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Extraction and Separation of Critical Metals from Unconventional Sources

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Global and domestic decarbonization requires widespread deployment of clean energy technologies such as electric vehicles (EV), wind turbines, and solar panels over the coming decades to meet the world's climate goals. Driven by the need for clean energy technologies, the demand for the key critical metals (CMs) utilized by these technologies, will increase significantly. This is due to the fact that the U.S. relies heavily on importing many CMs as the production CMs are primarily controlled by a few countries. Existing CM extraction processes are labour-intensive and create large volume of waste streams – which can be harmful to the environment. Therefore, the supply of CM will likely become more restricted in the future. Assuring a secure, reliable, and sustainable domestic supply of CMs is essential to both national security and net-zero carbon goals. Success depends upon enabling extraction and separation processes from unconventional, domestic sources together with developing next-generation recycling technologies.

In this study, we have performed column extraction chromatography of coal ash leachates, which contain significant quantities of rare earth elements (REE) and other CMs. Coal ash was reacted with citrate to leach the REE and CMs in an environmentally friendly manner. The resulting leachate was diluted in 0.01 M nitric acid and loaded to an extraction chromatographic resin containing di-(2-ethylhexyl)phosphoric acid on an inert substrate (Ln Resin). Other metals present in the leachate were removed in 0.01 M nitric acid whereas the REE and CM of interest are retained in the resin for further elution. The light REE elements were eluted together in using 0.1 – 0.5 M nitric acid and the heavy REE elements (including Y) were eluted in 1 – 3 M nitric acid. Additional work is investigating methods to improve separations of adjacent REE elements from each other. This work demonstrates the effective extraction and separation (of light and heavy REEs) from an unconventional, waste source. Success in this approach will allow for an emergent domestic market of CM from unconventional sources.

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