

## TO THE QUESTION OF COPPER ANODES QUALITY OF FIRE REFINEMENT

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The work of fire and electrolytic refinement divisions of copper in the conditions of the Zaporozhe factory of nonferrous metals is analyzed in article. Defects of copper anodes which arise by their manufacture are described. It is shown that usage of phosphorous copper at a stage of copper fire refinement not only reduce quantity of copper anodes with defects, but also improve working conditions of a electrolytic refinement division. In particular, the average exit on a current on commodity series on 4.0-5.2 % raises.

Keywords: copper secondary, fire refinement, electrolytic refinement, the anode, superficial defect, latent defect, deoxidizer

One of nonferrous metals which remains claimed practically in all spheres of human activity still has copper. The given metal not only strongly holds positions in such industries as the electrical engineer and electronics, manufacture of cable production, manufacture of heat-exchange devices and etc., but also wins new areas - building and a life of the human. The International Copper Study Group data testifies to it (ICSG), according to which in 2013 the part electrical engineers and electronics makes 30 %, a building part - 30 %, a part of industrial mechanical engineering - 12 %, a transport part - 13 %, other - 15 % [1]. Such distribution of copper on industries differs from distribution of copper which was in 2007 [2], when on a part electrical engineers and electronics the mechanical was 45-55 %, on a part engineering 10-15 %, building 8-10 %, transport 8-10 %. Growth of a copper part in building area is obvious.

Such growth of a share of copper is promoted not in the last instance by constant increase in production volumes of the refined copper after crisis of 2008-2009 years. According to data ICSG [3] the world volume production of refined copper in 2008 has made 18.214 million t., in 2009 - 18,248 million t., in 2010 – 18.981 million t., 2011 – 19.596 million t., 2012 – 20.129 million t. Under forecasts [4] in 2013 it will be made 20.912 million t. of the refined copper, and in 2014 – 22.061 million t. Accordingly the consumption of the refined copper will increase: in 2013 – 20.525 million t., and in 2014 – 21.429 million t.

Recently attempts to develop and introduce in practice new methods of refinement of copper which provided high degree of refinement from impurity at the minimum financial expenses [5]. These methods provide high degree of refinement of copper from impurity at corresponding primary preparation of the batch consisting of a breakage and a waste of copper. The copper made by these methods can be applied in building, transport and other industries where the high electrical conduction of copper is not required. However the basic scheme of manufacture of the refined copper of electrotechnical appointment for last decades considerably has not changed and includes such obligatory operations as fire and electrolytic refinement.

At the Zaporozhe factory of nonferrous metals (ZFNM) is realized the traditional scheme of manufacture of the refined copper from a breakage and a waste, according to which at first spend the fire refinement providing the maintenance of copper to 99.0-99.6 %, further the received copper spill in anodes and electrolytic refinement lead up to marks of copper M0к, M00к in accordance with GOST 859-2001.

The fire refinement of copper represents oxidizing process on which the purge by air of copper melt with its subsequent restoration by wood (operation «overpoling» is carried out). As a result of an overpoling the slag, in which the most part of impurity concentrates, is formed. The process of fire refinement of secondary blister copper has a number of essential features in comparison with the blister copper received from ore raw materials. This difference consists in the high content of following impurity: lead, zinc, iron, nickel. The content of the listed impurity on ZFNM in copper anodes is supported in following ranges, %: 0.1-0.3 *Pb*; 0.07-0.1 *Ni*; 0.01-0.05 *Sn*; 0.015-0.04 *Zn*; 0.002-0.02 *Fe*.

Except a chemical compound it is supervised overall dimensions and appearance of anodes. On a surface of anodes there should not be up rushes and a thickening of edges, «cones» and «bubbles», a continuous blistering, deepening's and ledges from development of casting moulds. The anode surface should be equal with curvature on a vertical no more 7 mm. On an anode surface it is not supposed inclusions of slag, clay, coal and others not copper inclusions which form superficial defects of anodes.

Except superficial defects can be present and latent defects which can be found out only at anode wear. At anode crystallization in its body nonmetallic inclusions (the rests of slag, fire-resistant lagging of a casting mould) which during wear of the anode part at an electrolysis are washed away by electrolyte stiffen and in an anode body there are through apertures which negatively influence on anode current density and, hence, on all process of an electrolysis. Latent defects of anodes are well visible at an unloading from electrolysis baths of the anode rests. Under production conditions ZFNM it is difficult to carry out control of latent defects, and it is impossible to reveal the rejected anodes. Therefore they arrive on an electrolytic refinement division and negatively influence indicators of its work.

The analysis of the anodes quality arriving on an electrolytic refinement division, and also the anode rests unloaded from commodity baths and directed on a meltdown, has yielded following results. The necessary quantity of anodes for loading of one commodity series consisting of 6 commodity baths makes 204 pieces. Average quantity of anodes with superficial defects (inclusions of slag, fire-resistant lagging) at loading of one commodity series has made 24-36 pieces or 11.8-17.6 %. The average quantity of the anode rests with through apertures at an unloading has made of one commodity series 36-48 pieces or 17.6-23.5 %. To summarize anodes with different defects it is impossible, as the same anode can have both superficial and latent defects.

On a fire refinement division of ZFNM by manufacture of copper anodes carry out the following sequence of operations: loading and fusion of the batch, a purge of copper melt by air, slag removal, restoration of superfluous oxygen by wood

(overpoling), preparation of melt for a tapping in a ladle, a melt tapping in a ladle, a casting of copper from a ladle on casting moulds, loading of crystallized anodes in a bath for cooling. For the purpose of decrease in quantity of copper anodes with defects on a fire refinement division it has been decided to enter in addition into melt of copper a deoxidant - phosphorous copper. For this purpose on a ladle bottom before a melt tapping placed phosphorous copper from calculation 1-2 kg on 1 t copper melt. The melt tapping in a ladle made and maintained some time. Then from a melt surface removed slag and spilt copper on casting moulds.

As a result deoxidant usage has decreased quantity of anodes with superficial defects to 18...30 pieces (8.8-14.7 %), the quantity of the anode rests with through apertures has decreased to 24-30 pieces (11.8-14.7 %). Besides, the analysis of work of an electrolytic refinement division on the given anodes within 2 months has shown that the average exit on a current on commodity series has made 90.8 % in the first month and 89.6 % - in the second month that more than an average exit on a current before the carrying out of researches (85.6 %). Also decrease in chemical dissolution of copper anodes in sulphate electrolyte (150...165 g/l  $H_2SO_4$ , 50...65 g/l  $Cu$ ) from 2.5 to 2.0 %, decrease in quantity of slime in electrolyte and increase of copper concentration in the electrolytic slime containing copper is fixed.

The usage of an additional deoxidant (phosphorous copper) at a stage of copper fire refinement has allowed to raise quality of copper anodes: to reduce quantity of anodes with superficial defects on the average by 3 %, and anodes with latent defects to reduce on 5.8-8.8 %. Work of an electrolytic refinement division on such anodes is characterized by increase of an average exit on a current on commodity baths on 4.0-5.2 % that has allowed receiving in addition nearby 21 t cathodic copper in a month.

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