INVESTIGATION OF FLY ASH AND ACTIVATED CARBON OBTAINED FROM PULVERIZED COAL BOILERS

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ABSTRACT

OBJECTIVES

One of the techniques for Hg capture in coal-fired boilers involves injection of activated carbon (AC) into the boiler downstream of the air preheater. Hg is adsorbed onto the AC particles and fly ash, which are then both removed in an electrostatic precipitator or baghouse. This project addresses the issues of Hg on activated carbon and on fly ash from a materials re-use point of view. It also addresses the possible connection between SCR reactors, fly ash properties and Hg capture. The project is determining the feasibility of separating AC from fly ash in a fluidized bed and of regenerating the separated AC by heating the AC to elevated temperatures in a fluidized bed. The temperatures needed to drive off the Hg from the ash in a fluidized bed are also being determined. Finally, samples of fly ash from power plants with SCR reactors for NO_x control are being analyzed to determine the effect of SCR on the ash. These analyses will also determine the properties of ash which are important for Hg capture.

ACCOMPLISHMENTS TO DATE

Experiments were performed with a mixture of activated carbon and fly ash obtained from a utility boiler to determine to what extent the activated carbon and naturally occurring carbon can be separated from the remainder of the mixture in a fluidized bed. The data show segregation is very sensitive to superficial gas velocity, with the strongest segregation occurring at superficial velocities of 0.7 to 0.8 cm/s. At these conditions, the carbon content at the top of the bed was approximately 27% and it was less than 17% in the bottom layer. Very little or no carbon segregation occurred at velocities much lower or higher than 0.7 to 0.8 cm/s. Samples of AC/Ash obtained from each layer of the bed during the tests at 0.6, 0.7 and 0.8 cm/s were analyzed for Hg content using a LECO Hg Analyzer. These results show a strong dependence of Hg capture on particle carbon content, with the Hg content approaching a value close to zero as LOI approaches zero.

Experiments were also performed with the AC/ash mixture in a heated fluidized bed to determine the temperature at which Hg is driven off. The data from each test show a relatively constant Hg concentration until a temperature of approximately 350°C was reached, after which the Hg concentration

decreased rapidly with temperature. The Hg concentration approached zero at temperatures close to 475°C.

Considerable effort has also gone into using Scanning Electron Microscopy and Transmission Electron Microscopy to study the physical and chemical characteristics of the AC/ ash mixture used for the fluidized bed segregation and Hg desorption experiments. Five distinct morphologies have been identified: large (30-100 μm), irregularly-shaped carbon particles, 0.1 to 20 μm spherical alumino-silicate particles, 50-100 μm hollow carbon particles with porous walls, fine 50-200 nm amorphous carbon particles, and large 20-50 μm angular activated carbon particles.

FUTURE WORK

One activated carbon/ fly ash mixture, obtained from a Hg-capture field trial at a utility boiler under NETL's Hg Program, has been tested, so far. The extent of the ability to separate carbon from non-carbonaceous ash constituents in a fluidized bed will vary from boiler to boiler due to differences in particle size and density distributions. We also suspect the Hg desorption temperature varies with the physical and chemical characteristics of the AC/ash mixture. As additional Hg-capture field trials are carried out by NETL and we are able to obtain additional suitable AC/ash samples, we plan to perform more experiments on carbon separation and Hg desorption.

We've also been searching for Hg in the ash and AC using SEM, TEM and XPS techniques, but the local Hg concentrations have been too small to detect by any of these methods. We plan to artificially dope samples of ash with elevated levels of Hg in an effort to make it possible to detect the presence of Hg. If we are successful in doing this, we hope to be able to determine the nature of the carbon particle to which Hg attaches and the type of Hg compound which is captured.

We have also obtained preliminary results from XPS analyses on the effects of an SCR reactor on fly ash surface chemistry. The data show differences in Cl, S and Fe, but further analyses are needed to reach firm conclusions. It is planned to carry out these analyses in the coming months.

PAPERS PUBLISHED, CONFERENCE PRESENTATIONS, PATENTS AND STUDENTS SUPPORTED

The students supported on this project include Brian Celeste, Aly Elshabasy and Zheng Yao. So far, there have not been any papers published, conference presentations made or patents filed.