Chemosphere Volume 301, August 2022, 134661

Leaching of rare earth elements from phosphogypsum

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Abstract

High amounts of phosphogypsum (PG) are generated in the production of phosphoric acid. Previous literature demonstrates that obtaining rare earth elements (REE) from PG is a promising alternative to managing this waste. However, the reported leaching efficiencies are low in most cases, or drastic leaching conditions are required. Therefore, this work aimed to study the leaching conditions of REE from PG to obtain high leaching efficiency values. Initially, a 24 factorial experimental design investigated the factors that affect the conventional acid leaching of REE from PG (leaching acid (citric and sulfuric acid), solid/liquid ratio, acid concentration, and temperature). Better leaching efficiency values of the sum of all REE (62.0% and 89.7% for citric and sulfuric acid, respectively) were obtained using an acid concentration of 3 mol L–1, solid/liquid ratio of 1/20 g mL–1, and temperature of 80 °C. Subsequently, the experiments optimization, performed through a central composite rotational design, indicated that the maximum leaching efficiency was achieved using a sulfuric acid concentration of 2.9 mol L–1, solid/liquid ratio of 1.7/20 g mL–1, and 55 °C. Under these conditions, the leaching efficiency of the sum of all REE was 90.0%. Leaching kinetics results showed that the equilibrium was reached in about 20 min for most REE. The mechanism investigation suggested that surface chemical reaction and diffusion through the boundary layer controlled the leaching.

Keywords

Rare earth elements, Phosphogypsum, Leaching, Reprocessing, Leaching kinetics