The Use of Red Mud as a Potential Precursor for Stabilizing Zn/Ni/Cu Bearing Wastes in Spinel Forms

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Abstract: Toxic metal pollution is a significant environmental problem in many regions. Red mud, which is from the aluminum industry, is a potentially under-utilized resource. Technological processes for using low-cost red mud as an alternative precursor for detoxifying metal pollutants urgently need to be developed. In this study, we systematically investigated the feasibility of using red mud to detoxify metal-containing wastes. To understand the mechanism of metal detoxification by red mud, CuO, NiO, and ZnO were blended with red mud at different weight ratios and the mixtures were then subjected to ceramic-sintering. After sintering, the X-ray diffraction results revealed that all of the metals (*i.e.*, Cu, Ni, and Zn) were able to be crystallographically incorporated into spinel lattices. Sintering the red mud at 1100 °C for 3 h effectively converted the metals into spinels. The mixing weight ratios strongly affected the efficiency of the metal incorporation. The red mud was able to incorporate 15 wt.% of metal oxides. The incorporation mechanisms mainly occurred between the metal oxide(s) and hematite. Modified TCLP tests were conducted to further evaluate the metal stabilization performance of the red mud, which demonstrated the leachabilities of ZnO and the sintered red mud + ZnO product. The concentration of leached metal was substantially reduced after the incorporation process, thus demonstrating that red mud can be successfully used to detoxify metals. The results of this study reveal that waste red mud can be feasibly reused as a promising waste-to-resource strategy for stabilizing heavy metal waste.
Keywords: Red Mud; Fly Ash; Nickel; Copper; Zinc; Spinel.