Development of resource-saving technology for copper production at “Almalyk MMC” JSC

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Abstract. This article discusses the possibility of introducing man-made waste from the production of nonferrous metals from metallurgical processing into copper production. Industrial tests have shown that with the use of technogenic waste from the production of nonferrous metals when smelting copper in metallurgical furnaces, it was possible to reduce the copper content both in the converter slag and in the slag of the reverberatory furnace with the possibility of additional extraction of noble metals. Based on the research carried out, a technological scheme for energy- and resource-saving copper production technology was developed.

1 Introduction

Currently, in the processes of pyrometallurgical remelting of sulfide copper concentrates with matte smelting in high-temperature furnaces operating on fuel and autogenous furnaces, a sufficient number of man-made formations are released in the form of copper production slag, the amount of which is sufficient to occupy large areas of land. The copper smelter at the “Almalyk Mining and Metallurgical Combine” JSC (“Almalyk MMC” JSC) is also no exception; in addition, large volumes of other man-made formations have accumulated in the dumps of this enterprise. Based on the results of many studies in this area, it was determined that the involvement of these wastes in production will allow the plant to significantly solve the problem of expanding the raw material base without increasing capital costs for mining and processing work and additionally obtaining hundreds to thousands of tons of copper, precious metals and other valuable products [1].

Waste from mining and metallurgical production takes up significant areas of land and can pollute air, soil and water. An assessment of damage from environmental pollution shows that the use of waste-free technology for the production of nonferrous and precious metals leads to an expansion of the possibility of creating economically feasible technologies that will help solve a number of problems associated with industrial waste disposal. A detailed study of the theory, technology and technology of metal production has made it possible to establish that the copper content in slag is influenced by numerous factors, of which the following should be considered the most important: preparation of the charge, parameters of

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the smelting technological regime, physical and chemical properties of the melts, high magnetite content in the slag melts, design units, organization of work, etc. [2].

2 Materials and methods

However, in our opinion, one of the main reasons for the high copper content in the waste slag of reverberatory furnaces is the high excess content of magnetite in converter furnaces poured into units, the use of which is provided by the existing technology for obtaining blister copper.

Considering the negative influence of converter slag magnetite in the operation of a proper unit, it will be very effective to pour prereduced converter slags over magnetite into a reverberatory furnace (the reduction of ferric iron to ferrous iron is achieved by reducing magnetite in the converter slag) [3].

Thus, one of the real, effective levers for managing the quality of the depletion process is the selection of effective conditions for the recovery of magnetite in the slag, which has optimal physicochemical properties. Clinker is used as a reducing agent—a technogenic waste from zinc production thatcontains the reducing agents carbon and iron. It has been established that the process of reducing ferric oxide in an iron silicate melt with clinker during the initial period occurs in a kinetic regime. After the concentration of magnetite is reduced to a residual 3-5% in the slag, the process of recovery moves into the diffusion region; i.e., restoring the excess content of ferric iron in iron silicate melts takes a short period of time—up to 10 minutes—during which the process can be carried out without significantly delaying the operation of the main industrial converter. Kinetic parameters such as the reaction order, activation energy, rate constant and transition diagram from the kinetic to the diffuse region of the process of reducing ferric iron from an iron silicate melt with clinker, which are necessary to improve the technology, have been established [4-6].

Progressive energy- and resource-saving technologies for the production of metal-composite materials based on local raw materials and waste from the mining and metallurgical industry (Figure 1) were developed based on the results of many years of fundamental and applied research, as well as innovative work. Moreover, a large amount of theoretical and experimental research has been carried out, as well as semi-industrial and industrial tests in industrial converters and the reverberatory furnace of “Almalyk MMC” JSC using real and existing control levers, such as the quality of depletion of dump slag in recovery processes with a simultaneous increase in copper yield and modernization of the process of reflective smelting and converter processing by selecting an effective slag composition with a minimum content of residual copper, which can subsequently be used in the production of building materials [7].

It was shown that when clinker is used as a magnetite reducer, which is contained in converter slag based on the developed copper production technology at “Almalyk MMC” JSC, the annual consumption of clinker can reach about 16000 tons, freeing up the occupied land area. This will lead to a 3.5 million m3 reduction in natural gas consumption for combustion. Moreover, the volume of harmful gas (CO_2) emitted into the atmosphere decreases. In addition, in the resulting slags, which are waste, the copper content decreases less 0.50%, and the resulting slags can be sent to other industries, for example, as building materials. By creating a waste-free technology for the production of copper by pyrometallurgical means at “Almalyk MMC” JSC, the process will proceed without storage in special dumps, which will lead to an improvement in the environmental situation in the region [8].

Reducing the magnetite content in the liquid converter slag poured into a reverberatory furnace significantly increases the SiO_2 activity of the waste slag during the smelting process, which promotes the occurrence of reaction 1, the reduction of magnetite with sulfide at the slag-matte interface.

$$3Fe_3O_4+FeS+5SiO_2=5(2FeO*SiO_2)+SO_2 \quad (1)$$

The restoration of magnetite in the furnace leads to the cessation of "accumulation", and the partial dissolution of magnetite in the matte ultimately contributes to the erosion of the deposit.

3 Results and discussion

Ten-days industrial tests were carried out on converters and a reverberatory furnace at the copper plant of "Almalyk MMC" JSC. The objective of the study was to reduce the magnetite content in converter slag poured into a reverberatory furnace to stop the formation of crust.

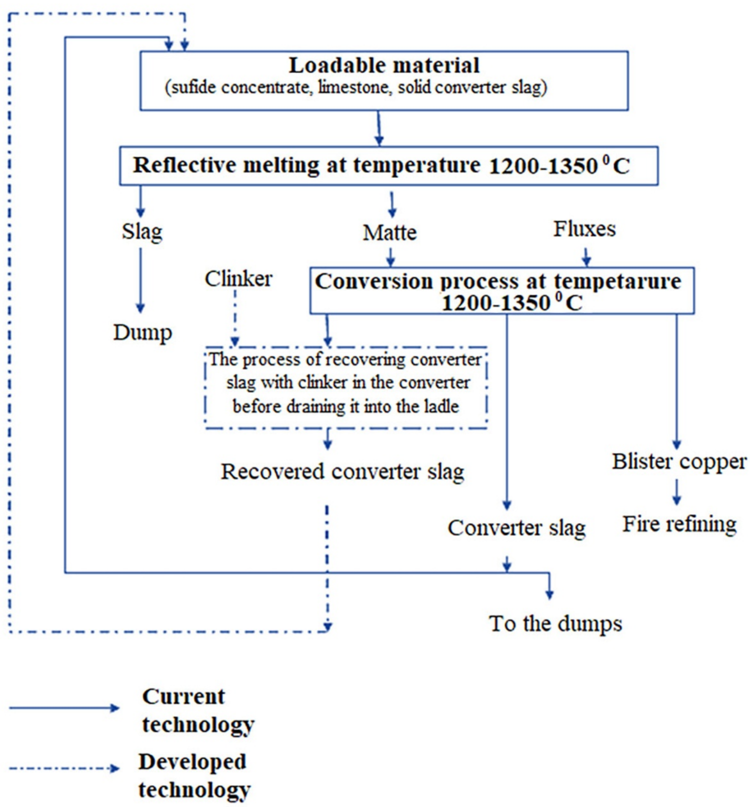

Fig. 1. Energy and resource saving technology Copper production.

The average magnetite content in the converter slag sample taken for testing was 18.99%. During testing, the magnetite content of the sample was reduced to 9.73%, which represents a reduction in magnetite content of 48.8%. The average copper content of the converter slag before testing was 3.87%. During testing, the copper content was reduced to 2.41%, which represents a reduction in the copper content of 37.8%.

The height of the mixture in the reverberatory furnace before industrial testing was 650 mm; after completion of the experiment, the height decreased to 600 mm. The results of the study revealed that reducing the excess magnetite content in the converter slag stopped the growth of magnetite deposits and created conditions for the recovery of magnetite from magnetite deposits with charged sulfides.

The developed technology solves not only the problem of processing technogenic waste but also reduces the copper content in dump slag, obtaining additional significant quantities of copper weighing 1116 tons, 81.92 kg of gold, 4028.28 kg of silver, and other valuable components from technogenic waste.

4 Conclusion

By creating an energy- and resource-saving technology for copper production at “Almalyk MMC” JSC, we can conclude that by reducing the magnetite content in the converter slag using clinker as a reducing agent, the problem of reducing its content was solved, and the possibility of reducing the copper content in the slag was created, making it possible to additionally extract valuable metals.Further processing of the recovered converter slag in a reverberatory furnace together with copper concentrate makes it possible to reduce the magnetite content when it interacts with the sulfides of the concentrate because it is possible to obtain a liquid metal homogeneous in chemical composition and waste slag with a copper content less than 0.5%.

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