Novel Process for Removal and Recovery of Vapor-Phase Mercury

Monthly Technical Progress Report
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Table of Contents

Tables

Figures

Novel Process for Removal and Recovery of Vapor-Phase Mercury

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 as liquid, elemental mercury. ADA Technologies holds a patent on this process (US 5,409,522, April 25, 1995) 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.

In the current project, ADA has been testing its process under conditions typical of coal-fired power plants where the mercury concentration is low (below 10 $\mu g/m^3$) 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

In June, we quantified the desorption of Unit 1 using new, heated, electropolished tubing for the regeneration sampling line and found that 5.1 mg of mercury desorbed. This amount of mercury is the expected amount that would be taken up by fully-saturated monoliths.

Task I-1: Screen Sorbent Configurations

There were no activities on this task during May.

Task I-2: Design and Fabricate Bench-Scale Equipment

There were no activities on this task during May.

Task I-3: Test Bench-Scale Equipment on Pilot Combustor

In June, Consol burned a low sulfur Pittsburgh coal for three weeks, and we obtained some quantitative sorption and desorption data. The skid operation record for June is given in Table 1.

Table 1 – Operation of 20 ACFM Skid in June, 1997

	Sorbent Unit Number 1		Sorbent Unit Number 2	
Date	Sorption Time (hours)	Desorption Time (hours)	Sorption Time (hours)	Desorption Time (hours)
June 4			12	
6/5			24	
6/6		8	12	
6/7		17		8
6/8				24
6/10			13	
6/11			24	
6/12	7		11	
6/13	8			8
6/14		8		13
6/15		13		
6/17			7	
6/18	4		18	4
6/19	24			16
6/20	7	11		
Total Hours	**50**	**57**	**121**	**73**

In May we saw substantial mercury in the regeneration line leading to the condenser, and we replaced that line with electropolished stainless steel and heated it. In this way, we were able to sample through this line to the continuous mercury analyzer with no concern that any observed mercury was coming from the sampling line itself.

On 6/6 overnight (into 6/7), we regenerated Unit 1 with the improved regeneration conditions wherein we were 100% sure that the regeneration gas temperature was 700^{o}F. Under these conditions, we were able to quantify the desorbing mercury. We desorbed 5.1 mg of mercury from the bed, almost precisely the capacity of mercury on the monoliths in the laboratory testing (Figure 1).

We were quite gratified to have finally worked through enough issues with the skid to get a good clean, quantifiable desorption and that it agreed with the amount of mercury that would be present on a fully-saturated monolith. Another interesting issue about Figure 1 is that all of the mercury detected was non-elemental.

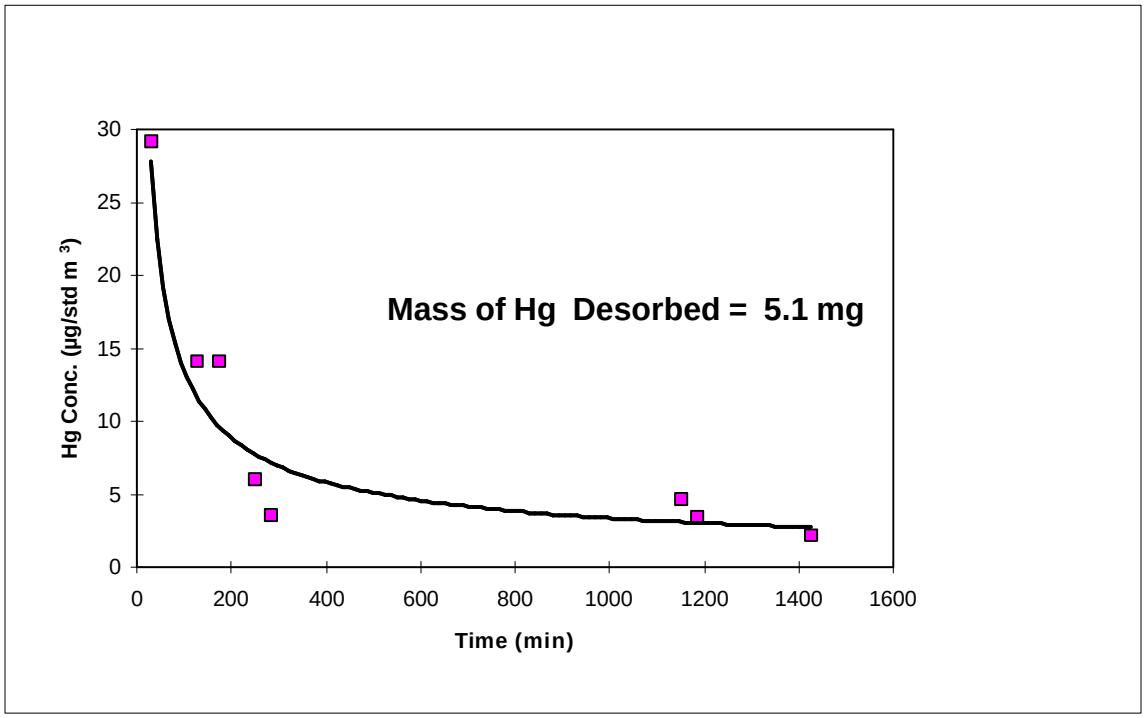

Figure 1 – Quantitative Desorption of Unit 1 with Clean Regeneration Sampling Line (6/6 and 6/7/97)

Our sorption work started in June with spiking elemental mercury into the flue gas just to test the unit performance. As expected, the sorbent unit (number 2) quantitatively removed this mercury from a concentration of about 10 to 30 µg/m^3 at the inlet to the noise level of the instrument at the outlet (less than 1 µg/m^3; Figure 2). The concentration of the inlet mercury dropped with time, but we did not want to spend effort on improving the constancy of the mercury doping system since the goal of the test had been achieved.

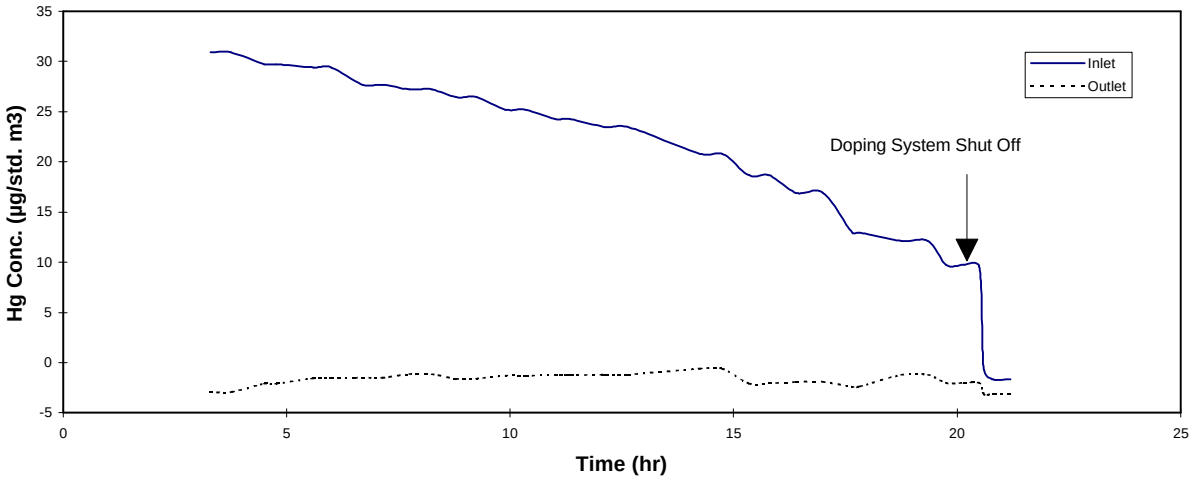

Figure 2 – Quantitative Uptake of Elemental Mercury in Unit 2; 6/5 and 6/6/97

After this test with spiked mercury, we then desorbed the unit for a total of 32 hours starting on 6/7 and ending on 6/8. Then we introduced flue gas again on the morning of 6/10 and sorbed for 48 hours.

Figure 3 shows a zero, span, inlet, and outlet data sequence on the afternoon of 6/10 when we had been sorbing on Unit 2 for about six hours. Adjusting for the zero offset of about two µg/m^3, the total inlet mercury concentration is approximately seven µg/m^3, 50% of which is non-elemental mercury. The total outlet mercury concentration is zero to within plus or minus one µg/m^3. This bed was still sorbing 15 hours later. The inlet concentration was still about seven µg/m^3, about 50% was non-elemental, and the outlet concentration was zero (Figure 4). Both of these figures show the simultaneous removal of essentially 100% of the elemental and non-elemental mercury.

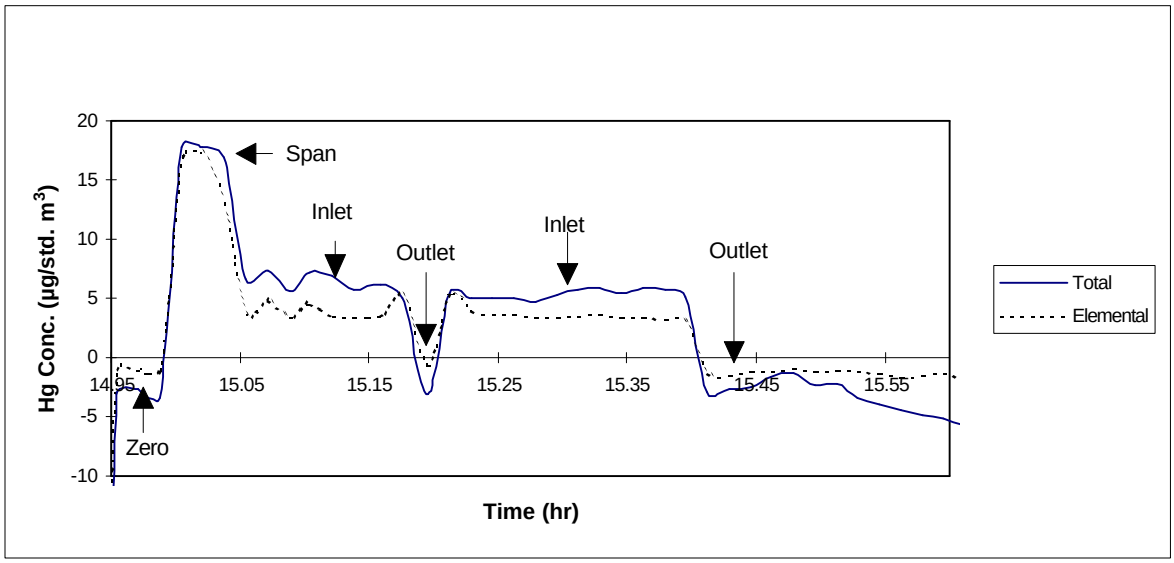

Figure 3 – Performance of Unit 2 with Low Sulfur Pittsburgh Coal; 6/10/97, approximately 3 pm.

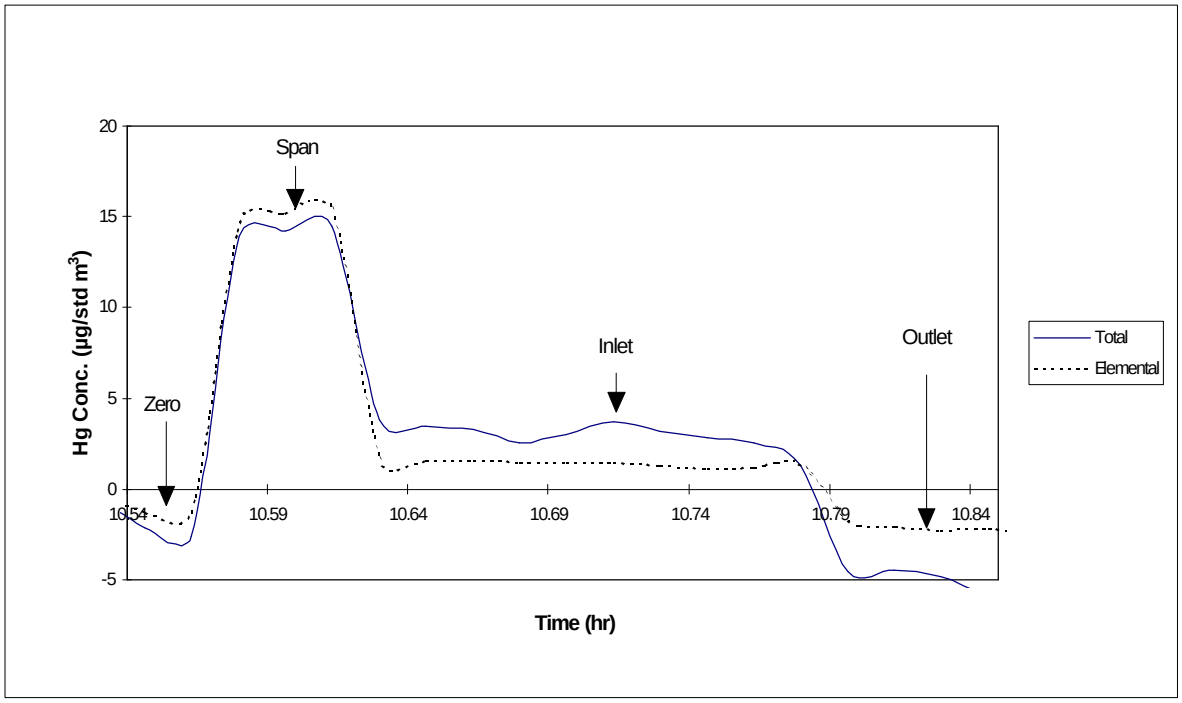

Figure 4 – Performance of Unit 2 with Low Sulfur Pittsburgh Coal; 6/11/97, approximately 10:30 am

The unit continued to sorb mercury through the entire 48 hours of testing. Given the inlet concentration of about seven µg per standard cubic meter and the inlet flow rate of 20 ACFM at 250°F, the total mercury going into the sorbent unit during the 48 hours was 7.9 milligrams. This ratio of this mass of mercury to the mass of active noble metal (51 milligrams of noble metal per sorbent module) is within the range we typically see in the laboratory before breakthrough. This run was the longest sorption period in the field tests.

Task I-4: Evaluate Economics

Work on this task begins in July, 1997.

Task I-5: Reporting

We prepared and submitted the monthly reports covering May, 1997.

Project Plan for Next Month

In July, we will perform the economic assessment of the Mercu-RE process.