

## Extraction of copper from copper bearing sulfide ores (chalcopyrite) by oxidative chemical leaching

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The extraction of copper from primary copper sulfide ores is much complicated and expensive. However, the successful metal extraction from natural mineral resources is very important, both environmentally and economically. The main objectives of this research work are to examine possible ways to increase the copper extraction from chalcopyrite ( $\text{CuFeS}_2$ ) using oxidative chemical leaching processes and to investigate oxidative leaching kinetics of chalcopyrite in sulfuric ( $\text{H}_2\text{SO}_4$ ) acid medium. Chalcopyrite mineral sample was obtained from Geological Survey and Mines Bureau (GSMB) in Sri Lanka. Initial investigations characterized the chalcopyrite ore mineralogically and chemically. X-ray diffraction analysis of chalcopyrite ore revealed that only chalcopyrite ( $\text{CuFeS}_2$ ), azurite ( $\text{Cu}_3(\text{CO}_3)_2(\text{OH})_2$ ), pyrite ( $\text{FeS}_2$ ) and pyrrhotite ( $\text{FeS}$ ) minerals were present. The copper content of the chalcopyrite ore sample was found to be 16.6% by weight according to the chemical analysis. The extraction of copper from chalcopyrite using hydrogen peroxide ( $\text{H}_2\text{O}_2$ ), ferric sulphate ( $\text{Fe}_2(\text{SO}_4)_3$ ), potassium permanganate ( $\text{KMnO}_4$ ) and potassium dichromate ( $\text{K}_2\text{Cr}_2\text{O}_7$ ) oxidizing agents in acid solutions was studied using the 63-90  $\mu\text{m}$  particle size fraction of chalcopyrite. The effect of temperature ranging from 30  $^\circ\text{C}$  to 70  $^\circ\text{C}$ , the effect of concentration of sulfuric acid ranging from 0.25  $\text{mol dm}^{-3}$  to 5.0  $\text{mol dm}^{-3}$  and the effect of pulp density ranging from 2% to 6% on the rate of dissolution of copper from chalcopyrite ore were also studied. The extraction rates are significantly influenced by the temperature and the concentration of the acid solutions. According to the oxidative chemical leaching results, the maximum extraction of copper was achieved with  $\text{KMnO}_4$  and then with  $\text{K}_2\text{Cr}_2\text{O}_7$ , followed by  $\text{H}_2\text{O}_2$  and  $\text{Fe}_2(\text{SO}_4)_3$ . In this study maximum extraction of 70.2 % of copper was achieved at 0.1  $\text{mol dm}^{-3}$   $\text{KMnO}_4$  in 1.0  $\text{mol dm}^{-3}$   $\text{H}_2\text{SO}_4$  acid. It was found that oxidizing agents improved the leaching kinetics of chalcopyrite in sulfuric acid medium saving both time and energy effectively and efficiently. A kinetic study showed that the dissolution of copper from chalcopyrite ore was controlled by chemical reaction process on the surface of particles. Based on the results obtained in this investigation, the apparent activation energy for the dissolution of copper using the Arrhenius expression was found to be 31.8  $\text{kJ mol}^{-1}$ .

**Keywords:** Copper extraction, Chalcopyrite, Sulfuric acid, Oxidizing agents, Leaching kinetics