

# TECHBRIEF

## IMPROVED RARE EARTH ELEMENT EXTRACTION METHOD FROM COAL ASH

### OPPORTUNITY:

This invention describes an improved method for extracting rare earth elements (REEs) from coal ash at ambient temperatures. This technology is available for licensing and/or further collaborative research from the U.S. Department of Energy's National Energy Technology Laboratory.

### CHALLENGE:

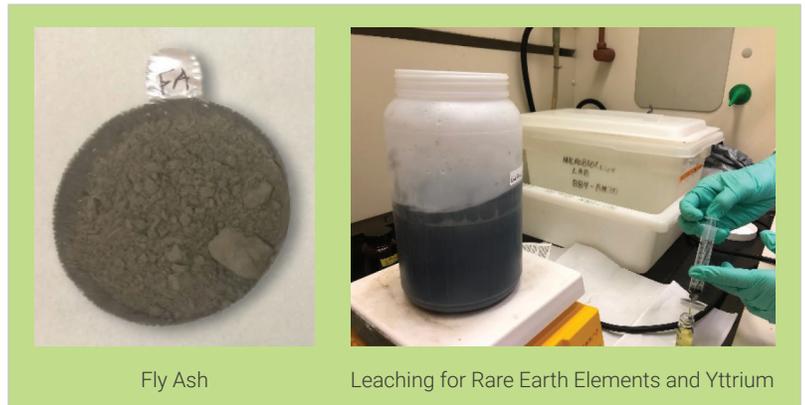
As China currently controls the supply and prices of almost all the world's REEs, developing a domestic supply is critical for the continued manufacturing of technologies that support nearly all modern devices, including critical systems for energy and national defense. REE extraction efforts from domestic sources of coal and coal-related resources have emerged as a viable solution, but successful methods must be both cost-effective and environmentally friendly.

Current methods and technologies for REE extraction from ore and other sources can be hazardous and expensive to implement without harming the environment or workers. For example, common practices employ high temperatures and strong acids or bases. This technology seeks to overcome these and other issues with current REE extraction methods by turning to a material that is currently viewed as a waste – coal ash.

### OVERVIEW:

The U.S. generates more than one-third of its electricity from coal combustion. As a result, approximately 113 million metric tons (t) of coal combustion products are generated annually, which includes 38 million t of fly ash and 9 million t of bottom ash. With median REE and Yttrium concentrations reported in U.S. ash as 481 milligrams per kilogram, it is estimated that a total of 8,910 t as rare earth oxides (REO) can be generated from all unused fly ash reserve annually in the United States. The annual REO production from fly ash along with bottom ash, if 100% recovered, will have the potential to satisfy 94% of U.S. annual demand (9,500 t reported in 2018).

This invention describes a method to extract REE from select coal combustion fly ashes using mild inorganic acids at ambient temperatures via a three-step mild acid extraction process that results in high levels of extraction (ranging from 80-100%).



Fly Ash

Leaching for Rare Earth Elements and Yttrium

(continued)



**FOR MORE INFORMATION:**

Customer Service:  
**1.800.553.7681**

626 Cochran's Mill Road  
P.O. Box 10940  
Pittsburgh, PA 15236-0940  
412.386.4687

3610 Collins Ferry Road  
P.O. Box 880  
Morgantown, WV 26507-0880  
304.285.4764

1450 Queen Avenue SW  
Albany, OR 97321-2198  
541.967.5892

**ADVANTAGES:**

- Extraction occurs at ambient temperatures and pressures.
- Pretreatment of ash is not required.
- Reduced amounts of acid needed, which reduces cost.
- Environmentally benign process.

**APPLICATIONS:**

- Extraction of REEs and other minerals like Scandium from ashes, either legacy waste material or newly generated material from the electricity sector.
- Extraction of REEs and other critical minerals from other ash products, such as those derived from biomass or waste combustion, or coal ashes produced from industries outside the electric utility sector.

**PATENT STATUS:**

U.S. Patent Pending (non-provisional patent application)

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Title: Step-leaching Process of Rare Earth Elements from Ash Materials Using Mild Inorganic Acids at Ambient Conditions

Inventors: Mengling Stuckman, Christina Lopano, Thomas Tarka

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