Opportunity and Significance

Rare Earth Elements (REEs) are elements with many high tech uses (e.g., smartphones, electric cars, advanced weaponry) and have been identified by the DOE to be critical to the US economy. Currently, China supplies over 85% of REEs resulting in an undiversified market and susceptibility to supply shock and economic insecurity. To address this susceptibility, this research aims to develop an economic and environmentally-friendly method of extracting REEs from nascent, plentiful sources such as coal and coal by products like fly ash.

**Numbers**

- 16 REEs (Y, Sc and Lanthanides minus Pr)
- $4 billion annual market - $4 trillion annually in associated products
- Nearly 1/3 of US energy production is from coal
- US burns 1 billion tons of coal per year of which only half is reused (other half is landfilled)
- 1.5 billion tons of fly ash in storage basins/landfills (significant opportunity even as US shifts away from coal use)
- Nearly 50,000-70,000 tons of REE in fly ash alone
- An estimated $200-$400 REE/ton

**Preliminary Results**

This research project focused on the osorb-ligand optimization portion of the overall project as depicted in the above diagram. First, Osorb - a commercially available organically modified media - is tested for its ability to retain REEs prior to ligand testing. Then, different ligand types helpful for the REE retainment/separation process which dissociate under acidic conditions to release the REEs are tested in association with the Osorb.

Methodology

1. Hydrothermal extraction of REEs
2. Select lanthanide-specific ligands to associate with solid phase (organosilica)
3. Optimize attachment of ligands to the solid phase to allow for flow-through separations
4. Test pH conditions for back-extraction
5. Evaluate resilience of material through cycling

Next Steps for Development and Test

Batch experiments establishing the best conditions (such as pH) and best ligand arrangements for efficient extraction of REEs from the alkaline feed solution attained from the hydrothermal leaching process will make it possible to use an aqueous, acidic solution to back-extract and concentrate the REEs into a relatively REE-heavy solution. (2% – 10 % by weight).

Research Partners

This project is a collaboration between Wayne State University (project lead), the University of California, Los Angeles, The U.S. Department of Energy, Los Alamos National Laboratory, and the National Energy Technology Laboratory.