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Optimizing of Work Arc Furnace to Decopperisation of Flash Slag

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Abstract

Discusses an attempt to optimize the operation of an electric furnace slag to be decopperisation suspension of the internal recycling process for the production of copper. The paper presents a new method to recover copper from metallurgical slags in arc-resistance electric furnace. It involves the use of alternating current for a first period reduction, constant or pulsed DC in the final stage of processing. Even distribution of the electric field density in the final phase of melting caused to achieve an extremely low content of metallic copper in the slag phase. They achieved by including the economic effects by reducing the time reduction.

Keywords: Electrorefining, Decopperisation, Slag suspension, Furnace

1. Introduction

The theme of the work is a new process for recovering copper from metallurgical slags interaction through control rooms of electrical current. There are known methods to recover copper from the slag consisting of the application of alternating current electroslag refining processes [1-4]. In the processes decopperisation slurry of slag is used dissolve Sodeberg electrodes impact on the weight of the slag flushed from the flash smelting furnace as waste recycling procedure. The main and only purpose of use in these processes is an alternating current melting slag. In addition, the effects obtained in the form of vigorous mixing bath, they are disadvantageous [5-7] and lead to the reduction of decopperisation of slag [8-10]. In addition, the vertical movement of the electrodes is not conducive to obtaining a reducing atmosphere, which is a prerequisite for proper overlap of the process in an electric arc furnace during decopperisation [4, 11-13].

The main technological problem while recovering the metallic phase of Cu-Fe-Pb rich in copper are little dispersed particles are not subject to the laws of gravity. In addition, the conditions which alternate reducing and oxidizing agents contribute to the formation of layers surrounding the spherical separation of metal [4, 7, 10, 14-16]. This is conducive to all the rapid, local variations in viscosity changing completely the nature of Newtonian fluid in a non Newtonian [17]. The little, dispersed particles (Figure 1) are suspended in the liquid slag unevenly distributed partly on the surface of the flow which is not conducive to the formation of the copper-rich metallic phase on the bottom furnace.

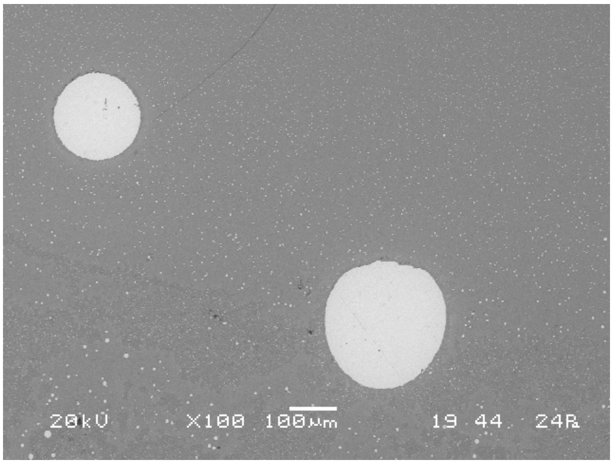

Fig. 1. An image of the structure of the slag suspension with little dispersion precipitates of Cu-Fe-Pb

In order to reduce these adverse effects are used mechanical devices, causing acceleration sedimentation minor defects of reduced copper. The use of these methods is very difficult or even impossible to use in large-size aggregates for which belongs to electric furnace to decopperisation of slags suspension.

2. The concept of operation of the furnace

A method of recovering copper from metallurgical slags presently applied technological concept is characterized in that throughout the period the reduction electrode is powered by alternating current (AC). The proposed concept, to optimize the process conditions in the final stage of the process (at a temperature of 1200-1350°C) suggest the use of direct current (DC). Carbon electrodes are an anode, while a cathode is full board or carbon electrode and a series of lower carbon electrodes (Figure 2 and 3) disposed on the bottom of the valley of furnace. This is achieved with the significant expansion of the impact of the electric field a current density of 0.1-10 A/m^2 the upper surface of the liquid slag. DC power supply can be pulsed.

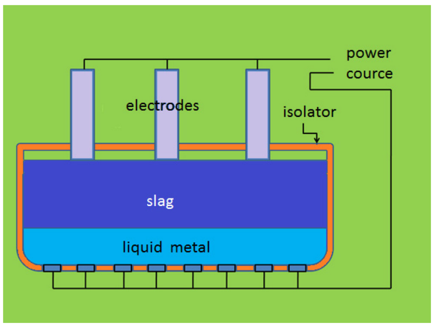

Fig. 2. The concept of refining the use of the flow of alternating and direct current

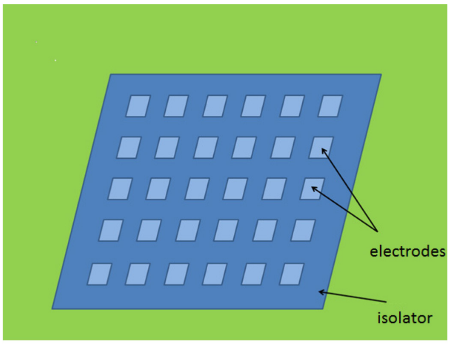

Fig. 3. Bus electrodes in the bottom of the furnace

Constructing shown in Figure bottom of the electro - arc furnace guided by the analysis of the flow of current fields. Presented furnace will help in getting the current flow distribution across the metal bath, which can be represented in the diagram - Figure 4.

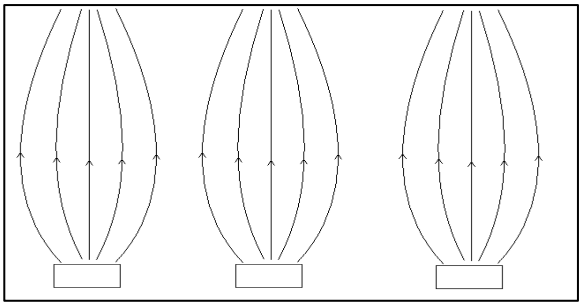

Fig. 4. Distribution of current fields in the furnace

3. Attempts on an industrial scale

The tests were performed in an resistively - arc furnace of the maximum weight slag to 50 kg. Held copper recovery process was carried out with a slag having basic composition of wt. 35 % SiO_2, wt. 25% CaO, wt. 8% MgO, wt. 15% Al_2O_3, wt. 15% CuO. The furnace design allowed the isolation liquid slag from the atmosphere. The furnace had ceramic lining of the backbone of the coal unit. Additionally, applied to the surface of the slag layer of coke (5% by weight of the slag), as the regulator. At a temperature of 1.350°C were kept in isolation slag bath from the atmosphere thereby formed spontaneously rich in nitrogen atmosphere conducive to the process of lowering the copper content of the slag.

Electrical Switch (scheme shown in Figure 5) of the power supply for the pulse DC accomplished with a current of intensity corresponding to 1 A/m^2 top surface of the slag bath to the positive pole and negative electrodes on the shaft of the coal. After stabilizing the rheological conditions for 20 minutes at approx. 1300°C, the current has been switched off and drain slag. The final content of a metallic alloy of Cu-Fe-Pb was 2%.

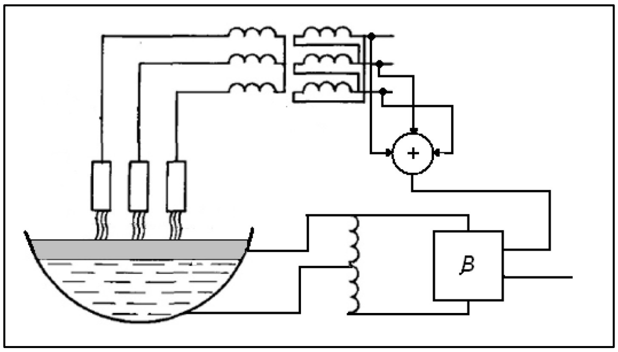

Fig. 5. Electrical diagram of the control process

The electrodes (Figure 4) heat the feedstock, through the electric arc, using the 3 - phase, alternating current. Used here are three graphite electrodes, each working in the circuit of the one phase star connection. They heat up the metal charge alternately moving in the vertical position, which is intended to protect them against short circuit with floating furnace feedstock. In addition, we used herein the flow of current through a bath where a liquid metal cathode and anode slag layer. As a result, the current flow will be theoretically occurred ions to pass from the slag to metal, electrolytic release of the compositions from the solution, the electrocapillary movements at the border metal - slag, Joule heat convection and the additional convection slag mass. The strength of the current through the bath is controlled operation of the transformer. Using feedback loops (B) - which may be a relay certain output is obtained automatically adjust the current flow dependent on the active operation graphite electrode arc furnace. Using the summation node obtain information on the current status of the various circuits that the feedback loop activate the flow of current in the bath adjustable auto-transformer.

4. Summary and conclusions

The main technical advantages of the application of the presented concept resulting from a substantial reduction of the phase rich in copper metal in the slag (from 0.8-1.0% to approx. 0.2-0.3%). There was a targeted acceleration of migration of ions mainly of the reagents towards the hearth constituting the cathode and electrolyte secretion from the copper metal is chemically bound in the slag. Accompanying electrocapillary movement in the border area of the non-metallic metal phase contributes to coagulation and coalescence of fine particles of reduced copper from the slag solution. A method of recovering copper from metallurgical slags does not preclude its use for copper alloys under refining.

We conclude that:
- method optimized recovery of copper from metallurgical slags is characterized in that the process is carried out in a single furnace - an electric arc furnace where the electrodes DC are used the same carbon electrodes producing an electric arc,
- the final stage of the process takes place at a temperature of 1200-1350°C with constant current, wherein the electrodes are an anode while the cathode role full plates or carbon and / or carbon number of the lower electrode at the bottom of furnace,
- furnace design provides the ability to use current pulse.

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