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Bioleaching of Heavy Metals in Contaminated Soils of the Old Smelting Site by Microbiological Sulfur Oxidation

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Potentially toxic heavy metals are very serious contaminants in the vicinity of the old smelting sites in Korea. The objectives of this study are to evaluate the bioleaching efficiency of heavy metals in contaminated soils around the Janghang old smelting site by microbiological sulfur oxidation, and to discuss the effect of various operational conditions such as sulfur concentration, bacterial inoculum amount, temperature, stirring, and soil- liquid ratio (SLR) on the efficiency. In this study sulfur granules were replaced with hydrophilic colloidal sulfur as microbial energy source in order to investigate the possible application of in-situ bioleaching of heavy metals in contaminated soils. The studied soil has pH of 5.8, CEC of 10.43 meq/100g and LOI of 3.9%. The concentrations of heavy metals in the studied soil were determined as Cu 114 mg/kg, Pb 235 mg/kg, Zn 94 mg/kg, As 71 mg/kg, Ni 18 mg/kg, and Cr 29 mg/kg by aqua regia digestion. From the batch tests, microbiological sulfur oxidation was identified through the decrease of pH and the increase of Eh and extracted metals. The bioleaching efficiency of heavy metals was enhanced with the increase in amount of colloidal sulfur input and initial bacterial inoculums. Bioleaching of heavy metals was efficient at 28˚C compared with 2˚C, which means microbial growth is inhibited in low temperature. Bioleaching efficiency of Cu, Zn, Ni and Cr showed similar increasing trend during before 12 days between stirring and non-stirring experimental sets. After 12 days bioleaching of heavy metals was constantly achieved in stirring condition, whereas no more extraction occurred in non-stirring condition. With the increase of SLR in bioleaching solution, the removal efficiency of heavy metals was decreased. The maximum removal efficiency was Cu 76%, Pb 54%, Zn 83%, Ni 69%, Cr 57%, and As 47%. The scale-up experiment with 3 L bioleaching solution with SLR of 2 was performed. As a result, the bioleaching efficiency of Cu and Zn gradually increased over reaction time, leading to Cu 56 % and Zn 62 % after 24 days, whereas Pb and As were not efficiently extracted from soil.