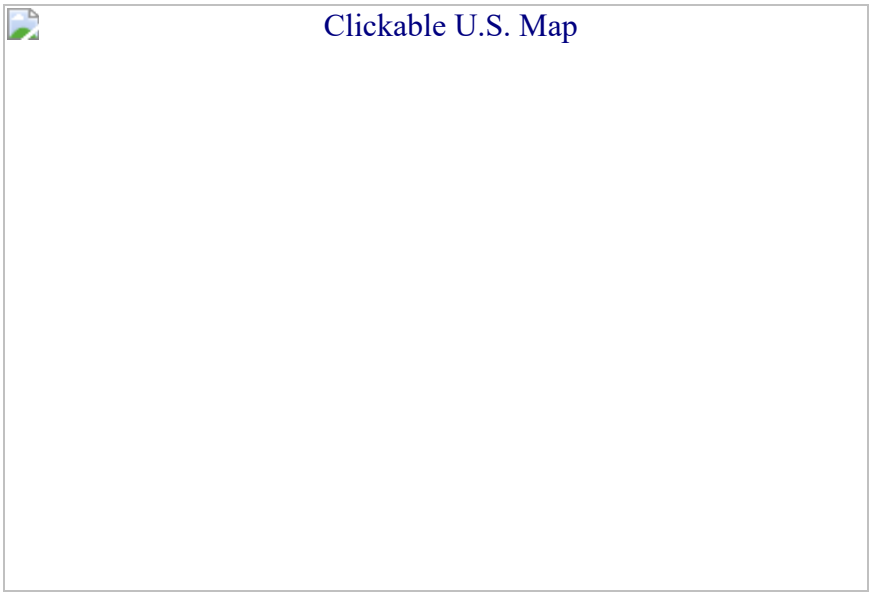
Completed Mercury Projects

View specific project information by clicking the state of interest on the map.



ALABAMA

Characterizing Toxic Emissions from Coal-Fired Power Plants

Southern Research Institute

The objective of this contract is to perform sampling and analysis of air toxic emissions at commercial coal-fired power plants in order to collect data that the EPA will use in their Congressionally mandated report on Hazardous Air Pollutants from Electric Utilities.

CALIFORNIA

Assessment of Toxic Emissions from a Coal-Fired Power Plant Utilizing an ESP

Energy & Environmental Research Corporation – CA

The overall objective of this project is to conduct comprehensive assessments of toxic emissions of two coal-fired electric utility power plants. The power plant that was assessed for toxic emissions during Phase I was American Electric Power Service Corporation's Cardinal Station Unit 1.

Co-funding of the EPRI Environmental Control Technology Center (ECTC)

Electric Power Research Institute (EPRI)

Co-funding of research, development and demonstration in the areas of: 1) hazardous air pollutants and fine particulate control; 2) advanced flue gas desulfurization; 3) NOx control strategies; 4) continuous emission monitors; 5) wastewater reuse and recycle; and 6) biomass cofiring at the 5 MW Environmental Control Technology Center located adjacent to the New York State Electric & Gas Corporation's (NYSEG's) Kintigh Generating Center.

COLORADO

Investigation and Demonstration or Dry Carbon Based Sorbent Injection for Mercury Control

Public Service Company of Colorado

Under the DOE/FETC Mega PRDA program, DOE, Public Service Company of Colorado (PSCo), and EPRI are funding both phase of work at being conducted at the pilot- and full-scales to evaluate carbon injection as a mercury control technology. ADA Technologies performs the fabrication, pilot operation, and reporting.

The pilot evaluations are being conducted on a pilot-scale particulate control module (PCM) drawing a 600 acfm (actual cubic feet per minute) slipstream of flue gas from the 350 MWe Comanche Station, Unit 2 of PSCo. The station has an opposed-fired furnace firing a Powder River Basin (PRB) coal from the Belle Ayr mine. Flue gas can be either drawn from the inlet (high particulate loading) or the outlet (essentially particle free) of the stations reverse-gas baghouse. In addition, the PCM can be configured as an electrostatic precipitator (ESP), a reverse-gas Baghouse or pulse-jet fabric filter, and as EPRI's TOXICON pulse-jet fabric filter.

Objectives of this two phase project include: 1) Determine mercury removal rates as a function of temperature and of carbon injection rate, as well as types of particulate control technologies and 2) Evaluate synergistic effects of multi-pollutant control, mercury via carbon injection and SO2 via sodium sesquicarbonate.

Novel Process for Removal and Recovery of Vapor Phase Mercury

ADA Technologies, Inc.

ADA Technologies, Inc. is developing a process for removing mercury from the flue gases of coal-burning boilers, such as those used by the electric utilities. The technique uses small quantities of a noble metal (such as gold) to adsorb elemental mercury and oxidized forms of mercury at ordinary flue gas temperatures; and to release the mercury at moderately higher temperatures. Since the sorbent is REgenerable and the process REcovers mercury for recycling commercially, it is called the "Mercu-RE Process".

Previously, ADA had tested the process in conditions simulating the flue gases of a coal-fired boiler, where the mercury concentration is low (about 10 mg/m3). The purpose of this project is to develop the process in a form suitable for controlling mercury emissions from coal-fired power stations. Finally, an economic assessment will be prepared with reference to a full-scale (500 MWe) utility system.

An Economic Sorbent for the Removal of Mercury from Coal Combustion Flue Gases

TDA Research, Inc.

TDA Research Inc. (TDA) has identified a low cost route to a carbon-based, sulfur containing sorbent that should have a high capacity for mercury and also for other air toxins including chlorine and hydrogen chloride. In Phase I, TDA prepared and tested the new sorbent. Phase II tests of this sorbent will be conducted at the ADA test site at Comanche Power Station, Pueblo CO.

Detection of Mercury at the Parts Per Quadrillion Level Using Cavity Ringdown Spectroscopy

ADA Technologies, Inc.

No information available. Not awarded, not funded

IOWA

Air Toxics Instrumentation

Ames National Laboratory

In previous work, commercially available instrumentation suitable for the monitoring applications of interest was reviewed and evaluated. Also, pertinent literature was assessed to obtain additional information on analytical methodologies which could potentially be used. Based on the results of that work and the continuing review of available instruments, analytical approaches which appear to have the most potential for monitoring application were identified. For HCl, the techniques currently being considered are infrared absorption, colorimetry, and ion mobility spectroscopy. For Hg, atomic absorption and atomic fluorescence techniques have been selected for testing in the laboratory. Subsequent laboratory work will determine which analytical systems show the most promise for on-line analysis of HCl and Hg.

Promising analytical instruments will be assembled and/or modified for application to monitoring hot pressurized gases from coal gasifiers. Additional work will involve developing suitable gas conditioning and sample introduction systems. After the laboratory studies have been completed, prototype instruments will be tested and evaluated in the field.

MASSACHUSETTS

Control of Mercury Emissions from Fossil Fuel-Fired Power Plant

Physical Sciences, Inc.

The goal of the Phase II project, building on the Phase I results, is to develop a zeolite sorbent and demonstrate at pilot scale the successful reduction of mercury emissions from an operating power plant, using a slip-stream from the flue gas system.

NORTH CAROLINA

Assessment of Toxic Emissions from Two Power Plants, One Utilizing a Baghouse and One Utilizing

Roy F. Weston, Inc.

The overall objective of this project is to conduct comprehensive assessments of toxic emissions from up to four coal-fired electric utility power plants. The two power plants that were assessed for toxic emissions during Phase I were Illinois Power Company's Baldwin Station Unit 1 and Minnesota Power Company's Clay Boswell Station Unit 2.

NORTH DAKOTA

Low Temperature NOx Reduction Using High Sodium Lignite Derived Chars

University of North Dakota Energy and Environmental Research Center

OBJECTIVE: The overall objective of the project is to demonstrate, at full-scale, the reduction in SO3 emissions as a result of flue gas humidification without impacting stack opacity or increasing corrosion of the ducting or the ESP.

STATEMENT OF WORK:

Description of Test Facility

Unit 4 of the R. Paul Smith Station is 87 MW and has an existing flue gas humidification system prior to an ESP that cools the gas from approximately 300^0F to 265-270^0F. For this project, a commercial SO3 generator (typically used for flue gas conditioning of ESPs) will be used to catalytically convert SO2 to SO3. The SO3 will be calibrated by the supplier and sized to provide an SO3 concentration in flue gas in the range of 10 to 30 ppmv. The SO3 injection system will be installed into the duct at a location approximately 30 feet upstream of the air heater. In this way, uniform dispersion of the SO3 prior to the humidification system can be achieved.

Sampling and Analysis

The project will consist of approximately 1-2 weeks of testing at the R. Paul Smith Station. The controlled condensation method (CCM) will be used to measure SO3 vapor concentration in the system. The flue gas will be sampled using a temperature control probe and filter to prevent condensation and remove particulate matter prior to the SO3 condenser. In the condenser, the particle- free gas is cooled to 142^0F to selectively condense vapor-phase SO3, which is then rinsed into a collection bottle and analyzed using ion chromatography. The SO3 sampling locations are as follows:

- Inlet of the humidifier
- Inlet of the ESP
- Stack

By sampling at all three locations, the variation of SO3 throughout the system can be monitored. Using a modified EPA Method 5, fly ash samples will be collected at the three sampling locations. These fly ash samples will be heated to remove any

condensed SO3 from the particle surface, and then the resulting ash will be analyzed for sulfates. By comparing these results to baseline data, the amount of reacted SO3 can be determined. Two SO3 samples and one EPA Method 5 sample are to be collected and subsequently analyzed at each sampling location for each test configuration. The primary variables are humidification, temperature, and SO3 concentration. Prior to the humidification system, the flue gas temperature is approximately 300^0F and the average SO3 concentration (without SO3 injection) is about 3-4 ppmv. Tests will be conducted by adjusting the humidification to control temperature and adjusting the SO3-injecting system to control the SO3 concentration. In order to minimize any acid deposition, each test will run for only 1 hour.

The EERC will measure mercury speciation at the inlet and outlet of the humidification system using the Ontario Hydro method. In this way, the effect of humidification on mercury can be determined. A coupon test will also be performed in the short term to examine the corrosion effects of flue gas humidification.
View Final Report [PDF-1692KB]

Trace Elements

University of North Dakota Energy and Environmental Research Center

Experimental work will be done to obtain basic partitioning information of the trace species in IGCC and IGFC systems. Trace species to be considered include arsenic, chromium, cadmium, mercury, selenium, lead, and nickel. Work would also involve the development of thermodynamic simulations, systems studies and small scale tests which would predict the species evolving from coal under various gasification conditions and where they will be deposited in advanced energy conversion systems. Finally, the work will involve the prediction of trace species at various locations in advanced energy conversion facilities and the validation of these predictions.

Enhanced Air Toxics Control Project

University of North Dakota Energy and Environmental Research Center

EERC will do the work with their pilot-scale pulverized- coal-fired combustor and pulse-jet baghouse, the Particulate Test Combustor (PTC). Task 1 is planning, facility preparation, and project management. Task 2 is initial trace element balances around the particulate control device and screening of 8 additives for ability to capture vapor-phase metals. Task 3 will be more in-depth testing of the most promising methods of air toxic control. Task 6 is 3 30-hour PTC tests per week for 5 weeks. Variables include coal and sorbent type, sorbent concentration, baghouse temperature, and Hg and Cl spiking. In the test matrix the coal and baghouse temperature are held constant while the sorbent and elemental Hg and HCl or elemental Cl spikes are presented as variables. For each test EERC will take 4 inlet and 4 outlet Method 29 samples to determine Hg removal. EERC will analyze the H2O2 and KMnO4 solutions separately to provide Hg speciation data. Inlet samples will allow a determination of the amount of Hg collected on the sampling filter. EERC will collect 4 baghouse hopper ash samples for each test and analyze them for Hg and loss on ignition. EERC will obtain a composite coal sample from each run and will do standard major elemental analysis on the ashed coal. EERC will do trace element analysis for Hg on digested coal samples. To establish analytical variability EERC will do 1 coal analysis for every 3 tests. The Cl content of the coal will be determined using ion chromatography. Method 29 will provide inlet and outlet particulate measurements to determine the overall baghouse collection efficiency. Task 7 will generate bench-scale test data with the filter holder/sorbent injection system to support EPRI'S modeling efforts. The exact variables will be based on the most recent results from fixed-bed testing and will be decided upon further discussion between EPRI, DOE, and EERC. Possible variables include sorbent type, injection rate, residence time, filter temperature, and fly ash type. However, once the variables are chosen, either a full or a fractional factorial design will be developed. The test matrix will include replicate runs to establish repeatability. A Semtech online Hg analyzer will measure Hg concentrations at the system inlet and outlet. Where possible, EERC will follow Radian-specified baseline conditions. Task 8 is 3 PTC tests per week for 4 weeks. EERC will base test variables on recent results from bench-scale testing and further discussion among EPRI, DOE, and EERC. Possible variables include sorbent type, concentration, residence time, filter-cleaning

parameters, coal type, and baghouse temperature. Once the variables have been chosen, the test design will be finalized. Another important aspect of the pilot- scale tests is evaluation of the Semtech Hg analyzer to measure Hg concentration in real flue gas. Method 29 samples will be taken at the inlet and outlet of the pulse-jet baghouse, and its ash will be evaluated for Hg. Once the Semtech analyzer's ability has been proven, Method 29 sampling will be reduced.

Formal Evaluation of Flue Gas Chemical Measurement Methods

University of North Dakota Energy and Environmental Research Center

Task 1 is planning and preparation before the first test and project management and reporting. All tests will use existing EERC test facilities (the pilot pc-fired combustor and analytical laboratories with only minor preparation). Additional sampling equipment was bought to maintain up to 48 Method 29 sampling trains. Task 1 is also a formal QA/QC program to provide a well-documented uncertainty analysis. Task 2 is a matrix of 10 pilot-scale tests; for 6 of these sampling will be done at both the inlet and outlet of the fabric filter. Eight will be a full factorial design, with coal type, baseline and spiked flue gas Hg concentrations, and the Method 29 filter temperature tested at 2 levels at the baghouse inlet. Four of them will include a full factorial design with coal type and Hg concentration tested at 2 levels for the baghouse outlet. In addition to the 2 full factorial designs, 1 test for each of the 2 coal types will also be done to compare Method 29 directly to Method 101A (total Hg measurement), as a QC check. For all tests, the pulse-jet baghouse will be operated at an A/C ratio of 4'/min and a filter temperature of 350 oF. Ports can be added to the combustion system to allow sampling procedures like the Bloom Method, to be compared to Method 29. A bituminous and a subbituminous coal were selected for testing because each has been extensively tested at EERC (substantial Hg data are available), and the predominant Hg species generated by each in the flue gas is quite different. Although direct spiking of the impinger solutions and filter is needed to find the analytical uncertainty, that of the entire sampling train must also be found. The Hg concentration will be increased by spiking the system with Hg vapor as close to the sampling nozzles as possible without incomplete mixing of the Hg with the flue gas. Method 29 specifies that the temperature of the filter following the sampling probe be maintained at 250 oF. Task 3 is a series of bench-scale tests that will test other variables, like Hg species (elemental Hg and Hg[II]Cl) and Hg and HCl concentrations in the gas stream. The tests will be a full factorial design with 3 variables tested at 2 levels. Two simultaneous Method 29 samples will be taken during each test; the entire set of 8 tests will be repeated to adequately establish the effect of the variables on Method precision and accuracy. Several test configurations to evaluate alternative Hg-sampling methods will be done in Task 4, including 3 weeks of pilot-scale testing and an additional 2 weeks of shakedown and natural gas tests. These tests will compare Hg speciation using the tris buffer method and the modified Ontario Hydro Method. As many continuous on-line mercury analyzers as possible will be used to measure total and speciated Hg. Task 5 will yield a topical report to present the state of the art of Hg measurement and an evaluation of wet and dry chemistry methods and continuous emission monitors. It will include information and data from all available sources, such as bench-scale and field data and information from vendor research organizations.

Mercury Sorbent Evaluation

University of North Dakota Energy and Environmental Research Center

The primary independent variables of the 1st series of tests will be ESP temperature, sorbent-to-Hg ratio, and fuel type. The primary dependent variables will be Hg removal across the ESP and Hg concentration in the ESP hopper ash. For the sorbent evaluation test, the primary variable will be additive type. The work covers a 2-year period; the 1st and 2nd years' work are designated Task 1 and Task 2, respectively. Tests will be conducted using EERC's pulverized coal fired particulate test combustor (PTC), and either the ESP or pulse-jet baghouse. Hg concentrations will be measured using EPA (Draft) Method 29. The H2O2 and potassium permanganate (KMnO4) solutions will be analyzed separately to provide Hg speciation data. A composite coal sample will be obtained from each run by collecting a small amount of coal from the combustor coal feeder on a regular basis. Standard analyses will include proximate, ultimate, BTU, sieve, and x-ray fluorescence major elemental analysis on the ashed coal. The sorbents will be injected pneumatically as dry powders just upstream of the baghouse, with a TSI dry

powder disperser, providing precise control over the additive feed rate. A total of 12 tests are planned for Task 1. 6 of the tests will be to evaluate the ability of an ESP to collect Hg with the addition of a Hg sorbent. The final 6 tests will be to screen additional sorbents identified by EPRI and DOE. For the ESP tests, the independent variables are coal type, flue gas temperature, and sorbent-to-Hg ratio. 3 tests will be conducted with the 1st coal at 2 different temperatures and 2 different additive ratios. These 3 tests will then be repeated using a 2nd coal, a medium-sulfur coal with approximately equal amounts of oxidized Hg (that captured in the H2O2 solution of EPA (Draft) Method 29) and elemental Hg (that captured in the KMnO4 solution of EPA (Draft) Method 29. EERC will complete 3 tests per week; 2 weeks of ESP testing are planned. The duration of each test will be approximately 24-30 hours on the PTC to allow adequate time for completion of 2 inlet and 4 outlet (Draft) Method 29 samples. Sorbent injection will start approximately 6 hours before the 1st outlet sample is taken to help ensure steady state. Following the ESP tests, up to 6 sorbent screening tests are planned, depending on the number of different sorbents identified and the availability of funds. These tests will be conducted using the pulse-jet baghouse at an air-to-cloth ratio of 4 ft/min. As was the case in the previous 6 tests, the duration of each test will be 24-30 hours, and 2 inlet and 4 outlet EPA (Draft) Method 29 samples will be taken. Task 2 will also consist of a total of 12 tests, each approximately 24 hours in duration and consisting of 2 inlet and 4 outlet (Draft) Method 29 samples. The exact test variables and conditions will be selected based on the results from Task 1 and other EPRI or DOE projects. In Year 2 a bench- scale fixed-bed system will be used to screen Hg sorbents and investigate the effects of process conditions and flue-gas constituents on the effectiveness of the Hg sorbents.

Value-Added Sorbent Development for Mercury Control

University of North Dakota Energy and Environmental Research Center

Numerous carbon sorbents have been tested at EERC and elsewhere under simulated flue gas conditions for the capture of mercury. In general sorbents derived from low-rank colas have shown better sorption properties than those traditionally made from "purer" carbon sources. The objective of this project is to evaluate the influence of inorganic components within the lignite dervied activated carbon and to determine their exact role.

Mercury Speciation Sampling at Great River Energy's Stanton Station and Public Service Company

University of North Dakota Energy and Environmental Research Center

The 1990 Clean Air Act Amendments required the U.S. Environmental Protection Agency (EPA) to determine whether the presence of mercury in the stack emissions from fossil fuel-fired electric utility power plants poses an unacceptable public health risk. EPA's conclusions and recommendations were presented in the Mercury Study Report to Congress and Study of Hazardous Advanced Pollutant emissions from Electric Utility Steam Generating Units. The first report addressed both the human health and environmental effects of anthropogenic mercury emissions, while the second addressed the risk to public health posed by the emission of mercury and other hazardous air pollutants from steam electric generating units. Although these reports did not state that mercury controls on coal-fired electric power stations would be required given the current state of the art, they did indicate that EPA views mercury as a potential threat to human health. Therefore, it was concluded that mercury controls at some point may be necessary. EPA also indicated that additional research/information was necessary before any definitive statement could be made. In an effort to determine the amount and types of mercury being emitted into the atmosphere by coal-fired power plants, EPA in late 1998 issued an information collection request (ICR). This required all coal-fired electric utilities to analyze their coal for mercury and submit the results on a quarterly basis. In addition, about 85 power stations were required to measure the speciated mercury concentration in the flue gas. These plants were selected on the bases of plant configuration and coal type. The Stanton Station located near Stanton, North Dakota, had two units (1 and 10) selected for detailed mercury speciation of the flue gas as part of the ICR process. Great River Energy, through the North Dakota Industrial Commission and EPRI (as part of a tailored collaboration), contracted with the EERC to do a study evaluating the behavior of mercury at the Stanton Station. The activities conducted at the Stanton Station by the EERC not only included the sampling needed to meet

the requirements of the ICR, but also involved a much more extensive mercury research program.

Mercury & Lead Sampling at Minnesota Power, Inc.'s Boswell Energy Center
University of North Dakota Energy and Environmental Research Center
Tests will be conducted at the Minnesota Power Boswell Energy Center in order to do mercury sampling using the Ontario Hydro (OH) mercury speciation method, provide such information for EPA's Information Collection Request, to evaluate the potential of several new speciating mercury continuous emission monitors, and to determine lead emissions at each stack.

Validation of Mercury CEMS When Cofiring Biomass at Madison Electric's Blount Station
University of North Dakota Energy and Environmental Research Center
Tests to be conducted at the Madison Electric Company located near Madison, Wisconsin, will determine the impact of cofiring with paper- and plastic-derived fuel (PDF) on mercury behavior. The tests will be done to evaluate the ability of mercury continuos emission monitors (CEMs) to speciate mercury under a variety of flue gas conditions.

Pilot-Scale Evaluation of the Impact of Selective Catalytic Reduction for NOx on Mercury Speciation
University of North Dakota Energy and Environmental Research Center
NOx reduction strategies include the installation of low-NOx burners, specifically those that employ selective catalytic reduction (SCR). Such devices employ catalysts that may impact gas phase reactions of mercury with other reactants present in those streams. This study will address the question as to what impact SRC technology has on total mercury emissions or on mercury speciation. This study will support DOE's overall effort in understanding and quantifying mercury emissions and mercury speciation as derived from coal-fired power plants and the relative complex interactions between one pollutant reduction technology (e.g., NOx) and how that might influence solutions for the reduction and/or capture of a toxic trace element, namely, mercury.

OHIO

A Study of Dioxin Emissions from Coal-Fired Power Plants
Batelle
The project is structured to collect and subsequently analyze representative solid, liquid, and gas samples of all specified input and output streams for selected toxic substances from coal-fired electric utilities; to determine the removal efficiencies of specified pollution control subsystems (wet FGD). The focus will be on mercury and speciated forms of mercury and on other toxic trace elements associated with the combustion of coal.

Multiple Pollutant Removal Using the Condensing Heat Exchanger
Babcock & Wilcox Co.
A recent innovation to the commercial condensing heat exchanger design, called the Integrated Flue Gas Treatment (IFGT) system, has shown improved pollutant removal capability in addition to recovering waste heat. The IFGT concept has the potential to fill market needs of both the electric utilities and industry. This project will determine IFGT performance in terms of erosion resistance and pollutant removal efficiencies for particle-laden streams produced by coal-fired boilers. Phase I consists of two parallel test campaigns conducted at pilot scale. One campaign will investigate the removal efficiency for a variety of pollutants using up to four different coals; tests will utilize a 0.8 MW unit located at the B&W Alliance Research Center (ARC) to investigate a range of variables broader than would be possible with a full scale unit. A second campaign will be conducted at the EPRI Environmental Control Technology Center (ECTC) where a 0.5 MW condensing heat exchanger will be exposed to coal flyash for a one year period of time to evaluate the erosion resistance of the Teflon covered heat exchanger tubes. These campaigns will

provide the data necessary to confidently design IFGT pollutant removal systems for a variety of coal-fired applications.

Advanced Emissions Control Development

Babcock & Wilcox Co.

B&W (McDermott Technology) is conducting a five-year project aimed at the development of practical, cost-effective strategies for reducing the emissions of hazardous air pollutants (commonly called air toxics) from coal-fired electric utility plants. The objectives of the project are to: (1) measure and understand the production and partitioning of air toxics species for a variety of steam coals; (2) optimize the air toxics removal performance of conventional flue gas cleanup systems (ESPs, baghouses, scrubbers); (3) develop advanced air toxics emissions control strategies; (4) develop and validate air toxics emissions measurement and monitoring techniques; and (5) establish a comprehensive, self-consistent air toxics data library. Development work is currently concentrated on the capture of mercury, fine particulate, and a variety of inorganic species such as the acid gases (hydrogen chloride, hydrogen fluoride, etc.).

Chemistry of Mercury Species and Their Control in Coal Combustion Environments

University of Cincinnati

This project is investigating the chemistry of mercury and species formed during coal combustion. This research includes: (1) controlled studies to examine the fate of mercury in high-temperature oxidizing environments and in the presence of other species such as sulfur and chlorine; (2) in-situ laser-induced fluorescence and elastic light-scattering measurements while combusting coal; and (3) studies of vapor-phase sorbent precursors for reacting and converting the mercury to the particulate phase. Results from this research will provide cost-effective solutions for mercury emission control.

PENNSYLVANIA

Evaluation and Further Development of Various Sampling and Analytical Methods for Determining

Advanced Technology Systems, Inc – Pittsburgh

The project is intended to evaluate and improve sampling and analytical methods used in the Department of Energy's effort to measure air toxic emissions from coal-fired power plants. An evaluation will be made as to the accuracy and reliability of the techniques used in the Department's Phase I assessment of toxic emissions conducted in 1993 at eight coal-fired power plants. The second part of the project will investigate the measures to improve the sampling and subsequent analysis for toxic trace elements while focusing on mercury and its speciated forms.

Removal of Selected Hazardous Air Pollutant Precursors by Dry Magnetic Separation

EXPORTech Company Inc.

EXPORTech’s research effort will demonstrate the dry magnetic separation of Hazardous Air Pollutants (HAPs) precursors, or trace elements, especially mercury, arsenic, and selenium from coal using a laboratory scale magnetic separator.

Correlate Coal/Scrubber Parameters with Hg Removal and Hg Species in Flue Gas

CONSOL Inc.

No description available.

Perform Sampling of Power Plan Emissions for Mercury Acid Gases

CONSOL Inc.

No description available.

Development of Novel Activated Carbon-Based Adsorbents for Control of Mercury Emissions from C

University of Pittsburgh

Activated carbon adsorption is a process that offers great promise for achieving high quality air emissions with respect to mercury and other trace elements that may be present in the flue gas emitted from a coal-fired power plant. This study will evaluate the use of a granular activated carbon (GAC) fixed bed adsorption system for mercury adsorption from flue gas. The impregnated carbon(s) best suited for use in a GAC fixed bed system will be determined. Additionally, the rate of mercury uptake with the most promising impregnated carbon(s) candidates will be determined under process conditions that are representative of coal-fired power plants.

Combined Theoretical and Experimental Investigation of Mechanisms and Kinetics

University of Pittsburgh

The overall goal of this research program is to gain fundamental understanding of the important chemistry and physics involved in mercury adsorption on carbonaceous surfaces. This knowledge will then be used to optimize adsorption processes and operating conditions to maximize the uptake of mercury within the required contact time. An additional long-term benefit of this research is the basic understanding of the Hg adsorption process. This knowledge may facilitate the design of new adsorbents for more efficient and cost-effective removal of Hg from a variety of effluent streams.

VIRGINIA

Precombustion Removal of Hazardous Air Pollutant Precursors

Virginia Polytechnic Institute, Center for Coal and Minerals Processing

This project involves the development of an optimized bench-scale processing circuit capable of efficiently removing trace elements from run-of-mine coals. The optimized circuit will be developed using characterization data obtained from detailed washability studies and release analyses tests conducted with several eastern U.S. coals. The optimized circuit will incorporate a variety of conventional and advanced coal cleaning processes that are believed to be the most cost-effective and commercially viable. The coal products from the optimized circuit will be further treated with complexing agents specifically designed to extract organometallic trace elements that are difficult to remove by physical cleaning operations. Finally, innovative bioremediation schemes will be investigated as a means of controlling the release of trace elements from the process waste streams. Emphasis has been placed on the development of a processing circuit that (i) maximizes the rejection of trace elements, (ii) minimizes the production of coal fines which are costly to process and less marketable, and (iii) minimizes the downstream impacts of the process waste streams on the environment.

WASHINGTON

Frontier Geosciences, Inc.

Frontier Geosciences, Inc.

NETL and Frontier Geosciences Inc are collaborating in the investigation of sampling techniques that measure the fractions of Elemental Hg and Oxidized Hg in coal combustion flue gas. A new, solid sorbent-based gas-sampling technique for mercury speciation (Solid Sorbent Ontario Hydro (SSOH) Method, devised by Frontier Geosciences Inc, will be investigated on a pilot-scale combustion facility where recent air toxics characterization studies have been conducted. For each test run, Duplicate Frontier SSOH traps will be run simultaneously with a single run using the Ontario-Hydro method, a draft ASTM, manual wet sampling technique for mercury speciation. In addition to the duplicate SSOH Mercury Speciation traps, Frontier will also run a single Sorbent Total Mercury (STM) Trap which has shown equivalence to US EPA Method 101A for total Hg in coal combustion flue gas. The results from the two simultaneous sampling methods will be compared. NETL will be operating the Pilot Scale facility and performing the Ontario Hydro Technique. Further the NETL lab will analyze the resulting Ontario Hydro samples. Frontier Geosciences will provide the solid sorbent speciation sample media and specialized sampling equipment for this effort and further, will train NETL personnel on site, to perform the

solid sorbent Hg speciation tests. Frontier will analyze the sorbent speciation samples in addition to measuring a subset of the Coal, Fly Ash and Ontario Hydro impinger solutions using USEPA Method 1631 (CVAFS), the latest fully validated Hg analytical technique which was authored by Frontier. The following will be performed to achieve these goals: 1. Pilot Scale Testing of the Ontario Hydro v.s. Frontier's Sorbent Ontario Hydro Speciation Method will be run simultaneously through a series of tests runs spanning 5 days. These sampling tests will be run at the outlet of a carbon injection and baghouse used as a mercury emission control system. 2. Sample Media from both techniques will be analyzed: NETL will perform analysis of the Ontario Hydro and Frontier will perform analysis for the Sorbent Ontario Hydro Method. 3. Data will be reduced and validated from each respective laboratory. The results will be pooled and a common report will summarize the results. 4. A comparison of results will aid in establishing reliability in the dry sampling technique as a viable way to determine mercury species in flue gas.

Objectives and Conclusions: The Frontier Geosciences Solid Sorbent Ontario Hydro Method has many advantages over the liquid impinger based Ontario Hydro Draft ASTM method for speciating Hg in flue gas. Frontier's solid sorbent technique enables one field person to take simultaneous samples at both the inlet and outlet of emission control equipment. Further, this technique enables the end user to take field duplicate and field triplicate samples and does not utilize any hazardous materials. Most importantly, this solid sorbent system has a 0.5ng Hg/m^3 detection limit which is greatly attributed to the low Hg blank of the solid sorbent trap itself and the analytical method used to analyze the traps (US EPA Method 1631). Overall, this exercise will help to assess if the new solid sorbent based technique can intercompare with the Draft ASTM method, and if so, potentially be used in equivalence. Title III of the Clean Air Act Amendments has called for the control of Hg emissions from combustion sources and therefore, the need for inexpensive, accurate and simple sampling techniques is of great importance in order to support this effort.

Continued Development of the Rotary Combustor for Refiring Pulverized Coal Boilers

Spinheat Limited

CONSOL, Inc.

The Rotary Combustor (RC) is a rotating drum into which are fed crushed coal and limestone; the periphery of the drum is perforated and serves as a distribution plate for the entering combustion air. The particles are suspended as a fluidized bed, giving a greater relative velocity between coal and air than in a PC burner, with greater intensity of combustion. The RC is designed to replace the conventional, pulverized coal burner. Since no pulverizer is needed, the RC may have lower capital cost. It is expected to produce low levels of both sulfur dioxide and NOx.

A prototype RC was built under an SBIR grant and tested on a boiler firing either coal or refuse-derived fuel; however, operations were concluded without fully successful results with coal. This combustor, modified on the basis of data from a half-scale cold-flow model, will be assembled to a test boiler in the R&D facilities of CONSOL, Inc. at Library, PA. After shakedown and parametric tests, a month-long endurance run will be provided to demonstrate reliability to a potential commercial user of the technology.

Reduction of Inherent Mercury Emissions in PC Combustion

University of Washington

Mercury is included in the list of 189 Hazardous Air Pollutants identified in the 1990 CAA. This has heightened interest in the control of Hg now being emitted from coal-fired power plants. This experimental study will provide fundamental information that could allow a cost-effective Hg control strategy to be devised.

The variability in the field data suggests that means exist to reduce inherent mercury emissions if the source of this inherent capture can be identified and controlled. The key mechanisms appear to involve the oxidation of the mercury to Hg ++ , generally producing the more reactive HgCl2 , followed by its capture by certain components of the fly ash or char, in time to be collected by cold-side particulate removal equipment. This research focuses on identifying the rate-limiting steps associated with the oxidation step. Key areas are enhancement of mercury oxidation and

providing a sufficient amount of an appropriate surface (e.g., ash aerosol) under the correct conditions to promote inherent capture.

University of Washington. The reduction of mercury inherent from flue gas is being investigated by examining: (1) the reaction order of Hg with HCl under realistic concentrations; (2) the promotion of the oxidation through free radical enhancement; (3) the role of other species in promoting the oxidation; (4) the role of ash aerosols of varying compositions (generated by artificial char combustion) on the retention of oxidized mercury; and (5) the influence of coal treatment to change aerosol yield on mercury capture.

WEST VIRGINIA

On-Site Support Services for the Morgantown Energy Technology Center (METC) – Radian Task

EG&G Technical Services of West Virginia

In a laboratory setup, determine the effectiveness of two collection techniques (charcoal adsorption and liquid absorption in impinger solutions) for mercury in reduced gas matrix. Selected variables that may influence sample collection efficiency will be characterized. The applicability of EPA Method 29 with some modifications to the speciation of mercury in reduced environment. Field testing will be conducted at a coal gasification facility to verify the applicability of the method(s) defined in the laboratory studies to accurately measure mercury in a reduced gas matrix of an actual gasification system. This field testing is funded separately by EPRI as a co-share.

Interactions Between Trace Metals, Sodium and Sorbents In Combustion

University of Arizona, Chemical Eng.

Exploiting the possible synergistic interactions between alkali and toxic metal processes could lead to the abatement of toxic metal emissions from coal-fired power plants. The project has both a fundamental and practical significance. The research addresses the high temperature chemistry and competitive kinetics of the interaction between volatile metals and a substrate. Investigations will be performed to answer the fundamental questions, such as: 1) Are metal vapor/sorbent reactions enhanced when the particle is fluid, compared to the standard reaction engineering processes involving pore diffusion, reaction and possibly pore plugging? and 2) How can the appropriate behavior be predicted? The practical side has to do with The Clean Air Act Amendments of 1990 which delineates as hazardous 189 elements and compounds, of which 11 are trace metals.

Contacts:

- For further information on the above completed projects, contact NETL Project Manager, Scott A. Renninger.

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