

Rare earth element recovery from coal fly ash by roasting and leaching methods

Ross K. Taggart¹, Jack F. King², James C. Hower³, and Heileen Hsu-Kim¹

¹Duke University, Department of Civil & Environmental Engineering, 121 Hudson Hall, Box 90287, Durham, NC 27708; ²Stanford University, Department of Civil & Environmental Engineering, 473 Via Ortega, Room 314, MC 4020, Stanford, CA 94305; ³University of Kentucky, Center for Applied Energy Research, 2540 Research Park Drive, Lexington, KY 40511

CONFERENCE: 2017 World of Coal Ash – (www.worldofcoalash.org)

KEYWORDS: rare earth, fly ash, extraction, recovery, roasting, leaching

Coal fly ash may be a promising source for strategic metals such as rare earth elements (REEs), which are critical materials in the defense, electronics, automotive, and energy industries. U.S. fly ashes of varied geological origin taken from a broad sample of power plants reliably contained total REE concentrations of 400-800 mg kg⁻¹. Previous research has shown that REE in fly ash are not surface adsorbed, but dispersed throughout the glassy particles themselves. Therefore, the initial extraction processes tested here focused on dissolving or breaking down the aluminosilicate structure of the fly ash. Two major classes of extraction methods were compared: acid leaching and roasting with various chemical additives. Parameters relevant to the scalability of the extraction methods were varied, including additive type, additive:ash ratio, and leach acid concentration. Depending on the geological origin of the coal, REE recovery could be as high as 80 percent using acid leaching. For ashes not amenable to acid leaching, roasting improved REE recoveries from 30-40% to 70-100% depending on the sample and sintering parameters. These findings suggest that REE recovery processes can be tailored to fly ashes based on general characteristics inherited from the feed coal.