PROJECT facts

Advanced Research

08/2007

U.S. DEPARTMENT OF ENERGY
OFFICE OF FOSSIL ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY

NETL

# LARGE-SCALE TESTING OF ENHANCED MERCURY REMOVAL FOR SUBBITUMINOUS COALS


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DEPARTMENT OF ENERGY • UNITED STATES OF AMERICA

## Description

In partnership with a number of key stakeholders, the U.S. Department of Energy's Office of Fossil Energy (DOE/FE), through its National Energy Technology Laboratory (NETL), has been carrying out a comprehensive program of research since the mid-1990s to develop advanced, cost-effective mercury (Hg) control technologies for coal-fired power plants. Anticipating new Federal rules and possible state legislation, NETL's Advanced Research group has supported the laboratory's Innovations for Existing Plants (IEP) Program in pursuing research to resolve mercury control issues facing the subbituminous and lignite coal industries. The effort to evaluate subbituminous coals involved a consortium led by the University of North Dakota's Energy and Environmental Research Center (EERC), with participation by Babcock & Wilcox (B &W), Kansas City Power and Light (KCP&L), Otter Tail Power Company, Electric Power Research Institute, Wisconsin Public Service, Dynegy, Southern Company, Texas-Genco, Ameren UE, PacifiCorp, and Cormetech.

Compared to higher rank bituminous coals, subbituminous and lignite coals are high in moisture, sulfur, and other base contaminants including mercury, and low in chlorine content. In general, coal-fired plants burning the latter types demonstrate significantly lower mercury capture using existing conventional air pollution control devices, compared to similarly equipped bituminous plants.

Mercury is a poisonous metal found in coal, which can be harmful and even toxic when absorbed from the environment and concentrated in animal tissues. Mercury is present as an unwanted by-product of combustion in power plant flue gases, and is found in varying percentages in three basic chemical forms (known as speciation): gaseous elemental mercury ($Hg^0$), gaseous inorganic oxidized mercuric compounds (primarily mercuric chloride – $HgCl_2$), and fly ash particulate-bound mercury ($Hg_p$). Research to date has considerably increased the understanding of properties of these various forms, and has led to effective technologies to capture and control them.

It has been estimated that U.S. coal-fired power plants currently emit about 48 tons of mercury per year. Control of power plant mercury emissions is mandated by a U.S. Environmental Protection Agency (EPA) rule issued in 2005 (the Clean Air Mercury Rule, or CAMR), which establishes a "cap-and-trade" program that applies to both existing and new plants. Phase I of this program will begin in 2010, with a 38 ton-per-year emissions cap. Phase II requires a 15 ton cap beginning in 2018. Following implementation of both phases, an overall average reduction in mercury emissions of about 69 percent will be achieved.

## PROJECT DURATION

**Start Date**
04/15/05
**End Date**
09/30/06

## COST

**Total Project Value**
$1,300,000
**DOE/Non-DOE Share**
$455,000 / $845,000

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## WEBSITE

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# Goals and Technical Approach

This field project followed a laboratory project for the large-scale testing of enhanced mercury removal for subbituminous coals that tested a multitude of mercury control and oxidation strategies. The goal for this follow-on project was to evaluate the best performing mercury control technologies from the lab testing to enhance the ability of existing pollution control devices to reduce total mercury emissions from three power plants using subbituminous fuel. Power plants firing subbituminous coals produce flue gases that contain greater than 80 percent elemental mercury, which is difficult to capture. The technologies were selected for their ability either to capture mercury, oxidize mercury, or do both, and included: powdered activated carbon alone (PAC), calcium chloride ($CaCl_2$), sorbent enhanced additive 2 (SEA2), and PAC in combination with $CaCl_2$ or SEA2.

The testing was conducted at Texas-Genco's W.A. Parish Unit 8, Thompsons, Texas (now owned by NRG Energy, Inc.); Otter Tail Power Company's Hoot Lake Unit 3, Fergus Falls, Minnesota; and KCP&L's Hawthorn Unit 5, Kansas City, Missouri. The units were equipped with Flue Gas Desulfurization/ Selective Catalytic Reduction (SCR), Electrostatic Precipitator, and SCR/ Fabric Filter, respectively.

# Accomplishments

**W.A Parish**

- The addition of $CaCl_2$ greatly improved Hg oxidation across the SCR.
- The majority of the oxidized Hg was captured in the FGD.
- Addition of 500 ppm of $CaCl_2$ resulted in 94 percent removal of total Hg across the FGD.

**Hawthorn**

- The addition of $CaCl_2$ improved Hg oxidation across the SCR and increased mercury removal to 84 percent.
- Adding PAC with $CaCl_2$ did not improve mercury removal compared to $CaCl_2$ addition alone.
- The addition of PAC at 2 lb/Macf in combination with SEA2 (0.0125 ppm) increased mercury removal to 95 percent.

**Hoot Lake**

- PAC addition alone provided poor Hg removal.
- PAC addition (1.35 lb/Macf) in combination with SEA2 (100 ppm) resulted in Hg removals of 74 percent.
- Increasing both concentrations of PAC (5 lb/Macf) and SEA2 (625 ppm) achieved mercury removals of 88 percent.

# Benefits

Research performed as part of NETL's mercury control program will be used to commercialize a broad range of mercury control technologies suited to coals of various compositions and to various air pollution control device configurations. Availability of these technologies will enable coal-fired power plant operators to employ a suite of control options to cost-effectively comply with the CAMR and other regulations. The technology or technologies that prove most effective will have several economic and operational advantages over existing sorbent-based technologies. For example, the SEAs tested in this program provided improved removal rates at lower carbon injection rates, compared to activated carbon injection alone. This translates into less material to ship off-site, less sorbent in fly ash, and a discreet sorbent product that eventually can be separated, regenerated, and reused.