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ANALYSIS OF FOUNDRY DEFECTS AND PREVENTIVE ACTIVITIES FOR QUALITY IMPROVEMENT OF CASTINGS

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Casting as complicated production processes carries risk of failures occurrence during all the process of accomplishment of the finished products. It's very important to have an apposite process inspection, to perform preventive activities, and to make use of research techniques for better loss prevention. The paper shows some simple techniques which can be used in identification of the main course of defects in production of castings for heavy industry. It proves that the basic influence on castings quality have material factors, accepted technology and as well as human factor.

Key words: *casting, cast iron, control, quality product*

Analiza ljevačkih grešaka i preventivne aktivnosti za poboljšanje kvalitete odljevaka. Lijevanje, kao i svi drugi proizvodni procesi, izloženo je riziku pojave grešaka tijekom cijelog procesa izrade proizvoda. Vrlo je važno da poduzeće ima dobru nadzornu službu, da provodi preventivne aktivnosti, da rabi istraživačke tehnike radi boljeg sprječavanja gubitaka. Ovaj rad pokazuje neke jednostavne tehnike koje se mogu rabiti u identificiranju glavnog uzroka nastajanja grešaka u proizvodnji odliva za tešku industriju. Dokazano je da glavni utjecaj na kvalitetu odliva imaju materijalni čimbenici, prihvaćena tehnologija i ljudski faktor.

Ključne riječi: *lijevanje, lijevano željezo, kontrola, kvaliteta proizvoda*

INTRODUCTION

Quality can be perceived in accordance with requirements, customer needs. It, in returns, implicates necessity of verification of this accordances, i. e. quality inspection. An that means how, on the ground of this inspection, to improve quality of articles and services. To speak about possible usage of repairing methods in firm, it is necessary to mention exact qualifications of criterions usage of quality improvement tools. Separations of quality criterions takes place to investigate all spheres of formation and usage of products: preproduction, production and afterproduction phase. Each of these phases is characterized by occurrence a sequence of information about quality, quality features evidenced in certain forms. Results assembled at researches and estimation, on the ground of represented criterions of production can be used for effective application of different kinds of analytic tools.

Half of success is in defining examined problem. Suitable manners permit an analysis in every phase of product formation - from designing to final product and its exploitation - because quality question is central question in every production stage.

Investigated area in this work is the process of casting. In this paper several analysis of quality tools are presented.

RESULTS OF INVESTIGATIONS

Elementary tools of quality assurance serve to assembling operating data about production process. It can be said, that these tools are methods to observe and diagnoses production process. Their meaning comes from the fact, that without honest and full information's about process it is difficult to speak about undertaking whatever efficient activities in management.

The processes which has dissected the analysis is the process of cast-iron pouring. For the characteristic criterion of quality level measuring it assumed quantity of defects in one year. The first step of analysis is the assessment of process by means of Ishikawa's diagram [1].

Ishikawa's diagram - diagram of cause and effect, or „fish bone" diagram - makes possible identification of sources of problems formation, helps qualify a sequence

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of causes of non-conformance's in following stages: researches, diagnosis and choice of therapy and makes easy problem solution [2].

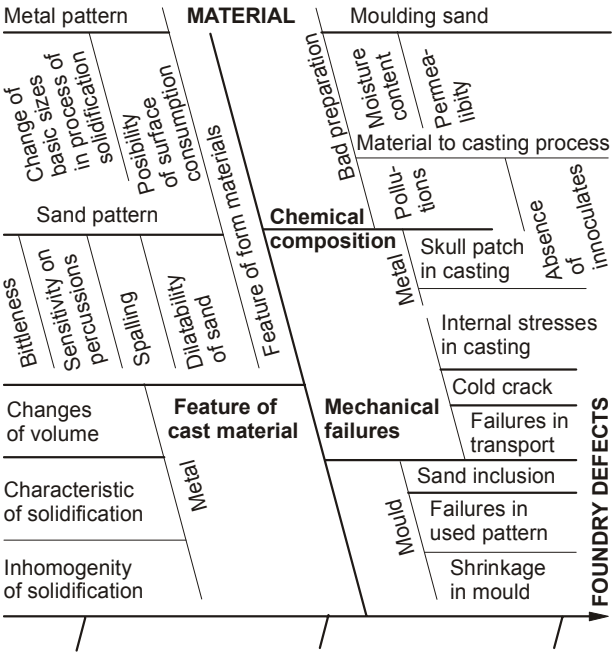

Figure 1. **Part of Ishikawa's diagram for problem of nonconforances formations in process of pouring casting articles**
Slika 1. **Dio Ishikawinog dijagrama - Problem neujednačenosti formacija u procesima lijevanja artikala**

Ishikawa's diagram makes possible choice of five main areas which are responsible for failures formation. These areas are: accepted technology - in investigated firm casting is realized by means of sand mould with partly automatized production-line - and by manual pouring of mould; this technology, as every other, possesses its own advantages and defects which are responsible for formation of foundry defects (more widely described in Pareto diagram - Figure 2.), man - qualifications, experience of workers, engagement in works which in significant manner influences final product quality, machine - outfit and its defectiveness, ease of use etc., environment - conditions of work, variability of temperatures and other factors which influence process, material - used raw material on mould, and patterns making and also pig iron casting - and its chemical composition. Part of Ishikawa's diagram (and more exactly speaking - one of higher cited areas) is represented on Figure 1. Represented diagram shows only a little part of the graph, which in reality is more complicated.

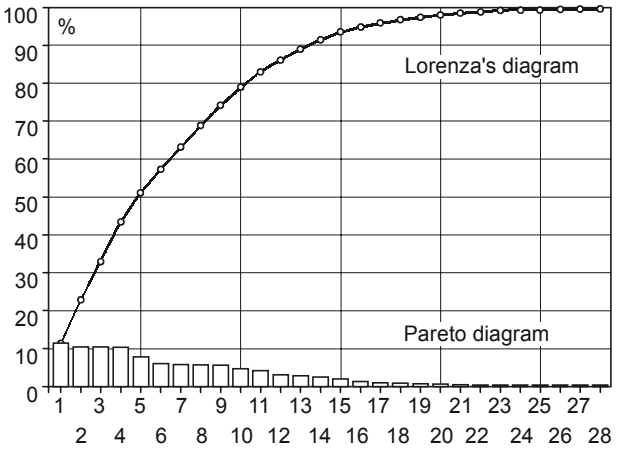

Figure 2. **Pareto-Lorenza's diagram for 2000 year**
Slika 2. **Pareto- Lorenzov dijagram za godinu 2000.**

Usage of Pareto-Lorenzo's analysis is often the first step in process of analyzing assembled data about failures [5]. Causes and effects are aligning in descending order and as cumulating amounts. It permits in final effect to identify little amount of causes, which develop bad results.

On example of foundry defects a grouping was made for researched period of one year - in 2000. Foundry defects were presented in Table 1. On the base of Table 1. a drawing in Figure 2. was made.

Table 1. **Foundry defects (gained in 2000)**
Tablica 1. **Ljevačke greške (u godini 2000.)**

No	Defects	Weig.	No	Defects	Weig.
1	Displacement	6 663	15	Blister	1 177
2	Misrun	6 080	16	Annealing crack	810
3	Slaggy	6 071	17	Burnt	603
4	Inhomogeneity	6 065	18	Porosity	538
5	Shrinkage depression	4 613	19	Indent	413
6	Hot crack	3 565	20	External blister	332
7	Mechanical failures	3 412	21	Cave sistaltic	295
8	Dustiness of surface	3 329	22	Cold crack	238
9	Fold	3 242	23	Ejecting	209
10	Tearing partly	2 763	24	Distortion	135
11	Pinhole porosity	2 496	25	Remote metal	46
12	Sand holes	1 838	26	Drops	22
13	Micro-hrinkage	1 699	27	Sand bucle	21
14	Segregation	1 466	28	Flood	4
				Total [kg]	58 145

For investigation aims on the graph are placed values for 20 % and 50 % types of articles with defects. On the base of Pareto-Lorenzo's analysis (Figure 2.) it is identified, that nearly 57 % of all the observed defects depend only upon six problem. The analysis of the problems can significantly improve quality of pouring off process in firm. The most important failures in the described process are [2, 7]:

1. Displacement - it is an absence of coaxiality of casting arises in consequence of inaccurate composition, locations (before process of casting) of each part of mould in relation to oneself.

2. Misrun - is called after too little system of inlet mould, too excessive speed of solidification, with too intensive cooling of mould and lack of suitable mould venting.
3. Slaggy - is called after pollutions in cast iron gathering on facing parts of casts. It may be caused can, perhaps through too little overflow channels and with insufficiently large surpluses.
4. Inhomogeneity - this is an absence of composition uniformity of chemical contents of metal.
5. Shrinkage depression - appears most often during stratified coagulations of alloys about relatively large range of crystallization temperatures.
6. Hot cracks - are entire or partial diminution of continuity of alloy on the section of casting article. Hot crack arises under influence of contraction break of solidification casting, irregularities of coagulation. It steps out mostly in thin-walled and larger-sized castings.

For these defects are responsible workers (displacement, slaggy, misrun), material factors (in homogeneity) and failures in technology of casting (shrinkage depression and hot cracks). Elimination of these nonconformance's (or their considerable reduction) can bring reduction of quantity of failures above 50 %.

In 2000 data were collected about failures and size of production processes of cast-iron. On their bases it was estimated "first-time-quality" factor - it is a measure of quantity of products which have good quality without necessity to do any correction. FTQ in 2000 amount average 94.54 %. For this specific trade it is a good result. Most of nonconformances may be corrected (3.28 %) in an easy way. Rest can be easy recast (2.2 %).

CONCLUSION

In the article is presented an example of foundry production, an usage of quality control tools. This was the point for good conclusions in relating to qualitative activity of analyzed firm. Passed at usage of selected methods of researches it gives base to introductions of correctness in casting process. Efficiency of usage of improvement methods in of quality of casting process perfectly is perfectly visible on represented examples.

Usage of Ishikawa diagram permitted to identify areas especially subjected to risk of failures formation. Ishikawa's diagram represents in a complex manner factors, which are responsible for examined problems - large quantity of defects are caused by material and defaults of employees and technology. Pareto diagram directs to irrevocable separation of main nonconformances: displacement, misrun, slaggy, in homogeneity, shrinkage depression, hot crack On the base of this diagram a conclusion was formulated, that the quantity of nonconformances in production process is influenced mainly by behavior of employees connected with negligence, noncompliance of technological process recommendations, of procedures etc.

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