Oxidation of Mercury via Catalytic Barrier Filters – Phase II

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ABSTRACT

OBJECTIVES

Development of mercury control technologies has been ongoing for the last decade. Implementation of EPA regulated controls for coal-fired power plants is scheduled for December 2007, yet there is currently no single best technology that can be applied broadly. Further, based on the current state of development, mercury control will be very costly, with estimates for its control as high as $0.004/kWH ($3-$7 billion/yr). Injection of sorbents into the gas stream to capture the mercury is one of the most promising methods of control. Capture of mercury in wet scrubbers, the same devices that capture oxides of sulfur (acid rain precursors) also shows promise. Unfortunately, the performance of sorbents is reduced for elemental mercury while none of the current wet scrubber methods capture any appreciable elemental mercury. Thus, if mercury control targets are to be met and control costs reduced, methods to oxidize the elemental mercury to Hg^{2+} in the flue gases from coal-fired power plants must be developed.

The University of North Dakota (UND) Chemical Engineering Department has investigated the use of fabric filters as a method of contacting the mercury laden flue gas with the oxidation catalyst under a DOE UCR Innovative Concept Phase I grant. Preliminary data generated for catalytically impregnated barrier filters during the Phase I grant demonstrated between 85% and 95% oxidation of elemental mercury is possible through a catalyst-coated fabric. The Phase I project was designed as a proof-of-concept study.

The Phase II project will further develop the feasibility of impregnated barrier filters for mercury control. The feasibility of oxidizing elemental mercury in coal combustion flue gas using catalytic material impregnated onto barrier filters will be determined through two basic activities: 1)investigating catalyst coating techniques and loadings, and 2)testing the performance of a catalytic barrier filter(s) under full combustion conditions.

ACCOMPLISHMENTS TO DATE

Task 1. Catalyst Coating Techniques and Loadings. A lab-scale fabric testing system was designed and constructed to conduct preliminary tests to identify the most attractive coating technique(s) and catalyst loading levels for a variety of filter bag materials. The system allows simulated flue gas mercury oxidation testing as well as simulated baghouse backpulse tests.

Task 2. Performance Testing under Combustion Conditions. Three coals were ordered and received using resources at the UND Energy and Environmental Research Center: Illinois #6, Wyoming PRB, and Pittsburg seam coal. Proximate and ultimate analyses, heating value, moisture content, and both major

and trace inorganic elemental analyses were performed. A continuous speciated mercury analyzer was ordered from Horiba Instruments.

FUTURE WORK

Task 1. Catalyst Coating Techniques and Loadings. The preliminary tests, described above will be conducted. Based on these results, a variety of pilot-scale filter bags will be coated with catalyst at target loadings. These bags will then be used for performance testing.

Task 2. Performance Testing under Combustion Conditions. The mercury analyzer system will be installed and calibrated. Baseline tests will be performed using a 19kW vertical downflow combustor and associated baghouse to assess the performance of the catalytic filter bags under conditions that scale to commercial systems. Based on the results of these initial tests, parametric tests will be used to more fully evaluate this technology.

PATENTS, and STUDENT SUPPORT

A provisional patent application was developed and submitted to protect the intellectual property associated with using catalyst on barrier filters for mercury oxidation. Docket Reference No.: 53455-1018P01.

Chemical Engineering doctoral student Chunmei Wang was assigned to the project. Ms. Wang's specialty and interest is in the environmental aspects of trace metals during coal combustion. During this progress period, Ms. Wang was responsible for obtaining coals plus their physical and chemical properties. Ms. Wang will also conduct elemental analysis, as required, and assist in both task 1 and task 2 experiments. Chemical Engineering masters student Carol Horabik was assigned to the project. Ms. Horabik has primary responsibility for the day-to-day work activities associated with coating barrier filter materials with catalytic material. Environmental Engineering masters student Jason Hrdlika was assigned to the project. Mr. Hrdlika will have primary responsibility for the task 2 combustion experimental testing.

PUBLICATIONS, PRESENTATIONS, and STUDENT SUPPORT

Publications: None to date

Presentations

Horabik, C., Wang, C., Hrdlicka, J., Mann, M., Muggli, D., and Seames, W., "Mercury Oxidation Via Catalytic Barrier Filters", University of North Dakota 2005 Scholarly Activities Forum Poster Session, February, 2005.

Supported Students

Ms. Chunmei Wang, graduate student, UND School of Engineering and Mines PhD Program
Ms. Carol Horabik, graduate student, UND Chemical Engineering Department Masters Program
Mr. Jason Hrdlicka, graduate student, UND SEM Environmental Engineering Department Combined B.S./M.S. program