THE ANALYSIS OF NON-CONFORMANCES OF METAL IMPELLER USING SELECTED QUALITY INSTRUMENTS

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Abstract

The analysis of non-conformances of metal impeller, which is a part of in-line fan, is presented in this paper. This fan is used as downcast and exhaust system, which can be relevant in industrial areas with small cubic capacity. Pareto-Lorenz's analysis, FMEA method and elements of Ishikawa's analysis were used in this paper. Major non-conformances occurring in product were identified, quantitative analysis of non – conformances was made, reasons of occurrence were determined and ways of prevent were presented.

Keywords: quality analysis, quality instruments, metal impeller, non-conformances

1. INTRODUCTION

The quality of products is one of the key factors that guarantee the success of the company on the market. Only products with high quality causes that the customer will return, and thus company will achieve the optimum profit [1, 2]. Quality, comfort and safety of finished products depend on the quality of manufactured components. Thus manufacturing products with the best quality parameters that are in accordance with specifications, standards and requirements is crucial for producers [2]. Continuous analysis of the quality at various stages of production process, from assessing the quality of using materials, through the various stages of manufacture (control components) up to the control of the finished product is one of the important factors for the quality of the finished products [1].

Many various factors: raw materials used in the process, machinery and devices, process parameters and people affect the quality of products [3, 4]. Optimal utilization of this factors ensures that products meet the quality requirements. Saving on one of the factors of production may involve high costs associated with other factors, as well as a significant reduction in quality.

The analysis of non-conformances of metal impeller, which is a part of in-line fan, is presented in this paper. Quality of the impeller is crucial for fan operation. Pareto-Lorenz's analysis, FMEA method and elements of Ishikawa's analysis were used in this paper. Major non-conformances occurring in product were identified, quantitative analysis of non – conformances was made, reasons of occurrence were determined and ways of prevent were presented.

2. CHARAKTERISTICS OF THE PRODUCT

Metal impeller, which is a part of in-line fan, is the element which is investigated in this paper (Fig. 1). This fan is used as downcast and exhaust system. Efficient removal of air and moisture, odors and mites is the purpose of this type of fan. It can be relevant in industrial areas with small cubic capacity [5].

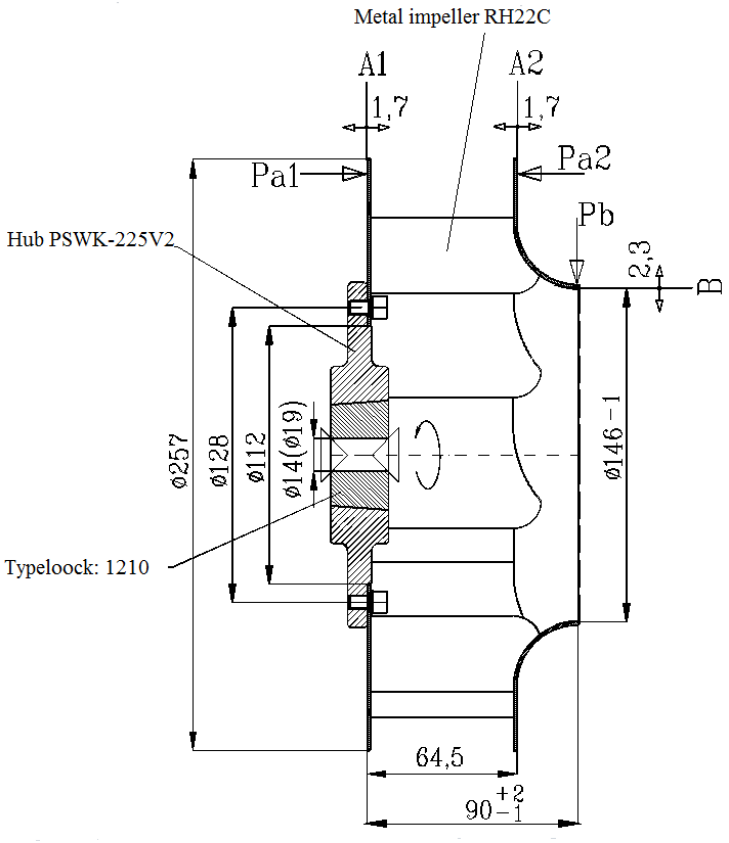

Fig. 1 Metal impeller. Side view [5]

The most important specifications of in-line fan [5]:

- Static pressure - 675 Pa,
- Acoustic pressure - 73 dB,
- Power supply voltage - 230/50 V/Hz,
- Engine speed - 2660 RPM,
- Power - 250 W,
- Current consumption - 1,11 A,
- Maximum operating temperature - 40 ˚C,
- Weight - 8 kg.

3. QUALITY EVALUATION OF METAL IMPELLER

Investigated product must have very high precision. Even small deviation causes that product must be classified as incompatible what means it must be either repaired or passed to the scrapping. In the study period, the percentage of non-conforming products in the total production volume was approx. 14-15%.

The quality evaluation of metal impeller was made. The following quality instruments were used to assess the quality of product: Pareto-Lorenz's diagram, FMEA method and elements of Ishikawa's diagram (due to the problem of presenting the whole analysis).

3.1. Pareto-Lorenz's analysis of non-conformances occurring in production of the impeller

The quantitative analysis of various types of non-conformances occurring in products was made. In the study period, seven main types of non-conformances which are caused by various reasons were recorded. Non-conformances may be caused by, among others, inadequate qualifications of workers, inadequate quality of materials used in production process, improper state of equipment, the use of inadequate technology as well as mistakes due to the fault of employees. These non-conformances were as follows [6]:

N1 – chips and erosion of the lacquered surface,

N2 - improper balance of the impeller,

N3 - dent on the metal surface of the impeller,

N4 – imprecise blanking of elements of the impeller,

N5 - inappropriate calibration of the impeller,

N6 – imprecise welding of elements of the impeller,

N7 – mechanical damages of the impeller.

Results concerning the quantities of particular types of non-conformances in the study period were collected. Based on these results the Pareto-Lorenz's analysis was made. The results of this analysis is presented in Fig. 2.

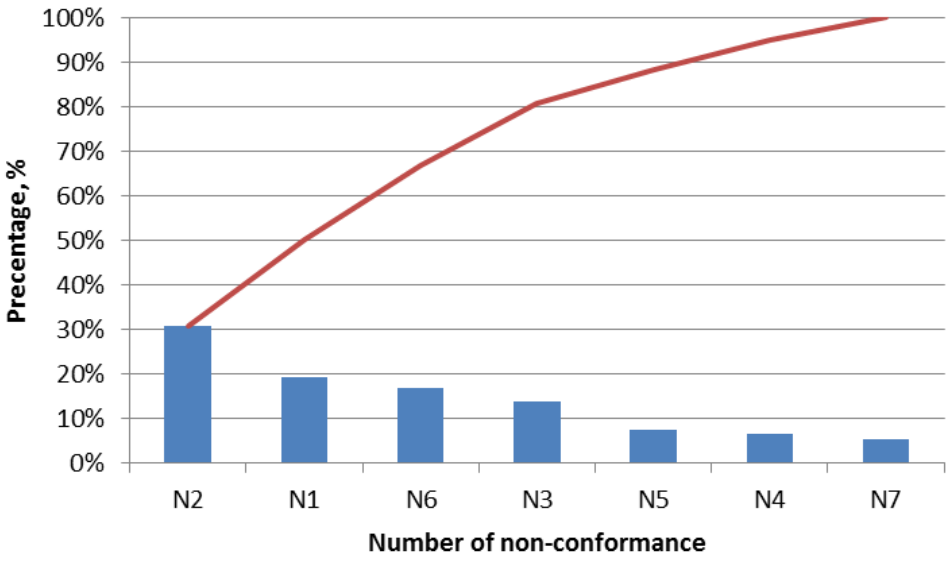

Fig. 2 Pareto-Lorenz's diagram of non-conformances occurring in production process of the impeller [Own study based on 5, 6]

Based on the results of Pareto-Lorenz's analysis (Fig. 2) it can be said that the largest number of non-conforming products (30.7%) are related to improper balance of the impeller (N1). Three non-conformances which occurring the least frequently: inappropriate calibration of the impeller (N5), imprecise blanking of elements of the impeller (N4) and mechanical damages of the impeller (N7) occur in approx. 19.3% of all non-conforming products.

3.2. FMEA analysis of non-conformances occurring during production process of metal impeller

The FMEA analysis of non - conformances occurring during the production process of metal impeller was made. During the analysis the following elements were identified: the effects of non-conformances, reasons of their occurrence and preventives. The results of the analysis are presented in Table 1.

Table 1 Results of FMEA analysis of non-conformances occurring during the production process of metal impeller [Own study based on 5, 6]

No.	The effects of non-conformances /functional limitations	Non-conformances	Reasons of occurrences of non - conformances	Evaluation			P	Preventives
				R	W	Z		
N1	Elements of the device housing	Chips and erosion of the lacquered surface	Poor quality of lacquer, poor technical conditions of equipment for painting	5	4	1	20	More accurate control of purchased lacquer, control of equipment of painting
N2	The impeller does not reach the proper number of revolutions per minute at work	Improper balance of the impeller	Uneven thickness of the sheet from which elements of the impeller were made	6	2	8	96	More accurate control of metal sheets delivered to the company
N3	The product does not fulfill its function, the impeller, the possibility of rubbing the impeller against elements of the device housing	Dent on the metal surface of the impeller	Employee error, inadequate transport of products among work stations	4	3	4	48	More accurate control of the product at each stage of production process
N4	Elements of the device housing, the possibility of rubbing the impeller against elements of the device housing	Imprecise blanking of elements of the impeller	Improper sizing of the elements by the worker, too large sheets of material to be cut	2	2	7	28	Control of materials delivered to the production devices
N5	Uneven operation of the device	Inappropriate calibration of the impeller	Inappropriate placement of central holes in the impeller disk	1	1	8	8	Instruct the employees about their quality of produced units
N6	The possibility of permanent damage to the impeller by detaching during operation of individual elements	Imprecise welding of elements of the impeller	Human error, lack of proper accuracy	9	5	10	450	More accurate random control
N7	The product does not fulfill its function, the impeller, the possibility of rubbing the impeller against elements of the device housing	Mechanical damages of the impeller	Incorrect settings of machines carrying out treatment process of individual elements the impeller	4	2	9	72	Checking and possible repairing machine tools

Based on the FMEA analysis presented in Table 1, it can be said that imprecise welding of elements of the impeller (N6) is the most critical non-conformance in the product. The number of priority for this non-conformance is 450. Making more accurate random control is the method of reducing the frequency of this non-conformance.

Next two non-conformances: improper balance of the impeller (N2) and mechanical damages of the impeller (N7) are also crucial from the viewpoint of FMEA analysis. More accurate control of metal sheets delivered to

the company and checking and possible repairing machine tools are proposed preventive actions for these two non-conformances.

3.3. The analysis of reasons of occurrence of most crucial non-conformances – elements of the Ishikawa's analysis

The analysis of reasons of most crucial non-conformances, which were identified in the FMEA analysis, was made. Elements of Ishikawa's analysis were used. Reasons of these non- conformances are presented in Fig. 3 – 5.

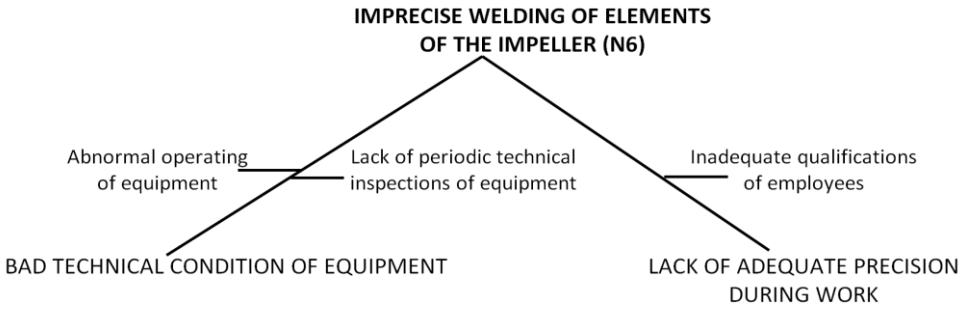

Fig. 3 The analysis of non-conformance N6 (Imprecise welding of elements of the impeller) in the production process of the impeller [Own study based on 5, 6]

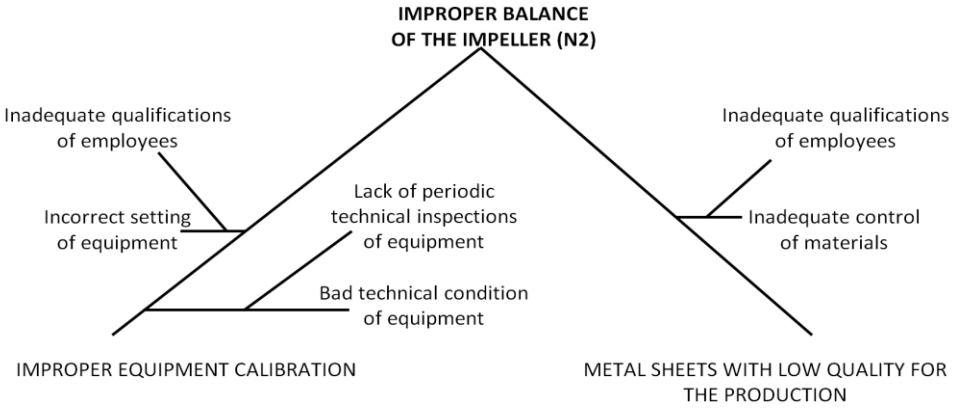

Fig. 4 The analysis of non-conformance N2 (improper balance of the impeller)) in the production process of the impeller [Own study based on 5, 6]

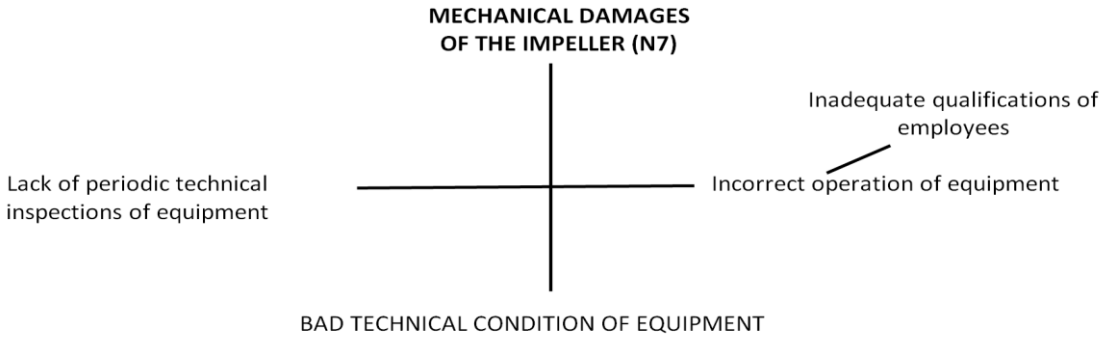

Fig. 5 The analysis of non-conformance N7 (mechanical damages of the impeller)) in the production process of the impeller [Own study based on 5, 6]

Based on the results of the analysis (Fig. 3 – 5) it can be concluded that main reasons of occurrence of most crucial non-conformances are mainly: inadequate qualifications of employees and the lack of periodic technical inspections of devices what affects their poor technical conditions.

CONCLUSION

The evaluation of quality of chosen product using selected quality instruments was the main purpose of this paper. Metal impeller, which is a part of in-line fan, is the element which was investigated. Based on the results presented in the paper it can be concluded that:

- Based on the results of Pareto-Lorenz's analysis it can be said that that the largest number of non-conforming products are related to improper balance of the impeller. The share of these products represents 30.7% of total number of non-conforming products.
- Based on the results of FMEA analysis it can be said that imprecise welding of elements of the impeller was the most critical non-conformance in the product. This non-conformance is crucial to the operation of the fan, in which this impeller runs.
- Based on the results of the elements of Ishikawa's analysis it can be said that inadequate qualifications of employees and lack of periodic technical inspections of devices were main reasons of occurring non-conformances,
- The high number of non-conforming products is caused by the necessity of obtain product with very high precision of operations. During the final quality control in the company defective items are detected and repaired or scrapped. The producer also offers potential customers free technical support and the guarantee in case of any defects during operation of device resulting from non-conformances.
- To significantly reduce the number of non-conforming products the following actions should be implemented:
  - Ensure qualified workers by e.g. training courses.
  - Check the conditions of machinery and equipment regularly. If it is necessary, purchase modern devices.
  - Carry out random control of the product regularly,
  - Verify suppliers of materials for production and cooperate only with suppliers who can deliver materials with required quality.

REFERENCES

[1] HAMROL A., MANTURA W. Quality analysis. Theory and practice. PWN, Warsaw 2009.

[2] SALACINSKI T. SPC – statistical process control of production. Publishing House of Warsaw University of Technology, Warszawa 2009.

[3] KADŁUBEK M. Identification of the Distribution Structure in Chosen Metallurgical Enterprise, . In METAL 2014: 23nd International Conference on Metallurgy and Materials. Ostrava: TANGER, 2014, pp. 1546-1551.

[4] BROŽOVÁ, S., PUSTĚJOVSKÁ, P., JURSOVÁ, S., INGALDI, M. Economic and technological aspects of the use of secondary metal-bearing raw materials for metallurgical production. In METAL 2014: 23nd International Conference on Metallurgy and Materials. Ostrava: TANGER, 2014, pp. 1618-1622.

[5] Information materials from Company X.

[6] MARKOWSKI L. Analysis and improvement of quality of products in the selected industrial company, Engineering work under the direction of Edyta Kardas, Czestochowa University of Technology, Czestochowa 2013.