PRESS-MOLD CASES MADE FROM CENTRIFUGALLY CAST WEAR-RESISTANT ALLOYS

A. A. Baranov, V. Yu. Slyusarev,
S. I. Marchuk, Yu. D. Sagalevich,
V. D. Chegonenko, N. P. Kabashnyi,
and V. F. Dzhos

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With the semidry method of shaping hollow refractories, the press-mold cases made of steel 20Kh followed by case-hardening and chilling are quickly worn out; their working life is usually several working shifts. Although the majority of other replaceable parts of the pressing equipment in the refractories industry are made from steel Kh12 [1], it was considered that the large dimensions of the casing (length more than 520, internal diameter 160-210 mm) and the thinness of the walls, equal to 10-20 mm, prevented them from being made of high-chromium steel alloys.

The Donetsk Polytechnic Institute and the Ukrognepornerud carried out research to increase the resistance of the press-mold cases. These were made from centrifugally cast, high-chrome cast iron IChK12 and steel Kh5M, whose chemical compositions are shown in Table 1.

The alloys were melted in an arc furnace and cast through a ladle with a stopper device into the centrifuge machine. The rotation frequency of the Ingot mold lined with a layer of quartz sand 5-6 mm thick was constant and equaled 1200 rpm. The cast blanks had an external diameter of 280, internal 150 mm, and length 7 m, which was due to the dimensions of the ingot available at the producer factory. In this case the yield of acceptable articles proved to be greater than in the production of casings from forgings.

The preliminary heat schedule for the blanks included homogenization at 1100°C for 7 h, recrystallization at 870°C, cooling to 500°C and annealing at 700°C in 12 h. After this treatment the hardness of the blanks did not exceed 250 HV which meant they could be easily machined.

The microstructure of the cast iron blanks was dense, without cracks and shrinkage pores; the zone of columnar crystals occupied a large part of the casting's volume. In the macrostructure of the steel blanks, we

<table>
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<th>TABLE 1. Chemical Composition of Alloys, %*</th>
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<td>Steel</td>
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<td>IChKh</td>
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<td>Kh5M</td>
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*Here and subsequently weight proportions indicated.

Fig. 1. Microstructure of centrifugally cast blanks made from iron, on external surface (a), in the internal part (b), and on the central part (c), × 100.
noted small pores arranged in the central part of the casting. In the cast-iron blanks the structure varied in the radial direction; toward the internal surface the amount of eutectic carbides arranged on the grain boundaries increased (Fig. 1), which is connected with the liquation of the carbon, chromium, and other elements in the radial direction [2]. The eutectic carbides were significantly dispersed compared with the station-cast iron of the same composition. The liquation in the steel blanks caused the development on their internal surfaces of small sections of eutectic carbides.

Preliminary laboratory studies showed that with a rise in chilling temperature for high-chrome cast iron from 850 to 1150°C the amount of residual austenite in it increases and reaches 90%; the dimensions of the grains of austenite do not change much, and the relative wear resistance of the material increases. A slight increase in the wear resistance is also noted with a rise in temperature used to chill the steel Kh5M from 850 to 950°C; the properties of the material in this case vary slightly.

As a coolant for the laboratory specimens we used oil, air, or liquid nitrogen. Cooling was done by the combined method: first, in oil or in air, and then in liquid nitrogen. The combined cooling somewhat increased the wear resistance of the blanks which is connected probably with the more complete breakdown of austenite, and the creation of high compressive stresses contributing to the conversion of the metastable austenite into deformation martensite.

The blanks were used to obtain cases of two standard sizes: length 750 and 520 and internal diameter 202 and 206 mm, respectively. The cases made of centrifugally cast iron in production conditions were heated to maximum possible temperatures in gas-flame furnaces (1080-1100°C), and those from steel Kh5M – to 950°C. The working surface of the case was protected with spent carburizing compound in which the specimen-markers were located to check the hardness and microstructure. After hardening in oil, the hardness of the cast iron cases was 43–45 HRC, the quantity of residual austenite 65%, and the hardness of the steel cases 57–59 HRC. The microstructure of the cast iron cases after chilling is shown in Fig. 2. The change in the linear dimensions and the ellipticity of the cases were slight and did not exceed 0.2 mm. When the cases were placed in the molds, the ellipticity was completely eliminated and there were no cracks.

Tests on the experimental cases made from centrifugally cast Kh5M after hardening from 950°C in oil showed no essential increase in wear resistance compared with steel 20Kh cases.

Tests on the cases made from centrifugally cast iron were made on the Laes press at the Zaporozhe Refactories Factory during the forming of high-alumina articles, causing enhanced abrasive wear. The resistance of the experimental cases for the molds during the first setting in the press proved to be three times greater than in ordinary cases. Originally the cases were made with the minimum tolerance; rejects after operation were slight, and after regrinding they were again fitted in the mold. The resistance after regrinding was not reduced. Thus, the use of cases made of centrifugally cast high-chromium cast-iron increases their resistance by at least 5 times compared with cases from 20Kh steel after case hardening and chilling, and substantially reduces the downtime of the equipment for replacing parts.

CONCLUSIONS

The cases of press-molds having large linear dimensions and thin walls can be obtained from centrifugally cast high-chromium cast iron with subsequent hardening at 1080-1100°C in oil. The resistance of the experimental cases when first placed in the mold is three times greater than in ordinary cases made of 20Kh steel. The regrinding of the cases within the tolerance limits for refractory products, specified by GOST 5500-75, and subsequent operation without additional heat treatment, makes it possible to boost their overall resistance.