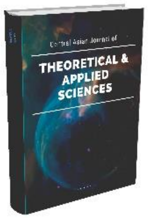

CENTRAL ASIAN JOURNAL OF THEORETICAL AND APPLIED SCIENCES

Volume: 03 Issue: 12 | Dec 2022 ISSN: 2660-5317
https://cajotas.centralasianstudies.org

Improvement of the Technology of Liquefaction of A500 Low – Carbon Steel Alloy in an Electric ARC Furnace

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Received 18th Oct 2022, Accepted 17th Nov 2022, Online 23rd Dec 2022

Abstract: *We can say that the mode of liquefaction of steel alloy in an electric arc furnace was considered, in which quality steel alloys were obtained by adding different types of flux to the composition of the alloy during the liquefaction process. Modern electric arc furnaces can be divided into three categories: direct arc EAF, indirect arc EAF, and induction furnaces. 2 – as shown in the picture. All types of 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. The electrodes of ordinary electric arc furnaces are cylindrical and the lining is basic.*

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

INTRODUCTION

All types of 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. The electrodes of ordinary electric arc furnaces are cylindrical and the lining is basic. In recent years, electric arc furnaces have been widely used in steel production. Its inner part is lined with magnesite or chromamagnesite bricks as refractory materials. Replacing an electric arc furnace repair liner from time to time means a valuable financial investment, as well as hours of downtime and lost production. It is known that electric arc furnace has a high level of corrosion resistance of its lining compared to other steel melting furnaces [1 – 4]. 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. This goal, along with the elimination of negative factors, constant exposure to high temperature (1500 – 1700°C), influence on the mechanical properties of metal at low and high temperatures, damage to the lining as a result of chemical interaction with slag and metal (mainly FeO, SiO_2 content), thermal shocks, erosion, direct impact of an electric arc, use of gas, oxygen, etc. [5 – 8] The simplicity of the structure of these furnaces has the advantages of adjusting the temperature of the furnace by changing the current parameter, working in different environments, and obtaining high-quality special steels from cheap hard materials [9 – 13].

MATERIALS AND METHODS

A 30 – ton electric arc furnace was used to produce fittings from high-quality steel alloys. One of the most important priorities of electric arc furnace liquefaction is to obtain quality castings. 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.

Today, liquefaction of high-quality structural steels in an electric arc furnace is widely used. 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. To load the slag into the furnace and take out the slag, its ceiling, i.e. the cover, is opened. Oxygen is sprayed into the alloy through its nozzles [14 – 18]. There are cooling panels inside the oven. In order to facilitate the removal of slag, it is necessary to install furnace bars.

After liquefaction, the metal is removed from the furnace, then the furnace is inspected and, if necessary, repaired. From the ceiling of the furnace, the powder is loaded into the furnace using cranes. In the process of loading slag into the furnace with the help of buckets, large slag materials are loaded into the bottom of the furnace [19]. This is due to the low risk of breaking the electrode and good protection of the furnace wall during melting. Electrodes are lowered after loading the furnace. The lining of this oven has been selected from basic materials. Chromamagnesite magnesite bricks were chosen as the 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 [20 – 21]. The consumption of refractory materials of the electric arc furnace should be the same, but due to various factors, it may be observed more or less in different parts of the furnace. 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. When the electric arc furnace was created, single electrodes were used, similar to the simple welding method. By welding electrodes, the electric current is passed through the electrode and passes to the metal surface. A contact is formed between them, the electrodes gradually melt and an arc appears. The heat emitted by the arc of the welded electrodes passes to the metal surface [22 – 24]. A mutual electric field is formed between the electrode of the electric arc furnace and the metal plates, and an arc is formed between them. At high temperatures, the material leaves the electrode as charged ions.

An arc can be divided into three different parts:

When an arc occurs, the cathode becomes negatively charged and a spot appears on the cathode.

The arc contains a superconducting plasma.

In the zone where the arc ends, there is an anode (positive charge). If the electrodes of an electric arc furnace are the cathode, the lower part of the furnace is the anode. There should be current conductors at the bottom of the oven.

Basically, heat exchange radiation passes from the electrode to the solid. Convective heat exchange occurs. The average temperature of the furnace is 6000°C, and there are 5 different phenomena.

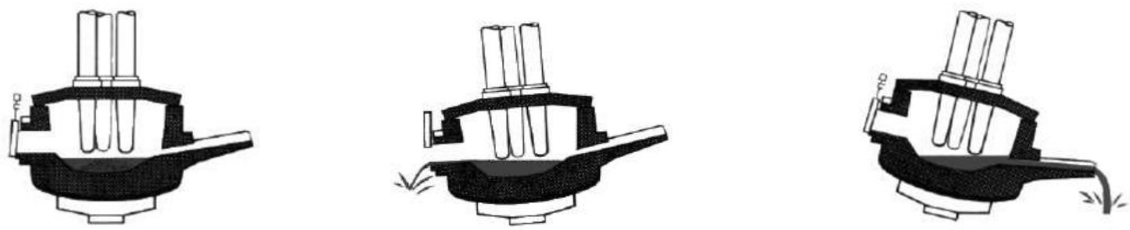
1. After the furnace is started, it is loaded and filled with concrete. Electrodes work at the top of the furnace. An arc forms between the electrodes and the ice and stabilizes them.

2. The electrodes touch the pressed concrete material and as a result of an arc, they are collected at the bottom of the furnace. The furnace is currently operating at medium high efficiency.

3. When the electrodes approach the bottom of the furnace, the solution begins to form.

4. The main part of the liquefaction works with the maximum power of the electrodes. The side walls of the furnace have water cooling panels. Pressed solid materials are loaded into the furnace.

5. When the bulk of the slag is melted and the temperature rises, the power should be reduced and the arc shortened to protect the furnace. At this time, protective foam putty can be used, it will not damage the walls due to long arc formation.



liquefaction process | slag extraction process | metal extraction process

1 – picture. The furnace can be rotated to facilitate the removal of metal and slag

2 – picture. Electric arc furnace working process

The effects of slag components (CaO, MgO, FeO, SiO_2, Al_2O_3) and metal (C, Mn) phases on the service life of the liner were graphically analyzed during the experiment in an electric arc furnace. In order to prevent overheating of the side walls of the furnace, the liquefaction process starts at low power. In order to protect the inner wall of the furnace and to speed up the liquefaction process, a liquid metal residue is left at the bottom of the furnace.

After liquidizing the steel alloy, the amount of carbon is 0.25% more, because it prevents the oxidation process. By this time, the main slag is formed, which is 55% manganese, 15% silicon and 15 – 20% iron oxide. The carbon monoxide in the lime mixture reacts with the iron oxide in the slag, causing the slag to foam. This foam protects the sidewalls and provides a high strength parameter. If the carbon content of the steel is high, then oxygen is sprayed into the liquid metal through the furnace, if it is low, additional coke is added. The steel alloy is liquefied at a temperature of 1650 – 1700^0. Then samples of the finished metal are taken and sent to the laboratory.

Also, after the expected result is achieved, it is poured into the prepared cavity, leaning forward. When the slag appears, it is quickly poured into the slag bath through the loading door of the furnace, bringing it to a reverse slope. After liquidizing the steel alloy, the carbon content is 0.25% higher because it prevents the oxidation process. Then samples of the finished metal are taken and sent to the laboratory. Depending on the brand of steel alloy, its liquefaction temperature is different, and the average liquefaction time is 2 – 3 hours.

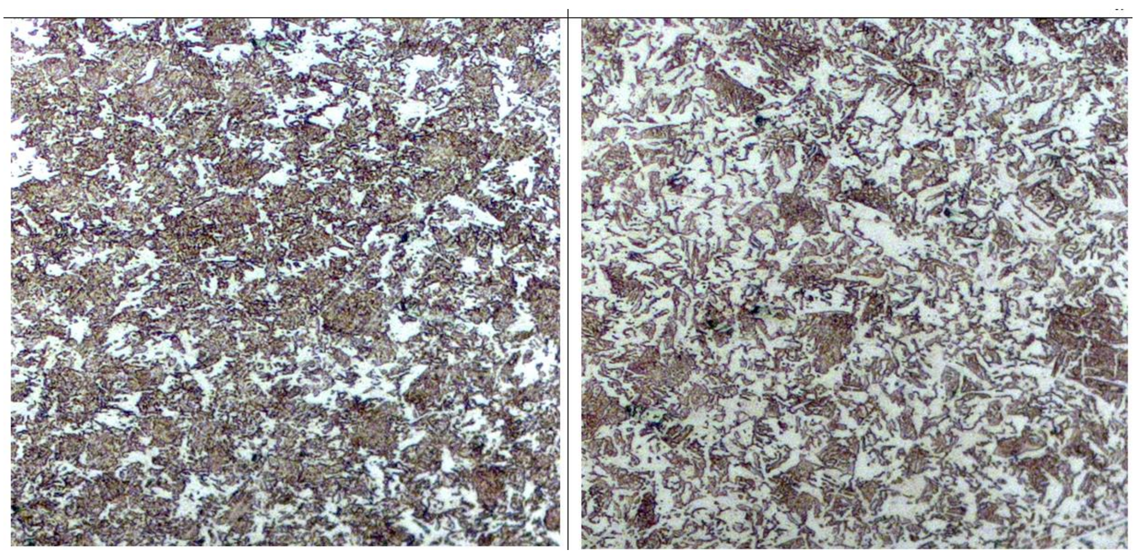
RESULTS

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 is listed in Table 1.

Table 1. 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

Samples were metallographically examined at "Lida Metal Technology" in a CARL ZEISS AXIOVERT 40 MAT microscope at a magnification of x500 to 1000 times, and the obtained results are presented in 3 – pictures.



a b

Fig. 3. Image of A500 alloy magnified x500 times

a – Reinforced layer, b – Transition layer

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 structure was observed.

CONCLUSION

In conclusion, it can be said that in Mechanical Engineering, process modeling and reduction of energy waste have shown to be a good tool. When the principle of energy balance of refined steel is observed, it is observed that the furnace is designed to produce 30 tons of liquid steel and there is material waste, approximately 4.32 tons will reduce 9.53 MW of energy. According to the balance results of the furnace refining process, the energy balance showed a 13.38% reduction in the consumption of charge materials and a 7.38% reduction in the energy required for production.

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