

Factors Governing Arsenic, Beryllium and Thallium Leaching from Coal Combustion Products

John D. Pugh¹, Ken J. Ladwig², Bruce Hensel³, James C. Redwine¹

¹Southern Company Generation, Earth Science and Environmental Engineering, 42 Inverness Center Parkway, Birmingham, AL 35242, ²The Electric Power Research Institute, 3420 Hillview Avenue, Palo Alto, CA 94303, ³Natural Resources Technology, Inc., 23713 West Paul Road, Unit D, Pewaukee, WI 53072

KEYWORDS: arsenic, thallium, beryllium, coal combustion products, leachate

ABSTRACT

Recent investigations have revealed valuable insights regarding leaching mechanisms of beryllium, thallium and arsenic from coal combustion products (CCPs). Both mineralogical and adsorptive controls over contaminant leaching are inferred based upon geochemical equilibrium analyses of a substantial field leachate dataset compiled by EPRI. Beryllium leaches at very low levels, and may be limited by chrysoberyl (BeAl_2O_3) solubility. Above pH of ~4, beryllium appears well-attenuated. Thallium concentrations are highest at near-neutral pH or extreme low pH, suggesting multiple controls. Potential controls over thallium leaching may include thallium sulfide solubility, thallium hydroxide solubility or cation exchange with ammonium. For arsenic, a pH-based model has been proposed describing multiple controls over its leaching behavior, including both mineral solubility and adsorption. Arsenic concentrations observed with variations in pH in field leachate suggest a mineral solubility-imposed upper concentration limit and a lower limit provided by adsorptive controls. A potential transformation from ferric arsenate (scorodite) to ferrous arsenate (symplesite) at near-neutral pH is supported by solution supersaturation with respect to atmospheric CO_2 , suggesting biological reduction of ferric to ferrous iron in the arsenate phase. Measured solution Eh at measured pH is shown to be useless for predicting arsenic speciation due to the likelihood of redox disequilibrium. The Electric Power Research Institute (EPRI) has initiated a series of publications for key chemicals present in CCP leachate that summarize information on occurrence, environmental geochemistry, health and ecologic effects, and remediation. Identifying contaminant leaching mechanisms provides information necessary to predict or mitigate adverse impacts to the environment.

Submitted for consideration in the 2009 World of Coal Ash Conference, May 4-7, 2009.