TITLE:	EFFECTS OF FLY ASH ON MERCURY OXIDATION DURING POST COMBUSTION CONDITIONS
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ABSTRACT

OBJECTIVE

The goal of this work is to provide fundamental information on post-combustion flue gas chemistry that will help predict mercury (Hg) speciation in flue gas streams from coal-fired boilers. This will be accomplished through an improved understanding of the role of fly ash on Hg chemistry. Bench-scale studies involving simulated flue gas streams will initially be used to study Hg speciation chemistry using rigidly controlled experimental parameters. In later portions of the study, a laboratory-scale combustor will be used. The simulated and actual flue gases will contain known concentrations of elemental Hg vapor and will be exposed to fly ash samples obtained from two different coals (one subbituminous and one bituminous) fired at full-scale utility boilers. Exposure of the simulated and actual flue gases to fly ash will be performed under a variety of temperatures and gas compositions, and the effects of the fly ash on Hg chemistry (i.e., speciation) will be determined.

ACCOMPLISHMENTS TO DATE

Work thus far has involved 1) building the bench-scale system to be used for simulating flue gas streams, 2) making appropriate facility modifications to accommodate the testing system, 3) acquiring all necessary equipment and supplies for the experimental and analytical aspects of the study, and 4) obtaining and processing electrostatic precipitator fly ash samples from two full-scale utility boilers

burning different coals. Individual components of the bench-scale system have been tested, and the fully integrated system will soon be operated and evaluated.

SIGNIFICANCE TO FOSSIL ENERGY PROGRAMS

Mercury emissions from coal-fired power plants, which are predominantly in the vapor phase, are of environmental interest and may be regulated in the future. Consequently, considerable research on the removal of Hg from flue gas streams is being performed. The effectiveness of Hg abatement technologies is highly dependent on the Hg species present, but the chemistry affecting Hg speciation is poorly understood. Therefore, it is currently impossible to predict Hg removal efficiencies for any Hg abatement technology. Fly ash is an important flue gas component that may lead to catalytic oxidation of elemental Hg or otherwise attenuate the Hg stream. However, the mechanisms by which fly ash affects the distribution of Hg species are unknown, and little work has been performed to study the role of fly ash as it relates to flue gas chemistry. Results of this study will yield important information relating to the chemistry associated with the capture and conversion of Hg by fly ash. This will enable more accurate predictions to be made on Hg removal efficiencies using a variety of Hg abatement technologies. In turn, this information will be useful in determining how best to optimize Hg removal by a given technology by adjusting plant operating and fuel composition variables.

PLANS FOR THE COMING YEAR

The fully integrated bench-scale system will be tested and evaluated. A variety of QA/QC tests will be performed to ensure that sampling and analytical protocols are acceptable in terms of accuracy and precision. After verifying proper operation of the bench-scale system and ensuring that sampling and analytical procedures are yielding high quality data, two fly ash samples will be tested for possible catalytic activity involving Hg oxidation. Bulk fly ash will be loaded onto quartz-fiber filters and exposed to simulated flue gas streams at various temperatures and with various gas compositions. Those gas streams will contain known amounts of elemental Hg vapor. An Ontario Hydro sampling train will be used to determine the amount of Hg retention and conversion resulting from the presence of the fly ash. If a substantial amount of Hg oxidation is observed for a particular fly ash, then that fly ash will be separated into iron-rich and aluminosilicate-rich phases. In addition, several size fractions of each of those phases will be obtained. Each fly ash fraction will then be tested under the conditions resulting in Hg oxidation in order to help determine which specific fly ash components are responsible for the oxidation. Finally, the fly ash samples will undergo extensive chemical, morphological, and mineralogical characterization in order to help determine the important fly ash characteristics, which appear to affect Hg oxidation.

ARTICLES, PRESENTATION, AND STUDENT SUPPORT

Journal Articles (peer reviewed): None (new project)

Conference Presentations: None (new project)

Students Supported under this Grant

- Hongqun Yang, graduate (Ph.D) student in chemical engineering, Iowa State University
- Jason Lewis, undergraduate student in chemical engineering, Iowa State University