High-quality steel liquefaction technology from fine slag materials

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ABSTRACT

We can say that high-quality steel alloy is being liquefied in an electric arc furnace, first of all, the chemical composition of low-carbon steel alloy has been developed, and solidified steel has been obtained. Then, in the process of fluidization, it was possible to obtain high-quality steel zagatovka by introducing different types of flux into the alloy. The heat provided for the main fluidization of the furnace can cause a large amount of burn from fine solids when the furnace electrodes are lowered. For this reason, the order of loading the slag into the furnace was developed, and it was achieved to reduce the amount of slag burning

Keywords: steel, alloy, slag, electric arc furnace, flux, modifier, slag, lining, magnesite, chromamagnesite, structure, electrodes, zagatovka

Introduction.

Our independent Republic of Uzbekistan is proud of its underground resources. It contains almost all the elements of Mendeelev's periodic system, and non-ferrous and ferrous minerals have a special place.[1-2] Especially, non-ferrous metallurgy is highly developed in our Republic, and now it competes with developed countries in the world market with metals such as copper, cadmium, gold, silver, uranium, molybdenum, etc. Ferrous metals, steel in general, are very important in the national economy. There is no sector in the national economy where ferrous metal is not used. The level of economic power of any country is determined in the first place by the amount of steel that can be melted. Without steel, mining, oil and gas industries, machine building, transport, and even agriculture will not develop.[3-4]

The reason for this is that ferrous metal alloys have satisfactory physico-chemical, technological and mechanical properties, and are characterized by the fact that the properties change due to the change in chemical composition, as well as the structural change due to thermal treatment, and the alloy's cost is cheaper.[5]

Foundry enterprises are one of the important branches of the machine-building industry, in which different metals or their alloys are poured into pre-made molds and ingots of various shapes and sizes are obtained.[6-7]

According to statistics, about 70% of the mass of ingots produced today are gray and high-

strength cast irons, about 20% are steels, and the rest are non-ferrous metal alloys.[8-9]

Materials And Methods

Today, electric arc furnaces are widely used for liquefaction of bulk products from high-quality steel alloys. Therefore, an electric arc furnace consisting of a 10 kg base liner was selected in order to liquefy high-quality cast products from steel alloys in laboratory conditions. [10] The diameter of the electrodes of the furnace is 40 mm, the length is 700 mm, and it is mainly intended for liquefaction in laboratory conditions. First of all, the chemical composition of A500 low-carbon structural steel alloy was worked out and solidified before liquefaction. The recommended chemical composition can be seen in Table 1.

1 – table

Chemical composition of the recommended A500 low-carbon steel alloy

Mark	C	Si	Mn	P	S	Cr	Ni	Cu
A500	0,30 – 0,35	0,6 – 0,9	0,9 – 1,5	0,03 – 0,05	0,035 – 0,045	~ 0,3	~ 0,3	~ 0,3

Before starting the oven, it is necessary to check its suitability. Once the steel is liquefied, you can see the corroded areas of the furnace lining. If such a situation is observed, a mixture made of magnesite powder was sprinkled on the damaged areas with the help of a special device. If we do not pay attention to this situation, the liquid alloy may leak out of the damaged parts of the lining.

Then the lid of the small ovens was opened and the solid was loaded through the top of the oven. In this case, first small and then large iron-slag wastes, recycled cast iron and limestone ($CaCO_3$) as a flux were introduced into the furnace and electrodes were lowered. If the large solids are loaded into the furnace first, followed by the small solids, the heat supplied to the furnace for primary fluidization may be greater than the amount of burn from the small solids when the furnace electrodes are lowered. For this reason, the order of loading the slag into the furnace was developed, and it was achieved to reduce the amount of slag burning. 1 – in the picture. A solid loading process for a 30-ton electric arc furnace under development conditions

1 – picture. the process of loading solids into an electric arc furnace

An electric arc was created by placing electrodes on the metal pieces of the sheet, connecting the necessary rectifier and current chain. For good arc burning, small pieces of coke were placed under each electrode to liquefy the slag faster. Due to the high-temperature zone created around the arc, the solid material was liquefied in a short time. During the liquefaction of slag materials, iron ore and furnace atmospheric oxygen are first oxidized to Ge, and the oxygen released as a result of reaching the formed GeO in the metal bath begins to oxidize Si, R, Mn, and partly S. The resulting oxides (SiO2, R2O5, FeO and MnO) combined with SaO to form a basic slag. To remove the slag, the slag was separated from the liquid alloy by turning 10-150 degrees towards the furnace window. Then, mixing the liquid alloy with a ladle, samples were taken from three places and the chemical composition was checked in the laboratory. Then the liquid metal was extracted. In a bucket, 2 kg of aluminum pieces were put into liquid alloy. The purpose of adding aluminum is that the gases carry the Al2O3 with them and increase the fluidity. After normalizing the amount of carbon and other elements in the alloy according to GOST requirements, the liquid alloy was poured into the mold and the expected results were achieved.

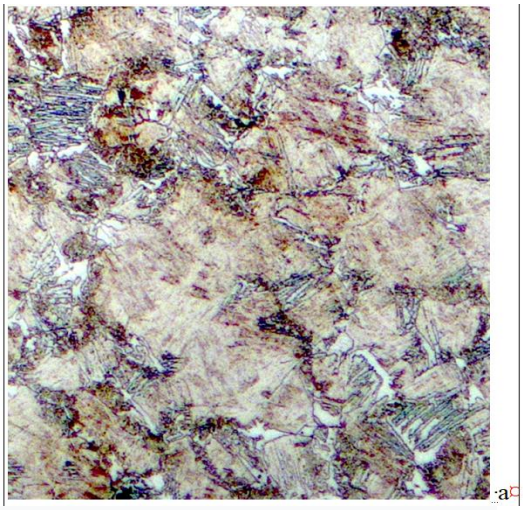
Results

High-quality low-carbon steel alloy was liquefied in an electric arc furnace, poured into a mold and cooled, and then the ingots were removed from the mold. Then the samples were processed step by step using 500, 1000 and 2000 micron SiC abrasive papers. After cleaning the surface of the samples, the chemical composition of the samples cast from the A500 steel alloy was determined in the laboratory of the "Lida Metal Technology" enterprise using the spectral analysis device "SPECTROLAB-10M". It is shown in table 2.

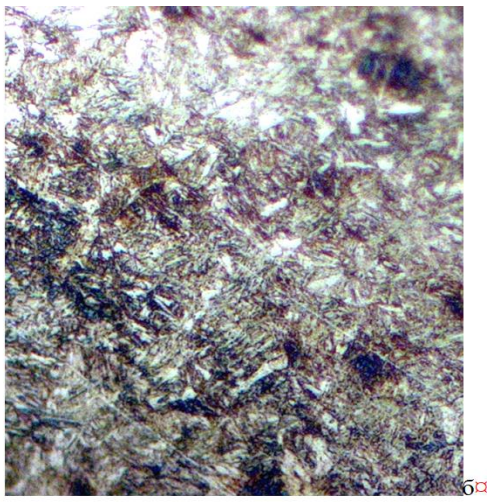
2 – Table

Mark	C	Si	Mn	P	S	Cr	Ni	Cu
A500	0,33	0,7	1,0	0,04	0,040	~0,3	~0,3	~0,3

Samples are magnified from x500x to 2000x on SEM Zeiss EVO MA 10 scanning electron microscope. Metallographic and elemental research was carried out at the "Center of Advanced Technologies under the Ministry of Innovation Development" and the obtained result is shown in picture 2 - a,b.



Middle zone



Upper zone

2 - a,b pictures show the microstructure of A500 low-carbon steel using SEM Zeiss EVO MA 10 scanning electron microscope.

2 a - as can be seen in the picture, Sorbitum, 1.3 mm thick zone when viewed in a scanning electron microscope with a magnification of x500. 2 b – picture Pearlite sorbite structure + ferrite, 1.9 mm thick zone structure was observed.

Consluction

Based on the experiments, we can conclude that the chemical composition of A500 low-carbon steel alloy was developed and solidified before liquefaction. Corrosion resistance of the furnace lining was reduced based on the intensity of dependence on the slag formed from the liquid metal. As a result, it was possible to increase the inner layer of the furnace lining by 8-10%.

In the period of liquefaction of the alloy, the technology of liquefaction was developed based on the introduction of flux into the furnace, which ensures the technology of obtaining high-quality cast products. As a result, the liquid metal content is used to develop the technology of loading flux elements into the furnace.

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