Economically Viable and Environmentally Benign High Performance Technology to Recover Rare Earth Elements from Coal By-Products

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Overview

Goal

Develop a bench-scale rare earth element (REE) extraction process for coal by-product materials utilizing a proprietary technology involving leaching processes and metal sorption media with the ability to process one kilogram batches and deliver a product meeting or exceeding DOE requirements

Objectives

- Identification/selection of coal by-product sources
- Develop leaching procedure for selected by-products*
- REE sequestration and recovery*
- Radioactive material separation*
- Waste water treatment for metal removal
- Scale-up of process to 1-kg coal by-product per batch

* These objectives have been successfully demonstrated at laboratory scale by Tusaar using other source materials.

Approach

Work Plan

Task 1.0 Project Management and Planning

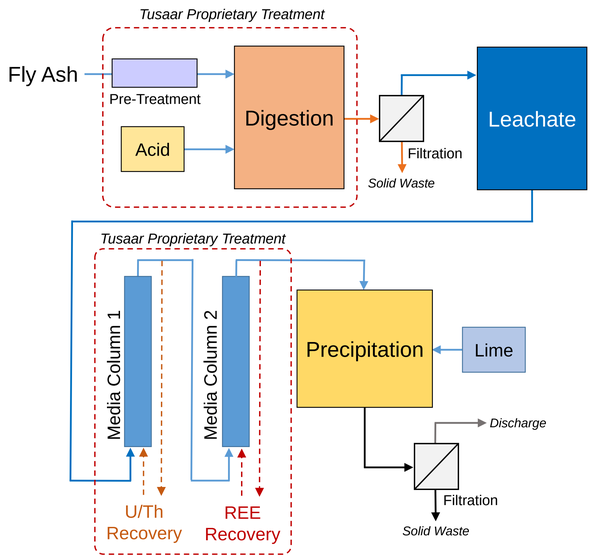
Task 2.0 Sampling/Characterization of Feedstocks
- 2.1 Source Material Identification
- 2.2 Source Sampling
- 2.3 Source Material Characterization

Task 3.0 Feasibility Study
- 3.1 Pre-Leach Treatment
- 3.2 Leaching
- 3.3 Leachate U/Th Removal
- 3.4 REE Sequestration
- 3.5 REE Recovery
- 3.6 REE Concentrate Product Precipitation
- 3.7 Wastewater Treatment
- 3.8 Economic Analysis

Go/No Go Decision Point

Task 4.0 Process Integration
- 4.1 Process Design
- 4.2 Process Demonstration
- 4.3 Economic Analysis Review

Test System

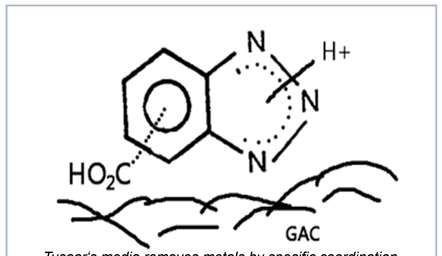


Benefits

- Possible reduction in the dependence of the US and other western countries on China
- Separation of U/Th may enable consumption of fly ash in more applications than currently used
- New commercial applications for fly ash will be an important financial component of coal-fired power plants

Technology

Background

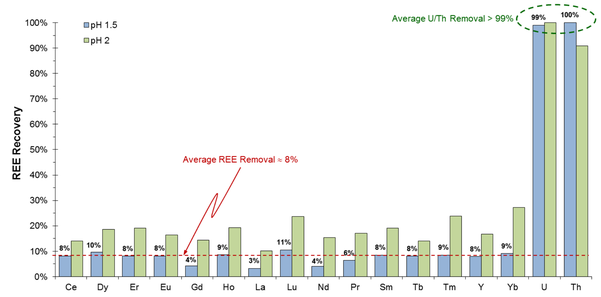


Tusaar's media removes metals by specific coordination between benzotriazole ligands and metals.

Advantages
- Metal removal at low pH operation, < 1.5
- Metal binding is very strong
- pH control can be used to remove specific metals
- Media can be regenerated >300 times

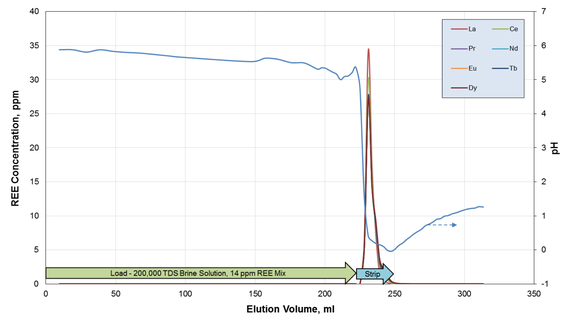
- Activated carbon media is modified by oxidizing agents and metal coordinating ligands to significantly increase metal sequestration
- Benzotriazole derivatives on the carbon surface coordinate specific metals at selective pH by forming a strong ion pair effectively removing target metal(s) from solution by displacing the original H^+
- Substitution of metal ions on the benzo group affect the electronic distribution to the triazole ring altering the ion strength, enhancing selectivity of metals
- Low pH disrupts the ion pair, altering the aromatic cloud which releases the paired metal into solution for removal and regeneration of media

U/Th Removal



Selective removal of uranium (U) and thorium (Th) from rare earth elements (REEs) in a fly ash digest liquor. At pH 1.5, REEs separation is minimal while U/Th separation is maximized.

REE Concentration



Tusaar media eluent containing concentrated, well separated REEs during extraction of metals from ligand modified activated carbon surface.

Coal By-Product Sources

Source	Total REE+Y (ppm)	Thorium (ppb)	Uranium (ppb)	Outlook Ratio*	% Critical Elements
1	603	50	8	1.062	35
2	647	27	12	1.019	35
3	647	47	32	1.019	35
4	472	40	5	1.192	35
5	909	50	19	1.076	35
6	647	39	5	1.019	35