DOE/NETL Mercury Control Technology Conference
Presentation Summary

Presentation Title: Sorbent Injection for Small ESP Mercury Control

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Topic Area: Sorbent Injection

Summary

This presentation summarizes results from Cooperative Agreement DE-FC26-03NT41987 titled "Sorbent Injection for Small ESP Mercury Control in Low Sulfur Eastern Bituminous Coal Flue Gas" being conducted by URS Group, Inc. The project objective is to demonstrate the ability of injected mercury sorbents to remove mercury from bituminous coal-combustion flue gas at plants configured with small electrostatic precipitators (ESPs); e.g., specific collection areas (SCAs) less than 300 ft^2/1000 acfm. This project is primarily funded by DOE/NETL and is co-funded by EPRI, Southern Company, Georgia Power, and Reliant Energy.

Parametric tests were conducted at Southern Company's Georgia Power Plant Yates Units 1 and 2 and at Reliant Energy's Shawville Station Unit 3 to evaluate the impacts of sorbent type and injection rate on performance. The plants fire low and medium sulfur bituminous coal, respectively. A 30-day continuous injection test was conducted at Yates Unit 1 to evaluate process variability and balance-of-plant impacts of the ACI process. Results from the Yates testing have been presented previously. This presentation will provide a brief overview of the Yates results and will then provide an update of recent Shawville test results.

Sorbents were injected upstream of cold-side ESPs on Yates 1 and 2. Flue gas mercury concentrations were monitored with mercury SCEMs at the ESP inlet, ESP outlet, and the Unit 1 scrubber outlet. Baseline measurements showed 4 to 7 $\mu g/Nm^3$ Hg (at 3%O_2) at the ESP inlet, 2 to 3.5 $\mu g/Nm^3$ Hg at the ESP outlet (e.g., 2.2 to 3.0 lb Hg/Tbtu), and 2 to 3 $\mu g/Nm^3$ at the FGD outlet, indicating an average removal of 35% across the ESPs.

Several carbon-based sorbents were evaluated during two rounds of parametric tests conducted in Spring 2004 and January 2005. In the first round, similar performances were observed with RWE Rheinbruan's Super HOK, Ningxia Huahui's iodated activated carbon (NH IAC), and Norit's Darco Hg. The highest mercury removal across the ESP was about 70 to 75% at 10 lb/Macf injection resulting in an overall ESP-FGD removal of about 80%. The ESP outlet mercury emissions were maintained below

2 lb/TBtu at a carbon injection rate of >5 lb/Macf. During the second parametric series, the Darco-Hg sorbent performed similarly to Darco Hg-LH indicating no appreciable improvement due to the bromine pre-treatment of the latter; both sorbents performed better than a coarse (e.g., larger particle size) version of the Super HOK sorbent. An injected mixture of Darco-Hg and fly ash did not appear to improve the mercury removal effectiveness compared to carbon only.

A month-long continuous injection test was conducted on Unit 1 in late 2004 with the Super HOK sorbent. Injection rates ranged between 4 and 10 lb/Macf providing ESP mercury removals of 60 to 90%; results indicated appreciable variability in mercury removal over this time. Increasing the carbon injection rate above 4.5 lb/Macf did not provide significant improvements in ESP mercury removal. Noted balance of plant impacts included carbon breakthrough at the outlet of the ESP as observed flue gas particulate and FGD scrubber samples; FGD byproduct solid inert levels increased from less than 2% at baseline to as high as 18% during the test. Carbon injection caused an increase in the arc rate of the ESP at low load conditions, as compared to baseline arcing.

Sorbent injection tests were conducted in July 2006 at Reliant Energy's Shawville Station Unit 3 which consists of a 175 MW pulverized coal boiler firing Eastern bituminous coal. The unit is equipped with two ESPs in series; the first has an SCA of 83 ft^2/kacfm and the second has an SCA of 229 ft^2/kacfm. The unit employs an SNCR system for NO_x control. Sorbent injection tests evaluated the injection of both activated carbon and a combination of lime and activated carbon upstream of either, or both ESPs. Parametric tests were conducted to compare the removal efficiencies of various sorbents added over a range of injection rates. A 48-hour continuous injection test was performed to evaluate ACI and ESP performance variability during periods of boiler load changes.

Sorbent injection was conducted upstream of first ESP to evaluate the performance of Super HOK, Darco-Hg and Darco Hg-LH, and a 35:65 Darco Hg/hydrated lime mixture. The three former materials were also injected upstream of the second ESP as were a coarse Super HOK material and Darco-Hg-LH. In addition, tests were conducted with Darco-Hg added upstream of the second ESP while a high surface area hydrated lime, provided by Chemical Lime, was injected upstream of ESP 1.

Analysis and interpretation of the Shawville 3 data are ongoing, but a number of preliminary observations and conclusions can be made. Baseline mercury removals varied significantly from day to day and ranged from 5 to 40%. Baseline mercury emissions ranged from 26 to 43 ug/Nm^3 and 80 to 90% mercury oxidation. Baseline SO_3 concentrations were low at approximately 1.7 ppm and were not impacted dramatically by the SNCR system operation.

For the ACI tests on the combined ESP1/ESP2 system, Darco-Hg provided the highest mercury removal (87%) at an injection rate of 11.7 lb/ Mmacf; removal performance appeared to plateau at higher injection rates. By comparison, approximately 56% removal was observed across the ESPs at a similar addition rate of Super HOK. The Darco Hg and Hg-LH materials showed no appreciable difference indicating no impact of

the latter's bromine impregnation. For tests where sorbent was injected upstream of the first ESP, most of the mercury removal was observed across the first precipitator.

Injection of pre-mixed hydrated lime and Darco-Hg upstream of ESP 1 resulted in flue gas SO_3 reductions and improved mercury removal at two tested carbon injection rates. Lime injection upstream of ESP 1 also reduced flue gas SO_3 levels and resulted in improved mercury removal for the Darco Hg carbon injected upstream of ESP 2; a carbon injection rate of 4.8 lb/Mmacf resulted in mercury 63% mercury removal with lime injection and 34% with no lime injection. The lime addition resulted in a reduction of flue gas SO_3 from 1.7 to 0.4 ppm.