Characterization and Removal of Lead from Battery Industry Sludge by Acid Leaching

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Sludge generating from battery manufacturing industry contain a high concentration of lead which may lead to severe eco-environmental consequences if it released into the environment. Acid leaching has been considered as a promising technique for metal recovery from industrial wastes including wastewater sludge. However, in order to utilize acid leaching in an effective manner, a better understanding about characteristics of sludge and mechanisms behind the acid leaching are important. The objectives of this study are to characterize the sludge from battery industry and to find out the mechanisms related for lead release with different types of acids. The X-Ray Fluorescence (XRF) analyzer was used to determine elemental composition of sludge. In order to assess bioavailability and fractionation of lead among different phases of sludge, single and sequential extractions were applied, respectively. The release of lead was investigated with six different acids namely; nitric, sulfuric, phosphoric, acetic, malic, and citric, with concentrations of 0.1–2.0 M. The XRF data reported that the 1.48% of the sludge obtained for the study is comprised with lead. From that fraction, 296.61± 20.31 mg kg^{-1} was observed as bioavailable concentration of lead. Results from sequential extraction indicated that the lead is mainly associated with Fe-Mn oxides bound fraction (5413.64 mg kg^{-1}) and carbonates bound fraction (2962.39 mg kg^{-1}). Nitric acid exhibited the highest release rate for lead (1.03×10^{-10} mol m^{-2} s^{-1}) at the concentration of 1.0 M. However, acetic acid provided the maximum rate of lead release (1.90×10^{-10} mol m^{-2} s^{-1}) at pH 1. The highest rate of lead release by acetic acid is described by ligand-promoted mechanisms which responsible for 8.7 times high rate (1.69 10^{-10} mol m^{-2} s^{-1}) than proton-promoted mechanisms. Therefore, this study highlighted the need of characterization of sludge and appropriate understanding of mechanisms which involved for metal release are essential to employ the optimum acid type for acid leaching.

Keywords: Industrial waste, sludge treatment, resource recovery, trace metals, leaching