Relative Chi-Square of the discrepancy = 8.867; RMSEA= 0.032; NFI = 0.961; CFI = 0.978; IFI = 0.985; SRMR = 0.0562).

4. Conclusion

The paper presented one of the most important aspects of a company's operations – its internal integration of different functions, most importantly the logistics and marketing functions. Previous studies show that internal integration of various functions, and also of the marketing and logistics functions, bring benefits to company operations. Our study confirms this premise and expands on it, showing that the interdependence of the logistics and marketing function is indeed important, and importantly contributes to the set measures of a company's performance.

We showed that the current state of interdependence and joint performance of activities is not on a desired level and therefore, the company performance suffers from it. However, in the case of joint performance on a suggested level, the company's performance would increase significantly and aid the overall company effectiveness and efficiency.

Bibliography

1. BALLOU R. H. (2004). *Business Logistics/Supply Chain Management, Planning, Organizing, and Controlling the Supply Chain*. Pearson Prentice Hall. New Jersey.
2. BOWERSOX D. J., CLOSS D. J. & STANK T. P. (2000). *Ten Mega-Trends that Will Revolutionize Supply Chain Logistics*. "Journal of Business Logistics", 21 (2), 1–17.
3. COYLE J. J., BARDI E. J. & LANGLEY J. C. JR. (2003). *The Management of Business Logistics, A Supply Chain Perspective*. South-Western Thomson Learning. Ohio, USA.
4. GUSTIN C. M. (1991). *Integrated Logistics: The Perceptions and the Future*. "Production and Inventory Management", 11 (6), 1–4.
5. KAHN K. B. &MENTZER J. T. (1998). *Marketing's Integration with Other Departments*. "Journal of business research", 42 (1), 53–62.
6. MORASH E. A., DRÖGE C. & VICKERY S. (1997). *Boundary-spanning interfaces between logistics, production, marketing and new product development*. "International Journal of Physical Management", 27 (5/6), 43–62.
7. SCHULTZ D. P. (1985). *Just-in-time system*. Stores. New York, USA.

ARCHIWUM INŻYNIERII PRODUKCJI
PRODUCTION ENGINEERING ARCHIVES

2016, Vol. 10, No 1, pp 33-37
ISSN 2353-5156 (print version)
ISSN 2353-7779 (online version)

Article history: Received: 08.02.2016 Accepted: 05.03.2016 Online: 31.03.2016

Available online on: http://www.qpij.pl **Exist since 1th quarter 2013**

SWOT analysis application for indications of the strategy action chosen enterprise in the construction sector

Agnieszka Czajkowska[1]

[1]Kielce University of Technology, al. Tysiąclecia Państwa Polskiego 7, Kielce, Poland, a_czajkowska@o2.pl

Abstract: Only ambitious and success-driven enterprises are able to adapt to continuous changes in closer and further business surroundings. Modern enterprises strive for meeting the customers' expectations and needs. Even the most successful enterprises cannot cease to be competitive and survive only with what they have already achieved. Enterprises have to adopt strategies to ensure continuous development. The aim of the SWOT method, on the one hand, is to indicate the direction the enterprise should take in order to utilize their potential as much as possible and, on the other hand, to realize the shortcomings that should be improved. SWOT analysis helps determine the strategic factors to be used during planning further development of the enterprise. The analysis carried out in the study provided a transparent insight into the factors which depend on the enterprise and those that cannot be affected directly. The recommended mini-mini strategy means that the enterprise is in a good market situation whereas external threats are deepened with internal weaknesses of the enterprise.

Key words – SWOT analysis, construction sector, mini-mini strategy

1. Introduction

The enterprise analysed in the study operates in the area of comprehensive performance of construction works, comprehensive construction of detached houses, production halls, public utility facilities and demolition of buildings. The SWOT (INGALDI M., ŠKŮRKOVÁ K. 2015) analysis was employed in order to point to the strategy of development in an enterprise that provides construction services. The aim of the SWOT analysis was to indicate the components of the assets which might be regarded as an advantage in the market rivalry with potential competitors, to reveal weaknesses that reduce the strength of the competitive effect and to identify specific competencies of the enterprise in order to use new opportunities that emerge in the international market (KOSIŃSKAE. 2008). The term SWOT TOWS is often used in the literature (ŻABIŃSKIL. 2000). The term TOWS (LAKE 2005) was obtained through reorganization of the letters in the acronym SWOT and points to the reversion of the order of the analysis. The difference lies in that the SWOT analysis starts from evaluation of internal strengths and weaknesses for which the method for the most effective utilization is attempted to be found, whereas in the TOWS analysis the opportunities and threats are first identified in the enterprise's surroundings and then they are compared to the internal capabilities of using these opportunities and balancing the threats. The SWOT acronym derives from the first letters of English words (OBŁÓJK. 2010):

- strengths (S),
- weaknesses (W) ,
- opportunities (O),
- threats (T).

The aim of the SWOT analysis is to compare the most important factors that characterize the standing of the enterprise and conditions in its surroundings in order to determine the optimal solutions for the activities which the enterprise will be able to start in the market (CZUBAŁAA. et al. 2006).

2. Material and methods

The SWOT analysis can be divided into the following steps:

Step 1: Determination of strengths and weaknesses as well as opportunities and threats of the enterprise analysed

One should select key areas of enterprise operation and determine whether they represent strengths or weaknesses of the organization and focus on the most substantial opportunities and threats. The SWOT method offers a method to identify strength, weaknesses, opportunities and threats in the enterprise (ROMANOWSKAM.2004). This analysis is based on the simple pattern of classification: all the factors that have an effect on current and future structures of the enterprise are divided into:

- external with respect to the organization and those having the character of internal determinants,
- the factors which have a negative effect on the organization and those having a positive effect.

Classification of the factors which affect the strategic position of the enterprise (Ingaldi and Jagusiak-Kocik 2013) in the SWOT analysis are presented in Fig. 1.

Step 2: All the characteristics should be described

A detailed description of the selected characteristics should be made.

Step 3: The strength of the relationship should be evaluated between strengths/weaknesses and opportunities/threats

The two analyses should be carried out:

- Analysis of the effect of strengths and weaknesses on opportunities and threats.
- Analysis of the effect of opportunities and threats on strengths and weaknesses in the enterprise.

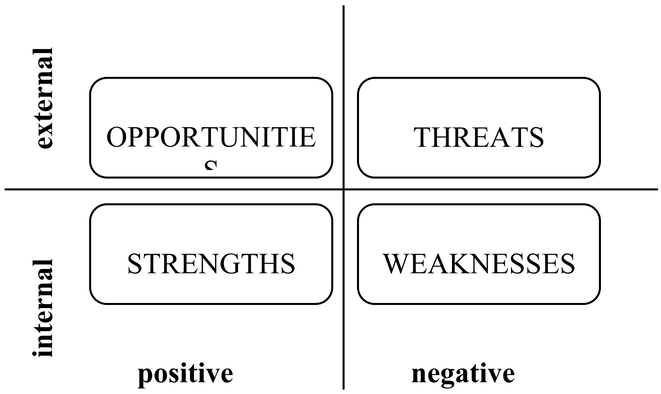


Fig. 1 Factors that affect the strategic position of the enterprise.

Source: OBŁÓJ K. 2001, CZAJKOWSKA A. 2014

Step 4: Based on the results obtained, the matrix of relationships should be prepared between individual factors.

Step 5: Proper strategy should be chosen

There are four strategies of operation discussed in the literature:

- Competitive strategy,
- Aggressive strategy,
- Defensive strategy,
- Conservative strategy.

The strategies of operation (OBŁÓJ K. 2001,CZAJKOWSKA A.2014) which can be used are presented in Fig. 2.

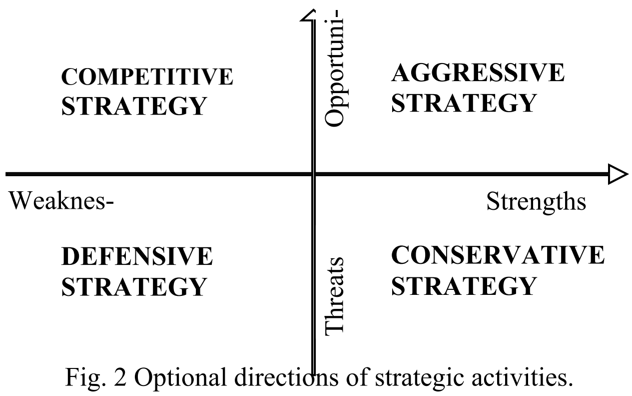


Fig. 2 Optional directions of strategic activities.

Source:Obłój K. 2001, Czajkowska A. 2014

3. Results and discussion

Potential strengths and weaknesses of the enterprise and opportunities and threats present in the environment are present in Table 1. Another step in the SWOT analysis is to investigate the relationships between weaknesses/strengths and opportunities/threats.
The two analyses should be carried out:

- The effect of opportunities and threats on strengths and weaknesses in the enterprise (Table 2).
- The effect of strengths and weaknesses on opportunities and threats, presented in Table 3.

The effect of strengths and weaknesses on opportunities and threats, presented in Table 2.

Table 1. Internal and external factors identified in the enterprise analysed in the study

Strengths	**Weaknesses**
Comprehensiveness of the services Organizational effectiveness Educated and experienced managers High quality of services Good reputation of the enterprise among customers Meeting deadlines Guarantees for the services performed Experience in the sector	No financial liquidity No competitive advantage Problems with new orders High prices compared to competitors
Opportunities	**Threats**
Favorable economic situation in the country Preferential loans for potential customers Increase in the demand for new flats Subsidies from EU funds Finding new markets Increasing number of investments	Increased competition in the local market High unemployment rate Decline in the incomes among the society Substantial limitation of construction tax deductions Freedom of entry of new competitors in the market Ageing society

Source: own study

Table 2. SWOT analysis for opportunities and threats / strengths and weaknesses

Strengths/ Weaknesses — Opportunities/ Threats	Comprehensiveness of the services	Organizational effectiveness	Educated and experienced managers	High quality of services	Good reputation of the enterprise among customers	Meeting deadlines	Guarantees for the services performed	Experience in the sector	No financial liquidity	No competitive advantage	Problems with new orders	High prices compared to competitors
Good economic situation in the country	0	0	1	1	0	0	0	0	0	0	1	0
Preferential loans for potential customers	0	1	0	0	0	0	0	0	1	0	2	0
Increase in the demand for new flats	1	0	0	1	0	1	1	0	1	0	1	0
Subsidies from EU funds	0	0	1	2	0	0	0	0	2	1	1	1
Finding new markets	0	0	0	0	0	0	0	0	1	1	2	1
Increasing number of investments	1	0	0	0	0	1	0	0	1	1	2	1
Increased competition in the local market	0	0	0	1	0	1	1	0	2	2	2	1
High unemployment rate	0	0	0	0	0	0	0	0	2	1	2	0
Decline in the incomes among the society	0	0	0	0	0	0	0	0	1	0	1	0
Substantial limitation of construction tax deductions	1	0	0	0	0	0	0	0	2	2	2	0
Freedom of entry of new competitors in the market	1	0	1	1	0	1	1	0	2	1	2	0
Ageing society	0	0	0	0	0	0	0	0	1	1	2	0

The effect of opportunities and threats on strengths and weaknesses in the enterprise , presented in Table 3.

Table 3. SWOT analysis for strengths and weaknesses/ opportunities and threats

Strengths/ Weaknesses \ Opportunities/ Threats	Good economic situation in the country	Preferential loans for potential customers	Increase in the demand for new flats	Subsidies from EU funds	Finding new markets	Increasing number of investments	Increased competition in the local market	High unemployment rate	Decline in the incomes among the society	Substantial limitation of construction tax deductions	Freedom of entry of new competitors in the market	Ageing society
Comprehensiveness of the services	1	1	2	1	1	1	1	0	1	0	1	0
Organizational effectiveness	0	1	0	1	1	1	1	0	0	0	1	0
Educated and experienced managers	1	0	1	2	2	1	1	0	0	0	1	0
High quality of services	1	1	1	1	1	1	2	0	1	0	0	0
Good reputation of the enterprise among customers	0	0	1	0	1	1	1	0	0	0	1	0
Meeting deadlines	0	0	1	0	1	1	1	0	0	0	1	0
Guarantees for the services performed	0	0	1	0	1	1	1	0	0	0	1	0
Experience in the sector	1	0	1	1	1	1	1	0	0	0	1	0
No financial liquidity	1	1	1	1	1	1	2	0	1	0	2	0
No competitive advantage	1	0	1	0	1	0	2	0	0	0	2	0
Problems with new orders	1	0	1	0	1	0	2	2	2	2	2	0
High prices compared to competitors	0	0	1	0	1	1	2	1	2	1	1	0

Source: own study

Based on the results obtained in the study, a matrix of relationships between individual factors was prepared. The following sums were input to the Table 4:

- strengths (S) and opportunities (O), sum: SO+OS
- strengths (S) and threats (T), sum: ST+TS,
- weaknesses (W) and opportunities (O), sum: WO+OW
- weaknesses (W) and threats (O), sum: WT+TW.

Table 4. Comparison of the sums of values

Factors	Sum
Strengths/Opportunities	50
Strengths/Threats	27
Weaknesses/Opportunities	36
Weaknesses/Threats	55

Source: own study

Results of the collective SWOT/TOWS analysis indicate that the enterprise studied should implement the mini-mini strategy, i.e. defensive strategy. Weaknesses of the enterprise are strongly connected with the threats. Therefore, the enterprise should focus on the activities aimed at survival in the unfavourable environment through minimization of the costs of operation or attempting to merge with the bigger enterprise. However, the assets of the enterprise are too poor to face the challenge of the threats.

4. Conclusion

Based on the analysis of the enterprise in the construction sector and the analysis of the environment the enterprise has to operate in, its prospective position was determined and, importantly, the strategy of operation was recommended. Unfortunately, the only strategy that can be recommended is the defensive (mini-mini) strategy. The analysis showed that the enterprise studied operates under little advantageous conditions and does not have strengths which could be used for improvement of its standing. The mini-mini strategy consists in reduction of the weaknesses, cost reduction and stopping investments. The enterprise might use the optimistic variant of the defensive strategy, take actions to ensure the survival of the enterprise and wait for new opportunities to emerge in the market.

Literature

1. CZAJKOWSKA A. 2014. Zastosowanie analizy SWOT do wskazania strategii działania wybranego przedsiębiorstwa produkcyjnego [in:] II. Techniki zarządzania przedsiębiorstwem. Wybrane zagadnienia produkcji i zarządzania w przemyśle, co-authored study edited by Anna Konstanciak Edyta Kardas, Wydawnictwo Wydziału Inżynierii Produkcji i Technologii Materiałów Politechniki Częstochowskiej.
2. CZUBAŁA A., JONAS A., SMOLEŃ T., WIKTOR J. 2004.Marketing usług. , Oficyna Ekonomiczna, Kraków.
3. INGALDI M., JAGUSIAK-KOCIK M. 2013.SWOT Analysis of the Process Improvement in the Company Producing Electric Sockets. [w:] Toyotarity. Evoluation and Processes'/Products' Improvement. Monograph. Ed. Borkowski S., Ingaldi M. Aeternitas Publishing House. Alba Iulia. Romania 2013. s.72-82.
4. INGALDI M., LESTYÁNSZKA ŠKŮRKOVÁ K. 2014. Company strategy determination in food company using SWOT method. Acta Technologica Agriculturae 3, Nitra, Slovaca Universitas Agriculturae Nitriae, 2014, Vol. 17. Iss. 3, pp. 66–69
5. KOSIŃSKA E.2008.Marketing międzynarodowy Zarys problematyki., Polskie Wydawnictwo Ekonomiczne, Warsaw 2008
6. LAKE N. 2005. Planowanie strategiczne w firmie. Gliwice: Wydawnictwo Helion.
7. OBŁÓJ K. 2010. Pasja i dyscyplina strategii. Jak z marzeń i decyzji zbudować sukces firmy. Warszawa : Wydawnictwo Poltext.
8. OBŁÓJ K. 2001. Strategia organizacji, PWE, Warszawa, p. 182.
9. ROMANOWSKA M. 2004. Planowanie strategiczne w przedsiębiorstwie, PWE, Warsaw, p. 79.
10. ŻABIŃSKI L. (red.) 2000. Analiza strategiczna przedsiębiorstwa na potrzeby wyboru strategii rozwoju (za pomocą metody SWOT). Katowice: Wydawnictwo Akademii Ekonomicznej w Katowicach.

ARCHIWUM INŻYNIERII PRODUKCJI
PRODUCTION ENGINEERING ARCHIVES

2016, Vol. 10, No 1, pp 38-41
ISSN 2353-5156 (print version)
ISSN 2353-7779 (online version)

Article history: Received: 07.02.2016 Accepted: 10.03.2016 Online: 31.03.2016

Available online on: http://www.qpij.pl **Exist since 1th quarter 2013**

Technical aspects of casting and their effect on the quality of Remanium CSe dental alloys

Dorota Klimecka-Tatar[1], Klaudia Radomska[2], Grażyna Pawłowska[2]

[1]Institute of Production Engineering, Faculty of Management, Czestochowa University of Technology, Armii Krajowej 19B, 42-201 Czestochowa, Poland, +48 34 3250 399, e-mail: klimt@wp.pcz.pl
[2]Faculty of Production Engineering and Materials Technology, Department of Chemistry, Czestochowa University of Technology, Armii Krajowej 19, 42-201 Czestochowa, Poland, +48 34 3250 604, e-mail: pawlow@wp.pcz.pl

Abstract: The study concerns on investigation of Remanium CSE alloy, one of the dental alloys used in metal-ceramic connection preparation. The alloys based on Ni-Cr-Mo are widely used in dental engineering because of their high mechanical, tribological properties as well as high corrosion resistance. The tested alloy has been processed in three ways – it has been remelted and then casted using three technologiescommonly used in dental laboratories, i.e. with: oxy-acetylene burner (1), induction furnace (2) and Volts arc (3). The aim of the study was to evaluate the effect of the melting and casting techniques on the mechanical strength and stereometric surface properties. The results revealed that the quality of Remanium CSe dental alloys significantly depend on the method of the material processing.

Key words: casting alloy, quality, surface roughness

1. Introduction

In prosthetic treatment, beneficial effects are achieved through proper selection of engineering materials with simultaneous control of technical procedures in prosthetic constructions preparation. For long-term use of dental restorations the materials should have satisfactory mechanical properties, strength and aesthetic (MAJEWSKI S., PRYLIŃSKI M. 2013; SCHMIDSEDER J. 2011; MARCINIAK J. 2003).

The formation of metallic prosthetic constructions are carried out by classical casting. The most popular methods include the use of oxygen-acetylene burner, and an induction furnace. Casting quality, especially when using oxygen-acetylene burner, depends on many external variable factors. Inter alia, on the quality of the material highly affect the use of non-protective atmosphere in the process - only in an induction furnace is it capable of being applied. The least frequently used technique is casting method Volta arc (KLIMECKA-TATAR D., RADOMSKA K., JAGIELSKA-WIADEREK K. 2014; RADOMSKA K., PAWŁOWSKA G., KLIMECKA-TATAR D. 2013). A number of research works (K. RADOMSKA, G. PAWŁOWSKA, D. KLIMECKA-TATAR 2015a,b,c,d) indicate the relationship between production methods, structural/chemical composition of based alloys and the quality of prosthetic constructions. Furthermore, the processing method affects the surface development and consequently on the contact area between the material and the wall of bacterial cells contained in body fluids in the patient's MOUTH (HILTBERT L.R., BAGGE−RAVN D., KOLD J., GRAM L 2013; TAYLOR R., MARYAN C.,

VERRRAN J. 1998; SZYMAŃSKI W. 2008; KAWAI K., URANO M., EBISU S. 2000; DELIGIANNI D., KATSALA N., LADAS S., SOTIROPOULOU D., AMEDEE J., MISSIRLIS Y.F. 2001). The surface roughness is a parameter that affects the wettability of the surface which, in turn, promotes the deposition of bacteria. Colonization of the material by bacteria can be a source of infection and constitute an obstacle to the proper functioning of prosthetic constructions. According to Bollena and Quiryena research (BOLLEN CM., LAMBRECHTS P., QUIRYNEN M., 1997) the arithmetic average of absolute values *Ra* = 200 nm is a threshold value and below it a significant reduction of bacteria number on the surface of the prosthesis is observed.

Previous studies of the team conducted on this group of dental alloys are related to their corrosion resistance. The aim of this study was to evaluate the effect of the melting/casting method on the mechanical strength of the dental alloy based on Ni-Cr-Mo and also the estimation of the quality surface based on the selected roughness parameters.

2. Experimental

2.1. Material

The material of investigation was Remanium CSe casting alloy with the chemical formula $Ni_{61}Cr_{26}Mo_{11}Si_{1,5}$ (the subscripts denote percentages by mass) with the residual content of: Fe, Co, Al and Ce. Metallic material were melt casted using: oxy-acetylene burner, induction furnace and Volta arc.

Table 1. Identification and characterization samples according to technologies of melting/casting

Sample symbol (Remanium CSe dental alloy)	The selected method of melting/casting
(1)	oxy - acetylene burner (ceramic crucible, air atmosphere)
(2)	induction furnace (ceramic crucible, air atmosphere)
(3)	Volta arc (ceramic crucible, air atmosphere, voltage 220V)

Source: own study

Melted dental alloy was introduced into the previously prepared molds, the shape of a disc with dimension $ø$ = 10 mm, *h* = 5 mm. The samples were made using three methods of melting/casting and determined as (1), (2) and (3) (Tab. 1). In order to standardize the surface of all the samples the surface was subjected to grinding aqueous paper ending gradation equal to 4000 to obtain the proper condition of their surface.

2.2. Methodology of research

Surface roughness is a characteristic of the solid surface and is recognizable optical or mechanical perceptible surface irregularities, not impacting on the shape. This parameter has a decisive influence on the functional properties of the final product.

The results of the surface roughness analysis of Remanium CSe casting alloy with the chemical formula $Ni_{61}Cr_{26}Mo_{11}Si_{1,5}$ are presented below. The roughness studies were conducted with contact profilometer (Taylor Hobson), section 4 mm for each sample. During the measurement the surface roughness profiles were recorded and outlined the Abbott curve, surface share of peaks and distribution of their size and the parameter values including stereometric parameter: *Ra, Rz* and *Rt* (RADOMSKA K., PAWŁOWSKA G., KLIMECKA-TATAR D. 2015b). To compare the quality of the casted material in terms of different melting/casting methods the mechanical properties were evaluated by Vickers hardness.

3. Results and discussion

In Table 2 and Fig. 1 the results of roughness measurements of $Ni_{61}Cr_{26}Mo_{11}Si_{1,5}$ alloy are presented – in this study numerical values of parameters: *Ra*, *Rz* and *Rt* were assigned.

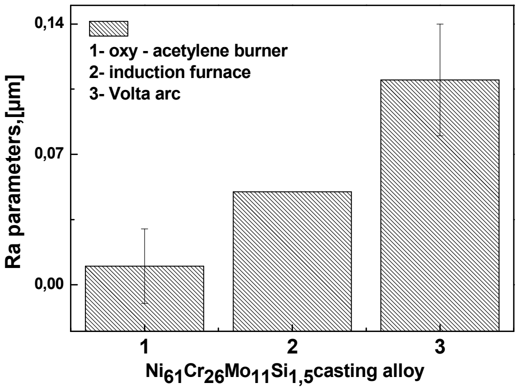
Table 2. The surface profiles' selected parameters of $Ni_{61}Cr_{26}Mo_{11}Si_{1,5}$ alloy

Parameters / Sample	Ra , µm	Rt, µm	Rz, µm
(1)	0,01±0,02	1,03±0,09	0,64±0,02
(2)	0,05±0,00	0,48±0,09	0,42±0,11
(3)	0,11±0,03	1,01±0,05	0,83±0,01

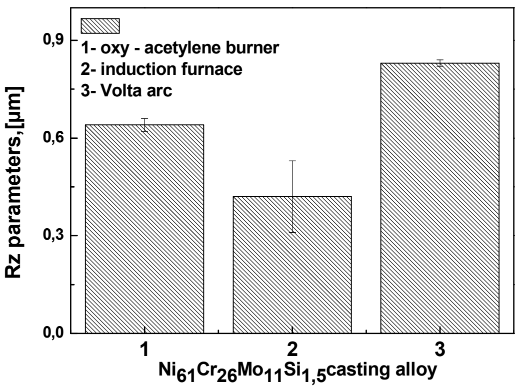
Source: own study

It was observed that all tested samples obtained using three methods of melting/casting are characterized by low surface roughness parameters *Ra* < 200 nm, which according to the Bollena et al. study (BOLLEN CM, LAMBRECHTS P, QUIRYNEN M. 1997) is a satisfactory value. However, the samples are recognized by different values of roughness parameters which is dependent on the processing technology (Fig. 1).

a)



b)



c)

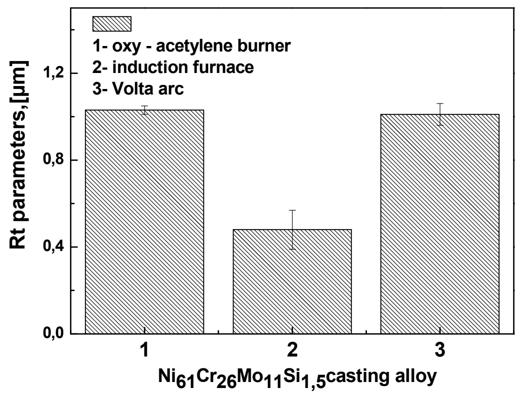


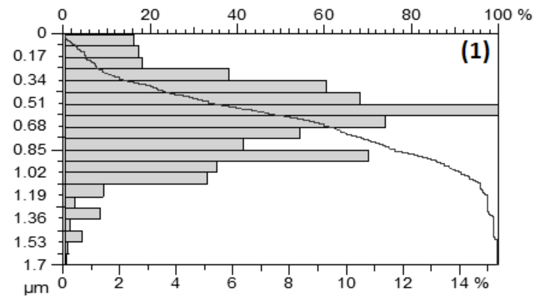
Fig.1. The comparison of the selected roughness parameters of $Ni_{61}Cr_{26}Mo_{11}Si_{1,5}$casting alloy with respect to different melting/casting methods: a) *Ra*, b) *Rz*, c) *Rt*

Source: own study

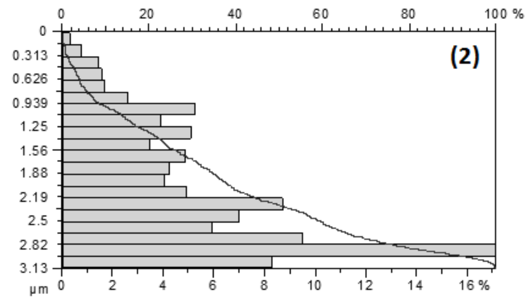
Although all samples had been subjected to the same final treatment (mechanical polishing) their surfaces are defected to varying degrees - taking into account all the roughness parameters, the smoothest surface obtained was done so by the materials made in an induction furnace (2) (Fig.1b). The method using Volta arch, as expected, had the most affects on the growth of roughness - in comparison to other samples (Fig.1c).

For registered profile the curve of vertices share and the verticle size distribution curve and The Abbott curve (bearing area curve) (Fig.2) has also been determined. Surface share of the vertices and their distribution indicates the smallest density of peaks for the sample (2) (Fig.2b).

a)



b)



c)

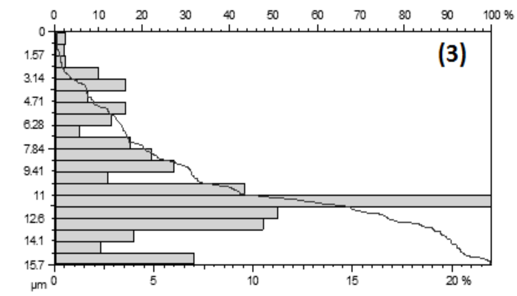


Fig.2. The Abbott curve (bearing area curve) of $Ni_{61}Cr_{26}Mo_{11}Si_{1,5}$casting alloy with respect to different melting/casting methods: a) oxy - acetylene burner; b) induction furnace; c) Volta arc

Source: own study

As follows from the Abbott curve the Remanium CSe alloy casted/melted in induction furnace should exhibit the highest wear resistance (Fig.2).

As one of the parameters testifying to the mechanical resistance of materials is hardness, it can be assumed that the use of an induction furnace provides the ability to obtain a product with the best mechanical properties. As follows from hardness measurements of the tested dental alloy, the HV is in the range 125 - 425. The highest HV value were obtained for Remanium CSe alloy casted/melted in induction furnace (2).

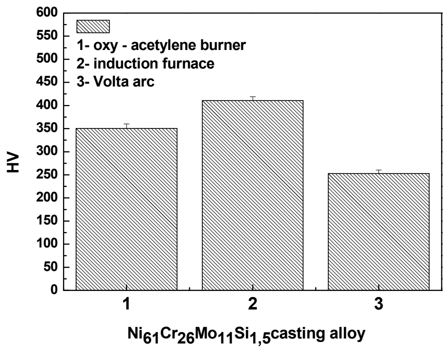


Fig.3. The hardness (HV) comparison of the $Ni_{61}Cr_{26}Mo_{11}Si_{1,5}$casting alloy with respect to different melting/casting methods

Source: own study

5. Summary and conclusions

Technology of metal melting/casting has a significant effect on the surface roughness which is closely associated with metals wettability and colonization of the material by bacteria. All tested samples exhibit a satisfactory surface roughness (Ra below 200 nm) with varying degrees of surface area which may determine the final machining. A suitable method allows for finishing the surface of a material with high quality parameters. Materials using arc Volts require chemical methods or electrochemical polishing and for the materials obtained in an induction furnace mechanical grinding may be sufficient.

Literature

1. BOLLEN CM., LAMBRECHTS P., QUIRYNEN M.1997. *Comparison of surface roughness of oral hard materials to the threshold surface roughness for bacterial plaque retention: a review of the literature.* Dent Mater 13 (4) 258-269.
2. DELIGIANNI D., KATSALA N., LADAS S., SOTIROPOULOU D., AMEDEE J., MISSIRLIS Y.F.2001. *Effect of surface rough− ness of the titanium alloy Ti−6Al−4V on human bone marrow cell response and on protein adsorption*. Biomaterials 22, 1241–1251.
3. HILTBERT L.R., BAGGE−RAVN D., KOLD J., GRAM L.2003. *Infuence of surface roughness of stainless steel on microbial adhesion and corrosion resistance*. Int. Biodeter. Biodegr. 52, 175–185.
4. KAWAI K., URANO M., EBISU S.2000. *Effect of surface roughness of porcelan on adhezion of bacteria and their synthe− sis glucans*. J. Prosthet. Dent. 83, 664–667.
5. KLIMECKA-TATAR D., RADOMSKA K., PAWŁOWSKA G.2015. *Corrosion resistance, roughness and structure of $Co_{64}Cr_{28}Mo_5(Fe,Si,Al,Be)_3$ and $Co_{63}Cr_{29}Mo_{6,5}(C,Si,Fe,Mn)_{1,5}$*. Jurnal of the Balkan Tribological Association, 1Vol.21, s.204-210.
6. KLIMECKA-TATAR D., RADOMSKA K., JAGIELSKA-WIADEREK K.2014. *Wpływ sposobu topienia/odlewania komercyjnego stopu Ni-Cr-Mo na jego odporność korozyjną w roztworze Ringera*, Ochrona przed Korozją, 7.
7. MAJEWSKI S., PRYLIŃSKI M.2013. *Materiały i technologie współczesnej protetyki stomatologicznej*, Lublin.
8. MARCINIAK J.2003. *Biocybernetyka i inżynieria biomedyczna 2000*, tom 4 Biomateriały, rozdział 2 Biomateriały metaliczne, PAN, Warszawa, 62-74.
9. RADOMSKA K.., PAWŁOWSKA G., KLIMECKA-TATAR D.2015. *The corrosion processes effect on surface roughness of bonded magnetic material based on Nd-(Fe.Co)-B powder type*. Solid State Phenomena. 1 Vol.227. s.39-42.
10. RADOMSKA K.., PAWŁOWSKA G., KLIMECKA-TATAR D.2013. *The effect of melting/casting method of Ni - Cr – Mo dental alloy on the corrosion resistance in Ringer solution*. Ochrona przed Korozją. 11.
11. RADOMSKA K., PAWŁOWSKA G., KLIMECKA-TATAR D.2015. *Wpływ parametrów technologicznych na właściwości materiałów inżynierskich stosowanych w medycynie odtwórczej*. Inżynieria Stomatologiczna-Biomateriały, 09/ 7.
12. RADOMSKA K., PAWŁOWSKA G., KLIMECKA-TATAR D.2015. *Struktura i właściwości tribologiczne biomedycznych stopów odlewniczych Co-Cr-Mo*. Inżynieria Stomatologiczna- Biomateriały, 09/13.
13. SCHMIDSEDER J. CZELEJ. 2011. *Stomatologia estetyczna*. Lublin.
14. SZYMAŃSKI W.2008. *Badanie biofilmu bakteryjnego na powierzchniach biomateriałów*. Praca doktorska, Politechnika Łódzka.
15. TAYLOR R., MARYAN C., VERRRAN J.1998. *Retention of oral microorganisms on kobalt−chromium alloy and dental acry− lic resin with different surface finishes.* J. Prosthet. Dent. 80, 592–597.

ARCHIWUM INŻYNIERII PRODUKCJI
PRODUCTION ENGINEERING ARCHIVES

2016, Vol. 10, No 1, pp 42-45
ISSN 2353-5156 (print version)
ISSN 2353-7779 (online version)

Article history: Received: 11.02.2016 Accepted: 13.03.2016 Online: 31.03.2016

Available online on: http://www.qpij.pl **Exist since 1th quarter 2013**

Determinants of the quality of sintered steel for the automotive industry

Barbara Lisiecka[1]

[1]Institute for Materials Engineering, Faculty of Processing Engineering and Materials Technology, Czestochowa University of Technology, Armii Krajowej 19, 42-200 Czestochowa, Poland, e-mail: lisiecka@wip.pcz.pl

Abstract The increasing demand on components obtained using powder metallurgy is driven by economic changes that have turned product quality into the most basic criterion which affects the interest in a component and its successful use. The improvement in quality should be expected in the beginning of the planning of the technological process and selection of adequate raw materials. High requirements concerning product quality management and production improvement stimulates the development of the current automotive industry where sintered steels represent the highest percentage of products. The multiphase sinters investigated in the study were prepared from two types of water–atomized steel powders: 316L and 409L. Optical microscopy, X–ray phase analysis and examinations of microhardness were performed in order to determine the microstructure and basic properties of sintered steels. The main assumption for this study was to analyse the microstructure and mechanical properties of sintered steels used for manufacturing of various car parts.

Key words – powder metallurgy, ISO/TS 16949, automotive industry

1. Introduction

Powder metallurgy (PM) is a technology used for manufacturing of structural materials from metallic powders with addition or without addition of non-metallic powders as a result of processes of forming and sintering. An interesting aspect of using the PM technology is a small number of process steps, which offer opportunities for bulk production of components with complex shapes while maintaining the dimensional precision and surface quality. Furthermore, a significant factor that makes the PM technology unrivalled is the degree of the consumption of raw materials of around 97%, which is considered as a chipless manufacturing of sinters (SHEPPARD L. 2007, WROŃSKA A., DUDEK A. 2014, LIPIŃSKI T. 2015).

Powder metallurgy of stainless steel components represents an important and dynamically growing sector of the PM industry. At present, the biggest consumer of sintered products is the automotive industry (ca. 73% of all sinters – see Figure 1). These products are mainly used for replacement of the components obtained using standard casting or forging methodologies. The most characteristic products of powder metallurgy for the automotive sector are parts of engines, bearings, gears, filters, pumps, rings in anti–lock ABS systems or flanges for exhaust systems (CIAŚ A., FRYDRYCH H., PIECZONKA T. 1992, ULEWICZ R., NOVY F., MAZUR M., SZATANIAK P. 2014, DUDEK A., WROŃSKA A., ADAMCZYK L. 2014).

The concept of quality has a long history and numerous definitions. One of them was created by Deming, who argued that quality is a *predictable degree of product homogeneity and reliability while keeping* *costs as low as possible and meeting market expectations* (PUENTE J., PINO R., PRIORE P., FUENTE D. 2002).

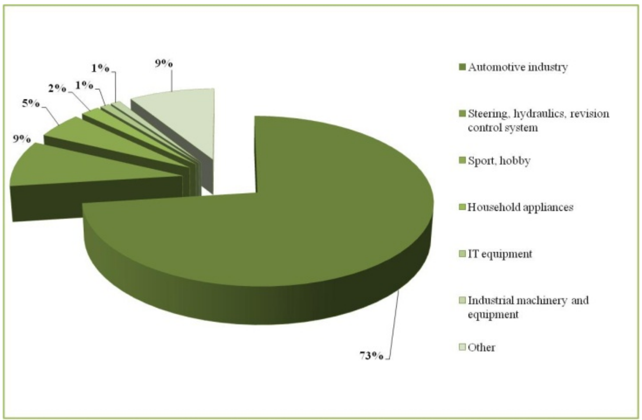


Fig. 1. Main customers for sintered products

Source: Author's own elaboration based on (CIAŚ A., FRYDRYCH H., PIECZONKA T., 1992)

The highest quality of products is expected in the automotive industry, leading to the necessity of certification for quality management standards (ISO/TS 16949) by suppliers of all components. ISO/TS 16949 defines the basic requirements concerning the quality at the initial stages of the research and development, material production, installation and service in the automotive sectors. The use of this specification is required over the whole supply chain, from producers of raw materials (steel, paint, polymers, composites) to companies that assemble bigger products (cockpit, gearbox etc.) (TORUŃSKI J. 2012, SPECYFIKACJA TECHNICZNA ISO/TS 16969:2002, SELEJDAK J. 2013, ULEWICZ R., MAZUR M. 2013).

2. Material and Methods

Sintered steels were made of water-atomized commercial powders 316L and 409L manufactured by Höganäs (Sweden). Table 1. presents chemical composition of the powders. The three different mixtures of ferritic and austenitic steel powders were prepared with the following composition: 80% 316L+20% 409L, 50% 316L+50% 409L, 20% 316L+80% 409L, which was subjected to uniaxial compaction at 720 MPa. The molded pieces were heated at the temperature of 1250°C for 30 minutes and then cooled at the rate of 0.5°C/s. The whole process was carried out in the reducing atmosphere using hydrogen which helps significantly limit oxidation of the batch and protects from reduction of the chromium content.

Table 1. Chemical composition of steel powders (%wt.)

Element	Powder grade	
	316L	409L
Cr	16.8	11.86
Ni	12.0	0.14
Mo	2.0	0.02
Si	0.9	0.82
Mn	0.1	0.14
C	0.022	0.02
S	0.005	0.01
Fe	Balance	Balance

Source: Author's own elaboration

The analysis of the microstructure was carried out using Axiovert 25 optical microscope. Vickers methodology (with load of 980.7 mN) was used to measure microhardness of the sintered stainless steel.

Identification of phase composition was carried out using the X–ray diffractometer (Seifert 3003 T–T) with a cobalt lamp with characteristic radiation wavelength of $\lambda_{\mathrm{cok}\alpha}$ = 0.17902 nm (Table 2. presents others parameters).

Table 2. X–ray diffractometer parameters

Parameters	Ranges
Supply voltage (U_r)	30÷40 [kV]
Current intensity (I_r)	30÷40 [mA]
Angle range (2θ)	10÷120°
Measurement step	0.1°
Pulse integration time (t_r)	10 [s]

Source: Author's own elaboration

3. Results and Discussion

The microstructures were observed using the metallographical sections etched with Nital. Figure 2 presents the microstructures obtained for sintered stainless steels by the optical microscope Axiovert 25.

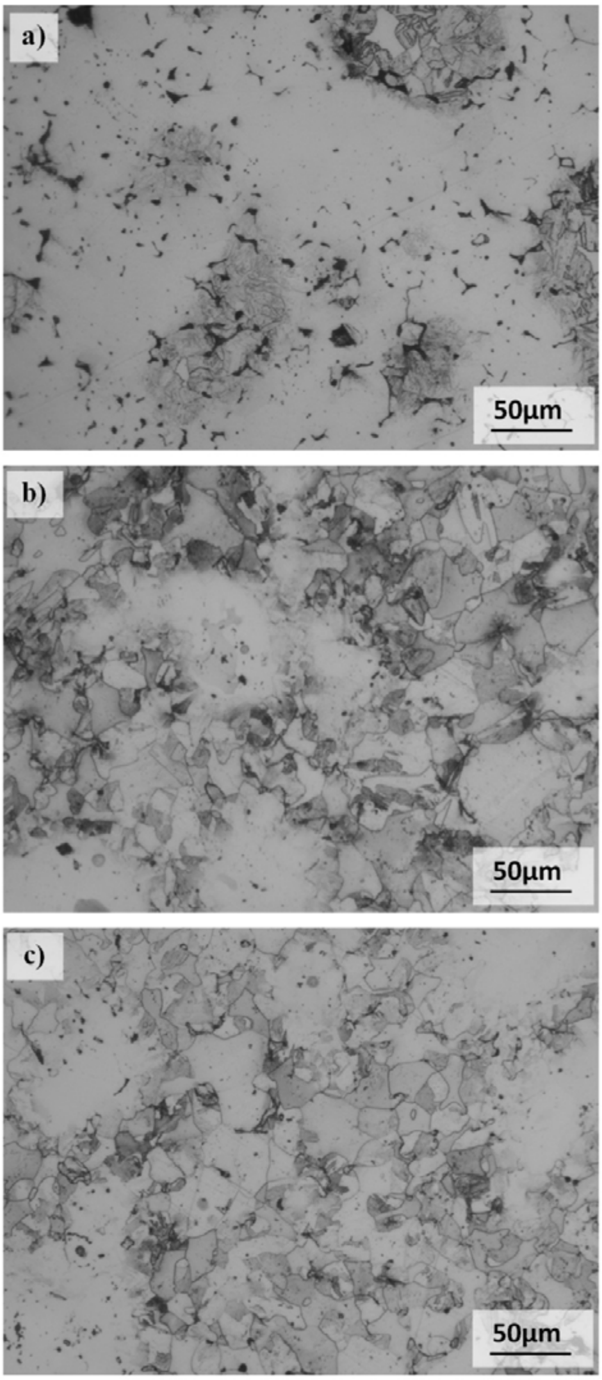


Fig. 2. Microstructure of sintered steels:
a) 80%316L+20%409L, b) 50%316L+50%409L,
c) 20%316L+80%409L

Source: Author's own elaboration

Hardness measurements were used to evaluate mechanical properties. The results represent the mean from four measurements (Figure 3).

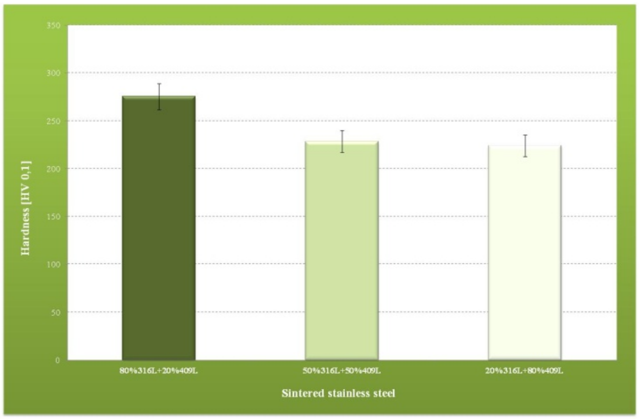
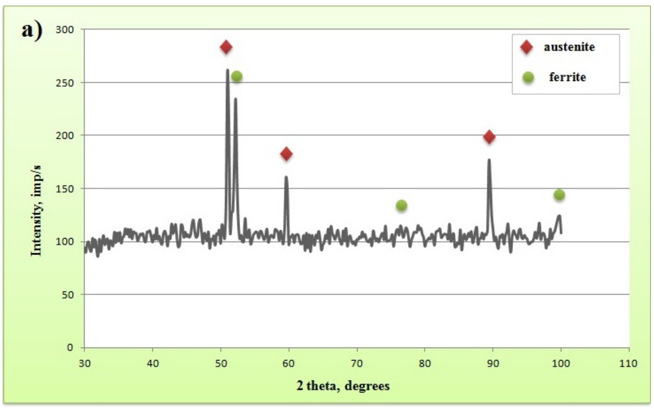
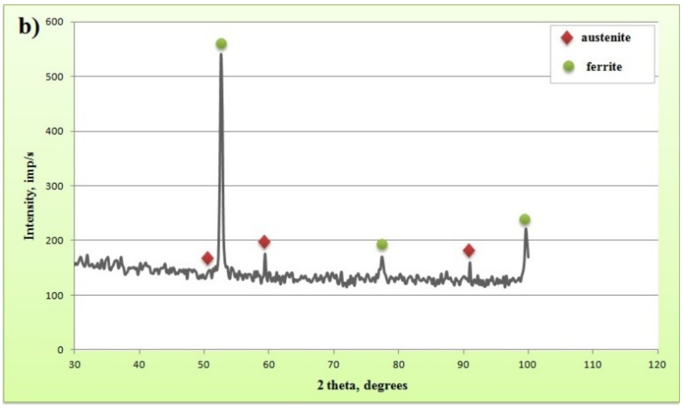


Fig. 3. Microhardness of sintered steel

Source: Author's own elaboration

Identification of the phase composition of the surface layers in sintered steels was carried out based on X–ray phase analysis. The results are presented in Figure 4. The phase analysis for individual specimens revealed presence of the austenitic and ferritic phases with the content proportional to the powders used, which was confirmed by microscopic observations.





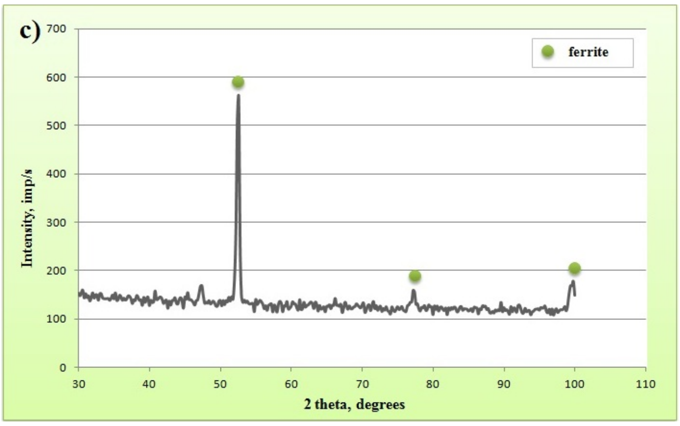


Fig. 4. Sinter diffractograms: a) 80%316L+20%409L, b) 50%316L+50%409L, c) 20%316L+80%409L

Source: Author's own elaboration

4. Conclusions

In an ever increasing climate of business competition, quality is expected in all types of services and commerce. It has a substantial effect on manufacturers, for whom quality should become a priority and on consumers, who have opportunities for finding the sources of supply they appreciate. A key decision is to properly choose materials for the components used in the automotive industry since this translates into the quality of the final product. Strength properties of the finished product depend directly on e.g. the structure, chemical composition and phase composition of the material. The sinters are selected depending on the expected application of the structural components of car parts.

Literature

1. CIAŚ A., FRYDRYCH H., PIECZONKA T. 1992. *Zarys metalurgii proszków.* Wydawnictwo Szkolne i Pedagogiczne WSiP. Warszawa.
2. SHEPPARD L. 2007. *The Powder Metallurgy Industry Worldwide 2007–2012.* Materials technology Publications. UK.
3. DUDEK A., WROŃSKA A., ADAMCZYK L. 2014. *Surface remelting of 316L + 434L sintered steel: microstructure and corrosion resistance*. “Journal of Solid State Electrochemistry” vol. 18, 11, pp. 2973–2981.
4. LIPIŃSKI T. 2015. *Analysis of impurity spaces as a percentage volume of non-metallic inculsions*. “Production Engineering Archives” vol. 4, 3, pp. 18–21.
5. PUENTE J., PINO R., PRIORE P., FUENTE D. 2002. *A decision support system for applying failure mode and effects analysis*. “The International Journal of Quality & Reliability Management” vol. 19, 1, pp. 137–150.
6. SELEJDAK J. 2013. *Use of the Toyota management principles for evaluation of the company’s mission*. “Production Engineering Archives” vol. 1, 1, pp. 13–15.
7. TORUŃSKI J. 2012. *Zarządzanie jakością w przemyśle motoryzacyjnym.* „Zeszyty Naukowe Uniwersytetu Przyrodniczo–Humanistycznego w Siedlcach Seria: Administracja i Zarządzanie” Issue: 92, pp. 23–32.
8. ULEWICZ R., NOVY F., MAZUR M., SZATANIAK P. 2014. *Fatigue properties of the HSLA steel in high and ultra-high cycle region*. “Production Engineering Archives” vol. 4, 3, pp. 18–21.
9. Ulewicz R., Mazur M. 2013. *Fatigue testing structural steel as a factor of safety of technical facilities maintenance*. “Production Engineering Archives” vol. 1, 1, pp. 32–34.
10. WROŃSKA A., DUDEK A. 2014. *Characteristics of surface layer of sintered stainless steels after remelting using GTAW method.* “Archives of Civil and Mechanical Engineering” vol. 14, pp. 425–432.
11. Technical Specification ISTO/TS 16969, Second edition 2002.

ABSTRACTS:

Agata Dudek

The article presents the results of studies on the implementation of statistical acceptance of products with the example of a styrene-rubber plastic connector, while considering particular stages of production. The characterization of factors determining the transition from normal inspection to relaxed or tightened inspection for products made of styrene-rubber plastic materials has been made. The effect of the type of inspection on the level of non-conformance of products has been determined.

Edyta Kardas

The quality parameters of products should be controlled at every stage of the production process, since it allows detection of any problems even in the initial stages of production processes and removes their causes during manufacturing. Final control of products is intended to capture non-conforming products that did not go to the customers. The results of such controls should constantly be analysed. Such analysis can help to detect the most common problems, determine some dependences or identify the causes of such situations. A lot of different instruments that can support improvement of processes can be used for this kind of analysis. The paper presents the possibility of using some tools which can be utilized to support the analysis and assessment of quality of products at different stages of the production process. The quality analysis of exem-plary products using selected quality methods and tolls is carried out. Metal sleeve, that is part of electronic control subassembly of anti-blocking system of ABS, which was the research component being studied.

Libor Trško, Otakar Bokůvka, František Nový, Ján Lago

This paper will explore the mutual correlation of fatigue characteristics ((Kath, σc, ac = f (Rm)) of five structural steels tested at high-frequency loading based on tests ($f \approx 20$ kHz, $T = 20 \pm 10$ °C, $R = -1$). Different fatigue resistance parameters have different meanings and misunder-standing can lead to significant quality problems in component operation. Consequently, it is necessary to completely understand the relation between the two most important fatigue characteristics which are fatigue limit σc and the threshold value of the stress intensity factor amplitude Kath and how they act with changing of steel ultimate tensile strength.

Alena Pauliková,Katarína Čekanová, Renata Nováková

The analysed theme of this article is based on the training of environmental measurements for workplaces. This is very important for sustainable quality in technical educational institutions. Applied kinds of software, which are taught at technical educational institutions, have to offer the professional and methodical knowledge concerning conditions of working ambient for students of selected technical specialisations. This skill is performed in such a way that the graduates, after entering the practical professional life, will be able to participate in solutions for actual prob-lems that are related to environmental protection by means of software support. Nowadays, during the training process it is also obligatory to introduce technical science. Taking into consideration the above-mentioned facts it is possible to say that information technology support for environmental study subjects is a relevant aspect, which should be integrated into the university educational process. There is an effective pro-gress that further highlights the focus on the quality of university education not only for environmental engineers. Actual trends require an increasing number of software/hardware educated engineers who can participate in qualitative university preparation, i.e.IT environmentalists. The Department of Environmental Engineering at the Faculty of Mechanical Engineering, Technical University in Košice, Slovakia is an institu-tion specified and intended for quality objectivisation. This institution introduced into the study programmes ("Environmental Management" and "Technology of Environmental Protection") study subjects with the software support, which are oriented towards outdoor and indoor ambient and in this way the Department of Process and Environmental Engineering is integrated effectively and intensively into the area of measurement training with regard to the requirement of quality educational processes.

Marek Krynke1, Krzysztof Mielczarek

In the article analysis of the discrepancies in the production process for selected products in a company producing candles was carried out. Using the Pareto-Lorenzdiagram and the FMEA method the most essential areas having influence on the production of candles were shown. Apart from factors connected with the manufacturing side of the process, factors of the labour organization and requirements concerning the quality of material were also noted. An appropriate quality of equipment constitutes one of the essential conditions of production process func-tioning and this directly influences manufacturing possibilities of the enterprise. A synthesis of immaterial factors that influence the production of the enterprise, taking into consideration conditions of functioning the production system, was also carried out. The set of factors selected for description was the fourteenth Toyota management principle. Respondents were asked to provide answers which could bring the best improve-ments.

Alena Pauliková, Katarína Čekanová, Melichar Kopas

This paper deals with transformation of the customer's requirements into the specified technical parameters by means of the QFD (Quality Func-tion Deployment) method on condition that the customer disposes of basic technical knowledge. The relevant technical parameters are describing an engineering product, which is chosen from the automotive industry area. The QFD method enables elaboration of the individual functions of quality using a multi-phased mapping process in order to transform efficiently the customer's requirements into the real technical parameters of the given product. The chosen technical product is the petrol engine 1.2 Ecotec® installed in the passenger car and it is working in the functional connection with 5 stage manual gearbox. This article analyses in detail only the first phase of the petrol engine production, taking into considera-tion the given technical requirements. The following step of this process is the next phase, which is focused on the engine aggregates, further it is the phase of the engine aggregate production and the final phase is the global production.

Joanna Rosak-Szyrocka

The main aim of this paper is to present the standard ISO/TS 16949. In the modern world of competition, quality is one of the most important factors. Modern organizations should gamble on quality, regardless of the type of business, because it is the basic form of running a business effectively. It is not only a factor of market success, but also an indication of organizational culture.

Darja Topolšek, Borut Jereb, Tina Cvahte

Researchers of different scientific disciplines, such as management strategies, organizational theories and marketing, have in the past explored relations of mutual influences and the importance of cooperation between different functions in a company. The increased focus on the logistics function has potential to increase competitiveness. This is especially true for globally aimed production companies. In any company, logistics functions cooperate with various related functions such as production, marketing, procurement, engineering or developing new products as well as with financial functions. Each of the aforementioned connections or cooperation among logistics and its complementary functions can have a decisive effect on the company's competitiveness. Using a survey, we determined which activities in the surveyed companies are performed by the logistical function together with the marketing function and which activities they suggest should be performed together but are currently not, meaning they are co-dependent. Since interfunctional integration between logistics and marketing increases the success of a company, we also examined the connection between the current joint performance of activities and the suggested joint performance of activities among the before mentioned sectors, connected to the effectiveness of the company. To examine the mentioned connections among the logistical and marketing functions, Explanatory Factor Analysis (EFA), Confirmatory Factor Analysis (CFA) and Structural Equation Modelling (SEM) were performed.

Agnieszka Czajkowska

Only ambitious and success-driven enterprises are able to adapt to continuous changes in closer and further business surroundings. Modern enterprises strive for meeting the customers' expectations and needs. Even the most successful enterprises cannot cease to be competitive and survive only with what they have already achieved. Enterprises have to adopt strategies to ensure continuous development. The aim of the SWOT method, on the one hand, is to indicate the direction the enterprise should take in order to utilize their potential as much as possible and, on the other hand, to realize the shortcomings that should be improved. SWOT analysis helps determine the strategic factors to be used during planning further development of the enterprise. The analysis carried out in the study provided a transparent insight into the factors which depend on the enterprise and those that cannot be affected directly. The recommended mini-mini strategy means that the enterprise is in a good market situation whereas external threats are deepened with internal weaknesses of the enterprise.

Dorota Klimecka-Tatar, Klaudia Radomska, Grażyna Pawłowska

The study concerns on investigation of Remanium CSE alloy, one of the dental alloys used in metal-ceramic connection preparation. The alloys based on Ni-Cr-Mo are widely used in dental engineering because of their high mechanical, tribological properties as well as high corrosion resistance. The tested alloy has been processed in three ways – it has been remelted and then casted using three technologiescommonly used in dental laboratories, i.e. with: oxy-acetylene burner (1), induction furnace (2) and Volts arc (3). The aim of the study was to evaluate the effect of the melting and casting techniques on the mechanical strength and stereometric surface properties. The results revealed that the quality of Re-manium CSe dental alloys significantly depend on the method of the material processing.

Barbara Lisiecka

The increasing demand on components obtained using powder metallurgy is driven by economic changes that have turned product quality into the most basic criterion which affects the interest in a component and its successful use. The improvement in quality should be expected in the beginning of the planning of the technological process and selection of adequate raw materials. High requirements concerning product quality management and production improvement stimulates the development of the current automotive industry where sintered steels represent the highest percentage of products. The multiphase sinters investigated in the study were prepared from two types of water–atomized steel powders: 316L and 409L. Optical microscopy, X–ray phase analysis and examinations of microhardness were performed in order to determine the micro-structure and basic properties of sintered steels. The main assumption for this study was to analyse the microstructure and mechanical properties of sintered steels used for manufacturing of various car parts.

ARCHIWUM INŻYNIERII PRODUKCJI
PRODUCTION ENGINEERING ARCHIVES

2016, Vol. 10, No 1, 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 4rd quarter 2013**

Instructions for the preparation of the paper for publication in journal PEA

first Name last Name[1], first Name last Name [2]

[1]Place of work, full address, country, phone, fax, e-mail address
[2]Place of work, full address, country, phone, fax, e-mail address

Abstract (1000 – 2000 characters). The purpose, methodology, main findings, the originality of the subject area (research), way of using. The word Abstract – bold, 9 font, text - 9 font.

Key words – maximally 6 terms (10 font)

1. General requirements

General requirements. Only papers presented in a standardized format, 210-297 mm **will be accepted – page volume 3 or 4.** Margins: top and bottom 3 cm, right 1 cm, left 2 cm, two columns with a width of 8.6 cm, accessed through between the columns of 0.8 cm. The text is justified, indenting of the paragraph 0.63 cm. Among the titles of each part of the paper intervals: two rows up and down one row. Main text 11 font Times New Roman, accessed through exactly 14 font, section titles 14 font bold Times New Roman. In section titles can be subsections. In other parts of the article the characteristics of letters and spacing requirements, see Specific requirements. Black colour of the all elements of the article. On the first page, please leave the space 8,2 cm for the Editorial Board. Then, after 1.5 cm put the title.

Specific requirements. Title should be in two lines, centred. Title 26 font, bold font Times New Roman. Below the title within 1 cm, the surname of the author(s). Surnames 11 font bold, Times New Roman. Select 1, 2 etc… close to the surname. Below surname(s) at a distance of 1 cm indicate the place of work, full address, country, phone, fax, e-mail address. Use 9 font Times New Roman. Then (within 1.5 cm) put abstract and key words.

2. Introduction

The presentation of the current knowledge in the subjected area. The justification of undertaken research necessity.

3. Methodology of research

The way of achieved results – experiment, the case study. This information should to be understandable for Reader (after completion the knowledge) that he could repeat research on his own.

4. Tables

Table names are above the Table. The word Table must be in the same line what name. Space between the name of the Table and its upper line is 6 pt. Under the Table obligatorily should be Source – 9 font.

5. Figures

All graphical forms: graphs, schemes, pictures, photographs, microstructure are treated as Figures. Description of the Figure: below, Fig. (next number). Name of the Figure, below Source – font 9.

The figures in electronic form should be delivered in form which is imported to the MS Word programme, i.e. tif, eps, jpg, bmp, pcx, wmf. We also ask to enclose files in the source version (in case of the need to insert correction e.g. into the description).

Figures and graphs must be made clearly, considering the fact that the column is 8.6 cm wide and page is 18 cm wide.

6. Formulas, equations

Formulas and equations should be placed in the separate line, before and after should be left one space. Every equation must be numbered. Put the numbers in round parentheses flush with the right-hand margin level with the last line of the equation. Obligatorily under the equation explanation of designations.

7. Citation

In the basic text scientific literature source should be marked applying the Harvard system – surname, the first letter of the name, the year of the edition, e.g. (NOWAK A. 2012). In the case of several repeated appearing of the same surname/surnames in the same year, the small letter of the alphabet (a,b,c,…) is being written, e.g. (NOWAK A., KOWALSKI Z. 2012a), (NOWAK A., KOWALSKI Z. 2012b). Letter of the alphabet is not written as small capitals.

8. Results and discussions

It is necessary to present achieved results of own research illustrating them by Tables, pictures, diagrams and giving in details relations between stated facts. That section should have a character of a scientific discussion that confirm or excluding data known from the literature.

9. Summary and conclusions

Please, provide what was done during the study and what research results have been obtained. Respond to the results of other researchers. Show the possibility of practical application, determine the future research direction.

10. Additional information

Please, provide the research funding source, thank the research inspirer and study participants.

Literature

Literature should be compiled in the alphabetical and chronological order. Using citations in the base body, then give the title, publisher, place of publication. In the case of journal, please provide the article's title, journal title and the number. The list of references should include a minimum of 15 items and all in English. The titles of references items written in another language must be translated into English by placing at the end of the original in parentheses, e.g. (in Polish). It is required that a minimum of four references were derived from published previous numbers of Production Engineering Archives. There are cannot post more than three own references position.

Formated articles should be sent to Joanna Rosak-Szyrocka, PhD, e-mail: asros@op.pl