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IMPROVEMENT OF THE TECHNOLOGY OF CASTING SHAFT COMPONENTS FROM 35XGCL BRAND STEEL IN AN ELECTRIC ARC FURNACE

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Abstract

In this article, 35XGCL steel alloy was liquidized. The resulting liquid metal is cleaned of non – metallic inclusions and gas pores by aluminum alloying, and casting technology was developed based on energy and resource efficient innovative technologies. In order to obtain a high – quality cast product, the composition of sand – clay and liquid glass mold mixtures was developed, and a high – quality cast product was liquefied. In addition, thermal treatment regimes were developed to increase the mechanical properties of the cast alloy, and as a result, a high – quality and resource – efficient cast product was obtained.

Keywords: chrome, manganese, alloyed, shaft, sand – clay mold, hardness, viscosity, gas pores, nonmetallic inclusions, fluxes.

INTODUCTION

Steel is the main structural material, and it has good ductility, plastic, weldability and machinability compared to cast iron. However, in spite of the greater specific gravity and faster corrosion, they are widely used in the machine industry for making cast irons of different shapes and rolled products. In particular, the demand for their high – quality, alloyed special brands is increasing [1 – 4]. Currently, steel is produced mainly in electric furnaces in metallurgical enterprises. In these methods, C, Si, Mn, P elements in the slag are oxidized, and the oxides combine to form slag. As a result, their amount is drastically reduced. The speed of the chemical reactions in this case depends on the composition of the frost and the temperature.

Industrially produced steels contain constant additional elements: carbon C, silicon Si, manganese Mn, sulfur S and phosphorus P. When steel is forged, its physical and mechanical properties change dramatically, its hardness and strength increase, it becomes malleable [5 – 6]. Depending on the amount of carbon and alloying elements in the chemical composition, steel is divided into carbon and alloyed types. The term alloyed steel includes low (alloying elements up to 2.5%), medium (alloying elements from 2.5 to 10%), high alloyed (alloying elements more than 10%) steels. Depending on their use, they are divided into construction (rolling) and mechanical engineering (construction), equipment engineering, and special types. Steel with special properties is stainless and acid resistant, heat resistant, corrosion and corrosion resistant, magnetic and other properties [7 – 10].

In the production of alloyed steel, the necessary chemical elements are added to the steel composition. Phosphorus and sulfur have a negative effect on the properties of steel, so the steel is cleaned of them. In this case, a basic flux is used [11].

In order to reduce steel, i.e. to reduce the amount of oxygen in its content, reducing agents (alloys containing Mn, Si, Al, Ca) are added to liquid steel. They combine with oxygen contained in iron oxide and purify it. The reduction can also be done by diffusion. In this method, reducing agents, ground into powder and placed on the slag, dissolve in the slag and reduce the iron contained in it. This, according to the law of distribution, causes the return of iron in the steel [12 – 14].

Global steel production is 20 – 25% of the total amount of all metals. Steel is the main material used in construction, machine building, tool making and other industries [15].

MATERIALS AND METHODS

Shafts made of 35XGCL brand steel are used for ball rolling machines in the “1st grade rolling” workshop of “UzMetkombinat” JSC. This 35XGCL brand steel alloy was cast in the “Casting Mechanics” workshop of the combine.

It is important to improve the quality of cast products cast from alloyed steels, increase their operational properties, and reduce their additional mass [16]. Alloying elements increase the fineness, viscosity, corrosion resistance and other mechanical properties of steel, as well as the machinability property, the depth of penetration and other technological properties, change the physical (magnetic and electrical) properties, improve the corrosion resistance properties at high temperatures and under normal conditions [17 – 20].

The shafts made of 35XGCL brand steel, which are cast for ball rolling machines, were cast in sand – clay and liquid glass molds in the “Casting – mechanics” workshop of JSC “UzMetkombinat”. The composition of the sand – clay mold is shown in Table 1, and the composition of the liquid glass mold mixture is shown in Table 2.

Table 1 Chemical composition of sand – clay mold mixture

Used sand, %	Quartz sand, %	Kaolin, %	Water, %	Anti – burn paint, mm	Mold drying °C	Mold holding time, hours
61 – 66	20 – 22	6 – 7	4 – 5	1 – 2 applied to the inside of the mold	300	11

Table 2 Chemical composition of liquid glass mold mixture

Quartz sand, %	Luquid glue, %	Freezer
99 – 100	4 – 6	CO_2

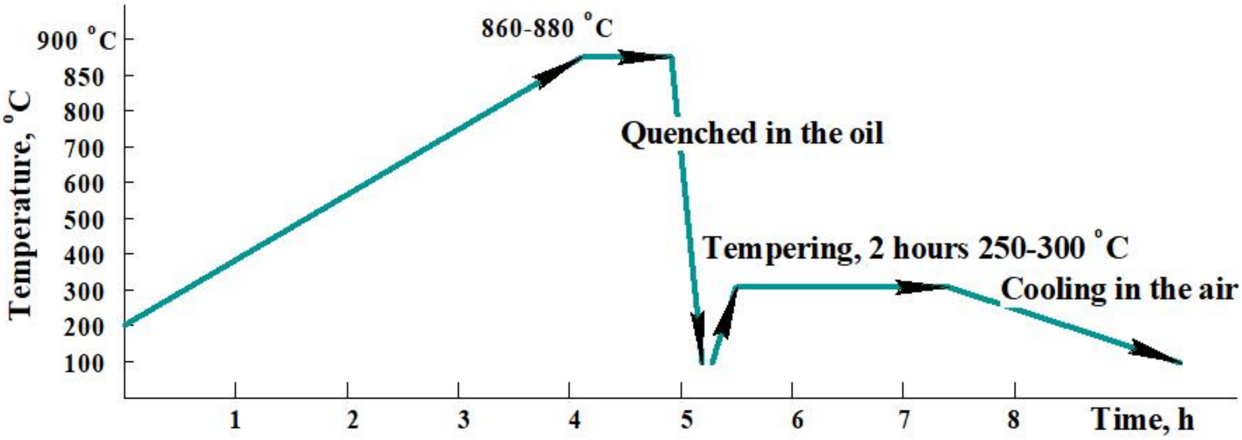
Raw materials for steel – 3 and steel – 5, ferroalloys, ferrosilicon (FeSi 75), ferromanganese (FeMn 90/FeMn 80), ferrochrome (FeX100), ferrotitanium (FeTi 30), coke, calcium carbonate ($CaCO_3$) as flux) and others were prepared. A basic 2.0 ton electric arc furnace was initially chosen to liquefy the alloy [21]. After checking that the inner lining of the furnace was in good condition, first small and then large solid materials were loaded into the furnace. As soon as the alloy begins to liquefy, 3 percent limestone ($CaCO_3$) by weight of the alloy is added to the furnace as a flux. According to the established standards, the metal liquefaction temperature was 1570° – 1580°C. After that, ferroalloys with high melting point were put into the furnace at 1575°C. FeO was introduced in the liquid metal furnace to reduce the carbon content of the alloy. As a result, the amount of carbon in the alloy was reduced by reacting with carbon dioxide (CO) and carbon dioxide (CO) oxidized other metals and mixed the metal well. After the alloy was completely liquefied, samples were taken from three places by mixing the liquid alloy, and the chemical composition of the alloy was checked on the "SPECTROLAB – 10 L" equipment (Table 3). When the liquid alloy reached a temperature of 1560 – 1570°C, it was poured into a special ladle preheated to a temperature of 800 – 850°C (Fig. 1).

1 – picture. The process of heating the vessel using gas

After removing 20% of the liquid metal into the cavity, 0.5-0.6% Al was added based on the weight of the liquid metal, and then the rest of the liquid metal was added [22 – 23]. The main purpose of this is to make Al mix well with the liquid metal. Al was added after pouring 20% of the liquid metal into the liquid metal. The main purpose of adding the Al element to the liquid metal was to reduce the oxygen and non-metallic inclusions in the liquid metal. It was added to the liquid metal in order to improve the fluidity of the steel alloy [24]. The process of loading liquid metal into a heated ladle is shown in Fig. 2.

2 – picture. The process of loading liquid metal into a ladle

Quymakorlik usulida qum – gilli qoliplarda quyib olingan val detallarining fizik – mexanik va texnologik xossalarini yaxshilash bilan birga ularni eksplutasion ko‘rsatkichlarini oshirish maqsadida ularga termik ishlov berildi [25 – 27].



3 – picture. Mode of heat treatment of the alloy

The main purpose of such heat treatment is to change the properties of the alloy due to structural changes without changing the chemical composition of cast products. Figure 3 shows the thermal treatment of the alloy.

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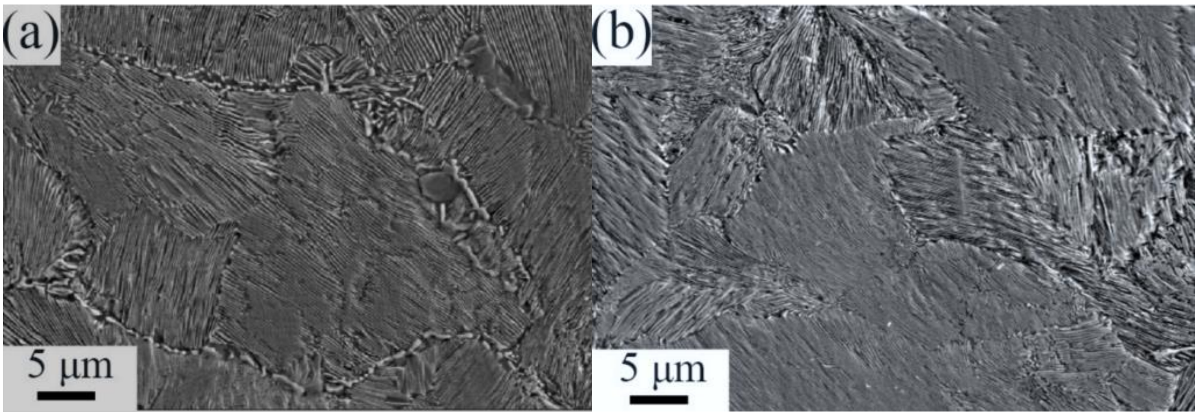
RESULTS

Production of high – quality cast products from 35XGCL steel alloys and reduction of gas pores and mirror inclusions in its content, liquefaction mode of alloys and their processing technology were developed, and high – quality cast products were cast. After removing the alloy from the casting mold, a special sample was prepared, and the chemical composition of the alloy was determined using the "SPEKTROLAB – 10M" device (Table 3).

Table 3 Chemical composition of the sample obtained based on the results of the research

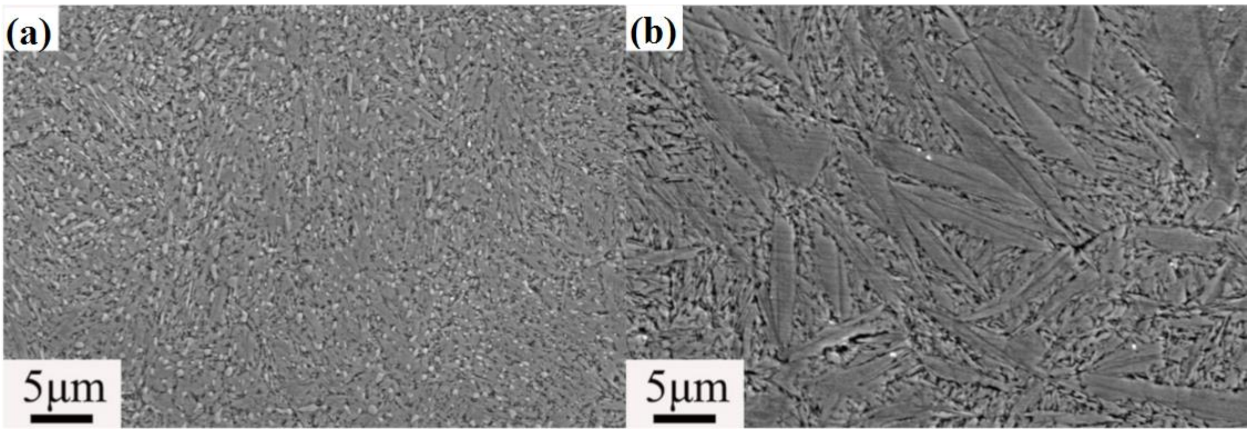
Brand steel	C	Si	Mn	Cr	Mo	Al	Ni	S	P
35XGCL	0,37	0,8	1,0	0,3	0,1	0,5	0,03	0,024	0,025

The samples were metallographically examined at the "Center of Advanced Technologies under the Ministry of Higher Education, Science and Innovation" at a magnification of x500 to x2000 on a SEM Zeiss EVO MA 10 scanning electron microscope, and the obtained results are shown in Figures 4 – a, b.



4 – picture. Microstructure of cast steel alloy

4 – a, b – microstructures taken in pictures can be observed using a scanning electron microscope with x500 to x2000 magnification.



5 – picture. The microstructure of the alloy after it was found in oil

5 – a, b – the alloy was heated to a temperature of 860 – 880°C for 4 hours, kept at this temperature for 1 hour and cooled in oil. Then it was fired at 250 – 300°C for 2 hours and cooled in the open air. Pearlite and more austenite can be seen in heat treated microstructures.

CONSCULION

Based on the implementation of liquefaction regimes of 35XGCL alloy at different temperatures in electric arc furnaces, the technology of obtaining cast products with surface cleanliness and high mechanical properties has been improved, and the technology of liquefaction of the alloy in an optimal way and pouring into casting molds has been developed. The alloy was treated with inert gases outside the furnace. Processing mode and casting technology were developed based on the dynamics of gas and mirror inclusions in the obtained alloy.

Also, when sand – clay mold and liquid glass mold mixtures are used, it was found that the surface flatness and quality of the cast product cast in the liquid glass mold mixture is better than the quality of the cast product obtained in the sand – clay mold.

Based on the results of the research, the following conclusions were reached, which were taken as the main reasons for the flux, furnace lining, quality of refractory materials, the preheating process of the slag, and other similar factors. Based on the stated reasons, the quality of the furnace lining and lining material were considered to be the most important factors that led to a decrease in the quality of the final casting.

The approach used in this work made it possible to achieve a complex and reliable result. In addition, as a remedial process, the furnace lining, furnace top, and furnace lining were replaced with high – quality refractory material. The results of the low quality were discussed and the rate of substandard castings was reduced as only 1 in 10 shafts were found to be substandard in the current study. In addition, it has been proven that by controlling the percentage of additives at each stage, the level of poor quality bulk product can also be reduced.

Also, in order to smooth the structure of the cast part and improve its mechanical properties, a thermal treatment regime was developed.

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