GRE and AEP Demonstrate Sorbent Activation Process for Mercury Control

Great River Energy (GRE) and American Electric Power (AEP) helped to develop and evaluate the first full-scale units of the sorbent activation process (SAP), a technology that uses on-site coal to produce activated carbon for direct injection into the flue gas for mercury control. The demonstrations were conducted at GRE's Coal Creek Station and AEP's Pirkey Power Station, both of which burn lignite coal. Tests to date confirm that the SAP activated carbon produced at both plant sites was capable of reducing the stack mercury emissions below the Mercury and Air Toxics Standards (MATS) limit of 4 lb/TBtu (for lignite plants).

The results from these demonstrations helped to provide a more robust near-commercial SAP design and establish the cost-effectiveness of SAP for controlling power plant mercury emissions.

Sparks fly as the Great River Energy team starts SAP installation at Coal Creek Station.

The AEP/SWEPCO H.W. Pirkey Power Plant SAP system.

"Great River Energy was excited to participate in the next phase of the SAP technology development at Coal Creek Station. While not all project expectations were met, several significant technological advancements were identified and implemented, thanks to the project team's persistence and ingenuity. This project truly represents the collaborative R&D effort at its best."

~ Greg Archer
Environmental Administrator

Need for Cost-Effective Mercury Control

Power plants in the United States face compliance with the stringent mercury regulations promulgated by the U.S. Environmental Protection Agency under MATS, which aims to reduce stack mercury emissions to < 4 lb/TBtu for lignite coals (< 8300 Btu/lb) and < 1.2 lb/TBtu for other coals (> 8300 Btu/lb).

Although injection of activated carbon (AC) is an effective technology for the control of mercury emissions, it represents a costly process. The delivered cost of commercially available AC is estimated to be U.S. $0.75 to $2.00/lb. For a 500-MW baseload plant with a 90% capacity factor, purchased carbon could cost a power plant $0.5 million to $10 million per year. If AC could be produced on site for less than half the cost of purchased carbon, a 500-MW plant could save $0.25 million to $5 million annually. For the power generation industry as a whole, the cost savings could exceed $500 million per year.

Sorbent Activation Process

The SAP concept simplifies complex AC manufacturing into a simple step. SAP involves processing pulverized coal that is on site at a power plant to form AC in an entrained flow reactor. The AC can then be injected directly into the power plant flue gas—either upstream of a particulate control device or between an electrostatic precipitator (ESP) and a downstream fabric filter—to capture flue gas mercury.

The technology for SAP was developed by EPRI, together with the University of Illinois at Urbana-Champaign (UIUC). Previously, SAP has been demonstrated at pilot scale at Ameren's Meredosia Power Plant (Powder River Basin coal, with ESP) and at Gulf Power's Plant Crist (bituminous coal, ESP) and at full scale at Dynergy's Hennepin Plant (Powder River Basin coal, TOXECON unit).

SAP has the potential to significantly reduce the cost of activated carbon injection, one of the most promising current options for control of mercury emissions from coal-fired power plants. The SAP technology also provides a unique advantage for a site to control a compliance feedstock. Rather than rely on commercial carbon vendors, with potential price volatility and shipment risks, an electric utility can produce activated carbon with its own site coal.

Demonstration at Coal Creek Station

GRE's Coal Creek Station, located in Underwood, North Dakota, has two units generating a

total of 1,100 MW. Both units fire North Dakota lignite coal that has been processed with GRE's novel multi-pollutant DryFine™ technology. As the test unit, Unit 1 is equipped with two air heaters, followed by two cold-side ESPs and four wet flue gas desulfurization (FGD) absorbers.

In 2012, a 100 lb/hr full-scale SAP unit was installed in Unit 1 to evaluate various lignite coal feedstocks and to assess longer-term operability. Several SAP refinements were implemented as part of the installation. A flue gas recirculation (FGR) system was designed and installed for better control of particle velocity inside the SAP reaction chamber. A cyclone was installed to separate the AC from the SAP exhaust and allow re-routing of the SAP exhaust back into the boiler. A stream injection system was installed for better temperature control.

SAP commissioning included baseline testing to assess the plant's exhaust gas characteristics prior to operating SAP. Commissioning also included commercial carbon tests as benchmarks for SAP performance. These latter tests included Darco Hg LH, as a brominated activated carbon, and non-brominated Darco Hg with boiler chemical additive (CaBr2).

SAP parametric testing was conducted to identify optimum operating conditions and to assess alternate feedstocks, including different lignite coals, Coal Creek DryFineTM coal, and baghouse fines. Long-term testing was initiated, but the SAP process was unable to run for 30 continuous days due to operational issues with both feedstock handling and reaction chamber operation.

Test results demonstrated that SAP was able to make AC similar to commercially available carbons from various lignite feedstocks. However, the lignite ash content did present operational challenges to SAP by contributing to accumulations within the activation chamber. The lessons learned from these tests were used to implement improved design and operation for the Pirkey SAP project.

Results also showed that SAP technology represents a cost-competitive option for controlling mercury relative to two key benchmark scenarios: AC injection plus bromide added to the boiler, and brominated AC.

Demonstration at Pirkey Power Station

Unit 1 of AEP's H. W. Pirkey Power Station is a 650-MW unit located in Hallsville, Texas. The unit operates with an ESP and FGD treating its flue gas. A new full-scale SAP system installed in the unit was designed to process 3,000 to 4,000 lb/hr of lignite coal and to produce 500 to 800 lb/hr of AC. The AC was injected into the air-heater outlet ductwork upstream of the ESP.

Unique to this installation, the feed coal to the SAP was extracted from one of the plant's pulverizers, and the product gas was separated from the AC by a cyclone before being injected before the ESP.

Startup, shakedown, component evaluation, and testing at Pirkey started in October 2012 and lasted until the end of September 2013. Before SAP testing was initiated, a series of short parametric tests were conducted with commercial AC to establish the baseline removal capability of commercial AC and also provide a benchmark for comparison of SAP AC. Tests were also conducted to identify design and operational issues associated with a first-of-a-kind unit startup and to gather information on suitable SAP operating conditions for producing high-performance AC.

Overall, using lignite as the feedstock, the SAP produced AC that was comparable to commercial brominated AC (BAC) in short-duration tests and was able to operate continuously for two weeks with minimal supervision. Based on project costs, the initial economic analysis shows that SAP AC can provide a significant cost savings over commercial BAC. These results are consistent with short-term tests conducted at other sites with Powder River Basin and bituminous coals.

While all of these tests show the feasibility of the SAP process, long-term continuous operation data is still needed to confirm commercial viability. "AEP/SWEPCO and the H.W. Pirkey Power Plant appreciated being involved in the technical design and construction challenge of implementing the SAP technology. The collaborate team environment of the EPRI Pirkey SAP team was evident in all that was accomplished. Through the life of the project, the EPRI Pirkey SAP team members obtained valuable experience and knowledge," said Arthur Rentzsch, AEP Project Manager.

Related EPRI Work

Sorbet Activation Process: Full-Scale Field Testing at American Electric Power's H.W. Pirkey Plant. EPRI. Palo Alto, CA: November 2014. 3002004294.

Program on Technology Innovation: Sorbent Activation Process (SAP) Development. Prototype and Full-Scale Field Testing. EPRI. Palo Alto, CA: November 2012. 1026725.

Sorbent Activation Process for Mercury Control: Field Testing at the Ameren Meredosia Power Plant. EPRI. Palo Alto, CA: 2009. 1019577.

Program on Technology Innovation: Sorbent Activation Process for Mercury Control. EPRI, Palo Alto, CA: June 2009. 1016797.

For more information, contact the EPRI Customer Assistance Center at 800.313.3774 (askepri@epri.com)

CONTACTS

Cassie Shaban, *Project Manager*
650.855.2345, cshaban@epri.com
Ramsay Chang, *Senior Technical Executive*
650.855.2082, rchang@epri.com

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Electric Power Research Institute
3420 Hillview Avenue, Palo Alto, California 94304-1338 • PO Box 10412, Palo Alto, California 94303-0813 USA
800.313.3774 • 650.855.2121 • askepri@epri.com • www.epri.com