Novel Process for Removal and Recovery of Vapor-Phase Mercury

Technical Progress Report
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The purpose of this project is to investigate the application of a sorbent-based process for removing and recovering mercury in the flue gas of coal-fired power plants. The process is based on the sorption of mercury by noble metals and the regeneration of the sorbent by thermal means, recovering the desorbed mercury for recycling. ADA Technologies holds a patent on this process (US 5,409,522) and has tested it under conditions typical of municipal waste incinerators. In this process, the noble metal sorbent is regenerated thermally, and the mercury is recovered for commercial recycle. Consequently, ADA has adopted the name "Mercu-RE" to describe its process.

ADA has been testing its process under conditions typical of coal-fired power plants where the mercury concentration is low (below $10 \mu\text{g}/\text{m}^3$) and little pressure drop can be tolerated. Methods of accommodating the Mercu-RE process to the circumstances and conditions of coal-fired power plants comprise the core of the program.

Overview of Progress

Phase I tasks 1 through 5 were completed as of October 1997. No additional activities have occurred under those tasks. Current period activities are summarized by task:

II-6 Modify 20-acfm Skid

During 3rd Quarter FY98, ADA completed the modifications to the 20-cfm test skid. We installed the redesigned sorbent vessels, coated the active sorbent onto the new support materials, and loaded the vessels. The new vessels are 8" diameter by 18" tall - significantly more compact than the prior 18"-diameter units. Vessel R-101 was loaded with a sorbent-coated monolith and vessel R-102 contains a loose packing of sorbent-coated 1/4" Raschig rings. The two support materials will be compared during the testing at the pilot coal-combustor. A high-temperature blower was acquired and integrated into the skid. This blower will recirculate the hot air used to heat the sorbent during regeneration. Changes were made to the gas flow paths and control valves to incorporate the direct-contact heating of the sorbent.

Testing began on the scrubber to capture mercury vapor from the regeneration gas. ADA fabricated a small scrubber vessel to be used during laboratory testing of the scrubbing conditions. Engineers began testing various scrubber conditions to determine the optimum conditions for mercury capture and operating simplicity. Early results indicate that operating conditions must be chosen carefully to avoid sludge accumulation in the scrubber. ADA also used the scrubber tests to verify operation of the mercury analyzer that will accompany the skid during the field tests.

In addition to the physical changes on the skid, ADA updated the control logic of the unit's onboard programmable logic controller (PLC). The PLC controls operation of the skid including safety shutdowns, flow and temperature control, and data logging. Toward the end of June, ADA began checking and debugging the operation of the redesigned skid in preparation for its shipment to CONSOL for Task II-7.

ADA completed subcontract agreements with two of our Phase II industrial partners: CONSOL Inc. and Burns & McDonnell.

II-7 Establish Routine Operation at Pilot Combustor – No work on this task.

II-8 Install and Shakedown Pilot System at Utility Site – No work on this task.

II-9 Test Long-Term Performance at Utility Site – No work on this task.

II-10 Prepare Economic Assessment for Full-Scale System – No work on this task.

II-11 Prepare Documents

Monthly reports for March, April, and May (status, summary, cost management, milestone schedule) were submitted during the quarter. Preparations began, including the submission of a paper, for participation at the FETC contractors' meeting to be held in July.

Project Plan for Next Quarter

In July, we will complete the checkouts of the 20-acfm skid and ship the unit back to CONSOL for testing on the pilot coal-combustor. The skid and analyzer will be installed at the coal-combustor. For the first couple weeks, ADA engineers will be onsite for the installation and startup of the unit. After this period, CONSOL staff will supervise the operation of the skid. ADA staff will visit the site as necessary. Throughout the tests at CONSOL we will monitor the operation of the unit remotely from our offices in Colorado.

The testing at CONSOL will begin with verification that all skid systems (electrical, controls, analytical, and process) are functioning. Operators will then run a series of tests to determine the breakthrough time. If the inlet flue gas is found to contain too little mercury to challenge the skid (e.g., less than $2 \mu\text{g}/\text{m}^3$), we will include tests where we spike mercury into the gas stream. Initial values for the regeneration cycle times and temperatures will be fine-tuned to the conditions present at the coal combustor. Finally, the system controls will be set for the optimized values and the unit will be allowed to run continuously.

The unit will be run in a dual-bed mode where one sorbent bed is online while the second bed is being regenerated. Overnight, on weekends, holidays and other periods when the combustor is not operating, the Mercu-RE skid will run in a “hot-standby” mode. In this configuration, ambient air will pass through the online sorbent bed. The system will cycle through its regeneration cycle as if it were online with flue gas. This procedure will facilitate smooth operation of the equipment by avoiding frequent start-up and shut-down procedures. The set up also supplies a greater challenge to the skid by maximizing the unit’s total operating time. At times when the combustor is scheduled to be down for an extended period, ADA and CONSOL will assess whether to shut down the Mercu-RE unit as well. These shutdowns will be evaluated on a case-by-case basis.

A key aspect of the testing is the sampling and analytical protocols. The ADA analyzer is the most versatile tool in that it provides a continuous response to mercury. The analyzer will provide the bulk of the data from the skid tests. As in Phase I, the analyzer will cycle between the inlet and outlet flue gas flows from the sorbent bed. Iodated carbon traps will be used as an occasional check on the mercury analyzer and to screen the gas leaving the mercury-capture device. Data from the incoming flue gas, exiting flue gas, and gas and solids from the mercury-capture device are necessary to close a process mass-balance on mercury. The sampling rate will be high during the initial weeks following the equipment set up at CONSOL. Once the unit’s operation has been established sampling will occur less often.

ADA will participate in the FETC contractors’ meeting at Morgantown on July 21-23.