Interactions Between Trace Metals, Sodium and Sorbents in Combustion.

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Prepared by

Jost O.L. Wendt and Sheldon Davis,
Department of Chemical and Environmental Engineering,
University of Arizona,
Tucson, AZ 85721.

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DOCUMENT CONTROL CENTER,
U.S. Department of Energy,
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INTRODUCTION

The proposed research is directed at an *understanding* of how to exploit interactions between sodium, toxic metals and sorbents, in order to optimize sorbents injection procedures, which can be used to capture and transform these metals into environmentally benign forms. The research will use a 17kW downflow, laboratory combustor, to yield data that can be interpreted in terms of fundamental kinetic mechanisms. Metals to be considered are lead, cadmium, and arsenic. Sorbents will be kaolinite, bauxite, and limestone. The role of sulfur will also be determined. The research is divided into five tasks.

Task 1: Combustor Modifications.

The existing laboratory combustor will be modified to allow injection of toxic metal surrogates, and withdrawal of particulate samples for subsequent analysis, without allowing leaks to impact the laboratory room environment.

Task 2: Screening Experiments.

Surrogate trace metals (3, listed above) will be injected through an otherwise "clean" gas flame stabilized in the combustor. Sorbents (3, listed above) will be injected through a port downstream. For each metal/sorbent pair, a statistically correct set of parametric experiments will be performed, quantitatively to determine the effects of a) sodium level, b) sulfur level, c) sorbent injection temperature, d) sorbent residence time, on trace metal capture. Measurements consist of the size segregated composition of the exhaust particulate matter. The objective function is the fraction of metal reactively captured by the sorbent. Solid and surface analyses will provide insight into mechanisms.

Task 3: Mechanisms.

Selected runs (6) from Task 2 will be repeated to obtain time resolved data on metal partitioning, with and without sodium and sulfur. The purpose will be to glean rates and mechanisms from size segregated particulate samples withdrawn. Advanced surface and solid analyses of sampled particulates will aid in mechanism building.

Task 4: Applications.

Three different, well characterized, pulverized coals will be burned, and the partitioning of the three toxic metals, in the presence of sorbents, examined, in the light of the mechanisms uncovered in Tasks 2 and 3. These mechanisms will also be used to determine the optimum application of sorbent injection in the presence of sodium and sulfur.

Task 5: Mathematical Modelling.

Tasks 2 through 4 will be accompanied by mathematical modeling. Empirical model building will be used in Task 2 to correlate, and interpolate the data. Deterministic and mechanistic modeling will be used to correlate and extrapolate the data of Tasks 3 and 4. This modelling will involve models of a) gas/solid reactions, and the appropriate particle size dependencies, b) gas phase reactions, either through partial/global equilibrium arguments (using CET89 software), or through CHEMKIN based detailed reactions, c) aerosol dynamics (using MAEROS), as required and appropriate.

PROGRESS FOR THIS QUARTER

Task 1: The construction of the mini-baghouse and associated equipment is complete. To be accomplished in the first month of the next quarter is standard quality assurance testing including

pressure testing. Additionally, operating procedures and regimes will be specified and validated.

Task 2: The development of a test plan has begun. It has been set that there will be two phases of screening experiments. The first phase will be parametric tests of the furnace. The goal of these tests will be to determine the characteristics of the furnace especially those that may have been affected by new construction. Among the characteristics of the furnace to be investigated are the pressure, temperature, and influx profile. The second phase will be the screening component as mentioned in the task outline.

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