PROJECT facts

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

Advanced Research

08/2007

MERCURY CONTROL TECHNOLOGIES FOR ELECTRIC UTILITIES BURNING LIGNITE COAL

Background

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 research program since the mid-1990s focused on the development of advanced, cost-effective mercury (Hg) control technologies for coal-fired power 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): particulate-bound mercury, oxidized mercury (primarily mercuric chloride — $HgCl_2$), and elemental mercury. Research to date has considerably increased the understanding of properties of these various forms, and has led to effective air pollution control devices (APCD) and technologies to capture and control them.

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 in the populous Eastern and Midwestern United States, where mercury deposition is the highest. Phase I of this program will begin in 2010, with

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a 38 ton-per-year emissions cap. Phase II requires a 15 ton cap beginning in 2018. It has been estimated that U.S. coal-fired power plants currently emit about 48 tons of mercury per year, so the Phase II cap will require an overall average reduction in mercury emissions of about 69 percent. The CAMR is tied to EPA's Clean Air Interstate Rule (CAIR), also issued in 2005, which permits "co-benefit" mercury reductions achieved through emission controls on sulfur dioxide (SO_2) and nitrogen oxides (NO_X).

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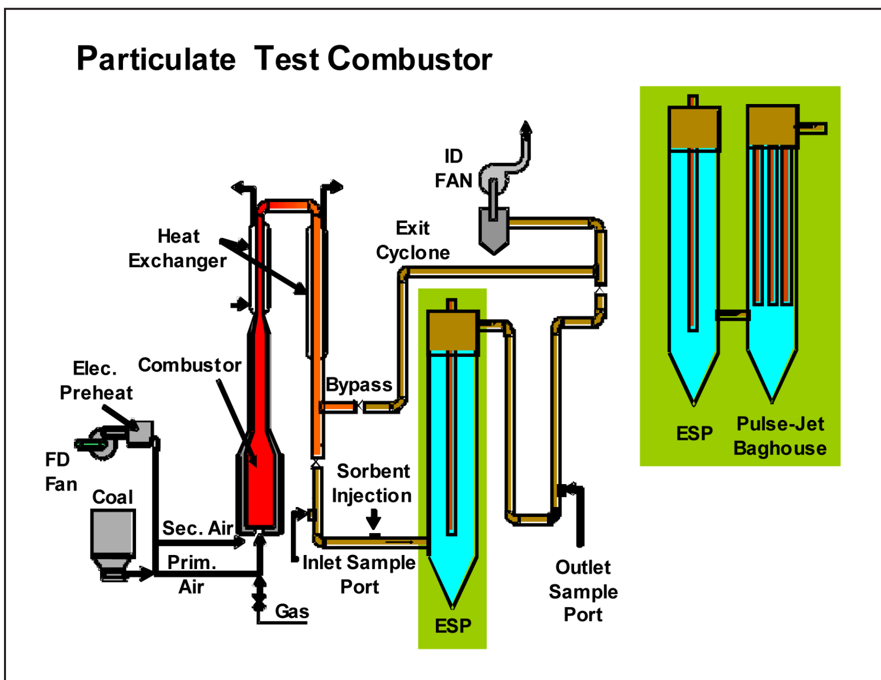
Description

In anticipation of the new rules taking effect, and of possible restrictive state legislation, NETL's Advanced Research organization has supported the laboratory's Innovations for Existing Plants (IEP) Program in leading a consortium-based research effort directed toward resolving the mercury control issues facing the lignite industry. Lignite is a coal that is high in moisture, sulfur, and other base contaminants including mercury, and low in chlorine content. In general, plants burning lower-rank lignite coals demonstrate significantly lower mercury capture using existing conventional air pollution control devices than similarly equipped bituminous coal-fired plants.



The lignite mercury control project is led by the University of North Dakota Energy and Environmental Research Center (EERC), with participation of a consortium that also includes power plant operators, manufacturers (in this case boiler manufacturer ALSTOM), the Electric Power Research Institute (EPRI), academia, state and local agencies, Natural Resources Canada, and the EPA. The objective is to test advanced innovative mercury control technologies to reduce mercury emissions from lignite-fired power plants by 50–90 percent, at costs that are one-half to three-quarters of current estimated costs.

PROJECT DURATION

Start Date

05/31/03

End Date

05/31/06

COST

Total Project Value

$1,930,000

DOE/Non-DOE Share

$770,000 / $1,160,000

Goals

The objective of this project was to examine how newer, cheaper mercury sorbents performed at a power station burning North Dakota lignite. Poplar River is a two-unit station owned by SaskPower and located in south central Saskatchewan, Canada.

Phase I of the project investigated various sorbents to evaluate their effectiveness for mercury speciation and capture when burning a Fort Union lignite coal. This testing was done at the pilot scale, and tested a range of configurations to determine the most promising technologies for mercury control. Results indicated that two technologies appeared to show the greatest promise: a fabric filter (FF), or the EERC's Advanced Hybrid™ filter coupled with activated carbon injection (ACI) of the sorbent.

Following Phase I, SaskPower decided to build a slipstream FF at Poplar River in order to conduct additional mercury removal research. The slipstream unit is referred to as the Emission Control Research Facility (ECRF) and allows for sorbent injection downstream of the primary particulate collector (in this case a FF) and upstream of a smaller, polishing FF. This EPRI-patented equipment configuration is referred to as TOXECON™.

The objective of Phase II was to evaluate the performance of various sorbents (both with and without additives), selected from Phase I, to effectively and economically remove mercury from the flue gas of a slipstream large enough to give representative mercury removal percentages. Initially, screening tests were conducted on nine sorbents to quantify the amount of sorbent injected versus mercury reduction. Following the completion of the screening tests, parametric tests were conducted to evaluate varying design and process conditions (air-to-cloth ratio, temperature, ash loading, pulsing frequency, pressure drop, and bag material) on mercury removal. Finally, long-term testing was conducted using the process conditions and sorbents selected from the screening and parametric tests. Three long-term mercury

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control tests were performed: one lasting 5 weeks and each of the other two lasting 10 weeks. All three tests maintained a baghouse air-to-cloth ratio of 6 feet/minute, and an outlet temperature of 300 °F. The 5-week test and one of the 10-week tests tested high- and low-ash conditions, respectively; while the other 10-week test evaluated the high-ash condition but with a switch from standard bags to high-permeability.

Accomplishments

Results of the long-term testing at high dust load indicate:

- 83 percent Hg capture was achieved at an ACI rate of 2.2 lb/Macf.
- Pressure drop issues resulted in increased cleaning frequency and indicated that a lower air-to-cloth ratio is necessary.

Results for the low dust condition indicate:

- 82 percent Hg capture was achieved at an ACI rate of 2.5 lb/Macf.
- Pressure drop was not a problem and cleaning frequency remained the same.

Results of the tests using high permeability bags at high dust loading indicate:

- 82 percent Hg capture was achieved at an ACI rate of 2.8 lb/Macf.
- Pressure drop issues were not a problem. The pressure drop was 1 in. W.C. compared to >10 in. W.C. when using conventional bags. However, there may have been increased fine particulate breakthrough.

Poplar River Plant