

FY01-XXXVIII-105
PILOT SCALE STUDY OF MERCURY OXIDATION CATALYSTS AT COAL CREEK STATION, UNDERWOOD, ND

CONTRACTOR: Great River Energy w/ URS as subcontractor

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PARTICIPANTS

<u>Sponsor</u>	<u>Cost Share</u>
Department of Energy (DOE)	\$847,616
Electric Power Research Institute (EPRI)	\$227,000
GRE in-kind services	\$31,360
GRE cash	\$42,000
City of San Antonio Public Services	\$28,624
ND Industrial Commission	\$92,000
Total	\$1,268,600

Project Schedule – 36 Months
 Contract Date - 3/12/2001
 Start Date –8/30 /2001(DOE Award)
 Completion Date – 8/30/2004

Project Deliverables
 Contract Signing – 3/12/01√
 Quarterly (7) Reports – 5/02 √√√√√√√
 Topical Report – 6/01/02√
 Final Report –3/31/05√

OBJECTIVE / STATEMENT OF WORK

Conduct pilot scale testing of mercury oxidation catalysts. Several mercury oxidation catalysts were tested as part of the Mercury Control Options Evaluation (FY01-XXXVII-103) at Coal Creek Station. During this short-term (minutes) testing, catalysts were shown to be capable of oxidizing between 80 and 95 percent of the elemental mercury present in the flue gas. The objectives of this project (FY01-XXXVII-105) include longer-term testing (months) of potential catalysts and attempt to optimize catalyst selection for mercury oxidation. Also, testing of mercury removal in a pilot wet scrubber will be conducted.

STATUS

The United States Department of Energy approved funding for this project on August 30, 2001. The final design of the test unit that will hold four catalyst types has been completed. A project kickoff meeting is scheduled for November 2001, with installation of the test unit at Coal Creek Station scheduled for March 2002.

In April 2002, the boiler was undergoing an annual maintenance outage. The location of the catalyst slipstream test unit will be external to the ductwork. Although installation of the test unit was scheduled to be completed by March, 02, the equipment was not in place but should be when the outage maintenance work is complete.

Installation of the slip-stream test unit occurred in September, 2002. Installation of two catalyst monoliths occurred in October, 2002, a third was installed in December, 2003 and a fourth is expected to be installed in March, 2003. Slipstream testing is anticipated to continue into the spring of 2004.

July – September, 2003. During the initial 6 months of pilot plant operation, a significant buildup of fly ash was observed in addition to a resulting in loss of Hg(0) oxidation. Sonic horns were effective in limiting fly ash buildup resulting in maintaining high catalyst activity. However, after 10 months of operation, a significant decrease of Hg oxidation has been observed.

Calendar Year 2004. Two topical reports were prepared entitled “ Pilot Testing of Mercury Oxidation Catalysts for Upstream of Wet FGD Systems, Site 1 Results”, and ”Pilot Testing of a Wet FGD system Downstream of a Mercury Oxidation Catalyst at Coal Creek Station”. The final report is being prepared.

Final Report (October 6, 2006)

The project demonstrated at pilot scale a mercury control technology that uses solid honeycomb catalysts to promote the oxidation of elemental mercury in the flue gas from coal combustion. Oxidized mercury is removed in downstream wet flue gas desulfurization (FGD) absorbers and leaves with the FGD byproducts. A pilot system was installed after the electrostatic precipitators at Coal Creek Station. The pilot system housed four different catalyst chambers. Flue gas was passed through each of the four catalysts chambers and mercury concentrations in the flue gas were measured before and after the catalysts. Testing began in October 2002 and continued though the end of June 2004, representing nearly 21 months of catalyst operation. The project was amended to use a pilot we FGD system to confirm that the oxidized mercury would be removed.

Even though the mercury oxidation catalyst pilot unit was installed downstream of a high-efficiency ESP, fly ash buildup began to pug flue gas flow through the horizontal catalyst cells. Sonic horns were installed in each catalyst compartment and effectively limited fly ash buildup. A palladium-based catalyst showed initial elemental mercury oxidation percentages of 95% across the catalyst, declining to 67% after 21 months in service. A carbon-based catalyst began with almost 98% elemental mercury oxidation across the catalyst, but declined

to 79% oxidation after nearly 13 months in service. The other two catalysts, and SCR-type catalyst (titanium/vanadium) and an experimental fly ash-based catalyst were significantly less active. The palladium-based and SCR catalysts were effectively regenerated at the end of the long-term test by flowing heated air through the catalyst overnight. The carbon-based catalyst was not observed to regenerate, and no regeneration tests were conducted on the fourth, fly-ash based catalyst.

Preliminary process economics were developed for the palladium and carbon-based catalysts for a scrubbed, North Dakota lignite application. At a 55% increase in mercury capture for plants that fire lignite with the catalysts being replaced every two years, the catalytic oxidation process can be 30 to 40% less costly than conventional (not chemically treated) activated carbon injection if the plant currently sells their fly ash and would lose those sales with carbon injection. If the plant does not sell their fly ash, activated carbon injection was estimated to be slightly less costly. There was little difference in the estimated cost for palladium versus the carbon-based catalysts. The pilot wet FGD demonstrated it was possible to remove 70-80% of the total mercury entering the FGD system. If the palladium-based catalyst can be regenerated to double its life to four years, catalytic oxidation process economics are greatly improved. With regeneration, the catalytic oxidation process shows over a 50% reduction in mercury control cost compared to conventional activated carbon injection for a case where the plant sells its fly ash.