Bioleaching of Rare Earth Elements from Phosphogypsum Using Aspergillus niger

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Rare earth elements (REE) are essential parts of cell phones, magnets, catalysts, and batteries. With the demand for REE rising dramatically, there is a global supply challenge. REE are difficult to mine, but they have been found in substantial quantities in phosphogypsum (PG), a by-product of fertilizer production. REE can potentially be recovered from this waste material through leaching. Bioleaching has been proposed as a low-cost and eco-friendly alternative to conventional leaching processes. The fungus Aspergillus niger produces high levels of organic acids, which can improve leaching through acidity and metal ion complexation. This experiment tested the ability of spent medium from the growth of A. niger to leach REE from PG. A. niger was cultured, and the gluconic acid content in the medium was determined to be 30 mM. The spent medium was evaluated in comparison to phosphoric acid, sulfuric acid, and sodium gluconate at equivalent concentrations. PG containing ~1 wt% REE was synthesized and characterized. Leaching of six REE (praseodymium, neodymium, samarium, europium, gadolinium, and terbium) from PG was studied. The quantity of REE leached into solution was determined using inductively coupled plasma mass spectrometry (ICP-MS). The results showed that A. niger medium was more effective at REE extraction than sodium gluconate and phosphoric acid but less effective than sulfuric acid. The leaching behaviors of the lixiviants were rationalized by a thermodynamic simulation. The considerable efficiency and environmental benefit of A. niger medium make it a promising option for recovering rare earths from PG.

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