Technospheric Mining of Cobalt from Nickel Slag: A Study on Complexation Leaching

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ABSTRACT

Nickel slag is a by-product of pyrometallurgical processing of nickel sulphide concentrates, which contains significant metals of value, especially cobalt (Co). This non-ferrous slag can be considered as an important secondary source of this critical metal. Cobalt is mainly associated with copper or nickel ores, and during smelting, considerable amounts of Co are lost to the slag. Cobalt is an important component for rechargeable batteries and widely used for superalloys, magnets, catalysts, etc. The recovery of Co from nickel slag has high economic advantages and strong environmental motivation and can be categorized under technospheric mining. Technospheric mining is a term used to describe the extraction of mineral or metal stocks accumulated in the technosphere, a material stockpile established by anthropogenic activity and technological processes. In this study, the recovery of Co from nickel slag produced in Western Australia by complexation leaching is reported. Two types of slag were collected from the furnace and converter. A furnace slag contains 0.19 wt% Co and 0.56 wt% Ni, and a converter slag 0.62 wt% Co and 1.20 wt% Ni. The effectiveness of low molecular weight organic acids, including citric acid ($C_6H_8O_7$), hydrogen peroxide (H_2O_2) as a reductant, and ethylenediaminetetraacetic acid (EDTA) on leaching Co from slags with minimal impact on the silicate components was evaluated. Key process variables, such as reagent concentration, leaching time, temperature, and their influences on Co dissolution were examined. Initial results indicated that a mixture of citric acid and EDTA seems to be the most promising combination achieving 79.2% Co and 78.6% Ni recovery at 80°C in 6 hours and minimal solid-liquid separation issues. Further studies are required to optimize Co recovery and understand mechanism but the results already present the potential of complexation leaching with organic acids as a method to recover Co from nickel slag.