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ENHANCING SURFACE ROUGHNESS OF CASTINGS WHEN SAND-RESIN MOLD CASTING

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Preliminary Note – Prethodno priopćenje

In this connection, studies aimed at improving the obtaining process of high-quality castings of mining equipment are relevant. At the same time there is a need for studying physical and mechanical relationship of mixes in which a resin from various factors is bonding (rate and time of thermal impact for mixture, rate of the enclosed load of mix in the course of forming, etc.).

In particular, there is reasonability of increasing the mixture pressure in the manufacturing process of a mold [1-3].

Keywords: castings, surface, roughness, mixture, microstructure

INTRODUCTION

Obtaining process of mining equipment castings (castings of combines, conveyors parts) in sand-resin molds does not quite meets current requirements. Casting in sand-clay molds (S) is characterized by low values of yield ratio owing to different types of defect: burning, shrinkholes, gas porosity, hot and cold cracks, blockages and other defects (Figure 1). In addition, casting in sand-clay molds does not always provide castings with the required level of mechanical properties.

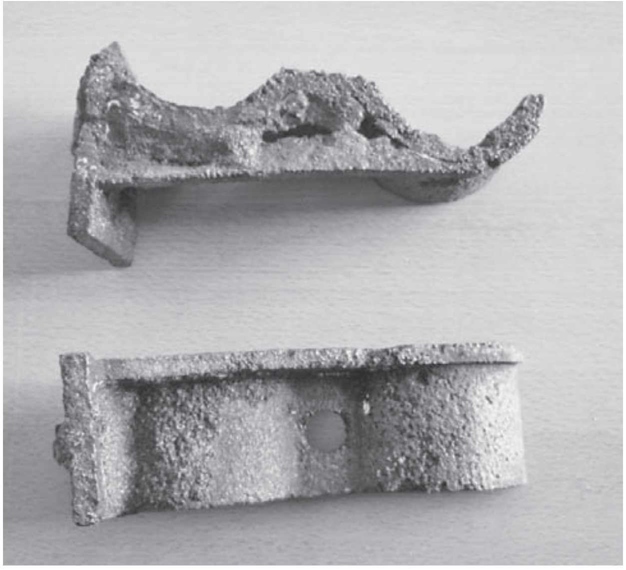

Figure 1 Incomplete molding and holes in the castings obtained by casting in sand-clay molds

EXPERIMENTAL PART
Equipment and tools

One of the important tasks in foundry production of mechanical engineering is increasing surface roughness of castings. In particular, obtaining castings of mining equipment with increased surface roughness.

Increasing roughness of mining equipment castings reduces specific amount of metal and size of allowances for machining [2]. Experimental studies to determine optimum casting manufacturing technique of part “Link” of mining conveyor by shell mold casting were carried out at Parkhomenko Karaganda Machine Building Plant LLP.

Experimental installation for the manufacture of shell molds made of sand-resin mixture (Figure 2) based on a forming semiautomatic device of model 51713 was developed for carrying out testing. It consists of the bunker in which sand-resin mixture is filled up, furnaces, plates for the additional application of loading, a table on which the electro-heated model plate with model is established.

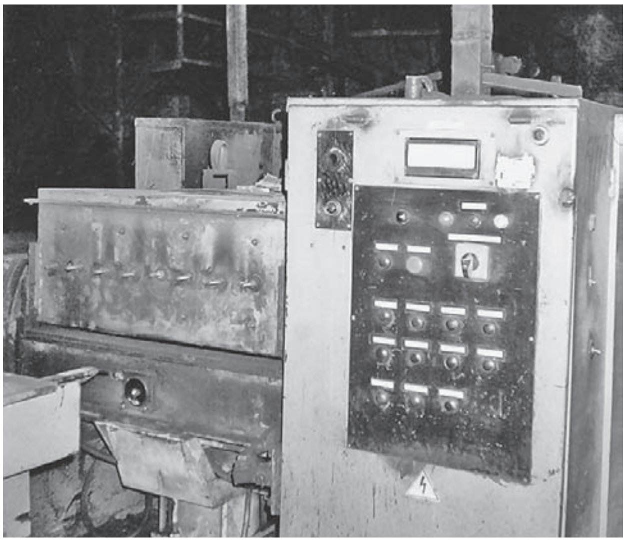

Figure 2 Experimental installation

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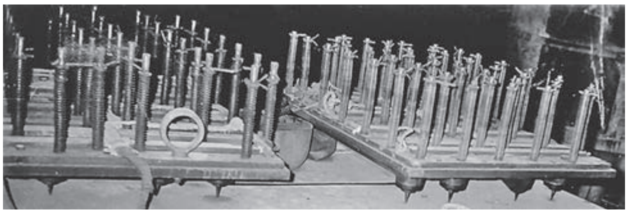

Figure 3 Casting models of "Link" (from side of pushers)

On a model plate castings of "Link" were established on which reverse side there were spring pushers (to separate a finished shell semi-mold from model) and electric heaters. The thermal sensor was also established there by means of which heating of a plate was controlled to 240 - 260 ^{0}C.

On the model a 100 mm high filling frame (molding) on perimeter coinciding with the bunker was established. Initially, models were covered with the shell of the drying furnace. Nearby there was the bunker in which mechanical mixture of sand was filled up with binder mixture and some additives. The machine can work both automatically, and manually.

Before work the model plate was covered with parting as which water mixture - 100 %, laundry soap - 3 %, PDMS (silicone) - 8 % were used. When applied on the hot model parting compound forms a thin and firm but heat-resistant film which remains after several removing covers from models.

When the molding machine switches on, the furnace rose up, and mix filling was carried out to the model plate from the bunker. At the same time the plate was lowered to the filling frame with filled mixture, giving static load on the mixture. Then the plate was reverted to initial state.

Under heat of pattern equipment, the binder mixture in a layer of the mixture directly adjacent to the model plate was melted and moistened sand grains.

After obtaining a shell, the plate came back to its initial state, and models with a shell were covered with the furnace in which temperature was about 350 ^{0}C. Instead of gas nozzles electric spirals were installed on furnaces. Thickness of a shell is 8 - 12 mm.

During the studies pattern-box equipment consisting of the following components was used:

– filling frame, size 800 × 600 × 100;

– heated model plate (Figure 3).

RESULTS AND DISCUSSION

To determine surface roughness of castings after cooling, samples with size of 30 × 30 × 15 mm were cut out by a disk mill. The plane of samples was smoothed out from easily separated burning of molding mixture. The rest burning (difficult separated) was removed in molding of a caustic soda at a temperature of 500 ^{0}C within 4 … 6 hours (when reaching constant weight of a sample). The relation of burning weight to the surface area of a sample (g / cm^2) was accepted to the quantitative characteristic of burning. As the obtained results of

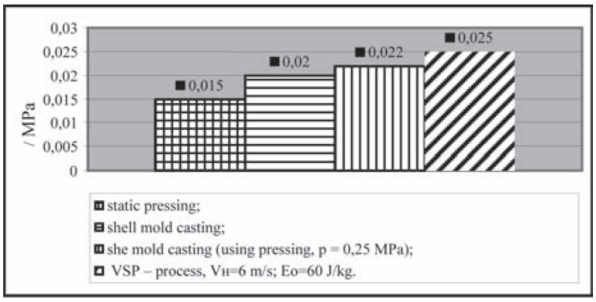

Figure 4 Impact of a compression method on burning

experiment show (Figure 4), the number of burning on castings can be reduced by the combined method (static pressure on mixture plus heating of sand-resin mixture).

In the sand-resin and sand-clay molds the liquid metal before surface skin occurs is able to penetrate deeper into the gaps between the grains due to insufficient degree of compaction. Compared to molds compacted by VSP process and compression process, wherein the intense forming process of a solid skin and mixture compaction process hampers the penetration of the liquid metal. Analysis of the experimental data shows that the amount of metal penetration depends on the casting wall thickness, the degree of compaction. For example, when used repressed operation casting shell molds, the number of burning in castings reaches 0,14 g /cm^2, whereas in the conventional filling without compaction mixture reaches 0,19 g / cm^2.

Analysis of the relative change in height of peaks on the mold surface showed that the increase of compaction causes improvement of surface roughness and molds, in turn, castings. Obtaining castings with a smooth surface can be achieved by using well-defined compaction modes. Roughness of castings was determined by roughness of molds.

As it can be seen (Figure 5), the dependence of the mold surface roughness on the casting surface roughness is linear and expressed by the dependence:

$$R_{zf} R_{zc} + = (20 \ldots 25\ \mu m).$$

The use of shell molds for the manufacture of mining equipment castings has significantly increased the roughness of the casting surface.

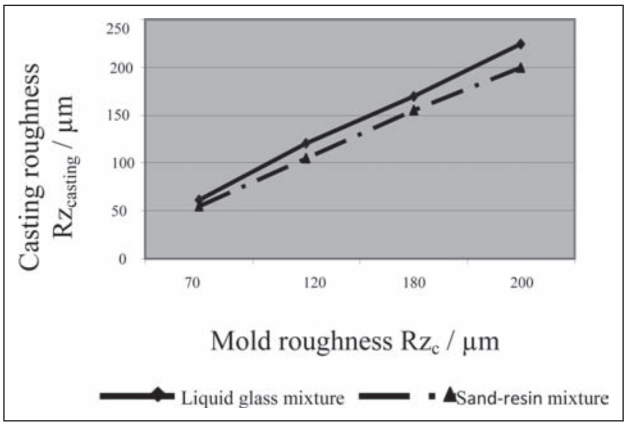

Figure 5 Dependence of casting roughness on mold roughness

CONCLUSIONS

The experimental data results to study the dependence of the burn-mixture to the pressure shown in Table 1 and the diagram (Figure 6). As can be seen from the diagram, the applied load during the formation of the shell mold significantly affects the size of burning in its decline.

Pressure 0,.18 ... 0.25 MPa, determined as the optimal for obtaining casting molds of "Link" can be regarded as very satisfactory and for the size of burning.

As the pressure increases, the reducing rate of burn-on castings decreases.

Table 1 **Impact of loading rate in the forming process of a shell on burning size of castings**

No.	Mixture pressure in the forming process / MPa	Burning size/ g / cm^2	Notes
1	0	0,19	Mixture composition: sand 1K0315 - 70 %+1K02 - 30 %, binder mixture – 5 %.
2	0,1	0,17	
3	0,2	0,14	
4	0,3	0,14	
5	0,4	0,12	
6	0,5	0,13	

Thus, according to results of the experiments the following conclusions can be drawn:

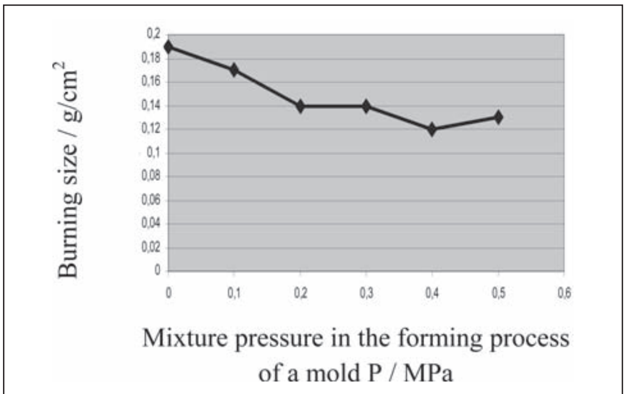

Figure 6 Dependence of burning size on the mixture pressure in the forming process

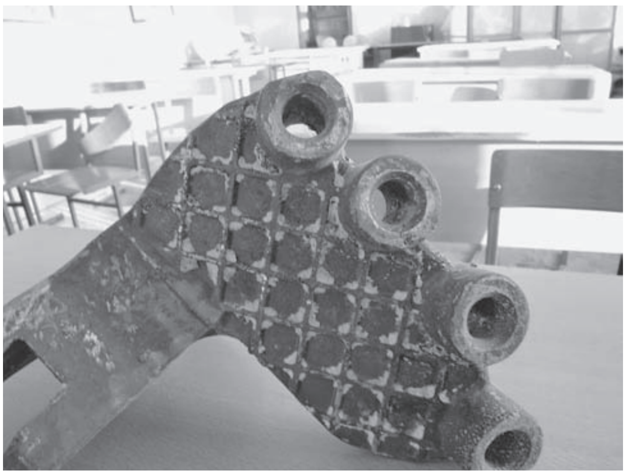

Figure 7 Casting "Link" with complicated geometry

- It is experimentally proved that the application of a load (1,8 ... 2,2 MPa) in the shell forming process significantly increases roughness of the mold surface, improves its mechanical properties, decreases the amount of burn-on castings (Figure 7).
- It is experimentally proved that increase in mixture pressure (on 0,03 … 0,05 MPa) reduces roughness of shell molds, without reducing technologically necessary size of gas permeability.
- Using this mold manufacturing technique for mining equipment castings is economically reasonable as the percent of casting defect decreases, specific amount of metal of castings due to casting wall thickness reduction and improvement of surface roughness decreases. Obtained molds have the uniform density and thickness of a shell, and also accurately reproduce a model configuration.
- It is experimentally proved that the suggested mold obtaining method for mining equipment castings is quite applicable under industrial conditions.
- After carrying out the appropriate heat treatment (depending on operating conditions of casting and

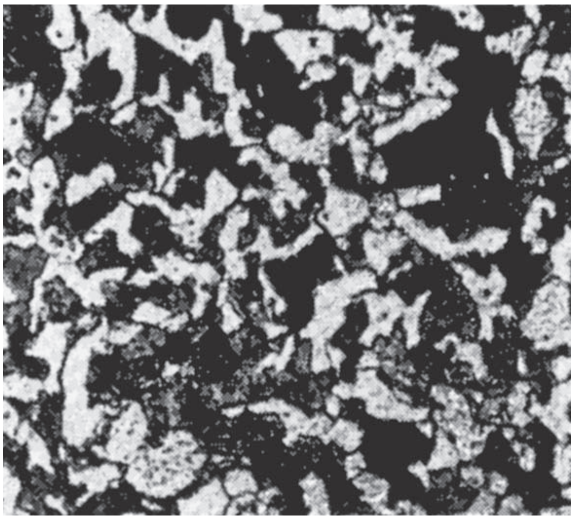

Figure 8 Microstructure of steel 45 after normalization (fine grains of ferrite and perlite, × 500)

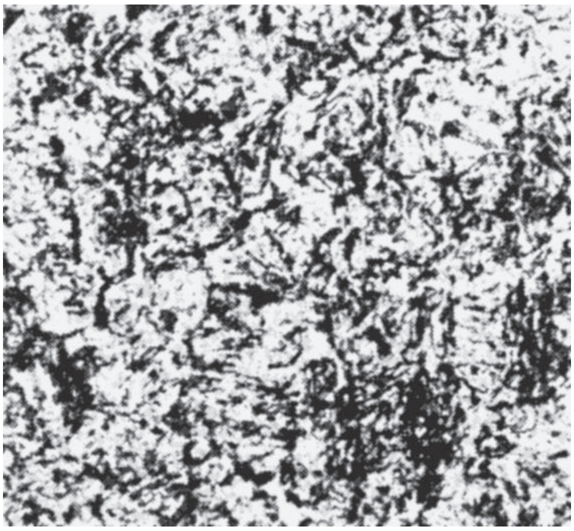

Figure 9 Microstructure of steel 45 after hardening in water (martensite, × 500)

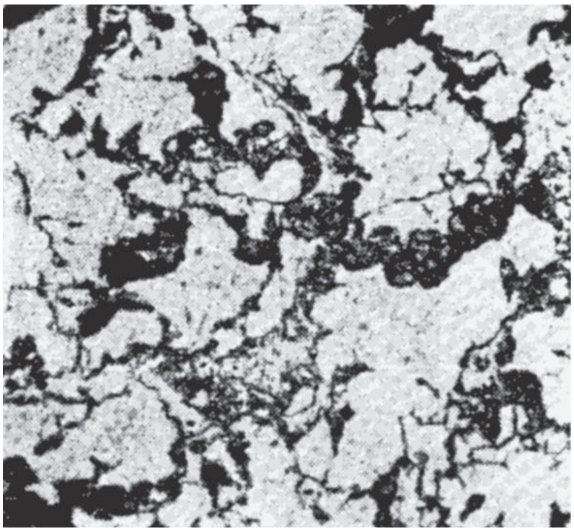

Figure 10 Microstructure of steel 45 after incomplete hardening (martensite, × 500)

its appointment) obtaining of the following microstructures of castings from steel 45 is provided: Figures 8, 9, 10.

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Note: The responsible for England language is Nataliya Drag, Karaganda Kazakhstan