Improvement Of Steel Liquidation Technology in Electric Arc Furnace

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ABSTRACT

This article examines the size, lining, quality of the loaded slurry, what fluxes should be used to separate the slag, what ferroalloys should be used for the melting of the elements, and its effect on the finished product. In addition, the advantages and disadvantages of the furnace were discussed.

Keywords: *Electric arc furnace, alloys, liquefied, electrode, copper cable, magnesite, chromagnesite brick, steel, graphite, slag, sand (SiO2), glass fragment, cast iron, ferroalloys and fluxes.*

Introduction

The physical concepts of the electric arc were explained in 1802 by the Russian physicist V.V.Petrov, and the concepts of the electric arc furnace have been studied in detail due to the widespread use of the electric arc furnace in various fields today. Electric arc furnaces are improving the liquefaction of ferrous metals and ferroalloys, producing high – quality and durable castings that meet world standards. The advantages of these furnaces over other furnaces are their energy saving and short liquefaction time. Several types of furnaces have been used to liquefy ferrous metals and their alloys. Various alloys are liquefied in induction, electrical resistance and electric arc furnaces. More electric arc furnaces are used to liquefy steels. The main reason for this is that the electric arc furnace produces a high temperature of 3500^0 C, in which the process of liquefaction of steel is fast. Typically, the electrodes are placed vertically and operate on three-phase alternating current. Depending on the size of the furnace, a current of 45 – 60 kA with a voltage of 100 – 600 volts is sent from the transformer connected to the electrodes by means of flexible copper cables.

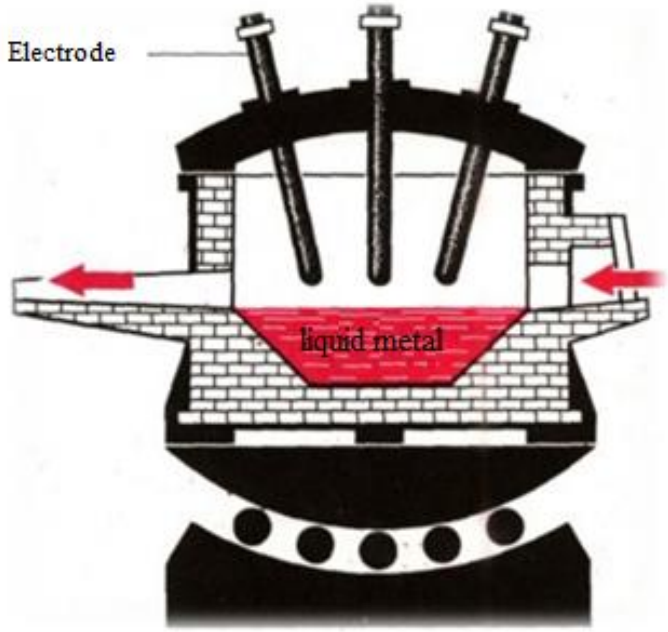

Figure 1. Appearance of electric arc furnace

In most cases, the walls of electric arc furnaces are made of magnesite or chromagnesite brick, which is the basis of furnaces. The lining of the oven is checked through the furnace window. The main reason for this is that the steel is acidic and can corrode the lining. In such cases, magnesite or chromagnesite powder is sprayed through a window. The powder then fills the lining of the lining and the process does not interfere with the liquefaction of the steel. The outer surface of the furnace is covered with a steel sheet. The ceiling and bottom of the furnace are spherical in shape and rest on rollers through their segments. Due to the spherical shape of the furnace, it is easy to pour the liquid metal from the crucible into the bucket. The roof is designed to be detachable or sliding to facilitate loading of the shaft. The slag is introduced into the furnace by a special machine. Through a window in the side wall of small – capacity furnaces up to 30 tons, shale materials are introduced into it by a special mechanism. The molten steel is discharged into the bucket through a casting channel mounted in its hole. To do this, using a special hydraulic or electric drive mechanism, the side of the bucket is turned to 40 – 45°, and to remove the slag – to the window of the furnace – 10 – 15°, and during operation it is closed with locks. Graphite electrodes mounted on their handles in the furnace cavity are automatically controlled by a special mechanism to lower or raise as needed through the ceiling holes. The diameters of the electrodes are 200-600 mm, depending on the size of the furnace, and the length is up to 3 meters. As a result of the addition of graphite electrodes to the liquid metal during operation, the electrode graphites are replaced from time to time.

At present, UzMetkombinat JSC has launched the most modern world – class EAF – 100 IMZ 3, the capacity of the furnace is 100 tons and is currently used for the production of fittings used as a building material. Production of 950,000 – 1,000,000 tons of steel per year has been launched.

Materials And Methods

The linings of electric arc furnaces are divided into basic and acidic types, based on the bricks used in the furnaces. Slag in liquid metal can be separated by adding limestone ($CaCO_3$) as a flux to the base furnaces. In acid furnaces, quartz sand (SiO_2) and glass fragments are used as flux. Slag – based furnaces contain a lot of SaO, if an acid furnace, the slag contains a lot of SiO_2. Depending on the lining of the furnace, the charge is calculated and the charge is loaded into the furnace. It is usually included as secondary shale materials (steel scrap, cast iron, wires, ferroalloys and fluxes). First, small slag materials are loaded into the kiln through a sieve, and then it is recommended to add large slags. The main reason for this is that when a high temperature is sent through the electrodes from above, the percentage of combustion may increase due to the effect on the fine-grained materials. After loading the charge and ferroalloys, three electrodes are lowered from above and a three-phase electric current is sent.

Steel Arc Furnace Lining

The lining of arc steel – making furnaces consists of three main parts: hearth, wall masonry and vault (Figure 2). The base of the lining, containing the furnace bath, is the hearth, which plays an essential role in steel melting. It works in harsh thermal and mechanical conditions. The cold charge is placed on the hot bottom when loading; the hearth undergoes sharp temperature fluctuations, shocks and pressure, therefore it must have the necessary mechanical strength at a temperature of (800 – 1000)° C. While stirring the liquid bath, the hearth is exposed to the erosion effect of molten steel. Finally, the bottom must have sufficient thermal resistance to provide a minimum temperature drop across the depth of the bath. Heat in the furnace is released in arcs, at the metal surface, and the heat flux is directed from the surface to the hearth. With the steady-state thermal regime of the bath, the value of this heat flux is determined by the heat losses through the hearth, which determine the temperature difference along the height of the metal. In view of this, the hearth of the arc furnace is made of three layers (Figure 2):

- internal padded, necessary in order to form a bath with walls impermeable to liquid metal;
- medium, consisting of refractory brick masonry and taking the mechanical load from the rammed layer;
- an outer heat – insulating layer that works in lighter thermal conditions and provides the necessary thermal resistance of the hearth.

For "main" furnaces, the inner and middle parts of the hearth are made of magnesite or dolomite, for "acid" furnaces – from dinas and quartz sand.

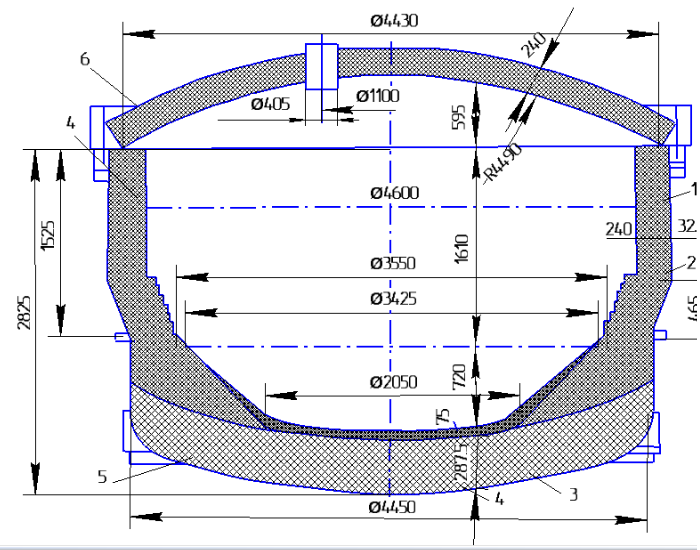

Figure 1 - asbestos; 2 - powder; 3 - fireclay brick; 4 - refractory brick; 5 - printed layer; 6 - vault.

The outer part of the masonry (thermal insulation) is made of chamotte or diatomite powder and asbestos. The bottom of the main arc steel-melting furnace is prepared as follows: a layer of sheet asbestos with a thickness of about 20 mm is laid on the metal frame of the bottom of the furnace, or a layer of chamotte or diatomite powder with a thickness of 30 – 40 mm is poured. On this preparatory layer, hiding all the irregularities of the casing (for example, welding seams), fireclay bricks are laid “on a die” in one or two layers (Figure 2, a), and on them “on the edge” several (depending on the size of the furnace) rows of refractory bricks (Figure 2, b). Magnesite bricks are laid without mortar, carefully rubbing them together.

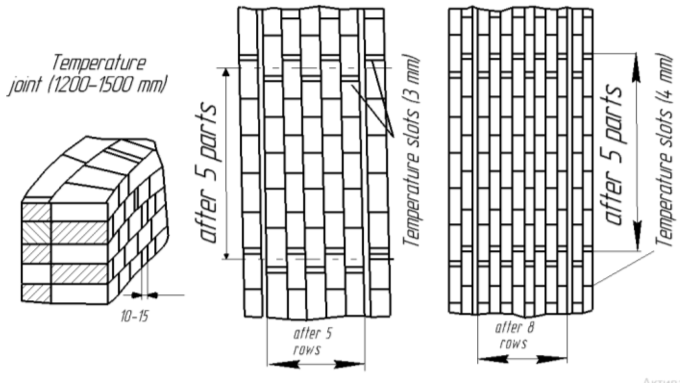

Figure 2 - Expansion joints in chipboard masonry
a - wall; b and c - hearth.

Rows of bricks should overlap, that is, the seams of adjacent rows should not overlap. Every five to eight bricks (Figure 2, b and c) in both directions, it is necessary to make expansion joints with a width of (3 – 4) mm. The hearth stuffing layer is a mass consisting of magnesite or dolomite powder or a mixture thereof, bonded with coal tar or liquid glass. Since magnesite powder is quite cheap, and the bottom on dolomite is less stable, the latter is almost never used in the linings of domestic furnaces. The thickness of the filling is 150 mm for small furnaces and reaches (250 – 300) mm for the largest ones.

Before filling the hearth, the masonry is well dried. Magnesite powder is sieved and mixed with previously dewatered coal tar.

Typically, the amount of resin is (10 – 12)% by weight. A mixture of magnesite with resin, heated to (80 – 85) ° C, is poured with a layer of up to 25 mm on the surface of the masonry, which is cleaned and smeared with resin, heated to (60 – 70)° C. The mass is rammed with pneumatic rammers, the strikers of which are heated from time to time. Then, the next layers of the same thickness are applied until the desired thickness and configuration of the rammed part of the hearth and slopes are achieved (Figure 1).

Conclusion

It is necessary to take into account the design of the 100 – ton electric furnace currently used at UzMetkombinat JSC, the bricks used for lining, and thus it is possible to obtain high-quality steel castings in the electric arc furnace. The advantage of this furnace over other furnaces is that it can heat the furnace quickly, the current can be easily adjusted, and additionally C (carbon) can be normalized by oxygen spraying. It is also possible to remove Fe from FeO by removing the harmful emelents in the steel from the slag in the furnace. The liquid metal inside the furnace can be tracked through the window and the required ferroalloys can be loaded through the window. The disadvantages of the furnace are that the higher the temperature of the furnace, the greater the amount of combustion in the furnace.