Field Test Program for Long-Term Operation of a COHPAC System for Removing Mercury from Coal-Fired Flue Gas

Quarterly Technical Report
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ABSTRACT

With the Nation's coal-burning utilities facing the possibility of tighter controls on mercury pollutants, the U.S. Department of Energy is funding projects that could offer power plant operators better ways to reduce these emissions at much lower costs. Sorbent injection technology represents one of the simplest and most mature approaches to controlling mercury emissions from coal-fired boilers. It involves injecting a solid material such as powdered activated carbon into the flue gas. The gas phase mercury in the flue gas contacts the sorbent and attaches to its surface. The sorbent with the mercury attached is then collected by the existing particle control device along with the other solid material, primarily fly ash.

During 2001 ADA Environmental Solutions (ADA-ES) conducted a full-scale demonstration of sorbent-based mercury control technology at the Alabama Power E.C. Gaston Station (Wilsonville, AL). This unit burns a low-sulfur bituminous coal and uses a hot-side electrostatic precipitator (ESP) in combination with a COHPAC baghouse to collect fly ash. The majority of the fly ash is collected in the ESP with the residual being collected in the COHPAC baghouse. Activated carbon was injected between the ESP and COHPAC units to collect the mercury.

Short-term mercury removal levels in excess of 90% were achieved using the COHPAC unit. The test also showed that activated carbon was effective on removing both forms of mercury, elemental and oxidized. However, a great deal of additional testing is required to further characterize the capabilities and limitations of this technology relative to use with baghouse systems such as COHPAC. It is important to determine performance over an extended period of time to fully assess all operational parameters.

The project described in this report focuses on fully demonstrating sorbent injection technology at a coal-fired power generating plant that is equipped with a COHPAC system. The overall objective is to evaluate the long term effects of sorbent injection on mercury capture and COHPAC performance. The work is being done on ½ of the gas stream at Alabama Power's Plant Gaston Unit 3 (nominally 135 MW). Data from the testing will be used to determine:

1. Is sorbent injection into a high air-to-cloth ratio baghouse a viable, long term approach for mercury control; and
2. Design criteria and costs for new baghouse/sorbent injection systems that will use a similar, polishing baghouse (TOXECON) approach.

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LIST OF GRAPHICAL MATERIALS

There are no graphical materials included in this report.

EXECUTIVE SUMMARY

ADA-ES began work on a Cooperative Agreement with the Department of Energy in September 2002 to fully evaluate activated carbon injection (ACI) in conjunction with a high-ratio baghouse (COHPAC) for mercury control. The work is being conducted at Alabama Power Company's Plant Gaston. During the two-year project, a powdered activated carbon injection system will be installed and tested at the plant for a continuous 1-year period of time. ADA-ES is responsible for managing the project including engineering, testing, economic analysis, and information transfer functions.

During the second reporting quarter, October through December 2002, progress on the project has been made in the following areas:

- A kickoff meeting was held with host site personnel.
- Information needed, as backup, for permitting requests was prepared.
- A team of individuals with diverse backgrounds from within ADA-ES and EMC Engineering was formed to support mercury measurement activities. The objective of this team is to critically assess analyzer design and performance for the Gaston program. Team meetings began in November. The first tasks were to define the mercury analyzer sampling schedule and analyzer design. An order for the measurement and control portion of the mercury analyzer was placed.
- Site support, facilities and personnel, issues were addressed.

INTRODUCTION

Cooperative Agreement No. DE-FC26-02NT41591 was awarded to ADA-ES to demonstrate Activated Carbon Injection (ACI) technology on a coal-fired boiler equipped with a COHPAC baghouse. Under the contract, ADA-ES is working in partnership with DOE/NETL, Alabama Power and EPRI.

A detailed topical report will be prepared at the end of the 1-year test period. Quarterly reports will be used to provide project overviews and technology transfer information.

Team Members

This program is made possible by significant cost share support from the following companies:

- EPRI
- Southern Company/Alabama Power

- Hamon Research-Cottrell
- Alleghany Power
- Ontario Power Generation
- TVA
- Arch Coal Inc.
- ADA-ES

A group of highly qualified individuals and companies were assembled to implement this program. Project team members include:

- ADA-ES
- EMC Engineering
- Southern Research Institute
- Grubb Filtration Testing Services
- Reaction Engineering International

EXPERIMENTAL

Host-Site Project Kick-Off Meeting

A kickoff meeting was held with Alabama Power Plant Gaston and Southern Company personnel on October 30. The objective of this meeting was for Southern Company and ADA-ES to present the project proposal to plant personnel for approval. This meeting was held without full-team participation so that any conflicts in scope-of-work could be worked out prior to completing the test plan. Topics discussed included:

- Review of project proposal to assure that project objectives and scope-of-work did not interfere with plant operation.
- Discussed risks of this test and how the project team would try to minimize the risks. Primary risk to the plant is the increase in cleaning frequency, to maintain target pressure drop, from the increase in inlet loading from the activated carbon. The most critical consequence would be an inability to operate at desired load and flow because of pressure drop restrictions. If this condition occurs, carbon injection will immediately be stopped until the situation is resolved. The long-term impact of higher cleaning frequency is shorter bag life. Bag life could also be affected by the presence of the activated carbon and possible oxidizing reactions on the surface of the bags. To reduce this risk, a set of replacement bags will be purchased for Unit 3B for the plant to use at their discretion.
- Reviewed drawings and scope-of-work for ACI equipment.
- Walked site to decide on location of equipment.
- Provided estimate of utility requirements, including power, water, and phone lines.
- Major action items from meeting were:
    - Compile leaching test results from short-term test for Southern Company to show to APC Environmental to get approval to dispose of ash/carbon in ash pond.
    - Southern Company to remove a pilot plant that is sitting in the space where the ACI system needs to be installed.
    - Prepare punch lists for mechanical and electrical contractors.
    - Send structural loading requirements to Southern Company to design foundation.

Leaching Test Results

Dr. Connie Senior of Reaction Engineering International (REI) compiled results from leaching tests performed on samples collected during the short-term ACI tests at Gaston. No significant leaching was observed, either from standard tests, like TCLP, or from column leaching test. A copy of a memo titled “Mercury leaching from Gaston long-term ash samples” is included in this report as appendix A.

Mercury Analyzer Procurement and Installation

A team of individuals with diverse backgrounds from within ADA-ES and EMC Engineering was formed to support mercury measurement activities. Mercury measurements are key to the success of this program. As learned from previous tests, once carbon injection begins, analyzer operation and maintenance, and timely data review require the most significant effort from on-site personnel. A team was formed to track time spent on each on the different process component groups of the analyzer (for example, extraction, conversion, transport, measurement, and control component groups), review component performance, and provide recommendations on improvements. The team goal is to reduce O&M requirements of the analyzers while maintaining or improving the quality of data obtained in previous tests.

The first team meeting was held in Denver on November 14. Primary objectives of this meeting were to define measurement schedule and sampling locations and decide what instrument to use.

Because of the success in the NETL multi-site test program with measurements using the Apogee/EPRI designed analyzers and the investment already made in sampling components, gas conditioning components, spare parts and the technical learning curve, it was decided to begin this test using a CVAA, extractive semi-continuous analyzer. As many parts as possible from the multi-site program will be used on the Gaston program. A request to transfer equipment was submitted to NETL.

Bids to supply the analyzer portion of the measurement system were received from Apogee Scientific and EMC Engineering. EMC was chosen to supply one analyzer. Some changes were suggested and integrated into the design of the new analyzer. Fabrication began in December 2003. The analyzer is scheduled to arrive at Gaston in early February. It is expected that at least two weeks of troubleshooting and training will occur before continuous operation begins.

Mercury measurements will be made at the inlet and outlet of the B-side COHPAC baghouse. These are the same locations used during the short-term test. One analyzer will be used to measure both locations. Highest priority is to gather long-term mercury measurements and the outlet. Inlet measurements will be made periodically. ADA-ES has an option to purchase a second analyzer from EMC if performance of the updated analyzer is acceptable and the need is justified.

At the conclusion of short-term tests at PG&E's Salem Harbor Station, DOE equipment and supplies were shipped to Gaston. This equipment arrived December 5.

On-site Support

The scope-of-work at Gaston will require two people on-site. Charles Linsdey will be the on-site project engineer for ADA-ES. Charles' primary residence is in Birmingham and he has worked for ADA-ES for over 5 years. He has extensive experience in sampling, data analysis, and operation of injection equipment. Charles has worked at Gaston on the short-term ACI tests and through several others programs. In December ADA-ES worked with Seatec, a local contract employee firm, to advertise in the area and screen potential applicants. An engineer was hired through Seatec with a start date of January 3, 2003.

An office trailer and shipping container for storage was leased. The trailer was installed and power connected by APC on December 16.

Site Visit by the Under Secretary of the Department of Energy

The Under Secretary of the Department of Energy, Mr. Robert Card, visited the site on December 17. Mr. Card spent about 45 minutes with Larry Monroe, Southern Company, and Jean Bustard, ADA-ES. Prior to the meeting it was requested that there be no press associated with this visit. Although no equipment was on-site, Mr. Card was interested in the scope-of-work and the mercury removal performance levels we were targeting. Southern Company and ADA-ES made a point to recognize all of the cost share participants and emphasize that this program would not be possible without their support. Mr. Card was very complementary of the industry cost share team and thanked the participants. Southern Company had large 5' x 7' sign made acknowledging all of the cost share participants and team members.

RESULTS AND DISCUSSION

None this reporting period.

CONCLUSION

None this reporting period.

REFERENCES

None this reporting period.

LIST OF ACRONYMS AND ABBREVIATIONS

ACI	Activated Carbon Injection
APC	Alabama Power Company
COHPAC	Compact Hybrid Particulate Collector
DOE	Department of Energy
ESP	Electrostatic Precipitator
kW	Kilo Watts
MW	Mega Watts
NETL	National Energy Technology Laboratory
O&M	Operating and Maintenance
S-CEM	Semi-Continuous Emission Monitor
TCLP	Toxicity Characteristic Leaching Procedure

APPENDIX A

Memo: Mercury leaching from Gaston long-term ash samples

REACTION
ENGINEERING
INTERNATIONAL

Date: November 6, 2002

From: Connie Senior, Reaction Engineering International

To: Jean Bustard, ADA-ES

Re: Mercury leaching from Gaston long-term ash samples

Leaching Protocol (EERC)

Many standard leaching procedures exist. The procedure used most often is the toxicity characteristic leaching procedure (TCLP). The method was designed to simulate leaching in an unlined, sanitary landfill, based on a co-disposal scenario of 95% municipal waste and 5% industrial waste. The method is an agitated extraction test using leaching fluid that is a function of the alkalinity of the phase of the waste. Typically an acetic acid solution having a pH of 2.88 is used.

The synthetic ground water leaching procedure (SGLP) was developed at the University of North Dakota Energy and Environmental Research Center (EERC) and was designed to simulate the leaching of CUBs under important environmental conditions. It was initially used to characterize highly alkaline CUBs, primarily fly ash produced from the combustion of low rank coals. The procedure was modeled after the TCLP, but allowing for disposal conditions other than those of a sanitary landfill. Deionized water is used as the leaching solution instead of the acidic solutions used in the TCLP. The SGLP was designed primarily for use with materials such as low-rank coal ash that undergo hydration reactions upon contact with water. Test conditions are end-over-end agitation, a 20:1 liquid to solid ratio and a thirteen-hour equilibration time.

Samples from Gaston were leached at EERC using the standard TCLP procedure and also the synthetic groundwater leaching procedure (SGLP). The Gaston samples were also subjected to sulfuric acid leaching (SAL) at a pH of 2, following procedures similar to TCLP and SGLP. This is an extreme condition that might simulate acid mine drainage. Table 1 gives the leaching results from EERC. With one exception, all of the results (in terms of Hg in leachate) were below the detection limit of 0.01 mg/L.

Table 1. Leaching results (EERC)

Sample ID	Sample Type	Location	*LOI* *wt%*	*Hg* *µg/g*	*Hg in* TCLP	Leachate SGLP	*(mg/L)* SAL
GAS00148	COHPAC Ash	B-Side	28.2%	30.6	0.01	<0.01	<0.01
GAS00148	COHPAC Ash	B-Side	28.2%	30.6		<0.01	
GAS00154	COHPAC Ash	B-Side	20.7%	21.7	<0.01	<0.01	<0.01

Column Leaching (NETL)

In addition to the standard leaching procedures carried out at EERC, column leaching experiments were performed by NETL's in-house research group (Ann Kim and George Kazonich). For this test, sample GAS00131 (long-term tests, B-side ash) was leached in different solutions: water, acetic acid, sodium carbonate, "acid rain" stimulant, and sulfuric acid. Leaching was carried out for 120-140 days. These results should be considered preliminary; analysis of a duplicate Gaston sample is currently in progress.

As the following graphs illustrate, very little mercury was leached from the Gaston sample. With the exception of the "acid rain" leachate (pH ~ 8), the mercury in the leachate was below 60 ng/L (or 6×10^{-5} mg/L). The "acid rain" leachate had a maximum mercury concentration of 0.02 mg/L, which is comparable to the TCLP and SGLP results from EERC.

In summary, mercury leaching from the Gaston long-term ash samples collected from the B-side of the COHPAC was measured in solutions ranging from pH 2 to pH 11 for periods of up to 140 days. No significant leaching was observed, either from standard tests, like TCLP, or from column leaching.

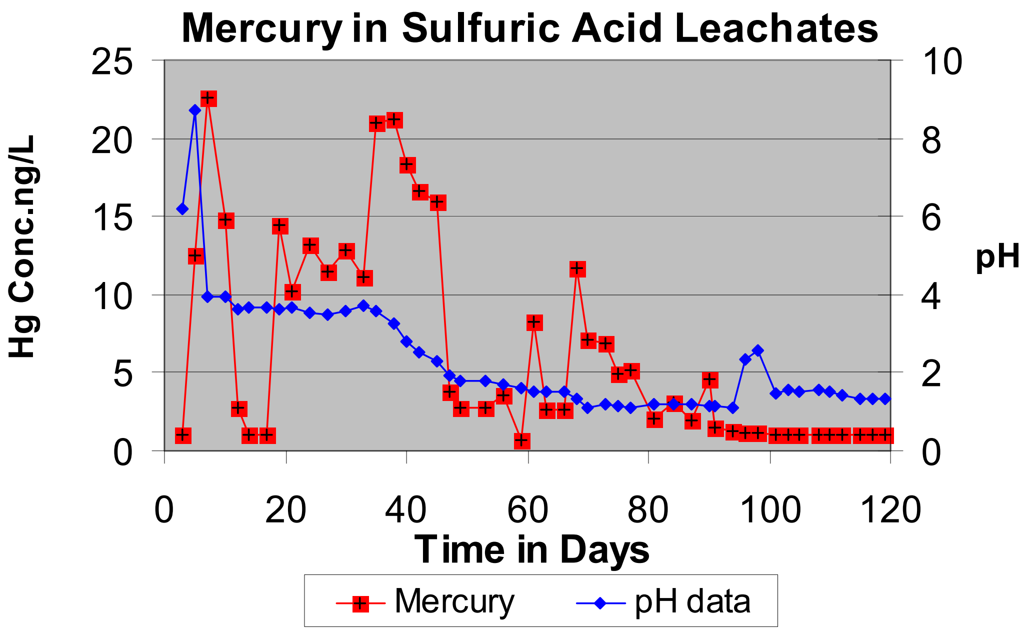
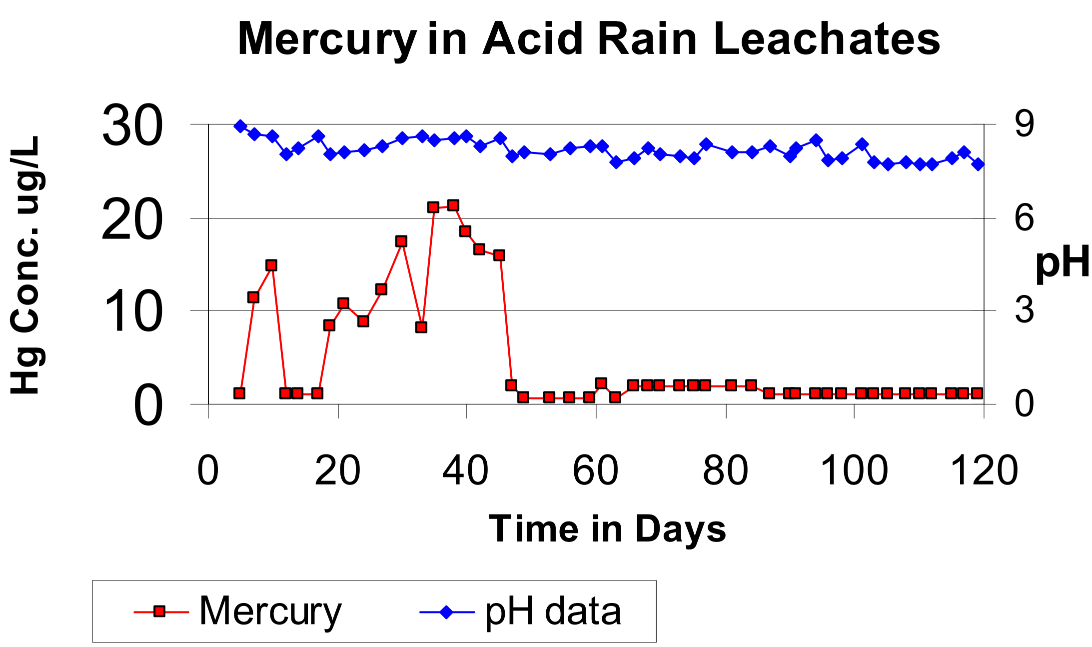


Figure 1. Concentration of mercury in leachate from column leaching procedure in sulfuric acid solution (Source: NETL).

Figure 2. Concentration of mercury in leachate from column leaching procedure in acid rain solution (Source: NETL).



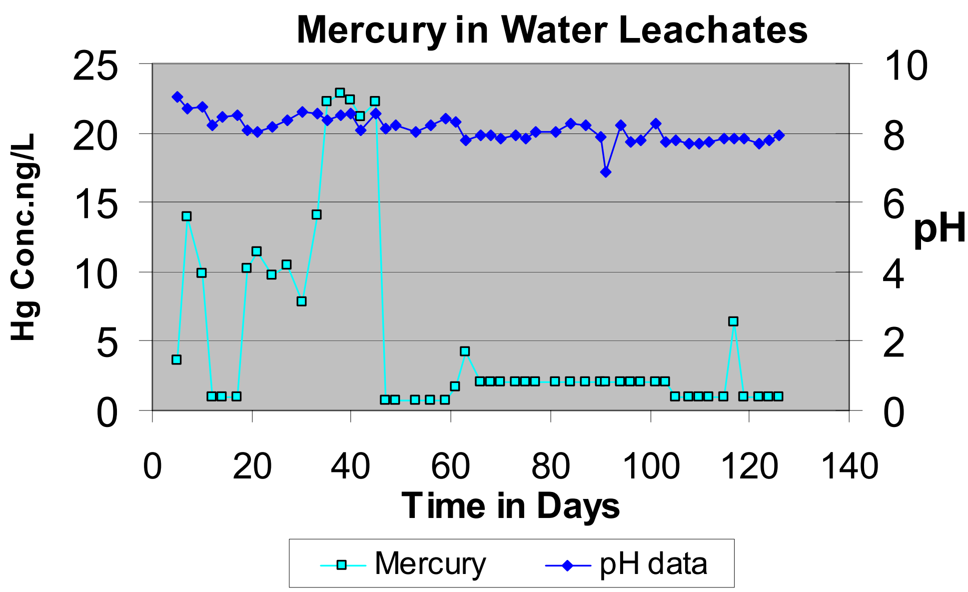


Figure 3. Concentration of mercury in leachate from column leaching procedure in water solution (Source: NETL).

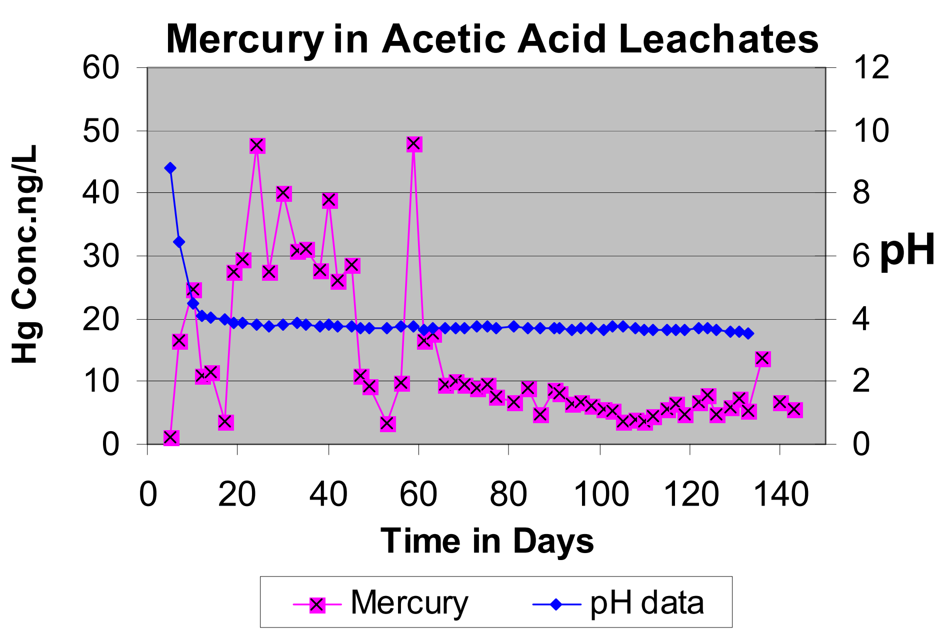


Figure 4. Concentration of mercury in leachate from column leaching procedure in acetic acid solution (Source: NETL).

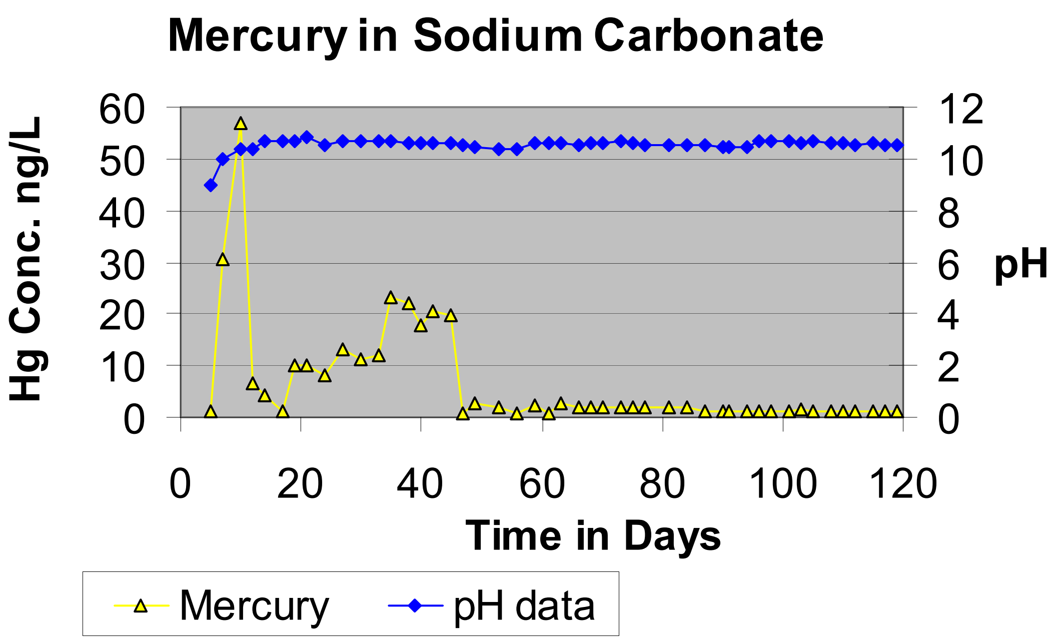


Figure 5. Concentration of mercury in leachate from column leaching procedure sodium carbonate solution (Source: NETL).