ABSTRACT OF DOCTORAL DISSERTATION

Leaching of copper sulfide concentrates under hydrothermal conditions

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The doctoral dissertation concerns hydrometallurgical processing of copper sulfide concentrates produced from Lubin-Glogow Copper Basin (LGOM) ore. The concentrate from Lubin Concentrator (KGHM Polska Miedz S.A.) was used in this study due its low quality and challenges posed by this material in pyrometallurgical processing. The aim of the study was to assess feasibility and effectiveness of pressure leaching at elevated temperature in order to recover copper and other useful metals present in the Lubin concentrate.

The following research was performed: mineralogical characterization of concentrate (before leaching), mineralogical analysis of the solid phase samples taken during the leaching and after completing the process; influence of critical parameters on leaching efficiency (temperature, oxygen partial pressure, sulfuric acid concentration, mixing speed, Fe(III) ions concentration), the effect of concentrate pretreatment before leaching process (regrinding, decomposition of carbonates), effectiveness of leaching by circulating the leach solution.

Mineralogical analysis shown that Lubin concentrate indicates multiple unique features (i.e., mineral complexity, ore minerals intergrowths and ore minerals/gangue intergrowths, wide range of particle size and high dispersion of ore minerals) which impact hydrometallurgical processing of this material. The highest efficiency of leaching was observed at 140˚C, at temperature in range from 160 to 200˚C a significant decrease of leaching rate occurred. It was confirmed that ferric ions leached from the sulfides have a positive influence on the leaching process as an oxidizing agent. It was also shown that the introduction of ferric sulfate as a source of Fe(III) ions (15-30 g/dm^3) negatively affects the leaching efficiency. The minimal oxygen partial pressure which allows to obtain high leaching efficiency was determined at 1.0 MPa. High rate of gangue decomposition was observed at 1.5-2.0 MPa. It caused significant increase of total pressure in the autoclave and released the products of decomposition to the leach solution. Optimal concentration of sulfuric acid was determined at 100 g/dm^3 and it was shown that pressure leaching in presence of oxygen requires lower pH than atmospheric leaching with Fe(III) ions. Physical and chemical pretreatment of the concentrate had a negative effect on leaching efficiency. Regrinding of the concentrate was

destroying the beneficial intergrowths of ore minerals. The recirculation of the leach solution was not possible without its proper regeneration. The mineral changes were observed in the solid phase samples collected during the leaching process. These changes (covellinisation) consisted in the direct or multistage transformation of the more complex copper sulfides (bornite, chalcopyrite, chalcocite) into the simplest sulfide, i.e. covelite. The mechanisms of covellinisation were presented for different cases of single minerals and their intergrowths.