Presentation Title: Leach Testing of FGD Materials

Presentation Authors: Karl Schroeder (presenting), Lee Beatty, Carol Cardone, Deborah Hreha, Candace Kairies, Paul Rohar, Robert Thompson, Fred White

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Summary: The burning of coal and the cleaning of flue gases produce a large volume of material or residue (including fly ash, bottom ash, boiler slag, fluidized bed combustion (FBC) ash and flue gas desulfurization (FGD) material) collectively referred to as coal utilization byproducts (CUB). FGD units typically use a lime or limestone reagent to capture SO_2 gas as calcium sulfite, most of which is subsequently converted to gypsum ($CaSO_4 \bullet 2H_2O$) in forced oxidation units. FGD-produced gypsum is mainly used as a substitute for natural gypsum in the manufacturing of wallboard, though it is also used, to a lesser extent, as a soil amendment or as an additive in cement. Coal contains a number of trace metals, and as a result CUB typically contain low concentrations of these metals. As stricter emission control/reduction policies, particularly those focusing on mercury, are implemented, an increase in metals concentration in these byproducts will likely occur. Wet FGD technologies used for the removal of SO_2 can result in the co-removal of highly-soluble oxidized mercury. Mercury removal efficiencies (on a coal-feed basis) in FGD units range from 50 – 75%, but when the units are preceded by selective catalytic reduction (SCR), devices which enhance the oxidation of Hg^0 to the Hg^{2+}, the range increases to 85 – 90%. Depending on the FGD process, a portion of this mercury may be incorporated into the FGD slurry and its solid byproducts including synthetic gypsum. The amount of mercury in FGD products may increase in the future if these units are optimized for co-capture. Among the issues that arise are the potential for atmospheric and groundwater releases of mercury during subsequent manufacturing processes, releases from the manufactured products, and post-disposal mobilization from the wallboard or other products. For this reason, it is important to understand the chemistry of the mercury-CUB interaction, to be able to predict the environmental fate of the CUB-bound mercury, and to be able to anticipate the effect of additional mercury loads in the CUB material.

The potential problems that may be encountered during the disposal of materials are most commonly addressed using laboratory leaching tests. In general, leaching techniques focus on the potential release of heavy metals to the surface and groundwater environments. Leaching studies of CUB are often performed to determine the compatibility of the material in a particular end-use or disposal environment. Typically, these studies involve either a batch or a fixed-bed column technique. A number of studies have shown that fixed-bed column leaching can be used to estimate the impact of coal utilization byproducts under simulated field conditions. Unfortunately, for some materials, permeability losses can occur in fixed-bed leaching columns, either because of cementitious properties of the material itself, such as is seen for FBC fly ash, or because of precipitate formation, such as can occur when a high-calcium ash is subjected to sulfate-containing leachates. Also, very fine-grained materials, such as gypsum, do not provide sufficient permeability for study in a fixed-bed column. A continuous, stirred-tank extractor (CSTX) is an alternative technique that can provide the elution profile of column leaching but without the permeability problems.

Objectives for this project are to to use the CSTX and mineral extraction techniques to investigate the stability of mercury and other metals (particularly arsenic and selenium) in CUB, to obtain fundamental chemical data on the leaching process (K_D, K_{sp}, rates, etc), and to explain the chemistry underlying the stability of mercury and other metals in CUB. In addition to the CSTX leaching studies, a sequential extraction scheme is used to subject FGD-derived materials to a series of phase-targeted dissolution reagents. The amount of Hg extracted by each solution is chemically related to the mineral phases targeted by that solution. In this manner, the mineral phases with the greatest affinity for Hg and the form in which Hg is naturally immobilized can be discovered and related to the mineralogy of FGD materials. This information may also provide a basis for advanced Hg capture and sequestration technologies.