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The use of quality management techniques to analyse the cluster of porosities on the turbine outlet nozzle

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Abstract
As part of continuous quality improvement in well-managed enterprises, identifying unconformity should initiate actions to find their causes. Therefore, it was proposed to the enterprise located in Podkarpacie to use in the sequential way the Ishikawa diagram and 5Why method. The aim was to analyse of unconformity (porosity cluster) on the turbine outlet nozzle and identify the root of its creation. In the enterprise, the quality analysis of the products with a fluorescent method was carried out, but after identifying the unconformity, non-analysis of their reason for their occurrence was not practiced. Therefore, it was intentional to propose the use of sequence i.e. Ishikawa diagram and 5Why method to identify the root of unconformity. The subject of study was the turbine outlet nozzle, on which the fluorescent method the porosity cluster was identified. With the use of the Ishikawa diagram, the main cause of the problem was pointed (unconformity during production), and by the 5Why method the root cause of the problem, i.e. unconformity material from the supplier, was identified. The proposed method sequence is a simple and effective way to make analyses of unconformities and it can be used in different products and service enterprises.

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1. Introduction

Production enterprises outsource the analysis of products in order to check their quality and identify potential unconformities. Early detection of an unconformity prevents wasteful enterprise resources. An important factor of such an analysis of products is meeting customer requirements, for whom the quality of products is a priority (Šolc et al., 2019; Krmela, 2017; Mazur & Momeni, 2019). One of the ways to analyse products in order to check their quality are non-destructive tests.

Non-destructive tests, in comparison with destructive tests, are considered a cheaper and more simple way to identify the unconformity of a product (Pacana et al., 2016). However, identifying the unconformity alone is insufficient. It is necessary to show the root of their appearance. Here, the ability to employ quality management instruments becomes useful. An example of the use of such instruments after an unconformity was identified by means of the fluorescence method was presented in this study.

In the enterprise located in Podkarpacie the analysis of the products with non-destructive method was made (fluorescent method, among others). The enterprise received unit orders to perform tests on different t ypes of products. One of the products there was a turbine outlet nozzle. An external customer ordered the fluorescent method to check the quality of this product. After the analysis by means of this method, the porosity cluster on the turbine outlet nozzle was identified. In the enterprise, these type of unconformities were identified repeatedly.

Therefore, it was considered that it was useful to analyse this problem in order to identify the root cause of it. The aim was to analyse of unconformity (porosity cluster) on the turbine outlet nozzle and identify the root of its creation. To make this possible, a simple and effective method of analysis was proposed using quality management instruments, i.e. the Ishikawa diagram and the 5Why method (Ulewicz, 2018; Knop & Mielczarek, 2018).

2. Experimental

The subject of the study was the turbine outlet nozzle. The material from which the product was made was alloy 410. Alloy 410 is an alloy casting, corrosion and heat resistant. An

external customer ordered the product analysis (turbine outlet nozzle) by means of the fluorescence method. The example of performing the fluorescent method was characterized in the literature on the subject (Pacana et al., 2019).

To analyse of unconformity, two quality management instruments were used, i.e. Ishikawa diagram and 5Why method. These methods, used in a sequential way, are complementary and allow to identify the root of the problem. Hence, they were selected to examine the problem, namely the porosity cluster on the turbine outlet nozzle (Ulewicz et al., 2016; Szczęsna & Klimecka-Tatar, 2017).

In order to identify the root cause of the problem, the next analysis was made with use the 5Why method.

The 5Why method, which is called a Why-Why diagram, is applied to identify the root of a problem. Also, like the Ishikawa diagram, the 5Why method was made in a graphical way. Analysing the problem using the 5Why method consisted of asking the "why?" question until the answer was exhausted and the root of the problem was found (Harmol, 2005; Pacana et al., 2019). The 5Why method allows taking action adequate to the root of the problem in order to eliminate or reduce this problem. The flow chart of the analysis is presented in Figure 1.

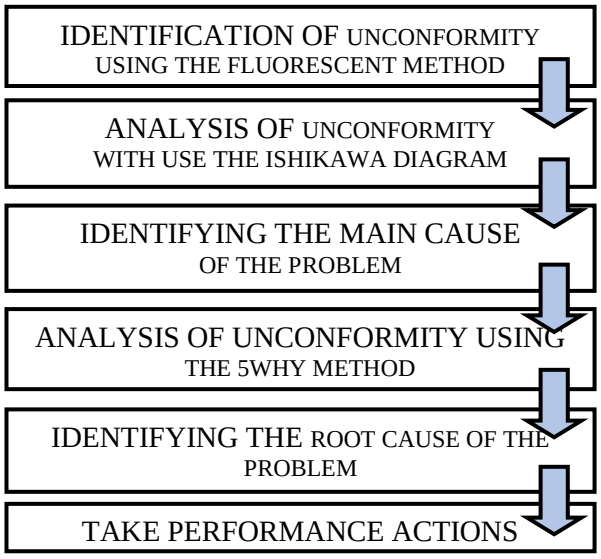

Fig. 1. The scheme of the analysis.

The Ishikawa diagram is called a fishbone diagram or cause and effect diagram. This diagram allows, in a graphical way, to show the causes, which can lead to a problem. Its graphical form allows a better understanding of the problem, making its analysis more effective (Pacana, 2019).

Creating the Ishikawa diagram, five of the basic six categories (5M + E) were selected to which the causes of the problem were assigned (Pacana et al., 2018; Wolniak, 2017). The selected categories included human, material, method, management and environment. The „machine" category was omitted due to the nature of the study (in the fluorescent method machine is not used). The use of the Ishikawa diagram enables to show the potential causes of the problem, (Chądzyńska & Klimecka-Tatar, 2017; Pacana, 2019; Zendla & Wolniak, 2015). After identifying the root cause, the improvement actions were proposed to eliminate or reduce the appearance of porosity cluster on the turbine outlet nozzle.

3. Results and discussion

After performing the fluorescent method on the turbine outlet nozzle, the unconformity – the porosity cluster which passed through on the product - was identified. An example of the identified unconformity is shown in Figure 2.

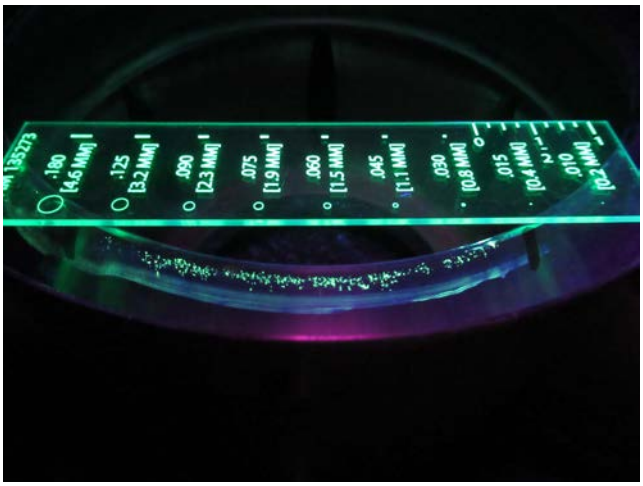

Fig. 2. The example of unconformity (porosity cluster) on the turbine outlet nozzle.

In order to identify the root cause of the problem, the analyse by means of the Ishikawa diagram and 5Why method was made in a sequential way.

The unconformity, which was identified by the fluorescent method, i.e. porosity cluster, was noticed in the main part of the diagram. Potential causes of the problem were ascribed to each of the selected category. Of these, the main cause was chosen, that is an unconformity created in production. The Ishikawa diagram is presented in Figure 3. In order to identify the root cause of the problem the next analysis was performed with 5Why method.

In the initial phase of 5Why method, the problem (i.e. porosity cluster) and the main cause of the problem (unconformity during production) were observed. The "why?" question was asked until the root cause, that is material with an unconformity form the product supplier, was identified. The analysis using the 5Why method is shown in Figure 4.

The improvement actions that were undertaken aimed to inform the customer about the identified unconformity and the source of its occurrence.

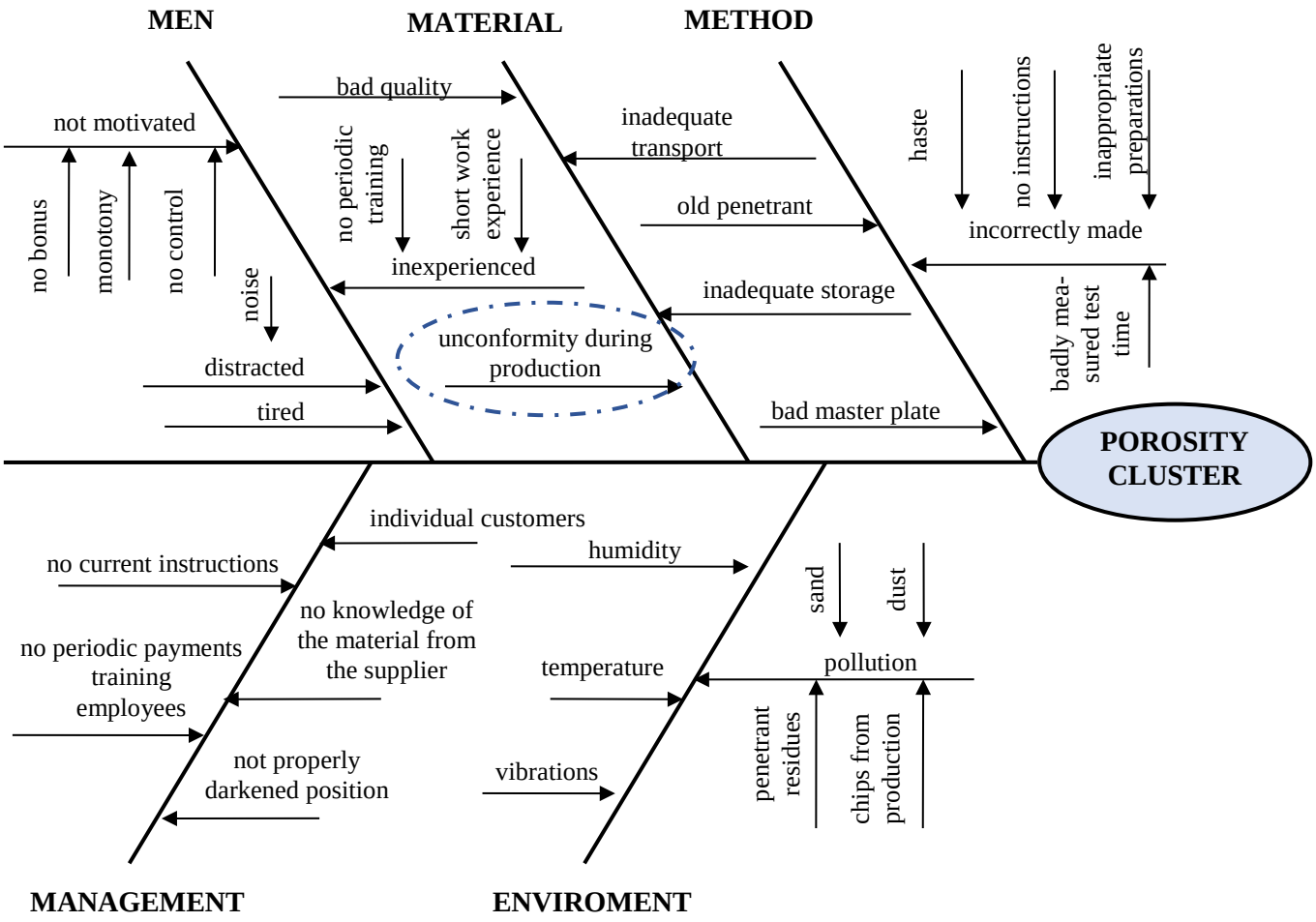

Fig. 3. The Ishikawa diagram for the problem of porosity cluster.

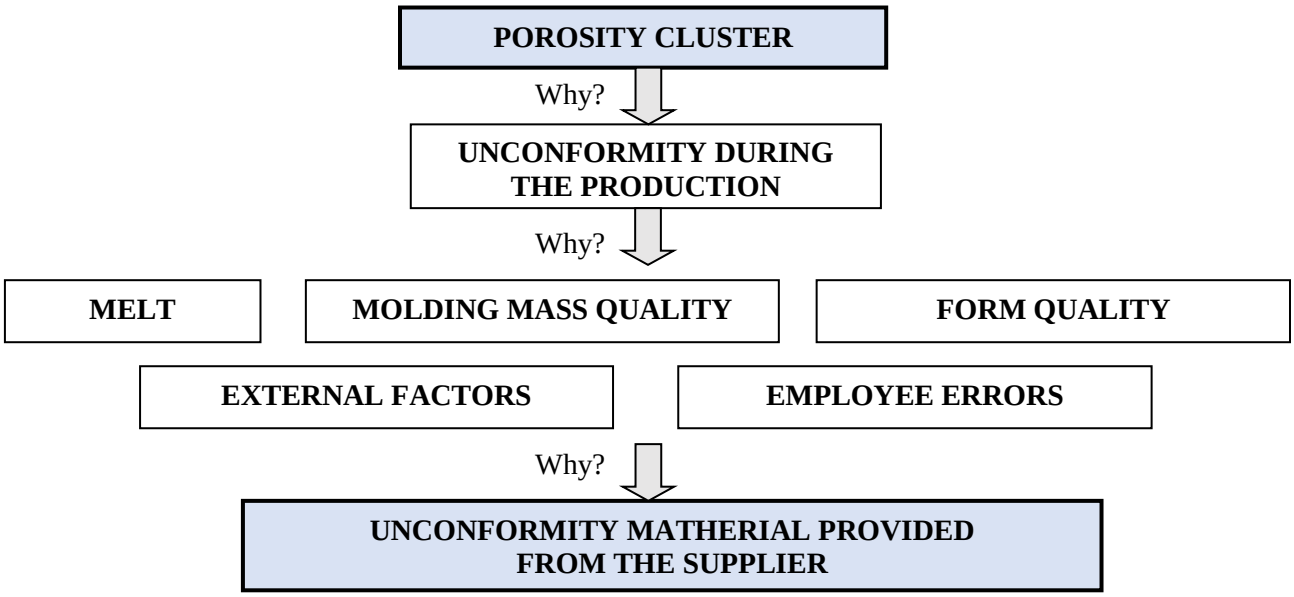

Fig. 4. The 5Why method for the problem of porosity cluster.

4. Summary and conclusion

As part of continuous quality improvement in well-managed enterprises, identifying unconformity should initiate actions to find their causes. Therefore, it was proposed to the enterprise located in Podkarpacie to use in the sequential way the Ishikawa diagram and 5Why method. The aim was to analyze of unconformity (porosity cluster) on the turbine outlet nozzle and identified the root of its creation. At the request of an external customer, the turbine outlet nozzle was analyzed by means of the fluorescent method. To identify the root cause of the unconformity the method sequence (Ishikawa diagram and 5Why method) was used. After analysis, it was concluded that:

- use of the fluorescent method was effective and allowed to identify unconformity (clusters of porosities),
- using the Ishikawa diagram, it was possible to identify potential causes and select the root cause of the problem (unconformity during production),
- 5Why method allowed to identify the source of the problem, i.e. unconformity material provided by the supplier,
- using the sequence (Ishikawa diagram and 5Why method) after identifying the unconformity with use the fluorescent method is effective and allows to identify the root cause of the problem,

The proposed method sequence is a simple and effective way to make analyses of unconformities and can be used in different products and service enterprises.

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使用质量管理技术分析涡轮出口喷嘴上的孔隙群

關鍵詞
质量
不整合
机械工业
石川图
5为什么方法

摘要
作为管理良好的企业持续质量改进的一部分，识别不整合应该采取行动来找到原因。因此，建议位于Pod-karpacie的企业以顺序方式使用Ishikawa图和5Why方法。目的是分析涡轮机出口喷嘴上的不整合（孔隙簇）并确定其产生的根源。在企业中，使用荧光方法对产品进行质量分析，但在识别出不整合之后，没有对其发生原因进行不分析。因此，有意提出使用序列即Ishikawa图和5Why方法来识别不整合的根。研究的主题是涡轮机出口喷嘴，在其上确定了孔隙簇的荧光方法。使用Ishikawa图，指出了问题的主要原因（生产过程中的不整合），并且通过5Why方法确定了问题的根本原因，即来自供应商的不整合材料。所提出的方法序列是分析不整合的简单有效方法，可用于不同的产品和服务企业。