

Presentation Summary

Brominated Sorbents for Small Cold-Side ESPs, Hot-Side ESPs, and Fly Ash Use in Concrete

DOE NETL DE-FC2C-05NT42308

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This presentation summarizes the results from DOE/NETL Cooperative Agreement DE-FC2C-05NT42308 titled “Brominated Sorbents for Small Cold-Side ESPs, Hot-Side ESPs, and Fly Ash Use in Concrete” which was conducted by Sorbent Technologies Corporation. Other project participants included host utilities (Progress Energy and Midwest Generation), project contractors (West Kentucky University for mercury CMM and Fuel Tech for CFD modeling), and field test partners (Headwaters Resources and Lafarge for fly ash by-product evaluation, Ohio Lumex for experimental mercury CMM).

Sorbent Technologies’ two novel sorbents (C-PAC™ and H-PAC™) for mercury removal from flue gas together with standard B-PAC™ were tested. The brominated mercury sorbent was tested at Progress Energy’s Lee Station Unit 1 which burns bituminous coal and uses SO₃ flue gas conditioning. The concrete-friendly brominated sorbent was tested at Midwest Generation’s Crawford Station with a very small ESP (SCA 118 ft²/K acfm) and Will County Station with a hot-side ESP. B-PAC™ was the primary sorbent tested at Lee Station Unit 1, C-PAC™ was the primary sorbent tested at Crawford Station with the high temperature version of C-PAC™ was the primary sorbent tested at the Will County Station. The configurations and long-run test results are summarized in the table below.

| Site | Coal | Particulate Control | LT Sorbent | Result |
|--|------------|----------------------------------|--------------------------|---|
| Progress Energy Lee Station | Bituminous | CS-ESP w/SO ₃ FGC | B-PAC™ @ 8 lb/MMacf | 85-88% + good opacity w/o SO ₃ |
| Midwest Generation Crawford Station | PRB | CS-ESP w/SCA=130 & fly ash sales | C-PAC™ @ 4.6 lb/MMacf | 81% + concrete-friendly |
| Midwest Generation Will County Station | PRB | HS-ESP & fly ash sales | H-PAC™ @ 5 lb/MMacf | ~67% on a hot-side ESP |

Progress Energy Lee Station

Progress Energy’s Lee Station Unit 1 boiler was built in 1952 and has a capacity of 79 MW. The boiler is not base loaded but has an operating factor of about 56%. The boiler is tangentially fired and uses low sulfur Eastern bituminous coal. The mercury content of the coal averages between 0.06 and 0.07 ppm mercury. The unit is not

equipped for SO₂ or NO_x control. A cold-side ESP with an SCA of 329 is used for particulate control. The inlet temperature to the ESP is less than 300°F, while the flue gas flow rate is about 300,000 acfm at full load. SO₃ injection is used to condition the fly ash to modify its resistivity and improve ESP performance.

The PS Analytical mercury monitors were used to test both the ESP inlet and outlet mercury content. Additionally, two more measurement methods were used to provide back-up measurements: the Ohio the Lumex Mercury CEM and an Appendix K mercury trap sampler. The baseline tests at Lee 1 demonstrated that the native mercury removal was between 20% and 30%.

Parametric tests indicated B-PAC™ injection can achieve high mercury removal rates when the SO₃ flue gas conditioning was off. The long-term continuous trial further confirmed that B-PAC™ had a significantly positive impact on ESP performance so that the SO₃ conditioning was not required during the long-term test. An average total mercury removal rate of 85% (CMMS) to 88% (Appendix Ks) was achieved over the thirty days with standard B-PAC™ at an injection rate of 8 lb/MMacf.

Midwest Generation Crawford Station

The Midwest Generation Crawford Station Unit 7 comprises two tangentially-fired boilers with a total gross capacity of 234 MW. The tests were conducted on the Reheat side of Crawford 7 with half of this capacity, or 117 MW. The boiler is not base-loaded, with an operating factor of about 50%. The boilers fire PRB coal with as-received moisture, ash, and sulfur contents of about 28%, 5% and 0.3%, respectively. The coal mercury content varies from about 0.05 ppm to 0.10 ppm on a dry basis. Each ESP is small with an SCA of only about 120. The flue gas flow rate to each ESP was approximately 460,000 acfm at full load. The native Hg removal during the baseline period varied between 6% and 22% and averaged less than 15%.

The program comprised of baseline measurements, Phase I parametric injection tests with C-PAC™, a 30-day long-term test, and Phase II parametric tests with non-concrete-friendly sorbents.

During the long-term test, C-PAC™ was injected at an injection rate of 4.6 lb/MMacf, and average total mercury removal of 81% was achieved, while the fly ash sales for concrete could still be retained. During the second parametric tests, the B-PAC™ sorbent had similar mercury performance, achieving about 70%, 80% and 90% mercury removal due to the sorbent at injection rates of 2, 4 and 6 lb/MMacf, respectively.

During the long-term test, foam index values of the fly ash samples containing the C-PAC™ sorbents at 4.6 lb/MMacf indicated that the fly ash could meet its contractual requirement for use in concrete. Concretes made with the fly ash and slightly elevated AEA additions had the same wet and dry air entrainment characteristics, bubble stability, setting characteristics, microstructures, and strengths over time.

As with gas-phase-brominated B-PAC™ at Lee Station Unit 1, a significant ESP opacity-reduction co-benefit was observed with C-PAC™ injection.

Midwest Generation Will County Station

Sorbent Technologies evaluated H-PAC™ sorbent and a high temperature version of C-PAC™ at Midwest Generation's Will County Unit 3 in July and August of 2007. The Will County Unity 3 boilers are tangentially fired with a capacity of 278 MW. The testing was performed on the Superheat boiler with a capacity of 139 MW. The boiler is not base-loaded but has an operating factor of about 50%. The boilers fire PRB coal with a mercury content of 0.10ppm. The boilers are equipped with low NOx burners and hot-side ESPs each with an SCA of 233 ft²/K acfm. The inlet temperature to the ESPs varies between 500°F and 700°F, depending upon load. The flue gas flow rate to each ESP is approximately 500,000 acfm at full load. Both C-PAC™ and H-PAC™ sorbents were used in this test program. The parametric tests and continuous run with C-PAC™ were performed first to avoid any impact on the fly ash properties by non-concrete friendly sorbents. There was a second round of parametric tests after the continuous run in which other H-PAC™ sorbents and Norit Darco® Hg-LH were evaluated.

With injection rate of 5 lb/MMacf, both the gas-phase-brominated H-PAC™ and high-temperature C-PAC™ both achieved about 60-70% mercury removal at Will County, while the salt-phase brominated Norit product only got about 35% mercury removal.