High Yield and Economical Production of Rare Earth Elements from Coal Ash

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Outline REE Extraction Process

- Physical separation stage, followed by a chemical separation stage, followed by a post-processing stage
- Proposed Product: REY-rich Scandium-rich Concentrates
- Higher Value Products: REY-rich Scandium-rich concentrates
- By-products: Cement substitute, cementsophs, secondary fuel carbon

Coal Combustion Enriches REE Content in Ash by ~X10

- Rare earth elements (REEs) in coal are concentrated by coal combustion processes.
- OECD estimate that ~1000 tpd of coal ash in the U.S. contains ~100 tpd of REEs.

Example of Russian Far East Coal (Black Stone Deposit)

- Example of a Russian Far East coal showing REE enrichment.
- Coal Ash LREE/HREE Ratio = 5:1

Pozolanicity Testing – Strength Activity Index

- Pozolanicity testing is conducted to assess the reactivity of coal ash in cementitious applications.
- Strength Activity Index (SAI) is used to evaluate the potential of coal ash as a replacement for Portland cement.

Process Economics

- Plant Size: ~1000 tpd
- Plant Attributes:
  - Co-located at a coal mine and downstream chemical processing facility
  - Modular design for flexible capacity and transportability
  - Ash fraction supplied to local market
- Process
  - Carbon, magnetic ash, ~200 mesh non-magnetic ash
  - Annual production of major REEs, Sc, and byproducts

Conclusions

- The REE process is economically viable and environmentally beneficial.
- Byproducts include cement substitutes, cenospheres, and secondary fuel carbon.
- The REE process is competitive with current REE supply chains.

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