**Characterization of Coal Combustion By-Products for
the Re-Evolution of Mercury into Ecosystems**

**Quarterly Technical Progress Report
April 1, 2002 through June 30, 2002**

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ABSTRACT

The U.S. Environmental Protection Agency (EPA) and state environmental agencies are suggesting that mercury (Hg) in coal combustion by-products is re-emitted into local ecosystems by additional processing to final products (i.e., wallboard, etc.), by dissolution into groundwater, or by reactions with anaerobic bacteria. This perception may limit the opportunities to use coal combustion by-products in recycle/reuse applications. In this program, CONSOL Energy Inc., Research & Development (CONSOL) is conducting a comprehensive sampling and analytical program to address this concern. If the results of this work demonstrate that re-emissions of Hg from waste disposal and by-product utilization are over-stated, additional regulations regarding coal combustion, waste disposal, and waste material utilization will not be required. This will result in continued low energy cost that is beneficial to the national economy and stability of local economies that are dependent on coal.

The main activities for this quarter were: fly ash and FGD slurry samples from four coal-fired utilities were leached and the analysis was completed; the re-volatilization study has begun; the literature review was completed.

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INTRODUCTION

This is the Technical Progress Report for the seventh quarter of activities under DOE Cooperative Agreement No. DE-FC26-00NT40906. It covers the period April 1, 2002 through June 30, 2002. Specific research objectives are to:

- Determine the Hg concentration in coal combustion waste streams
- Estimate the percentage of Hg collected in the combustion waste streams
- Determine if the Hg in these samples is leachable or volatile
- Evaluate the fate of Hg in coal fly ash during the manufacture of Portland cement
- Evaluate the fate of Hg in FGD gypsum during the manufacture of wallboard
- Evaluate the fate of Hg in coal ash material used to make manufactured aggregate
- Compile a literature review of the Hg chemistry and transformations in ecosystems
- Evaluate the extent that Hg is leached and converted to methylmercury in sulfite sludge FGD landfill
- Evaluate the extent that Hg is leached and converted to methylmercury in fly ash slurry impoundments
- Objectively report findings to the scientific community and regulatory agencies

EXECUTIVE SUMMARY

In a number of policy papers, EPA and state environmental agencies suggest that mercury (Hg) in coal combustion by-products may be re-emitted into the ecosystem by processing into products (i.e., wallboard), by dissolution into groundwater, or by reactions with anaerobic bacteria. This perception may limit the opportunities to use coal combustion by-products in recycle/reuse applications.

CONSOL Energy Inc., Research & Development (CONSOL) recently conducted a study, co-funded by DOE and the Ohio Coal Development Office (OCDO), which showed that the mercury disposed with fixated FGD solids was stable. The solids passed the standard TCLP toxicity test procedures, and no re-emissions occurred when the FGD solids were exposed to an elevated temperature for three months. While these results are encouraging because they do not show any adverse environmental impacts, they represent only two data points. In this program, CONSOL will expand this data-set by conducting a comprehensive sampling and analytical program to include ash, FGD products, and coal combustion by-products representative of the entire coal-fired industry. This work is necessary to help identify potential problems and solutions important to energy production from fossil fuels. If the results of this work prove that re-emissions of Hg from waste disposal and by-product utilization are over-stated, additional regulations regarding coal combustion, waste disposal, and waste material utilization will not be required. This will result in continued low energy cost that is beneficial to the national economy and stability of local economies that are dependent on coal.

EXPERIMENTAL

The Cooperative Agreement is divided into six tasks: 1) Program Development; 2) Literature Review of the Chemistry in Both Natural and Industrial Environments Specific to Factors that Enhance or Inhibit Mercury Methylation; 3) Sampling and Characterization of Coal Combustion Samples and By-Products; 4) Characterization of Ground Water Around an Active FGD Disposal Site to Determine the Potential for Hg Release into the Local Ecosystem; 5) Characterization of Ground and Surface Water from Active Fly Ash Slurry Surface Impoundments to Determine the Potential for Hg Release into the Local Ecosystem; 6) Data Reduction and Reporting; 7) Technology Transfer; and 8) Final Report. Agreement activities for this quarter are listed below.

- Task 2 (Literature Review of the Chemistry in Both Natural and Industrial Environments Specific to Factors that Enhance or Inhibit Mercury Methylation). The literature review was updated with current literature and will be documented in the third quarter 2002.
- Task 3 (Sampling and Characterization of Coal Combustion Samples and By-Products) sample collection and laboratory work continued.
- Task 4 (Characterization of Ground Water Around an Active FGD Disposal Site to Determine the Potential for Hg Release into the Local Ecosystem) arrangements are being made with the host site.

RESULTS AND DISCUSSION

TASK 1 – PROGRAM DEVELOPMENT This Task was completed in November 2000.

TASK 2 - LITERATURE REVIEW OF THE CHEMISTRY IN BOTH NATURAL AND INDUSTRIAL ENVIRONMENTS SPECIFIC TO FACTORS THAT ENHANCE OR INHIBIT MERCURY METHYLATION The objective of Task 2 is to conduct a comprehensive literature review that includes data from recent studies (i.e., within the last two years) conducted as a result of a variety of clean water initiatives. Work conducted on Task 2 for this reporting period includes updating the review, written last quarter, by collecting papers published within the last three months. CONSOL plans to issue the comprehensive review in the third quarter 2002.

TASK 3 - SAMPLING AND CHARACTERIZATION OF COAL COMBUSTION SAMPLES AND BY-PRODUCTS The objective of Task 3 is to obtain coal ash, FGD sludge, by-product feedstock, and by-product samples, and determine their Hg content and potential for ground water contamination. The potential for Hg re-emission during the manufacturing of Portland cement, wallboard, and manufactured aggregate also will be determined. Work performed on Task 3 for this reporting period includes completing the leaching of the remaining four plant samples that have been collected; mercury analyses have been completed on these samples. The remaining seven samples will be collected and leached in the next quarter.

By agreement with the Contracting Officer, the plants are identified by code number. The following table shows the progress of sample collection and analysis:

Table 1. Progress of Sample Collection and Analysis

Plant Code	Coal Source	Particulate Control	FGD Type	Sampling Completed	Leaching Completed	Analyses Completed
1	Pittsburgh Seam	ESP	Mg/Lime			
2	Pittsburgh Seam	ESP	Forced Oxidation			
3	Ohio 5, 6, or 11	ESP	Mg/Lime	X	X	X
4	Illinois 6	ESP	Natural Oxidation	X	X	X
5	Eastern Low Sulfur Bit.	Baghouse	Lime Spray Dryer			
6	Illinois/W KY Blend	ESP		X	X	X
7	Powder River Basin	Baghouse				
8	Powder River Basin	Baghouse				
9	Powder River Basin	ESP	COHPAC	X	X	X
9a	Powder River Basin	ESP	COHPAC w/ carbon injection	X	X	X
10	Waste Bituminous coal	Baghouse	CFB Boiler			
11	Southern Appalachian Bituminous	Baghouse	Circulating Fluidized Bed	X	X	X
12	Manufactured aggregate			X	X	X
13	Pittsburgh Seam	ESP	Mg/Lime			
14	Eastern Low Sulfur Bit.	Baghouse	Lime Spray Dryer	X	X	X
15	Pittsburgh Seam	ESP	Inhibited Oxidation	X	X	X

Eight TCLP filtrate samples were sent to Frontier Geosciences for additional mercury analysis. Frontier labs used Cold Vapor - Atomic Fluorescence Spectroscopy (CV-AFS) to analyze a suite of eight samples. The amount of mercury found in the leachates ranged from 7.5 ppt to 83.7 ppt. The results of Frontier's analyses supported CONSOL's findings, to date. The following table shows the results from the analyses:

Table 2. Results of CV-AFS Analysis

Plant Code	Sample Type	Scrubber Type	Coal Source	Frontier		CONSOL
				Total Hg	Ext. Fluid	Total Hg
				ppt*	pH	ppb
9	ESP Ash	ESP	Powder River Basin	10.5	4.98	<1.0
9	ESP Ash	ESP	Powder River Basin	38.0	2.90	<1.0
9	ESP Ash	ESP	Powder River Basin	7.5	DI	<1.0
4	Flyash	ESP	Illinois 6	38.0	4.98	<1.0
4	Flyash	ESP	Illinois 6	50.4	2.90	<1.0
4	Flyash	ESP	Illinois 6	83.7	DI	<1.0

* Blank and dilution corrected

TASK 4. CHARACTERIZATION OF GROUND WATER AROUND AN ACTIVE FGD DISPOSAL SITE TO DETERMINE THE POTENTIAL FOR Hg RELEASE INTO THE LOCAL ECOSYSTEM

The objective of Task 4 is to obtain ground water samples in and around the boundary area of an active FGD disposal site. The samples will be collected quarterly, at up-gradient and down-gradient site-monitoring wells and at site run-off and under-drains. The water samples' temperature and pH will be monitored in the field then they will be sent to the laboratory to be analyzed for alkalinity, acidity, major and trace metals, major anions, and sulfide. Work conducted in Task 4 for this reporting period includes making arrangements with the host site to begin obtaining ground water samples.

CONCLUSION

The major conclusions this quarter are summarized below:

1. Task 2, the literature review, was completed.
2. Fly ash and FGD slurry samples from nine coal-fired utilities have been collected and leached in Task 3.
3. Samples from four plants were leached in Task 3.
4. Re-volatilization testing on nine coal-fired utilities has begun.

REFERENCES

(None)