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Analysis of the technological process of rings of train wheels

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ABSTRACT

Purpose: The aim of this paper is to show the analysis of a specific process of manufacturing the rings of train wheels. Secondly this work presents the exemplars of possible faults in this technology.

Design/methodology/approach: The presented work bases on the investigations made in chosen manufacturing plant. Also laboratory tests have been made to point the discovered problems.

Findings: Results show that it is important to apply in modern manufacturing processes the system of monitoring. Also it helps to establish the continuous quality assurance system. Moreover it is proved that quality system must cooperate with the training system.

Research limitations/implications: The presented elaboration includes results from one manufacturing plant. It is consider with the fact that this production process is rare so it is difficult to receive comparative data. Secondly, the limitation of this work is the commercial secret. Some specific parameters of presented process are secret. Also the name of manufacturing plant is omitted.

Practical implications: The implication of the work could be found in two remarks. Firstly it is important to introduce to the industry practice the integrated approach. Secondly the human and technical factors are equally important.

Originality/value: The value of this work is its subject. In this work a very rare technological process is presented. Secondly, in this work it is presented the analysis of quality parameters of this process. Also are proposed the general solutions of same faults.

Keywords: Quality assessment

1. Introduction

The presented work includes the analysis of manufacturing process of rings of train wheels [1, 2]. This process is conducted in the X steel mill. This code name is used because of the commercial secret. The described plant has 160 years of history and manufacturing experience. In this steel mill, in a Rings Department has been made the presented researches.

The charge materials for the presented technological process are: circular conventional ingots from Polish and foreign suppliers, COS circular ingots from foreign suppliers, ingots from Mittal Steel with the cross-section 280x400 mm, rolled on the round bars with diameters: 190, 200, 225, 250, 280 and 300 mm and rectangular bars with dimensions: 280x300 mm, forging and skinning bars from Polish and foreign suppliers.

The profile type and grade of charge are chosen according to the requirements of the specific order [3, 4].

The schematic production process is presented on the Figure 1. This process begins from the control operations to determine the quality of the charge. Next the charge material is cut. After this operation the control process is repeated. Next the material is heated to obtain needed plastic parameters [5].

Next the material is hot pressed or rolled and marked. After that it is transferred to the cooling bed. This operation let to preserve the form which material obtain in the rolling process.

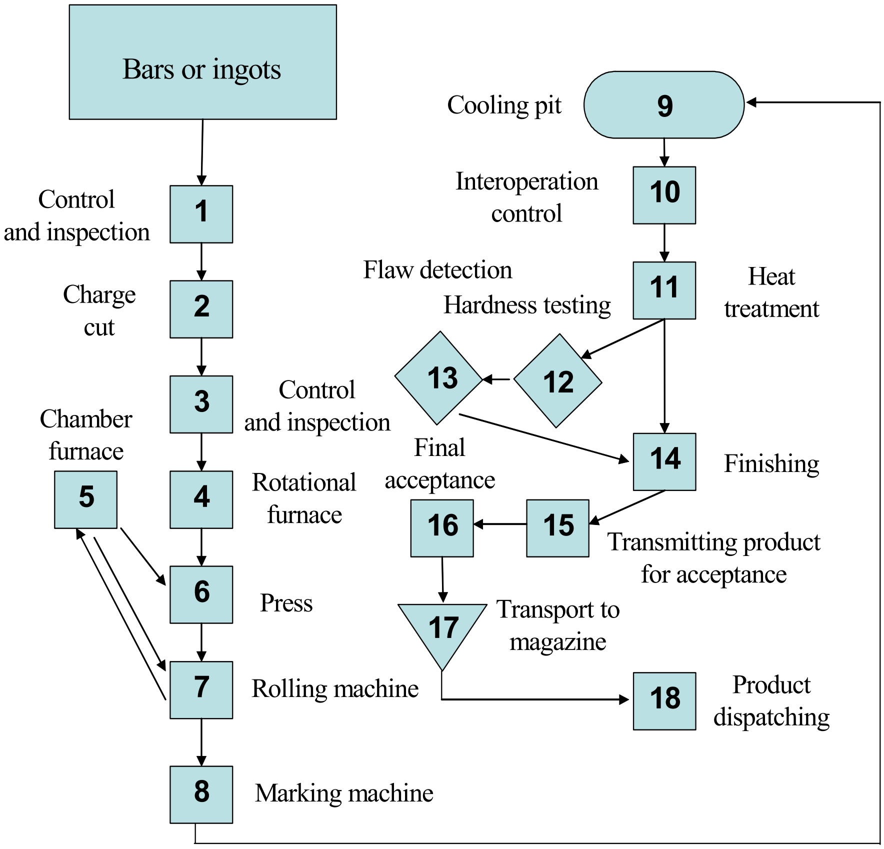

Fig. 1. The technological process of manufacturing the rings of train wheels [2]

After this phase the material already obtained the form of a ring [6]. Next the rings are controlled to check their geometrical parameters. It is very important detect all failure elements on this stage on the process [7, 8].

After this interoperation quality control rigs are made subjects of the process of heat treatment. This is a very important process because it could strongly influence the quality parameters [9].

In the last phase the rings are finished and controlled generally to check whether they fulfill the requirements of the offeree [10, 11, 12]. If they are positive classified they are stored or prepare for shipment.

As it was shown in the description of the presented above manufacturing process it has been planned five operations of quality control. This amount of these operations let the steel mill to introduce the system of monitoring the process. Also it could help to control the parameters in this low serial process. This modernization changed the market identity of the firm.

2. Charge preparing

As it was stated in the preparing phase the charge material is tested according its compatibility with the order specifications. After this control it is placed on the buffer field. They are also marked to code next technological operations. This is the beginning of the technological process, which is presented on the Fig.2.

In the next stage the material is cut using band-saw. As the results one obtains so called charged blocks. Additionally the blocks are weighted to control its volume. To determine the needed tolerance of weight measure it is applied an electronic balance. A fault in this operation causes series defects of the manufactured rings so it is needed to control all parameters precisely.

3. Production

In the main phase of the technological process the blocks are transported to the buffer near the rotational furnace. To transport the blocks is used a overhead crane. At the furnace the blocks are secondly controlled. In this test process controlled are: the surface state, the dimensions and the marks. After positive result the blocks are transported using charging car on the furnace chute according to the production plan.

The heating process is conducted in a rotational furnace with the hearth of the diameter 13.3 m and width of 2.8 m. The furnace is equipped with a computer control panel. This system allows controlling all important parameters of the heating process.

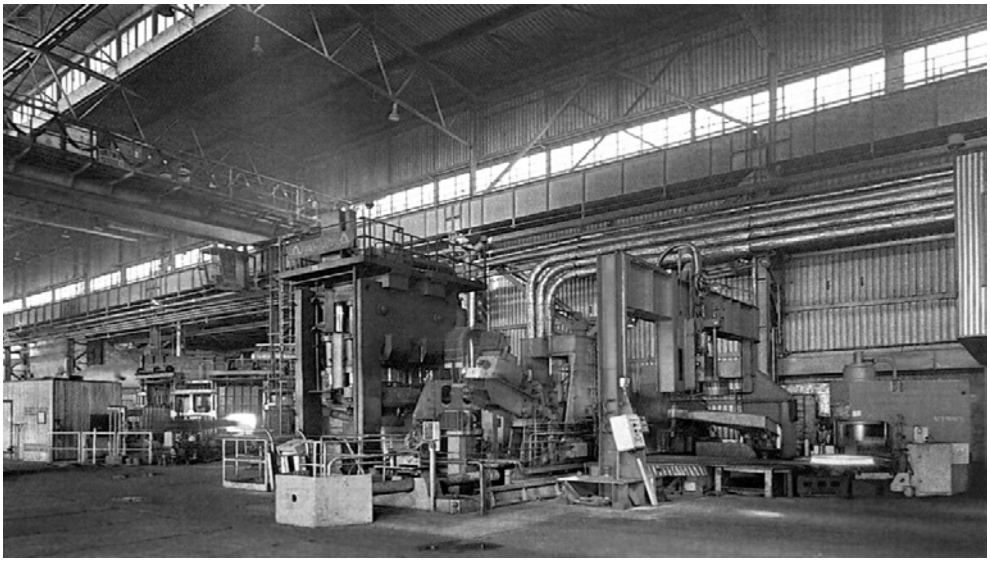

Fig.2. The view of the production line

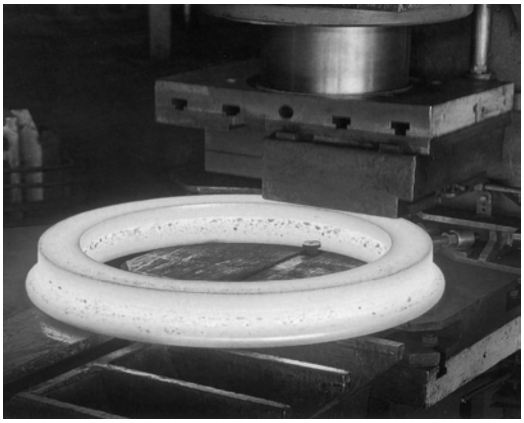

Fig.3. The pressing operation

The capacity of the furnace is 9.5 t per hour. This furnance is presented in the Figure 3. The charge material is placed in the furnace using the hydraulic transport system. It is controlled by the operator.

The heating process bases on the combustion of the natural gas. The short-flame torches are situated in the ceiling of the furnace.

In the furnace chamber one can stand out three heating zones: preheating, heating and compensating. After soaking process the blocks are place on the stand for scale hammering. Next they are weighted.

To form the rings the blocks of material are pressed [13]. In this operation the HRP-4000 hydraulic press is used. This is a computer controlled press. On this stand the block is upset according to required parameters. This process is presented in the Figure 3. The result of the pressing operation is preformed ring. On the press table could be mounted a flat or profile die.

The next operation is a rolling process. In this process the radial-axis RAW 125/100 rolling mill is used. The rolling process is realized synchronous in the radial (main and shank roller) and axial (top and bottom cone roller) impressions. Additionally the rolling mill is equipped with the centering arms. They control the axial position of the material. It lets to avoid the ovality of the manufactured ring. During the rolling process the diameter of the ring increases.

4. Heat treatment

The heat treatment process is conducted in the shaft furnace. In this steel mill there are five such furnaces. These furnaces are complemented with the chamber furnace.

5. Laboratory analysis

All the rings manufactured in the steel mill must fulfill specific strength requirements. To assure such parameters and to assure the needed quality level the qualification laboratory in the steel mill conduct special tests. In the laboratory are conducted next tests: yield point, strength resistance, impact resistance and fatigue resistance. Also tested is the macro-structure, the grain size and the amount of non-metallic inclusions. Next all results are compared and analyzed [14].

6. Faults analysis

The main faults that could affect the manufacturing process are: the condition of machine tools and its equipment, the measurement process and the human faults during control operations. Also it is important to properly conduct the particular technological operation because each of them could result in different fault. One of them could be reparable and other are non-reparable.

As the example of technological faults one can describe these ones that are generated during the heat treatment operation. To these faults include: structural changes, surface changes, fractures and pits. Rigs with these faults are treated as scrap.

7. Conclusions

Conducted researches in a X steel mill showed that the process of continuous monitoring resulted in decreasing the number of faults in about 30 %. It proves that this new production organization let to improve the level of quality assurance. Also it resulted in higher profits of this industry plant. Next researches should be conducted as simulation investigations [15].

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