Optimization of Process Parameters for Copper Extraction from Wastewater Treatment Sludge by Sulfuric Acid

Authors : Usarat Thawornchaisit, Kamalasiri Juthaisong, Kasama Parsongjeen, Phonsiri Phoengchan

Abstract : In this study, sludge samples that were collected from the wastewater treatment plant of a printed circuit board manufacturing industry in Thailand were subjected to acid extraction using sulfuric acid as the chemical extracting agent. The effects of sulfuric acid concentration (A), the ratio of a volume of acid to a quantity of sludge (B) and extraction time (C) on the efficiency of copper extraction were investigated with the aim of finding the optimal conditions for maximum removal of copper from the wastewater treatment sludge. Factorial experimental design was employed to model the copper extraction process. The results were analyzed statistically using analysis of variance to identify the process variables that were significantly affected the copper extraction efficiency. Results showed that all linear terms and an interaction term between volume of acid to quantity of sludge ratio and extraction time (BC), had statistically significant influence on the efficiency of copper extraction under tested conditions in which the most significant effect was ascribed to volume of acid to quantity of sludge ratio (B), followed by sulfuric acid concentration (A), extraction time (C) and interaction term of BC, respectively. The remaining two-way interaction terms, (AB, AC) and the three-way interaction term (ABC) is not statistically significant at the significance level of 0.05. The model equation was derived for the copper extraction process and the optimization of the process was performed using a multiple response method called desirability (D) function to optimize the extraction parameters by targeting maximum removal. The optimum extraction conditions of 99% of copper were found to be sulfuric acid concentration: 0.9 M, ratio of the volume of acid (mL) to the quantity of sludge (g) at 100:1 with an extraction time of 80 min. Experiments under the optimized conditions have been carried out to validate the accuracy of the Model.

Keywords : acid treatment, chemical extraction, sludge, waste management