Full-Scale Evaluation of Carbon Injection for Mercury Control at a Unit Firing High Sulfur Coal

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This six-site project is part of an overall program funded by the Department of Energy's National Energy Technology Laboratory (NETL) and industry partners to obtain the necessary information to assess the feasibility and costs of controlling mercury from coal-fired utility plants. Host sites included in this program are listed in Table 1 with their associated coal type and air pollution control configuration. These host sites reflect a combination of coals and existing air pollution control configurations representing 78% of existing coal-fired generating plants and, potentially, a significant portion of new plants.

Field testing began in the spring of 2004 and will be completed in early 2007. Testing was completed at AEP's Conesville Station during 2006. Results from Conesville testing will be presented in this NETL Meeting.

Table 1. Host Sites Participating in the Sorbent Injection Demonstration Project.

	Coal/Options	APC	Capacity MW/ Test Portion	Current Hg Removal (%)
Sunflower Electric's **Holcomb Station**	PRB and Blend	SDA – Fabric Filter	360/180 and 360/360	<15
AmerenUE's **Meramec Station**	PRB	ESP	140/70	15–30
American Electric Power's (AEP) **Conesville Station**	Bituminous Blend	ESP + Wet FGD	400/400	~50
Detroit Edison's **Monroe Power Plant**	PRB/Bit Blend	SCR + ESP (SO_3)	785/196	10–30
Missouri Basin Power Project's **Laramie River Station**	PRB	SDA – ESP	550/140	<20
Ameren's Labadie Power Plant	PRB	ESP (SO_3)	630/630	<30

The test program at Conesville was designed to evaluate and demonstrate the effectiveness of sorbents for mercury control in high sulfur flue gas. The 400 MW AEP's Conesville Unit 2 normally fires high sulfur eastern bituminous coal and it is equipped with cold-side ESPs and a wet scrubber. Because of the high sulfur, Conesville represents one of the more difficult applications for mercury control with sorbent injection.

The native mercury capture across the ESP at Conesville was very low, ranging from 0 to 20%. During baseline testing, the ESP inlet mercury concentration ranged from 13 to 33 lb/TBtu. The fraction of oxidized mercury measured upstream of the wet scrubber was limited to 70%. Most of the oxidized mercury was removed in the WFGD, resulting in 50 to 60% overall mercury removal. Most of the mercury at the outlet of the WFGD was in the elemental form.

Sorbents were pre-screened for their mercury removal potential in a fixed-bed apparatus throughout the test period at Conesville. More than fifty (50) sorbents from 15 different suppliers were tested. These included activated carbon, enhanced activated carbon, mineral, and alkaline materials. The benchmark sorbent, DARCO® Hg, demonstrated roughly 10% of the equilibrium adsorption capacity for mercury compared to capacity measured at sites firing Powder River Basin coal. Several sorbents demonstrated better performance than DARCO® Hg, but none showed more than a 40% improvement over DARCO® Hg. The top performers were typically blends of alkali materials, such as trona or lime, and activated carbon.

Five weeks of full-scale parametric testing were conducted at Conesville from March through August 2006: Twenty (20) sorbents from 5 suppliers were selected for full-scale testing. Each sorbent was tested at a single injection concentration for nominally 2 hours to determine whether it demonstrated promise in this difficult environment. NORIT provided several products, including mixes of alkali with coal-based carbon, non-coal-based carbon, and mixes of sorbents and other materials that may protect the sorbents from SO_3. Several of these materials were produced by NORIT at the request of the test team. Calgon, Sorbent Technologies, EERC, and Donau also provided sorbents that they believed were more tolerant to SO_3 in the flue gas. Co-injection of ALSTOM's KNX coal additive with DARCO® Hg was also evaluated. The effectiveness of the sorbents tested was limited to less than 35% mercury removal across the ESP at injection concentrations up to 18 lb/MMacf.

An alternative lance configuration was used to determine if the low mercury removal was a result of poor carbon distribution. No significant difference in performance was noted with the alternative design.

The challenges identified and characterized at Conesville stemming from the high concentration of SO_3 may represent a larger hurdle to mercury control for the industry than from high sulfur units alone. The presence of SO_3 in flue gas appears to decrease mercury capture by activated carbon, sometimes dramatically. SO_3 may be present in sufficiently high concentrations in several common configurations including low sulfur units using SO_3 for flue gas conditioning and units where an SCR converts sufficient SO_2 to SO_3. Although sorbents tested at Conesville did not show significant mercury removal, many performed better than the benchmark sorbents DARCO® Hg and DARCO® Hg-LH, suggesting limited tolerance to SO_3. Some of these materials may be applicable to other configurations with lower flue gas SO_2 or SO_3 concentrations.

The goal of this DOE program is to achieve 50 to 70% mercury capture across the ESP. Because this goal was not reached at Conesville, the test team recommended to DOE that long-term testing be cancelled at Conesville and testing be continued at another site with lower levels of SO_3. DOE has approved testing at Ameren's Labadie Power Plant to determine if some of the sorbents identified at Conesville would be effective at Labadie. Labadie fires PRB coal, is configured with an ESP, and uses SO_3 for flue gas conditioning. A significant negative impact of SO_3 on the mercury removal performance of injected sorbents has been demonstrated during previous testing at Labadie. Testing is scheduled to begin at Labadie in December 2006.