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FOCUS ON QUALITY ASSURANCE IN THE ROLLS MANUFACTURING – APPROACHES FOR INCREASING THE ROLLING-MILL ROLLS QUALITIES

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ABSTRACT: *Quality assurance is the activity of providing evidence needed to establish quality in work, and the activities that require good quality are being performed effectively. All those planned and systematic actions are necessary to provide enough confidence that a product or service will satisfy the requirements for quality. Our approaches the issue of quality assurance of the rolling mill rolls, from the viewpoint of the quality of materials, which feature can cause duration and safety in exploitation. The experimented research, as well as the optimization of the manufacturing technology, allows the conclusion of direct results for the rolls. The beneficiaries of these results are the unit in witch the rolls are manufactured, as well as the unit that exploits them. The technological manufacturing process of the rolling mills rolls, as well as the quality of material used in manufacturing them, can have a different influence upon the quality and the safety in the exploitation.*
KEYWORDS: *Quality assurance, cast-iron rolls, manufacturing, laboratory research, mathematical modeling*

INTRODUCTION

In our foundries, specialized in the cast iron rolls, in spite of trying the most accurate guidance of the iron melting processes, of the outside treatments melting aggregate, of the molding and drying of moulds (the so-called casting process), of the cooling and the directional solidification of the castings in the moulds, as well as of the rapping, cleaning and the subsequent processing of the rolls, the performance factor remains relatively low.

Quality assurance covers all activities from design, development, production, installation, servicing and documentation. It includes the regulation of the quality of raw materials, assemblies, products and components, services related to production and inspection processes. Production logistics is the term used for describing logistic processes within an industry. Also, the purpose of production logistics is to ensure that each equipment and technologies is being fed with the right product in the right quantity and quality at the right point in time.

What materials, products, or information come into the activity? What materials, products, or information flow out of the activity? Quality engineers use the D-M-A-I-C model (define, measure, analyze, improve, and control) to document processes before beginning process improvement. If processes are documented, another series of logical questions apply: Are the processes being followed? Are they within acceptable control and performance parameters? Are they outdated? Can they be improved? Those are the questions which determine the correlations between the logistics process and the quality assurance.

Roll makers always ask about rolling conditions and the necessity to choose the right grade of roll material and roll users always ask about the mechanical and physical properties of roll material. Sometimes they feed these figures into their rolling model, but sometimes they also need them for unknown reasons. This information is very rarely useful for selecting the right supplier. Roll makers and roll users frequently have to discuss experiences, performance results, and special requirements of the mill. Roll failure problems can be solved by good cooperation. In engineering and manufacturing, quality control and quality engineering are involved in developing systems to ensure products or services are designed or produced to meet or exceed customer requirements. These systems are often developed in conjunction with other business and engineering disciplines using a cross-functional approach. By collecting data from samples at various points within the process, variations in the process that may affect the quality of the end product can be detected and corrected, thus reducing waste as well as the likelihood that problems will be passed on to the customer.

THE RESEARCH ACTIVITIES AND THE OBJECTIVES

In a typical scientific research process there is a stage that consists of the following activities: a review of literature, an exploration of existing theories, a review of theoretical background and a definition of the terminology used.

The research activities devoted to materials relate to their production, characterization and use. These, mainly focused on ferrous alloys (particularly on irons), relate to:

- *Optimization of the processes for developing new technologies in collaboration with industry;*
- *Production technologies;*
- *Research into solutions for management of products;*
- *Improvement of the quality of cast and rolling products;*
- *Development of statistical tools for quality control;*
- *Theoretical modeling and experimental study.*

The main objectives, in accordance with the above mentioned activities, are the followings:

- *Study of the influence of chemical elements on iron mechanical properties;*
- *Modeling in order to optimize the production flows;*
- *Characterization of mechanical properties;*
- *Development of new technologies;*
- *Multivariate statistical analysis of industrial data;*
- *Analysis on various methods to improve the hardness and mechanical properties;*
- *Simulation of melting, forming, casting and cooling processes;*
- *Optimization of production processes.*

The final scope is the optimization of the specific processes, that's equivalent to respond to new economic and environmental imperatives, designers must optimize the real behavior of the casting materials.

The multidisciplinary point of view relates to the use of various research methodologies. Modeling refers to the representation of knowledge through algorithms and tools. The resulting models are used both in applications that aim at scientific understanding and also in applications that aim at practical understanding. Scientific and technological methodologies refer to empirically-based and modeling-based approaches that draw upon advanced tools for measuring and processing information.

QUALITY ASSURANCE IN THE ROLLS CASTING INDUSTRY

Specialty literature, from Romania or from foreign countries, offers for study a rich technical material, concerning the manufacturing process of rolling mills rolls and the lamination process, as special treaties, didactic handbooks, studies of production and special papers. The area of mathematically modeling and the metallurgical processes optimization is approached in the specialty manuals and scientific papers, since there are no treaties in area. The researches of durability in the exploitation is near un-existent, with the exception of some specialty works, treated summary and to general mode, as well as of some works elaborated by the didactic staff from Faculty of Engineering from Hunedoara, along researchers and specialists from the rolls manufacturing industry and from rolling sectors.

In the rolling industry, the quality of rolls is in directly accordance with the quality of technologies (defined by the casting equipments, materials, applied procedures, etc) and also, by the quality of the manufacturing process (charging, melting, inoculation, ladle treatment, casting, cleaning, etc), which are presented in Figure 1.

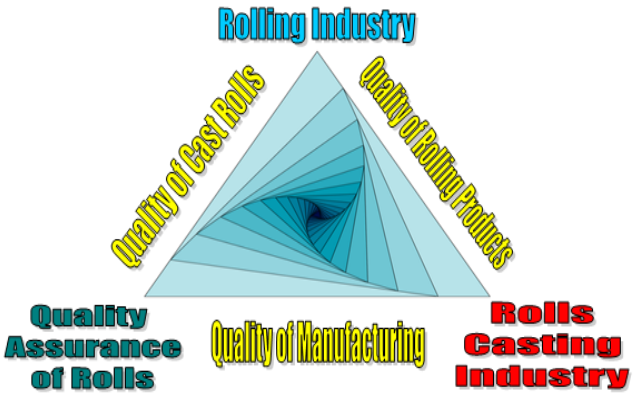

Figure 1. Quality assurance in the rolling industry and the rolls casting Industry

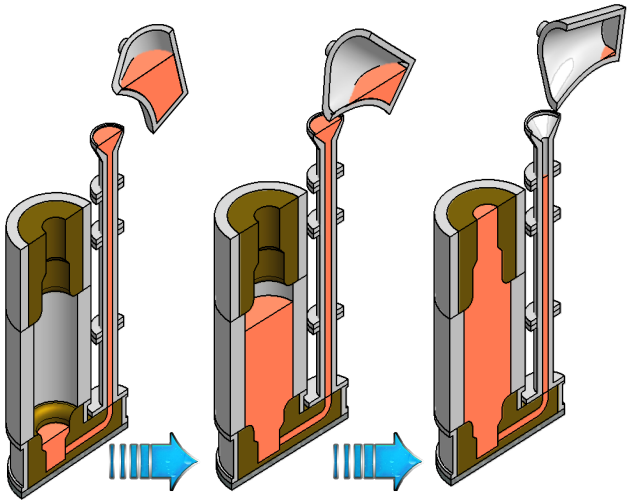

Figure 2. Casting technology of the iron rolls (simplex procedure)

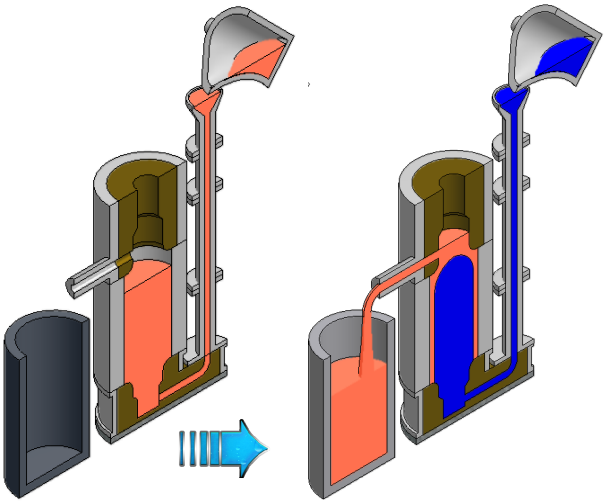

Figure 3. Casting technology of the bimetallic iron rolls

The manufacture of rolls (see Figure 2 and Figure 3) is in continuously perfecting, the requirements for superior quality rolls are not yet completely satisfied, in many cases, the absence of quality rolls preventing the realization of quality laminates or the realization of productivities of which rolling mills are capable. Basic properties of rolls and properties of the material are two totally different sides of a problem and very often this difference is ignored. However, when we start to discuss about the rolls mechanical properties, we have to analyze the rolls material or the roll-properties.

The technological manufacturing process of the rolling mills rolls, as well as the quality of material used in manufacturing them, can have a different influence upon the quality and the safety in the exploitation. Our approaches on quality assurance of the rolling mills roll are defined from the viewpoint of the quality of materials, which feature can cause duration and safety in exploitation.

The quality assurance research fields can be defined through the general research area, through the different experiments effectuated in the laboratories, and, also, through the modern calculation programs, optimization technologies and better capitalization of the manufacturing data.

The entire operations from selection of raw materials to dispatch of finished products go through a series of quality control checks conducted by a team of metallurgists. The products are tested for surface hardness by the conventional hardness testing equipment along with sample checks. In the laboratory to confirm to specification defined by the customers. The metallographic and mechanical tests are carried out to ensure the over all internal soundness, in particular, the quality of bound between the shell and core.

Depicted, developed, specified process and methods have been institutionalized for achieving the quality requirements of products of various grades. Synchronization between all activities and sub process are maintained to build desired properties in products.

All the incoming materials are checked according to laid down procedures for acquiring right material to manufacture specified products. At each stage of manufacturing, Quality Control Inspectors are engaged to ensure only defect free materials are produced. By identifying non-conforming products, actions are taken to prevent recurrence of defects as a continuous process of improvement.

Finally, each product goes through final inspection before being shipped. The foundry has modern inspection and testing facilities to keep update with the present requirements of fast and accurate inspection and testing need. The cast rolls are inspected during the course of manufacturing, after completion and are held to our strict quality control criteria. In conclusion, every stage of the production process from design and development through to implementation must be conducted correctly.

QUALITY OF ROLLS ASSURED BY THE MODELING OF ROLLS MANUFACTURING TECHNOLOGIES

Industrial engineering is also operations management, systems engineering, production engineering, manufacturing engineering, or manufacturing systems engineering. Where most engineering disciplines apply skills to very specific areas, industrial engineering is applied in every industry. Industrial engineers typically use computer simulation, especially discreet event simulation, for system analysis and evaluation. The computer is used to generate a numerical model of reality for the purposes of describing complex interaction among components of a system.

Quality assurance can be defined as all activities that contribute to defining, designing, assessing, monitoring, and improving the quality of products. In quality assurance, data are used to analyze processes, identify problems, test solutions, and measure performance. Data are important because they ensure objectivity. The collection and analysis of data allow us to develop and test hypotheses. Comparing data from before and after a change can allow us to verify that the changes have actually led to improvements.

Starting from the principle of modeling process, used as necessary basic instrument, both in phase of conception, as well as in the industrial technologies analysis, is determined the optimum regimes of the cast rolls, from the view from chemical composition, as one as the most important parameters of disturbance of the manufacturing process.

The enunciation of some mathematically modeling results, described through a number of multi-component equations determined for the spaces with 3 the and 4 dimensions, as well as the generation of some regression surfaces, of some curves of levels, of the volumes of variation, of the lines of outlines of the volumes of variation of surfaces and the areas of variation of these, can be represented and interpreted by technologists and can be considerate diagrams of correlation between the analyzed variables.

From this point of view the multidisciplinary research is inscribes in context of scientific capitalization of the process and the industrial technologies optimizations, on the way of the analysis and the mathematical experiment. The quality assurance through the modeling phenomenon is presented in Figure 4(a-g) as a logistic chart.

Figure 4(a). The Iron Melting Process

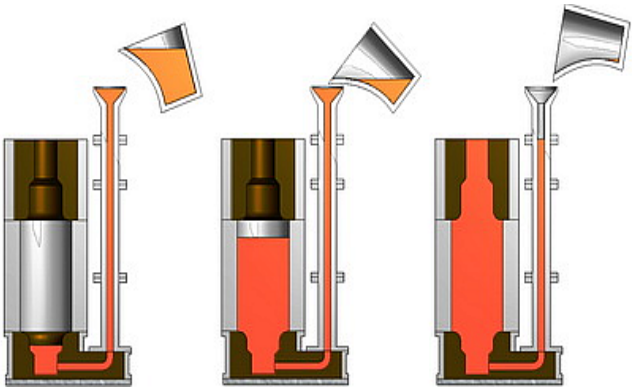

Figure 4(b). The Casting Process

Figure 4(c). The Products (Cast Rolls)

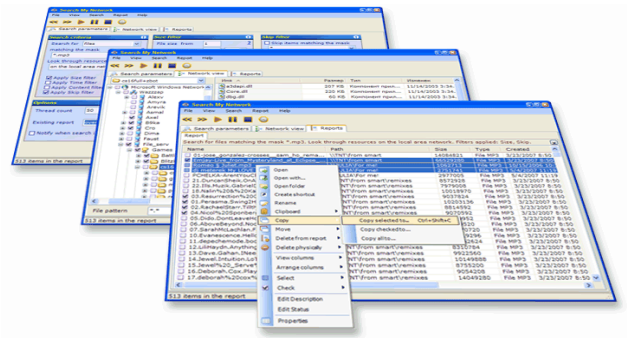

Figure 4(d). Databases Upgrade

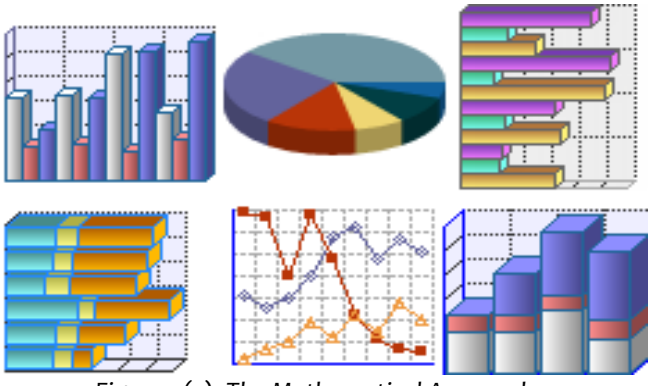

Figure 4(e) .The Mathematical Approaches & the Graphical Addenda

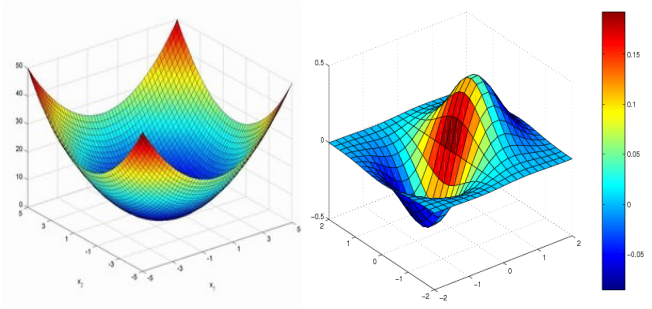

Figure 4(f). The Optimizing, Modeling & Tailoring

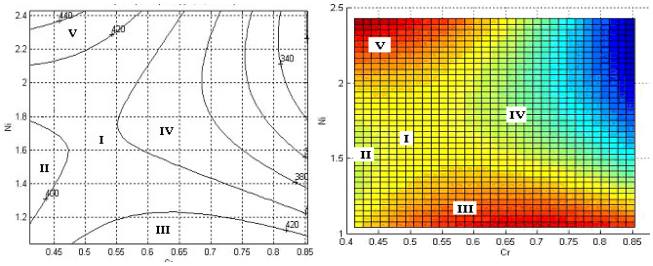

Figure 4(g). The Plotting & Technological Domains

The character of the metallurgical processes optimization is influenced by the complex peculiarities of these, which take place into a great number of variables (parameters) that operates independently or cumulate.

For these reason, to analyze the metallurgical processes is used, mainly, the statistical fundamental methods that permit to draw conclusions, from the observed values, about the repartition of the frequencies of various parameters, about their interaction, about verification validity of certain premises, and about the research of the dependencies among different parameters. However, the statistical methods of the metallurgical process analyses do not solve a series of aspects regarding the mode of establish the decisions for the management of the process. Thereof, parallel with the statistical methods it was developed optimization methods.

The optimization of any technological process has, as a base, a mathematical model. The search for the best solution, for the truth, requests either to find, on the way of a study, definitive truths, or of relative valid truths, valid only in certain conditions, and which, in relation with the definitive truths, include implications and errors. Because we disposed of real data, the optimization model is based on industrial data, obtained from cast-iron rolling mills rolls. Their analysis shall lead to the optimization pattern, through the prism of the multi-component correlations, enounced by mathematical formulae.

Through its nature, the quality assurance in the rolls manufacturing is a research with interdisciplinary character. It approaches, on aside, the technical area of manufacturing and exploitation of rolls, both in theory and practice, and on the other hand, the areas of the statistical mathematic analysis, of the

algorithms and the numerical calculus methods, as well as the mathematically molding and optimization area, applied to a product so simple from point of view of the geometry, but so complex, as structure, property and characteristics ensumed, as the rolling mills rolls are.

These results are immediate practical utility both the cast-iron rolling mills roll manufacturing industry, and the rolling sectors. In this sense, these researches results can be used in the collective framework of the foundries and the rolling mills sectors, for assurances quality of rolls as far back as phase of production, as well as in exploitation these, what lead to, inevitably, to the assurance quality of produced laminates.

CONCLUSIONS

The aim of the purpose research is to answer to as many questions possible regarding the quality of the rolls. In this sense the realization of optimum chemical compositions of the cast-iron can constitute a technical efficient way to assure the exploitation properties, the material from which the rolling mills rolls are manufactured having an important role in this sense.

In these sense, our researches propose to analyze the optimization of the manufacturing technology of the cast rolls, especially those from cast-iron - using electronic calculus technique as the modeling phenomenon and mathematical interpretation of the technological processes.

The proposed research theme solicits the uses of knowledge from science and the material engineering areas (the elaboration of the cast-iron, the treatment in liquid state of the cast-iron, the preparation of the molding sands, the preparation of the combined casting equipments, the drying of the forms, the cast in metallic and combined forms, the preparation of surfaces, the quality of the cast pieces, the reject forms of castings, the metals lamination, the rolls calibration, etc.), from the mechanic engineering (the hardness measurement, the foundry equipments, the plastic deformation equipments, the study of wear, the thermal fatigue study), from the mathematical sciences (statistics, mathematical regressions, mathematical modeling and optimization, etc.), and from the informatics, programming and calculus techniques. For the obtaining outcomes in this research area, is required the transfer of the concepts and the methodology between the mentioned areas.

Through the original aimed elements mentioned above, the suggested researches allow the enunciation of new approaches in the area afferent to the theme. The best way to roll makers to achieve better rolls is to ensure that better materials and improved manufacturing processes are used and that roll users take account of rolling conditions and improved rolling processes. When we start to discuss about the rolls mechanical properties, we have to analyze the rolls material or the roll properties.

The choice of material for rolls is the operation which takes into consideration the own solicitations of the lamination process afferent to the type of laminates (half-products or the finite laminates), and the features of different materials considerate optimum in the fabrication of different typo-dimensions of rolls.

In conclusion, the rolls quality problems can be solved by good cooperation between the rolls manufacturers and roll users. Engineering is concerned with the design of a solution to a practical problem. A scientist may ask "why" a problem arises, and proceed to research the answer to the question or actually solve the problem in his first try, perhaps creating a mathematical model of his observations. By contrast, engineers want to know "how" to solve a problem, and "how" to implement that solution. In other words, scientists attempt to "explain" phenomena, whereas engineers use any available knowledge, including that produced by science, to "construct" solutions to problems.

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