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DEVELOPMENT NEW BRANDS OF RESISTANCE WHITE CAST IRONS

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Abstract:
This article, high-chromium 280X29NL cast iron has been modified to reduce the chromium content from 28.86 to 31% to 16 to 18%, Mo 2%, Ti to 1.72%, Cu to 1%, without changing the chemical composition and without reducing the mechanical properties of the alloy. new five-brand alloys have been developed that are relatively inexpensive and brittle.

Keywords: Alloy, Induction Furnace, Chromium, Molybdenum, Titanium, Structure, White Cast Iron, Cementite, Grinder.

INTRODUCTION

According to the results of research conducted by professors and teachers of the Department of "Casting Technologies" of Tashkent State Technical University at the enterprise "NMZ" of Navoi Mining and Metallurgical Complex, currently in abrasive operating conditions in mining, metallurgy, chemical engineering and a number of other enterprises casting of working machine parts from alloy cast iron is underway. 280X17M2L, 280X15TDL, 280X14MDL, 280X11DL, 270X18G3L, 280X29NL, 300X32N2M2TL brands of cast iron are mainly used.

Nowadays, mechanical engineering requires the use of materials with good mechanical properties, but alloys that increase the tensile strength, relative elongation and strength, as well as the properties of abrasion resistance, corrosion resistance, heat resistance, ie other types of abrasive and aggressive details are important to increase the service life of parts under different operating conditions. First of all, it applies to alloys such as iron-carbon alloys, including high-chromium cast iron, the production of which is increasing year by year [1].

Cast iron is an unwanted alloy of iron-carbon alloys with a carbon content higher than 2.14%. The components of the alloy affect its color during fracture: the surface formed by the refraction of a white cast iron sample appears white back to sunlight, which is why white cast iron is composed entirely of cementite. Cementite name Floris Osmond and J. According to Vert's research, iron is a chemical compound formed with carbon (Fe_3C), which contains 6.67% carbon, an substance with an orthorombic crystal structure, high hardness. Cementite is present in many steels and cast irons, and its crystalline structure is shown in Figure 1.

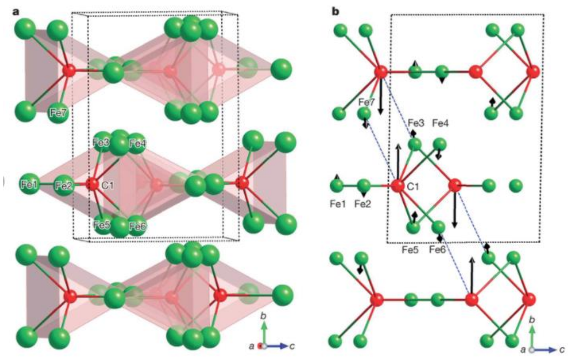


Figure 1. Orthorombic Fe_3C. Crystal structure of cementite

The corrosion resistance of cast iron is mainly provided by carbides with a structure (Cr, Fe, Mn) $_7$ C_3. This is because this carbide is 1.5 to 2.0 times harder than cementite carbide. Another complication associated with this is that the amount of chromium in cast iron with 3% C for the formation of carbides in the system C_3 (Cr, Fe, Mn) $_7$ C_3 is a maximum of 12 to 27% [2].

MATERIALS AND METHODS

At present, the defects of the disks of CEMCO and BARMAK crushers operating on the basis of centrifugal force in the process of crushing ore in the production conditions of NMZ of Navoi Mining and Metallurgical Plant and the causes of their formation were analyzed.

Figure 2. Appearance of a disc cast that has become unusable

In order to increase the service life of the part by providing strength on the surfaces of parts with a high tendency to corrosion under the influence of strong stress and a high probability of cracking, changes were made in its chemical composition. Research work of domestic and foreign manufacturers on ductile high-chromium cast iron-based cast alloys, as well as research conducted by foreign research institutions and laboratories to extend the service life of cast discs made of high-ductility chromium cast iron.

The chemical composition of the ingot is developed in order to increase the ductility of high-chromium cast iron castings in order to increase the service life of high-friction discs of CEMCO and BARMAK crushers, which operate mainly by centrifugal force. [3]. Five chemical compositions have been developed that are economically inexpensive without reducing the mechanical properties of brittle white cast iron alloys Table 1.

Table 1

The chemical composition of the proposed alloy

Brands	**Elements, %**									
	C	**Si**	**Mn**	**Cr**	**Mo**	**Ti**	**Ni**	**Cu**	**P**	**S**
280X17M2L	2,8-3,0	1,1-1,2	0,6-0,8	17,2-18,2	1,8-2,0	-	-	-	0,022-0,024	0,007-0,009
280X15TDL	2,8-3,0	1,1-1,2	0,6-0,8	15-16	-	1,31-1,78	-	-	0,02-0,04	0,07-0,09
280X14MDL	2,8 – 3,0	1,1 – 1,2	0,6-0,8	14-15	0,8-1,0	-	0,9-1,0	0,9-1,0	0,02-0,04	0,07-0,09
280X11DL	2,8 – 3,0	1,8 – 2,0	0,4 – 0,5	10–11	-	-	-	-	0,04 – 0,05	0,04 – 0,05
270X18G3L	2,7-3,2	0,4-0,8	3,8-4,0	19-20	-	-	-	-	0,05-0,06	0,04-0,05

Based on the chemical composition given on the basis of **the first proposal**, the slag was calculated and the IST - 0.4 induction furnace (see Table 1) was first equipped with 250 kg of B65 (return), 135 kg of cast iron (pig iron) and 13,350 kg of FeMo 60, 2 kg. FeSi 75, 1,250 kg FeMn 90 ferroalloys were isolated. After the first start-up of the furnace, 125 kg of B65, 75 kg of cast iron and 8 kg of FeMo 60 were loaded into the furnace. modifiers were loaded in the furnace and bucket at 0.4 – 0.6% by weight. Al, Mg, and Ti were used as modifiers. The process of liquefaction of the sample took 2:50 hours and the slag separated from the liquid alloy was removed from the furnace (slag mass was 10.6 kg, metal burning in the furnace was 2 – 3 %, ie 8 – 12 kg) and poured into a sand – clay mold.

Based on the chemical composition given on the basis of **the second proposal**, the charge was calculated and IST - 0.4 induction furnace, first of all 242 kg B65 (return), 150 kg cast iron (pig iron) and 5 kg FeTi 35, 3 kg FeSi 75, 1,250 kg FeMn 90 ferroalloys were isolated. After the first start-up of the furnace, 121 kg of B65, 75 kg of cast iron and 19.7 kg of FeTi 35 were loaded into the furnace. due to the weight of the liquid metal, modifiers were loaded in the furnace and bucket at 0.4-0.6%. Al, Mg, and Ti were used as modifiers. The sample dilution process took 3:10 hours. Then the slag separated from the liquid alloy was removed from the furnace (slag mass was 9.8 kg, metal burning in the furnace was 2-3%, ie 9-10 kg) and modifiers were added to the heated bucket and poured into a sand-clay mold.

Based on the chemical composition given on the basis of **the third proposal**, the charge was calculated and IST - 0.4 induction furnace, primarily 234 kg B65 (return), 157 kg cast iron (pig iron) and 4,250 kg Cu, 6,650 kg FeMo 60, 1,750 kg of FeSi 75 and 1.0 kg of FeMn 90 ferroalloys were isolated. After the first start-up of the furnace, 117 kg of B65, 80 kg of cast iron and 6,650 kg of FeMo 60 were loaded into the furnace, and after 1:25 h due to the weight of the liquid metal, modifiers were loaded in the furnace and bucket at 0.4-0.6%. Al, Mg, and Ti were used as modifiers. The sample dilution process took 3:22 hours. Then the slag separated from the liquid alloy was removed from the furnace (slag mass was 11.0 kg, metal burning in the furnace was 2-3%, ie 7-8 kg) and modifiers were added to the heated bucket and poured into a sand-clay mold.

Based on the chemical composition given on the basis of **the fourth proposal**, the charge was calculated and 202 kg of B65 (return), 195 kg of cast iron (pig iron) and 2 kg of FeSi 75, 1,250 kg of FeMn 90 ferroalloys were first allocated to the IST-0.4 induction furnace. After the first start-up of the furnace, 105 kg of B65, 100 kg of cast iron and 1:15 hours later, the remaining B65, cast iron and 2 kg of FeSi 75, 1,250 kg of FeMn 90 ferroalloys and the weight of the liquid metal in the furnace, 0, At 4 - 0.6%, the modifiers were loaded in the furnace and bucket. Al, Mg, and Ti were used as modifiers. The sample liquefaction process took 3:30 hours. Then the slag separated from the liquid alloy was removed from the furnace (slag mass was 7.9 kg, metal burning in the furnace was 2-3%, ie 8-9 kg) and modifiers were added to the heated bucket and poured into a sand-clay mold.

Based on the chemical composition given on the basis of **the fifth proposal**, the charge was calculated and 260 kg of B65 (return), 124,500 kg of cast iron (pig iron) and 1,750 kg of FeSi 75, 13,800 kg of FeMn 90 ferroalloys were first allocated to the IST-0.4 induction furnace. After the first start-up of the furnace, 130 kg of B65 and 115 kg of cast iron were loaded into the furnace, and after 1:40 hours, the remaining B65, cast iron and 1,750 kg of FeSi 75, 13,800 kg of FeMn 90 ferroalloys and the weight of the liquid metal in the furnace were added 0.4 - 0.6% modifiers were loaded in the furnace and bucket.

Al, Mg, and Ti were used as modifiers. The sample dilution process took 3:25 hours. Then the slag separated from the liquid alloy was removed from the furnace (slag mass was 9.6 kg, metal burning in the furnace was 2-3%, ie 7.5-8 kg) and modifiers were introduced in the heated bucket.

After the liquid alloy was completely liquefied in the furnace, the temperature of the thermocouple Positherm alloy was determined to be 1410 - 1482^0 C. Before pouring it into the bucket, the bucket was heated to 750 - 800^0 C on a gas burner for 40 - 45 minutes (Fig. 3)..

Figure 3. In the process of heating the bucket on a gas stove

The main reason for this is that the inside of the bucket is watered with quartz sand (80%) and liquid glass (20%), and if a liquid alloy is poured into the bucket in the cold state due to moisture, the alloy will scatter and oxidize due to high alloy temperature. Therefore, by heating the bucket and using a thermocouple Positherm, the temperature of the alloy was determined at a temperature of 1410 - 1482^{0}C, it was removed into the bucket and a certain amount of FeSi 75 and Al was introduced into the bucket. The main purpose of this was to recover Fe in FeO. The following reaction occurs [4]:

$[2FeO] + [Si] \rightarrow (SiO_2) + [2Fe] + Q$

$[FeO] + [Mn] \rightarrow (MnO) + [Fe] + Q$

$[5FeO] + [2P] \rightarrow (P_2O_5) + [5Fe] + Q$

$[3FeO] + [2Al] \rightarrow (Al_2O_3) + [3Fe] + Q$

After the FeO was recovered in the bucket, the liquid alloy was poured into the sand-clay mold through a side-by-side injection system. For all four proposed samples, the slag was calculated, liquefied in an IST-0.4 induction furnace and poured into a sand-clay mold. Figure 4 shows the appearance of a mold made by placing four supply disc details on a sand-clay mold. As can be seen from this figure, the liquid metal flowing from the main supplier fills the mold cavity through the auxiliary suppliers, and each mold cavity is supposed to fill the mold cavity from the mold cavity to the second mold cavity so that it is filled evenly.

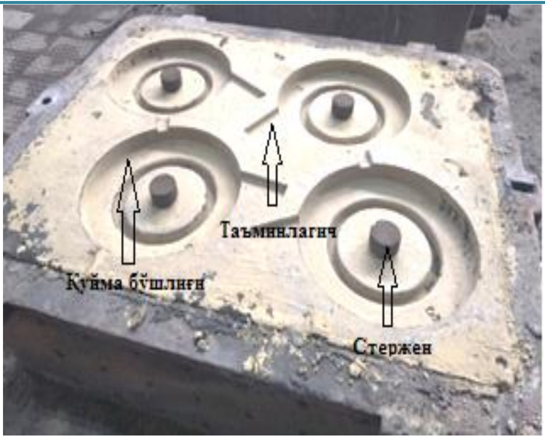


Figure 4. Sand-clay mold prepared for casting from liquid alloy

Castings in a sand-clay mold were sprayed with air and carbon dioxide under a certain pressure. As a result, the sand-clay mold was cooled to 2-150 degrees / min.

The total weight of the liquid alloy was 400 kg, of which an average of 8 - 10%, ie 7.9 to 11.0 kg of slag (slag density 2.5 g / cm^3, the composition of the slag from MnO, FeO, SiO_2, CaO, P_2O_5 mirror additives)) and the combustion of the metal averaged 2 to 3 percent and amounted to 7 to 12 kg [5].

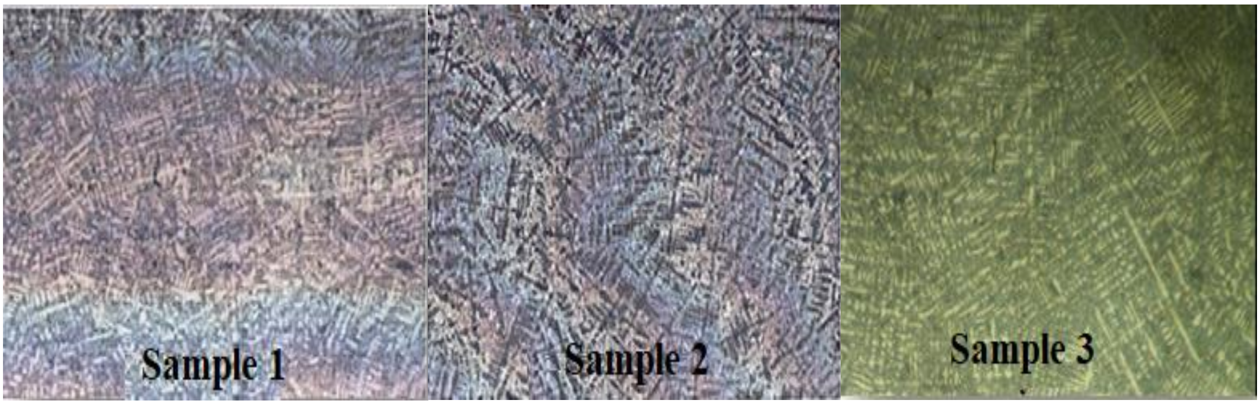
RESULTS

After removal of the liquid alloy from the slag, a sample of the liquid alloy was taken, the composition of the alloys was determined on the equipment "SPEKTROLAB - 10 M" in the Main Laboratory Center of the plant "NMZ" and the following chemical composition was obtained.

Table 2
Chemical composition of alloys

Brands	Elements, %									
	C	Si	Mn	Cr	Mo	Ti	Ni	Cu	P	S
280X17M2L	2,87	1,18	0,89	16,53	2,07	-	0,63	0,61	0,062	0,036
280X15TDL	2,75	1,87	0,97	14,62	0,03	1,72	0,16	0,90	0,034	0,023
280X14MDL	2,75	0,99	0,67	13,88	0,80	-	0,75	1,05	0,070	0,036
280X11DL	2,87	1,85	0,58	10,54	0,025	-	0,16	0,81	0,078	0,044
270X18G3L	2,67	0,92	3,10	18,33	0,20	-	0,49	0,48	0,052	0,014

The ingot was separated from the sand-clay mold on a vibrating device and the samples were cleaned of sand, treated on a fine sandpaper, immersed in ethyl alcohol and hydrochloric acid for 10-15 seconds, and analyzed for microstructure by magnification x100 and x300 times under a microscope METAM RV-23. and other samples were prepared and the hardness of the TK-2M hardness tester was measured.



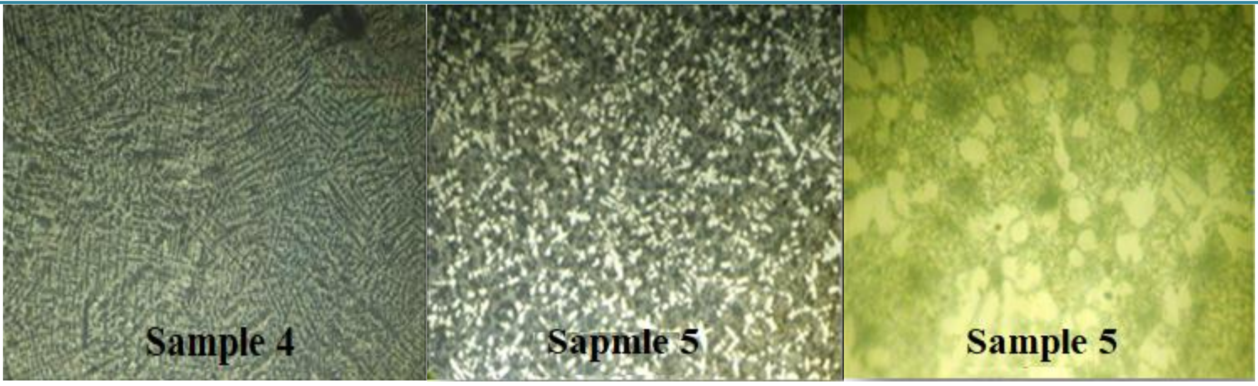


Figure 5 Microstructure of five alloys of a new brand developed

CONCLUSION

Based on the above data, a technology has been developed to increase the service life of the discs of CEMCO and BARMAK crushers, which operate under the influence of centrifugal force, which is obtained by casting from high-strength chromium cast iron. Based on the analysis of the initial results obtained, the following conclusion was developed:

Figure 5 shows the structure of the first sample 280X17M2L brittle white cast iron, the structure of which is 100x magnified under a microscope METAM RV-23. When the sample was measured with a TK-2M hardness tester, the hardness was found to be 42 - 44 HRC. Normative document of test method - GOST 3443 - 87, conditions of research - Air temperature - 260, humidity - 56%.

Figure 5 shows the structure of the second sample 280X15TDL brittle white cast iron, the structure of which is 100x magnified under a microscope METAM RV-23. When the sample was measured with a TK-2M hardness tester, the hardness was found to be 43 - 45 HRC. Normative document of test method - GOST 3443 - 87, conditions of research - Air temperature - 260, humidity - 56%.

Figure 5 shows the structure of the third sample of ductile white cast iron brand 280X14MDL, the structure of which is 100x magnified under a microscope METAM RV-23. When the sample was measured with a TK-2M hardness tester, it was determined that the hardness was 53 - 55 HRC. Normative document of test method - GOST 3443 - 87, conditions of research - Air temperature - 260, humidity - 56%.

Figure 5 shows the structure of the fourth sample 280X11DL ductile white cast iron, the structure of which is 100x magnified under a microscope METAM RV-23. When the sample was measured with a TK-2M hardness tester, it was determined that the hardness was 55 HRC. Normative document of test method - GOST 3443 - 87, research conditions - Air temperature - 260, humidity - 56%.

Figure 5 shows the structure of the fifth sample of ductile white cast iron 270X18G3L, the structure of which is 100x magnified under a microscope METAM RV-23. When the sample was measured with a TK-2M hardness tester, the hardness was found to be 56 - 58 HRC. Normative document of test method - GOST 3443 - 87, conditions of research - Air temperature - 260, humidity - 56%.

A new brand of white cast iron was introduced to replace the brittle white cast iron. The use of the new brand of ductile white cast iron has allowed to increase the service life of the supply disk from 45 to 46 hours to 53 to 54 hours.

A new brand of brittle white cast iron casting technology has been introduced. The introduction of the developed technology allowed to increase the hardness of the working surface of the casting by 22-24%.

During the cooling of the casting, a scheme of placing the disc in the casting mold, which provides a uniform distribution of the reinforcing surface, was introduced. The introduction of the developed scheme allowed to increase the bending strength of cast parts on the thin part of the working surface by 10-12%.

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