ISSN NO: 2770-4491
Date of Publication:11-02-2023

Improvement of the Technology of Liquidation of Steel Alloys in A Basic Lined Furnace

Saidkhodjaeva Shokhista
Docent, Tashkent State Technical University, Uzbekistan
Gulyamov Saidsulton,
Researcher, Tashkent State Technical University, Uzbekistan
Hkamroev Vokhid
Senior teacher, National University of Science and Technology “MISIS” in Almalyk, Uzbekiston
Urinboev Umidjon
Researcher, Tashkent State Technical University, Uzbekistan
Abdullaev Rustam
Researcher, Namangan City Department of Economic Development and Poverty Reduction, Uzbekistan

Annotation: In this article, in order to obtain reinforcement products from high – quality steel alloys, the chemical composition of A500C steel alloy was developed. In addition, the mode of liquefaction of steel alloy in an electric arc furnace was considered, and quality cast products were obtained by adding a modifier to the composition of the alloy during the liquefaction process.

Key words: steel, alloy, slag, slag, electric arc furnace, flux, modifier, brand, liner, refractory material, structure, magnesite, chromamagnesite.

Introduction

Today, the foundry industry is developing day by day, and in modern engineering, like all industries, it is an important factor to ensure that machines and machine mechanisms, including technological equipment used for metallurgical plants, have the necessary workability and operational reliability [1, 2]. Also, one of the urgent scientific and technical problems that is expected to be solved is the production of high – quality, corrosion – resistant and high-strength heavy industrial products in machine-building production enterprises that meet world standards [3, 4]. The leading scientists of the world have developed various technologies for increasing the corrosion resistance of the furnace lining during the liquefaction of steel alloys in an electric arc furnace, as well as various projects for the implementation of the developed technologies. Although there are several types of furnaces for fluidizing steel alloys, electric arc furnaces and induction furnaces are currently the most commonly used and are selected depending on the type of alloy being produced. In recent years, electric arc furnaces have been widely used in steel production. Its interior is lined with magnesite or chroma magnesite bricks as refractory materials [5 – 9]. Replacing an electric arc furnace repair liner from time to time means a valuable financial investment and is associated with several hours of downtime and lost production. It is known that electric arc furnace has a high level of corrosion resistance compared to other steel melting furnaces. It is necessary to think about extending the service life of the lining of the electric arc furnace, so that the maximum economic efficiency is achieved. Electric arc furnaces are designed for liquefaction of steel and alloy at high temperature, and their refractory lining is covered with basic or acidic materials. In general, it is necessary to control these furnaces during operation without losing sight of their maximum performance [10 – 14]. If there is a fire in the furnace at this time, it will cause huge losses and profits for the producers. Therefore, before starting the oven, it is important to inspect the inner lining of the oven. We need to know how many times to get products from the oven lining and when to overhaul it [15].

Materials And Methods

Currently, basic electric arc furnaces are used to obtain high-quality cast products by liquefying steel alloys. A 30 – ton electric arc furnace was used to produce products from high – quality steel alloys. The electric arc furnace used for research can be seen in Figure 1. One of the main priorities of an electric arc furnace is to obtain quality castings. The main reason why we choose an electric arc furnace is that the steel

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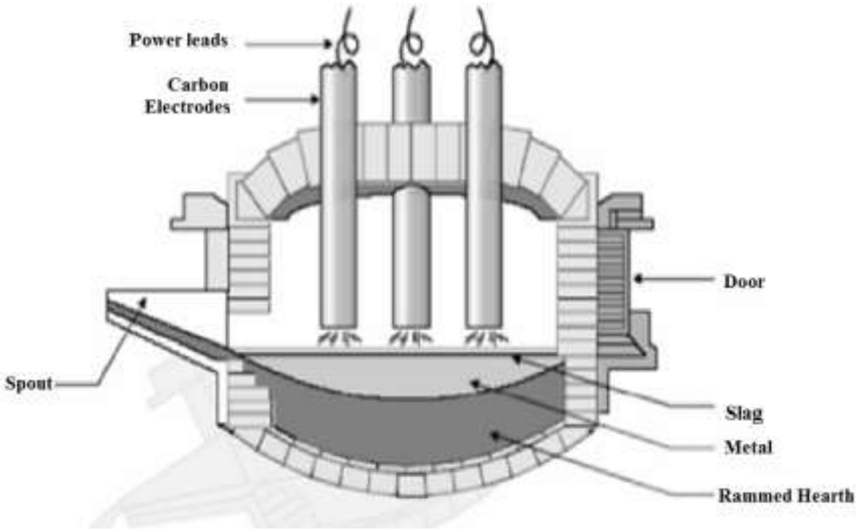
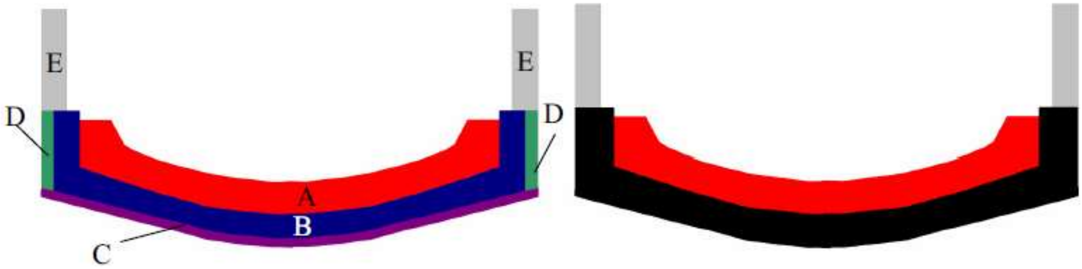
alloy is acidic, which causes the lining of the furnace to corrode quickly. For this reason, an electric arc furnace was used. The walls of basic furnaces are made of magnesite brick, and the bottom is covered with magnesite powder [16 – 20].



1 – picture. An electric arc furnace used for liquefaction of steel alloy

At the “Lida metal technology” LLC enterprise in the city of Ohangaron, a rough calculation was carried out for the production of fittings from the A500 steel alloy. The furnace is designed for liquefaction of 30 tons of steel alloy, its internal diameter is 9.4 m and it is designed for direct three – phase connection to a 30 kV high – voltage network. The lining of this oven has been selected from basic materials. Magnesite chromamagnesite bricks were used as material. The purpose of choosing a basic lining is to remove the slag from the steel alloy by adding flux, i.e. $CaCO_3$, to the slag and make it free of harmful elements [21 – 25]. The consumption of refractory materials of the electric arc furnace should be the same, but it may be more or less observed in different parts of the furnace due to various factors. Due to this, the lining layer of the electric arc furnace has layers of different materials of different thickness in different places, as well as the slag line, side walls, and many furnaces.



a: initial design **b: proposed design**

Figure 2: Inital (a) and final (b) configuration of the lining of the electric arc furnace. B,C, and D refractories were replaced by a magnesia – carbon with a higher thermal conductivity.

The most important part of the furnace, i.e. the slag line with MgO-C lining, materials with various carbon and antioxidant additives were used. Advantages: high strength, fire resistance, low porosity, good mechanical properties, abrasive wear and low wetting by slag. Water-cooled panels or fins are usually mounted on top of the case. In modern ovens, it is located in the area of the side walls. It is necessary to control the temperature regime of the refractory lining (check its temperature, measure the temperature of the coolant, etc.) to prevent emergency situations [26 – 28]. The most important thing is to distinguish negative factors.

For the first time, the optimal chemical composition of the alloy was developed for liquefaction of A500 low – carbon steel alloy. The developed chemical composition can be seen in Table 1

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Table 1
Recommended chemical composition of A500 brand

Brand	**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 furnace, it is necessary to check that it is suitable for work. Once the steel is liquefied, the furnace lining may be corroded. If such a situation is observed, a mixture made of magnesite powder is plastered on the damaged areas. Then the ceiling of the small furnaces is opened and the solid is loaded. In this case, first small, and then large iron and tin waste, recycled cast iron and limestone ($CaCO_3$) and modifiers, i.e. ferrochrome, ferrotitanium, are introduced into the furnace and electrodes are lowered. If large solids are loaded into the furnace first, and then small solids are loaded, the amount of burn may be high if the heat passes through the electrodes. For this reason, the method of loading the furnace was developed, and at the same time, by adding modifiers, not only the quality of our product, but also the lining, i.e., the corrosion resistance of refractory materials, was increased [29].

An electric arc was created by placing electrodes on the metal pieces of the sheet and connecting a current circuit. Due to the high temperature zone formed around the arc, the solid material was liquefied in a short time. In the electric arc furnace, the oxygen contained in the air oxidized Fe and formed FeO for the first time. Therefore, this process is important to recover Fe from FeO.

In this process, the following reaction occurs:

$Fe + ½ O_2 = FeO$ (1)

$FeO+Mn$ $(MnO)+Fe+Q$

$2 FeO+Si$ $(SiO_2)+2Fe+Q$

$3 FeO+2Al$ $(Al_2O_3)+3Fe+Q$

As the reduction of Fe from FeO increased, the color of the shale became lighter [30]. White slag contains 55 – 60 % CaO, up to 0.5% FeO. The carbon in the superheated slag reacts with the lime to form calcium carbide:

$3C + CaO$ $CaC_2 + CO$

In the presence of CaO in the composition, favorable conditions were created for the reduction of Fe and Mn from FeO and MnO in the metal:

$[3 FeO] + (CaC_2)$ $3Fe + CaO + 2CO$

$[3Mn] + (CaC_2)$ $3Mn + CaO + 2CO$

This process took 0.5 – 1.0 hours. The slag solidified as a white powder upon cooling. A certain amount of chromium powder was added to the liquid alloy as a modifier. The main purpose of this is to increase the number of crystal centers during solidification of liquid metal and to obtain a cast product with a fine-grained structure. Then, during the process, a sample was taken and the chemical composition was checked. To remove the slag, it was turned 10-150 degrees towards the furnace window, and the slag was separated from the liquid alloy. Then, the liquid alloy was mixed with a ladle, samples were taken from three places, and the chemical composition was checked in the laboratory, FeO (okolina) was added to the furnace to reduce the amount of carbon in the alloy, and after the amount of carbon and other elements in the alloy was normalized according to GOST, the alloy was poured into a mold and the expected results were obtained. has been achieved.

Results

The surface of the developed armature samples was cleaned with SiC. Then it was determined in the "SPEKTROLAB – 10 M" model spectral analysis unit and listed in Table 2.

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Table 2
Chemical composition of liquefied A500 brand

Brand	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

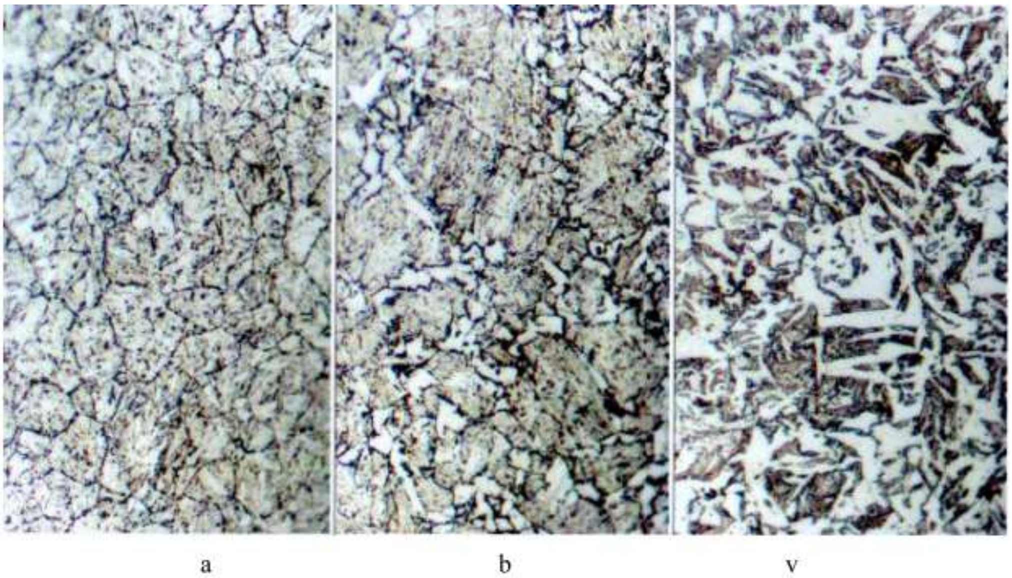

Fig. 3. Image of A500 alloy magnified x500 times
a – Reinforced layer, b – Transition layer, v – Base metal

3a – as can be seen in the picture, Sorbitum, a 1.1 mm thick zone when viewed in a scanning electron microscope with a magnification of x500. 3b – picture Pearlite sorbite structure + ferrite, 1.8 mm thick zone. 3v – picture Pearlite sorbite structure + lamellar pearlite + ferrite structure was observed.

Conclusion

In conclusion, we can say that the earthquake resistance, corrosion resistance and structure and mechanical properties of the alloy composition were improved by introducing modifiers of reinforcements made of low-carbon A500 steel. As a result of this research, the service life of electric arc furnaces in factories was increased not only by increasing the consumption of refractory materials..

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