Direct electrowinning of copper from solution after Cu concentrate bioleaching

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Abstract

Significant progress in technology of copper concentrates bioleaching, which provides possibilities to produce sulfate solutions of copper concentration above 40 g/dm³ and with efficiency over 90 %, underlay the studies into production of electrolytic copper directly from such solutions without a traditionally applied solvent extraction operation.

The studies were conducted with the solution produced at BRGM (France) by bioleaching of ZG Lubin copper concentrate. In the experiments an electrolyser was used with two anodes made of Pb1Ag alloy and with one cathode of acid resistant steel. The applied cathode current density was 200 A/m², electrolyte temperature was 55°C, and inhibitors were composed of bone glue and thiourea.

The first tests were conducted both in continuous and cyclic mode and showed possibilities for production of metallic, compact cathode deposits, however current efficiencies were relatively low, at the level of 61 - 77%, while electric energy consumption was 2500 – 3100 kWh/t Cu, which undoubtedly results from high iron(III) content in the solution. Tests for iron(III) ions removal from the solution were undertaken. Iron(III) content was reduced by hydrolytic precipitation and in a form of jarosite. With the first technique about 96% of Fe was removed, but filtration process was difficult and copper loss to the residue was about 4%. Application of jarosite method brought 71% iron removal. Filtration run easily and copper loss to the residue was about
3%. Tests of copper electrowinning from solutions of reduced iron(III) content showed high current efficiencies: 96% and 91%, respectively.

The produced cathode deposits, although presenting compact metallic structure and meeting the highest Cu-CATH-1 cathode deposit quality standards, were characterised by dendritic bottom edges. It was suspected that the accretions result from excessively high Cl\(^-\) ions concentration in the solution. During copper removal from the solution of decreased content of iron(III) and chloride ions content reduced to the level of 0.078 g/dm\(^3\) (84% chlorine removal) high current efficiency of about 91% and relatively low electrical energy consumption at the level of 2000 kWh/t Cu was reached. The accretions on the exposed edge of cathode deposit were significantly reduced.

In the technology for treatment of Lubin concentrates by bioleaching the solution after copper electrowinning should be recycled. Considering the fact that some impurities will accumulate and that it is necessary to maintain solution components, such as iron and chlorine, at a required level, the adapted composition of the solution was similar to the actual solution recycled to the bioleaching process. Production of copper from thus prepared solution in the conditions described in the above tests resulted in 92% current efficiency, relatively low electrical energy consumption of 1900 - 2000 kWh/t Cu, while the cathode deposit was of compact structure and high purity.

Based on the produced results of copper removal it was possible to prepare a flow-sheet for hydrometallurgical treatment of Lubin concentrate by bioleaching and electrowinning of copper from the produced solution.

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