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Development of Technology for Obtaining a High-Quality Alloy

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ABSRACT: Due to the high tendency of alloyed white cast iron to gas pores, it is difficult to obtain quality castings from them. This article suggests several technologies to solve the following problems. In addition, sands and rods for pumps and collars made of 280X29NL and 300X32N2M2TL alloyed white cast iron were selected. For pumps and collars, it is recommended to obtain high-quality castings with good granularity of sand and its degree of purity, as well as the gas permeability of the rod.

KEY WORDS*:* high-alloy white cast irons, material, foundry, casting mold, shrinkage hole, gas pore, sand and rod.

I.INTRODUCTION

High-alloy white cast irons are an important group of materials whose production must be considered separately from that of ordinary types of cast irons. In these cast iron alloys, the alloy content is well above 4%, and consequently they cannot be produced by ladle additions to irons of otherwise standard compositions. They are usually produced in foundries specially equipped to produce highly alloyed irons.
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II. SIGNIFICANCE OF THE SYSTEM

White cast irons are very prone to the formation of shrinkage holes, and therefore, when casting from these alloys, the rods should be set in the same way as when casting from steel. Top and side gains are applied. If possible, the metal should be poured through the rods, which guarantees its directional solidification. In view of the difficulty of any processing of white cast irons, the grommets must be easily detachable by means of “pinching”.

III. LITERATURE SURVEY

Due to the high tendency of alloyed white cast iron to gas pores, it is difficult to obtain quality castings from them. This article suggests several technologies to solve the following problems. In addition, sands and rods for pumps and collars made of 280X29NL and 300X32N2M2TL alloyed white cast iron were selected. For pumps and collars, it is recommended to obtain high-quality castings with good granularity of sand and its degree of purity, as well as the gas permeability of the rod.
For this, a thin rod is placed between the riser and the casting (Fig. 1).

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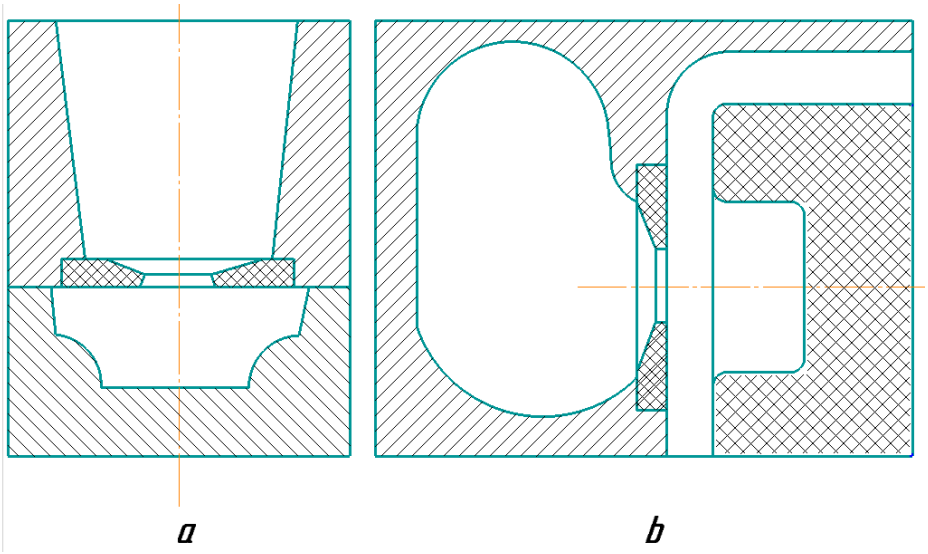

Figure: 1. Easily separable profits: upper (a) and lateral (b)

The dividing rods are made from a rod liquid glass mixture. For massive profits, dividing rods from clayey chamotte, chromomagnesite clay mixtures are used. Installing several risers instead of one large one allows you to equalize the cooling rate of different parts of the casting, which helps to reduce thermal stresses. It is recommended to calculate the profits according to the norms for steel casting.

IV. METHODOLOGY

The gating system of white iron castings, especially nihard type, due to their lower liquid fluidity, should have a larger (20–40%) cross-sectional area than gray iron castings. The feeders, like the rods, must have pinches at the point of their connection with the casting, so that they can be easily beaten off. If the design of the casting allows, the feeders and risers should be buried in the body of the casting so that the protrusions remaining after the beating of the feeders and risers do not go beyond the contour of the casting surface mating with other parts.

It is noted [1, 3] that in order to obtain minimum thermal stresses, it is necessary to supply feeders to the thin parts of the casting and to disperse the supply of metal. To avoid difficult shrinkage, the gating system should not form a rigid connection with the casting. This can be achieved by pouring metal through two risers.

Form technology. Since white cast irons are prone to cracking, a technology must be used that ensures the production of castings with the lowest possible stresses. It is possible to reduce stresses by decreasing the cooling rate of the casting in the mold, equalizing the temperature of different parts of the casting, and decreasing the mechanical inhibition of shrinkage.

The use of sand molds instead of metal molds allows for a slower and more uniform cooling of the casting, reduces mechanical inhibition of shrinkage, which ensures lower stresses. Dry molds are better than wet molds, provide slow cooling of the casting, but create greater mechanical resistance to shrinkage. Therefore, dry molds help to eliminate cold cracks and increase (compared to wet) the risk of hot cracks.

The main measure for dealing with hot cracks is to increase the malleability of the molding sand and eliminate the causes that make shrinkage difficult. In the production of castings from wear-resistant alloys, it is recommended to make the rods from a mixture containing at least 20% sawdust and not more than 5% clay to increase the flexibility of the rods. You should select such mixtures that, when heated, quickly lose their strength and minimally resist shrinkage at high temperatures.

Rods for castings from wear-resistant cast irons at NMMC were made from a mixture of composition,%: open pit sand - 30, refractory clay - 5, burnt molding mixture - 45, sawdust - 20.

When making rods from this mixture for the impellers of the 10UVLKh2M pump (weight 150 kilos), hot cracks sometimes appeared, which were caused by insufficient compliance of the rods from this mixture.

Then the sand of the quarry, containing 12-15% of clay, was replaced by sand, in which the clay content did not exceed 5%.

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Vol. 7, Issue 10 , October 2020

This increased the flexibility of the rods and eliminated the marriage by cracks [2].
The use of molds, in particular metal molds and with refrigerators that accelerate crystallization, makes it possible to obtain high wear resistance and strength of massive castings.
Installation of special external and internal coolers in massive parts of castings helps to equalize temperatures over the section of the part and, consequently, to reduce stresses in castings.
Duration of exposure of castings in the mold. Increasing the holding time of the castings in the mold helps to reduce stresses. The holding time depends on the geometry and weight of the castings. For example, comparatively compact and equal castings of impellers of pumps 8SHNV with a diameter of 500 mm (weight 130 kilos) from 280X29NL cast iron were knocked out of the mold 5–6 hours after pouring, while there were no cracks. Thin-walled castings of impellers of pumps 10UVLH2M with a diameter of 650 mm (weight 150 kilos) must be kept in the mold for at least 12 hours; knocking out these castings 6 hours after pouring led to the formation of cold cracks on the wheel rims. Large and complex impellers of pumps 20GR 8 and 20P 11 are kept in the mold for about 72 hours. Castings such as armor plates for mills should be kept in the mold for 8–24 h, depending on the thickness and weight of the casting. The method of quick knocking out of castings of impellers and pump casings weighing up to 400 kilos and mill linings weighing up to 500 kilos turned out to be good.
These castings were removed from the metal molds 12–15 minutes after pouring and placed in the recesses (on a sand bed), and then covered with a layer of dry sand. The temperature of the castings during knockout was 800–900 ° C. This technology completely eliminated the appearance of cold cracks in castings.
For castings from white iron, depending on their purpose, complexity, mass production, one or another type of casting mold, cores, cooling mode, etc.

V. EXPERIMENTAL RESULTS

Slurry pump parts. Snails, armor disks and impellers are the most common, made of white cast iron.
Casting these parts (small mass and with the same wall thickness) is not very difficult. The manufacture of large-sized castings with walls of different thickness is difficult due to the tendency of such parts to crack formation, therefore, a very thorough development of the technology is required.
At most domestic enterprises, pump parts are made of cast irons 300X32N2M2TL, 280X29NL.
Table 1 shows the composition and properties of molding and core sands used in the manufacture of castings for slurry pumps in the foundry of FMP.

Table 1

Molding and core mixtures used in the manufacture of slurry pump castings

A. Mixture	*B.* Composition, vol. %					
	C. quartz sand *D.* *E.* 1K025A *F.* 1K025A	*G.* clay *H.* refractory	*I.* spent *J.* molding *K.* mixture	*L.* woody *M.* sawdust	*N.* liquid *O.* glass	*P.* NaOH
Q. № 1. Fillingmolding *R.*	*S.* –	*T.* –	*U.* 100	*V.* –	*W.* –	*X.* –
Y. № 2. Facingmolding	*Z.* 24,5	*AA.* 2,5	*BB.* 73	*CC.* –	*DD.* –	*EE.* –
FF. № 3. Facingliquidglass	*GG.* 98	*HH.* 2	*II.* –	*JJ.* –	*KK.* 7	*LL.*–
MM. № 4. Rodliquidglass	*NN.* 86	*OO.* –	*PP.* –	*QQ.* 14	*RR.* 4,5	*SS.* 0,45
TT. № 5. Rodforcenterrods	*UU.* 78	*VV.* 4	*WW.* –	*XX.* 18	*YY.*–	*ZZ.*–

AAA. Mixture	*BBB.* Composition, vol. %		*CCC.* Physical and mechanical properties			
	DDD. fueloil	*EEE.* Sulfite bard	*FFF.* gaspermeabl evalue	*GGG.* σ_v^{sj} *HHH.* N/m m^2, *III.* in wet *JJJ.* cond	*KKK.* σ_v^{sol} *LLL.* N/m m^2, in dry *MMM.* cond ition	*NNN.* W ,%

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Vol. 7, Issue 10 , October 2020

				ition		
OOO. № 1. Fillingmolding	*PPP.* –	*QQQ.* –	*RRR.* 50	*SSS.* –	*TTT.* –	*UUU.* 5 - 6
VVV. № 2. Facingmolding	*WWW.* –	*XXX.* 3,5	*YYY.* 100	*ZZZ.* 3,5 - 5	*AAAA.* –	*BBBB.* 4, 5 – 5,5

Окончание таблица 1

CCCC. Mixture	*DDDD.* Composition, vol. %		*EEEE.* Physical and mechanical properties			
	FFFF. Sulfitebard	*GGGG.* gaspermeablevalue	*HHHH.* Sulfitebard	*IIII.* gaspermeablevalue	*JJJJ.* Sulfitebard	*KKKK.* W,%
LLLL. № 3. Facingliquidglass	*MMMM.*–	*NNNN.* –	*OOOO.* –	*PPPP.* –	*QQQQ.* –	*RRRR.* –
SSSS. № 4. Rodliquidglass	*TTTT.* 0,45	*UUUU.* –	*VVVV.* 100	*WWWW.*1,0 – 1,7	*XXXX.* 100	*YYYY.* 3 – 3,8
ZZZZ. № 5. Rodforcenterrods	*AAAAA.* –	*BBBBB.* 4	*CCCCC.*100	*DDDDD.* 2,0	*EEEEE.* 80 - 100	*FFFFF.* 4 - 5

The snail is cast in sand molds, the facing layer of which is made from mixture №. 2 (see Table 1), the inner surface of the part is formed by a rod. In fig. 2 shows a diagram of the casting of a 12 GR 8 pump volute (its weight is about 485 kilos). The metal is fed through the mold connector to the outer surface of the casting through four feeders with a section of 15 x 34 mm each.

ISSN: 2350-0328
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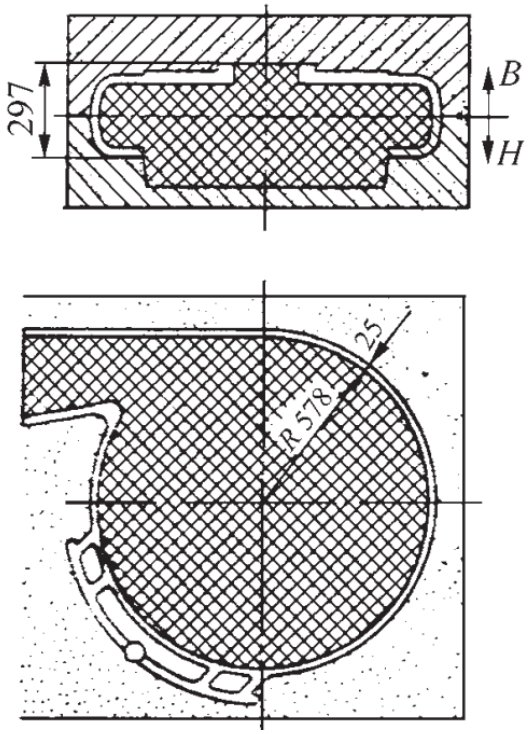

Figure: 2. Diagram of the molding of the pump snail casting 12GR - 8 (weight about 485 kilos)

Armored discs are cast in sand molds from liquid glass mixture №. 4, blown by CO_2.
The use of this mixture made it possible to drastically reduce the marriage of dinners.
The supply of metal (when casting the armor of the 12GR-8 pump disk weighing 80 kilos) is carried out through the mold connector to the inner surface of the casting through four feeders with a section of 1226 mm each.
To increase the flexibility of the rods, a significant amount of sawdust is introduced into the rod mixtures.
Impellers. The metal is fed to the lower disc through four feeders 15 mm high and 34 mm wide each (Fig. 3). The casting is made in sand molds, the outer layer is made of facing mixture №. 3 (see Table 1).

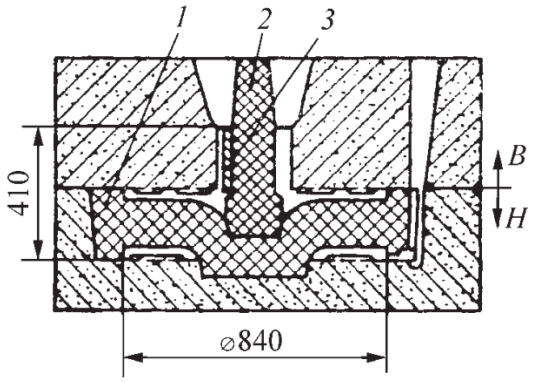

Figure: 3. Diagram of the casting of the impeller (weighing about 280 kilos) of the pump 12GR - 8 (1-3 cm. Text)
Rod 1, made of liquid glass (with sawdust) mixture №. 4, is covered with zircon paint and dried. Rod 2 is made from rod mixture №. 5. Before installation in the shape of rod 2, insert 3 of steel St.3 is attached to it (installed in the groove of the rod and tied with wire). The insert and wire must be thoroughly free of rust. The mold is poured at 1350 - 1400 ° C. The casting cools down in the mold for 14–20 hours, then, after knocking out and cleaning from the cores, it is cleaned in a shot blasting chamber. Feeders and bays are beaten off, and their remains are cleaned with abrasive wheels, the profit is cut off on a lathe in the process of machining the casting.

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Vol. 7, Issue 10 , October 2020

Heat treatment of castings from cast iron 300X32N2M2TL is usually not carried out. It is recommended [4] that cast iron 280X29NL be kept in the mold after pouring at the rate of 1 hour for every 10 kilos of cast metal.
The casting of impellers of pumps of the 5GR-8, 8GR-8 type (weight 80 and 100 kilos, respectively) and others (smaller than 12GR-8) is often performed without profit, and the shrinkage cavity in the thermal unit of the wheel hub is eliminated using different refrigerators ..
Casting according to this scheme (Fig. 4) and mechanical processing of a large batch of 6FSH - 7 a pump impellers from 280X29NL cast iron showed the rationality of this technology, which makes it possible to obtain dense castings without shells without using profits.

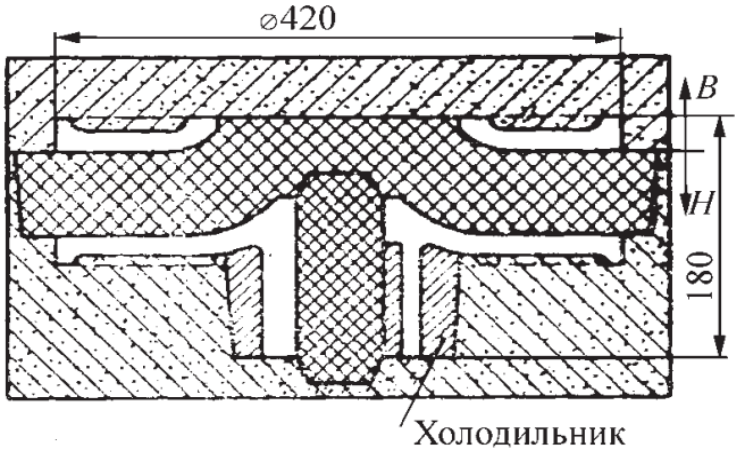

Figure: 4. Forming scheme with a cooler (at the hub) of the pump impeller 6FSh – 7 a (weight about 90 kilos)
At NMMC, when concentrating copper ore, 8NP slurry pumps were used. The impellers of these pumps were made with discs of different thicknesses, since the disc on the pressure side wore out faster and therefore was made thicker.
A diagram of the 8NP impeller forming is shown in Fig. 5 However, this technology did not ensure the elimination of shrinkage looseness in the thick disc and, despite the thickening of this disc, slightly increased the service life of the part.
A technology was developed (Fig. 6) with the use of a metal insert - a refrigerator, which made it possible to eliminate shrinkage looseness and provide a significant increase in the service life of the impeller and pump 8NP.

Casting of slurry pump parts into metal molds. In most cases, the designers of slurry pumps, knowing the difficulties of machining parts made of white cast iron, tend to design parts of these machines with a minimum amount of machining. Often, machining is reduced to the so-called surface inspection [5],

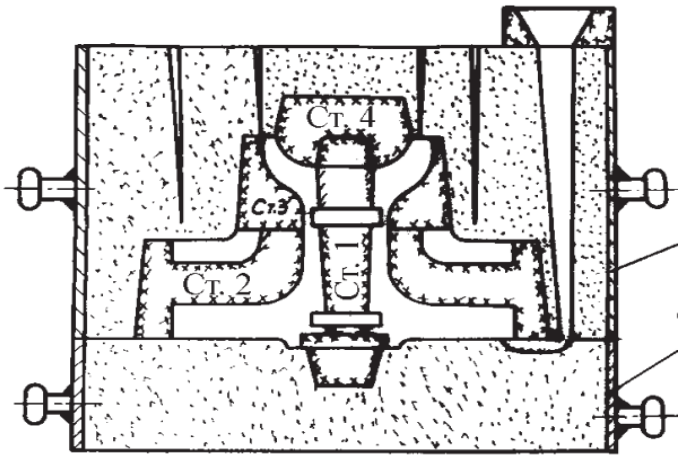

Figure: 5. Scheme of forming impellers 8NP

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Vol. 7, Issue 10 , October 2020

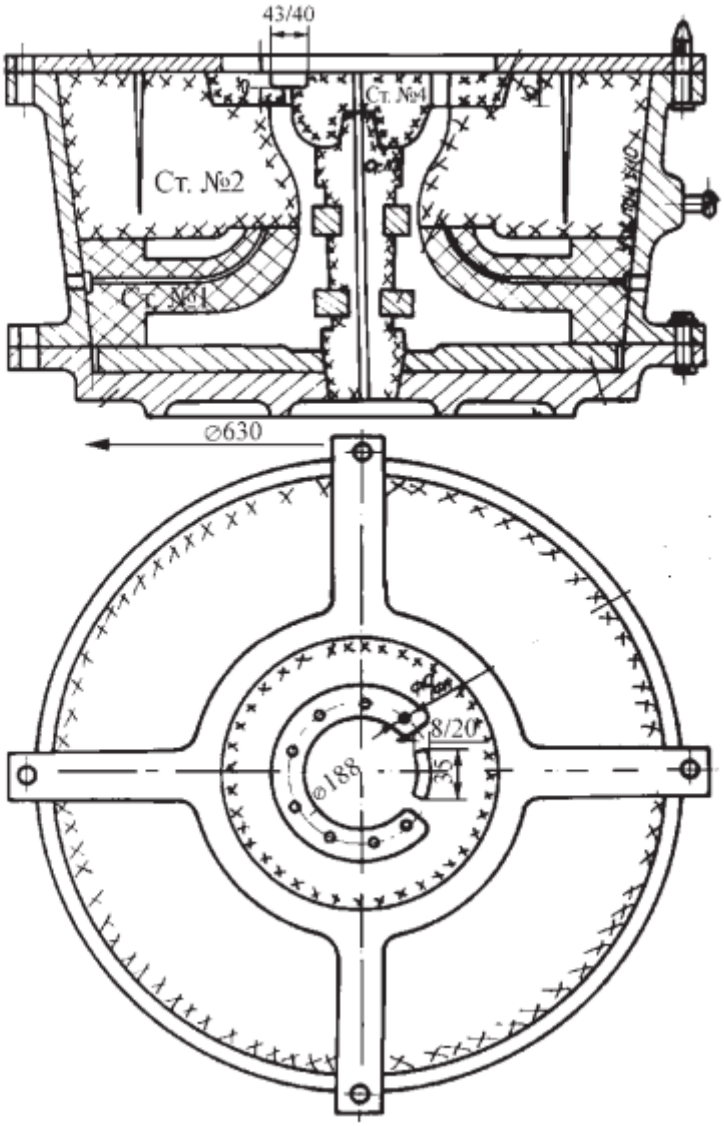

Figure: 6. Scheme of forming 8NP impellers using a refrigerator (insert)

as casting into earthen molds does not provide sufficient accuracy, and there are sometimes protrusions on the castings (due to uneven density of the earthen mold). These circumstances force to carry out 100% machining of the slurry pump parts.

Quality castings can be obtained using the recommended technology.

VI.CONCLUSION AND FUTURE WORK

Due to the high tendency of alloyed white cast iron to form gaseous pores, it is somewhat difficult to obtain quality castings from them. The optimal form for alloyed white cast iron was selected using the technology we recommend, and it was mentioned that this form can be used to obtain high-quality castings without gas pores. Also, the technology of obtaining quality castings from alloyed white cast iron depends on many factors. For this reason, mold sands and rods were selected for pumps and collars made of alloyed white cast iron. The selection was made taking into account the degree of purity of the mold sand and the clays in the mold sand and their size. At the same time, binders for the stem and additives were selected to improve gas permeability. In conclusion, it has been proved that it is possible to obtain quality castings for pumps and collars from alloyed white cast iron using the proposed technology.

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Vol. 7, Issue 10 , October 2020

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