Sharif University of Technology

Department of Materials Science and Engineering

M.Sc. Project

Chloride Leaching of Chalcopyrite Concentrate by $CuCl_2$

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Abstract

High advantages of hydrometallurgy have led to its recent development in metal extraction. Many investigations are being carried out on applying hydrometallurgy processes on copper extraction. In this study, the chloride leaching of chalcopyrite in a concentrated sodium chloride solution (4M) –which is a novel process–, using $CuCl_2$ as leachant is investigated.

Main effects and interactions of temperature (50–90°C), time (2–6 hr), $CuCl_2$ concentration (0.1–0.5M), pulp density and HCl concentration (0.1–1M) at constant stirring rate (600 rpm) on leaching is studied using 2^k factorial design and applying Design–Expert 7.0.0 software. While the effect of pulp density is almost negligible, temperature has a definitely positive effect on the leaching. After temperature, main effects of time and $CuCl_2$ concentration are in the next ranks of importance respectively. While all the interactions are almost positive, the interactions of temperature –time and time–$CuCl_2$ are more intense.

Based on the results of the screening experiments, optimization tests were designed by applying Response Surface Methodology (RSM) and Central Composite Design (CCD). In the optimal point, 79.76% copper extraction was achieved in the following conditions: T=90°C, t=4.36 hr, $[CuCl_2]$ =0.25M (2.5 times of stoichiometric quantity of oxidant as required). According to Pourbaix diagram $CuCl_3^{2-}$ is the predominant species at optimal condition.

The batch leach kinetics appears to fit a shrinking particle model. The leaching rate was controlled by a surface chemical reaction with apparent activation energy of 52.06 KJ/mol and a reaction order of 0.617. The kinetics equation of the process was established as:

$$1-(1-\alpha)^{0.33}=1.17\times10^{5}\times\exp\left(-\frac{52.06\times10^{3}}{RT}\right)C^{0.617}t$$

Keywords: Chalcopyrite, Leaching, $CuCl_2$, Kinetics, 2^k factorial, Pourbaix diagram.