A Pollution-Prevention and Economically-Viable Technology for Separation of Rare Earth Elements from Powder River Basin (PRB) Coal Ashes

PI: Maohong Fan – University of Wyoming
Co-PIs: Hanjing Tian – West Virginia University; Eric Williams and Gabrielle Gaustad – Rochester Institute of Technology; Hertanto Adidharma
Maciej Radosz - University of Wyoming
NETL Project Contact: Mr. Vito N. Cedro

Background for Proposal

Catalysts (petroleum refining...)
Electronics (display phosphors...)
Magnets, Glass; ceramics; metal alloys...
Mass: ~185,000 tons in 2014 • ~300,000 tons in 2020
Revenue: ~ USD 5.0 billion in 2014 • ~ USD 9.0 billion in 2020

Equipment and Facilities

Feasibility Study

- UW+WVU:
  Discussion of information developed in sampling and characterization plan
- RIT:
  Waste management characterization and benchmarking
- Comparison of REEs from coal ash with current REE production and coal ash disposal

Technical Approaches

2 wt-% Rare Earth Production

- REEs and other valuable materials leaching from coal ashes
- Separating REEs+other-valuable materials loaded solid from leaching mixture
- De-watering solid for obtaining at least 2 wt-% REEs containing solid

Factorial Study

- Characteristics of coal ashes
  - Physical
  - BET characteristic
  - Theromo-analysis
- Chemical
  + Concentration of REEs
  + Concentration of other elements

Risk Management Plan

- Proposed systematic random coal ash sampling method is problematic
  - Try alternative probability sampling methods such as cluster random sampling
- Competition of REEs with other valuable elements (Cu, Pb, Mn, Ni, etc.)
  - Control pH
  - Control leaching fluid
- Long time needed for separating the small REEs-containing solid
  - Use an environmentally friendly assisting agent

Milestones

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Objective</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milestone 1</td>
<td>CAA project management plan</td>
<td>CAA plan completed and submitted according to NSF requirements</td>
</tr>
<tr>
<td>Milestone 2</td>
<td>Coal ash sampling and characterization plan</td>
<td>CAA/NSF</td>
</tr>
<tr>
<td>Milestone 3</td>
<td>Coal ash sampling and characterization plan</td>
<td>Milestone 3 is completed and submitted according to NSF requirements</td>
</tr>
<tr>
<td>Milestone 4</td>
<td>Coal ash sampling and characterization plan</td>
<td>Milestone 4 is completed and submitted according to NSF requirements</td>
</tr>
<tr>
<td>Milestone 5</td>
<td>Coal ash sampling and characterization plan</td>
<td>Milestone 5 is completed and submitted according to NSF requirements</td>
</tr>
<tr>
<td>Milestone 6</td>
<td>Coal ash sampling and characterization plan</td>
<td>Milestone 6 is completed and submitted according to NSF requirements</td>
</tr>
<tr>
<td>Milestone 7</td>
<td>Coal ash sampling and characterization plan</td>
<td>Milestone 7 is completed and submitted according to NSF requirements</td>
</tr>
<tr>
<td>Milestone 8</td>
<td>Coal ash sampling and characterization plan</td>
<td>Milestone 8 is completed and submitted according to NSF requirements</td>
</tr>
<tr>
<td>Milestone 9</td>
<td>Coal ash sampling and characterization plan</td>
<td>Milestone 9 is completed and submitted according to NSF requirements</td>
</tr>
<tr>
<td>Milestone 10</td>
<td>Coal ash sampling and characterization plan</td>
<td>Milestone 10 is completed and submitted according to NSF requirements</td>
</tr>
</tbody>
</table>

Equipment and Facilities

- Background for Proposal
  - Catalysts (petroleum refining...)
  - Electronics (display phosphors...)
  - Magnets, Glass; ceramics; metal alloys...

Feasibility Study

- UW+WVU:
  - Discussion of information developed in sampling and characterization plan
- RIT:
  - Waste management characterization and benchmarking
- Comparison of REEs from coal ash with current REE production and coal ash disposal

Technical Approaches

- 2 wt-% Rare Earth Production
  - REEs and other valuable materials leaching from coal ashes
  - Separating REEs+other-valuable materials loaded solid from leaching mixture
  - De-watering solid for obtaining at least 2 wt-% REEs containing solid

Factorial Study

- Characteristics of coal ashes
  - Physical
    + BET characteristic
    + Thermo-analysis
  - Chemical
    + Concentration of REEs
    + Concentration of other elements

Risk Management Plan

- Proposed systematic random coal ash sampling method is problematic
  - Try alternative probability sampling methods such as cluster random sampling
- Competition of REEs with other valuable elements (Cu, Pb, Mn, Ni, etc.)
  - Control pH
  - Control leaching fluid
- Long time needed for separating the small REEs-containing solid
  - Use an environmentally friendly assisting agent

Milestones

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Objective</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milestone 1</td>
<td>CAA project management plan</td>
<td>CAA plan completed and submitted according to NSF requirements</td>
</tr>
<tr>
<td>Milestone 2</td>
<td>Coal ash sampling and characterization plan</td>
<td>Milestone 2 is completed and submitted according to NSF requirements</td>
</tr>
<tr>
<td>Milestone 3</td>
<td>Coal ash sampling and characterization plan</td>
<td>Milestone 3 is completed and submitted according to NSF requirements</td>
</tr>
<tr>
<td>Milestone 4</td>
<td>Coal ash sampling and characterization plan</td>
<td>Milestone 4 is completed and submitted according to NSF requirements</td>
</tr>
<tr>
<td>Milestone 5</td>
<td>Coal ash sampling and characterization plan</td>
<td>Milestone 5 is completed and submitted according to NSF requirements</td>
</tr>
<tr>
<td>Milestone 6</td>
<td>Coal ash sampling and characterization plan</td>
<td>Milestone 6 is completed and submitted according to NSF requirements</td>
</tr>
<tr>
<td>Milestone 7</td>
<td>Coal ash sampling and characterization plan</td>
<td>Milestone 7 is completed and submitted according to NSF requirements</td>
</tr>
<tr>
<td>Milestone 8</td>
<td>Coal ash sampling and characterization plan</td>
<td>Milestone 8 is completed and submitted according to NSF requirements</td>
</tr>
<tr>
<td>Milestone 9</td>
<td>Coal ash sampling and characterization plan</td>
<td>Milestone 9 is completed and submitted according to NSF requirements</td>
</tr>
<tr>
<td>Milestone 10</td>
<td>Coal ash sampling and characterization plan</td>
<td>Milestone 10 is completed and submitted according to NSF requirements</td>
</tr>
</tbody>
</table>