TECHBRIEF

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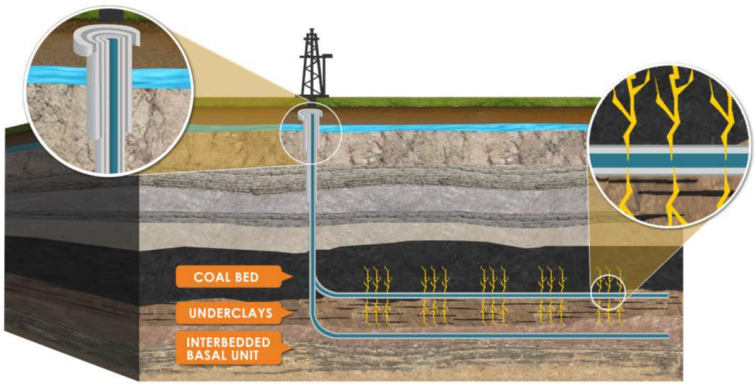
Organic Acid–Salt Solutions for Low-Temperature Rare Earth Extraction



In-situ recovery concept drawing of one possible extraction method, applied in advance of underground mining.

Opportunity

Recovering rare earth elements (REEs), or critical minerals from domestic sedimentary materials remains difficult using conventional high-temperature strong-acid leaching processes that dissolve large amounts of unwanted minerals and introduce safety, waste-handling and cost barriers. The U.S. Department of Energy's National Energy Technology Laboratory (NETL) has established a low-temperature extraction method that uses tailored organic acid solutions containing both an organic acid and an ionic salt to selectively mobilize REEs from underclays, claystones, shales, coal-mining waste and waste coal. These Organic Acid Solutions (OAS) operate at near-ambient temperatures and moderate pH levels, allowing selective leaching of rare earths and yttrium while substantially limiting dissolution of iron, aluminum, thorium and other problematic gangue elements. By leveraging mild chemistries inspired by natural weathering processes, the approach can reduce processing hazards, shorten extraction steps and enable the productive use of clay-rich materials that are currently discarded. This technology is available for licensing and/or further collaborative research from NETL.

Problems Addressed

- REEs are vital for advanced technological and energy applications, yet the global supply is largely dominated by international competitors, creating strategic vulnerabilities for the U.S.
- There are significant hurdles to efficiently recovering these critical elements from underutilized domestic resources, such as coal-related waste materials and underclay deposits.

Potential Commercial Application

- REEs from Coal-Related Waste Streams: a cost-effective method to extract valuable REEs and critical metals from abundant coal mining wastes and byproducts, transforming liabilities into assets.
- REEs from Sedimentary Geological Deposits: selective recovery of REEs and critical metals from natural clay-rich geological formations, including through innovative in-situ methods.

Competitive Advantages

- Cost efficiency: Organic acid leaching operates effectively at lower temperatures, decreasing energy consumption and associated costs compared to high-temperature inorganic acid leaching.
- Selective extraction: Organic acids like citric acid preferentially leach heavy rare earth elements, enhancing selectivity over traditional inorganic acids.

Intellectual Property Status

A U.S. patent (US11814700) was issued on November 14, 2023, and expires on September 4, 2040.

Publications

J. Yang, et al. Assessing the Extractability of Rare Earth Elements from Coal Preparation Fines Refuse Using an Organic Acid Lixiviant. (2021). Mining, Metallurgy & Exploration. DOI: https://doi.org/10.1007/s42461-021-00439-2.

Licensing

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