FY05-LII(52)-137
"Mercury Oxidation via Catalytic Barrier Filters: Phase II"

Contractor: University of North Dakota, Dept. of Chem. Eng.
Principal Investigator: Dr Wayne Seames

PARTICIPANTS

Sponsor	Cost Share
DOE	$200,000
University of North Dakota	$ 15,000
Basin Electric Power Cooperative	$ 3,000
Montana-Dakota Utilities	$ 3,000
Great River Energy Cooperative	$ 3,000
SaskPower	$ 3,000
Minnkota Power Cooperative	$ 3,000
NDIC	$ 15,000
Total Cost	$245,000

Project Schedule - 30 Months

Contract Date – 3/23/05

Start Date – 3/23/05

Completion Date – 10/1/07

Project Deliverables

Contract Signed: March 23, 2005 (✓)

Annual Reports:

Year 1: 10/1/05 (✓);

Year 2: 10/1/06 (✓);

Final Report: 10/1/07 (✓);

OBJECTIVE / STATEMENT OF WORK:
Initiate a Phase II program to continue explore the feasibility of oxidizing elemental mercury in coal combustion flue gas using catalytic material impregnated onto fabric barrier filters.

STATUS

Year 1 Annual Report (10/31/05):

- Task 1.1. Determining the best method of catalyst coating: complete
- Task 1.2. Evaluating effectiveness of coating under varying filtration velocities and back pulse cleaning cycles: complete
- Task 2. Perform bench-scale tests to determine catalyst performance using simulated flue gas: experimental apparatus constructed, on-line Hg analyzer acquired and commissioned, testing to occur in year 2
- Task 3. Performance Testing of Catalytic Barrier Filter(s) in a 17-kW Furnace: coals acquired and characterized, testing to begin in year 2

Year 2 Annual Report (10/1/05 – 9/30/06):

- Task 1.1) Determining the best method of catalyst coating: complete

- Task 1.2) Evaluating effectiveness of coating under varying filtration velocities and back pulse cleaning cycles: complete
- Task 2) Perform bench-scale tests to determine catalyst performance using simulated flue gas (In progress): Three catalysts (titania, gold on titania, and Pd on alumina) were investigated using a simulated flue gas. Use of a wet conditioning system will be used to complete Task 2 in the first quarter of year 3 (fourth quarter of 2006)
- Task 3) Performance Testing of Catalytic Barrier Filter(s) in a 17-kW Furnace: coals acquired and characterized, testing to begin in year 3 (first quarter of 2007)

Final Report

Work Accomplished:

1) Screened three different fabric filter catalyst coating methods and determined their ability to maintain ample and uniform loading under back-pulse cleaning cycles similar to those experienced in a baghouse. A test apparatus was constructed to automatically simulate back pulses of the filters. Filter samples were back pulsed up to 1000 times to determine the long term integrity of the catalyst loading.
2) Tested the impact of important flue gas constituents on the performance of the catalyst coated filters in a bench-scale reactor using a simulated flue gas stream under conditions similar to commercial coal-fired power plant baghouses. Parametrically studied Cl_2, HCl, SO_2, and NO.
3) Tested the performance of catalyst coated filters under actual combustion conditions in a baghouse that services a 19 kW downflow laboratory combustor for 4-6 hours using three study coals: Illinois #6 bituminous, Eagle Butte subbituminous, and Falkirk lignite. A 36 hour verification test was then performed with the Eagle Butte.

Results:

1) A simple spray coating process appears to be the most simple and effective technique. A double dip coating method is also effective but involves a more complex process than spray coating. Increases in pressure drop across a catalyst-coated filter were found to be insignificant when compared to a bare filter.
2) Au/TiO_2 and Pd/Al_2O_3 performed well in the presence of Cl_2. Pd/ Al_2O_3 performed the best with the addition of Cl_2 and SO_2. Pd/ Al_2O_3 had the best overall performance and was selected for use in the small pilot-scale testing.
3) Very little elemental mercury could be measured in the Illinois #6 flue gas because of its high chlorine and sulfur content. Eagle Butte and Falkirk flue gases were tested with Pd/Al_2O_3 and 90% mercury oxidation was achieved.

Potential applications of the project: Fabric filters utilized with subbituminous and lignite coals generated high concentrations of elemental mercury can be replaced with catalyst-coated filters. If an FGD is used, the oxidized mercury will be removed to levels within compliance requirements. For other systems, a packed bed of activated carbon or other oxidized mercury sorbents can be utilized to achieve removals. The amount of activated carbon needed for oxidized mercury sorption is substantially lower than that required for elemental mercury.

Private partner contributions: Funds were received from five utilities to match funds received from the NDIC and supplemented by funding from DOE and UND for the purchase of a Horiba DM-6B continuous emissions monitor type atomic absorption spectrometry-based mercury analyzer with dry gas conditioning system. This analyzer was a key component in the work performed under this project.