ELECTRIC POWER RESEARCH INSTITUTE

On-Site Sorbent Activation for Mercury Control at Coal-Fired Power Plants

Technology Innovation

Innovative technology simplifies carbon activation process, enabling on-site sorbent production for lower-cost control of mercury and other pollutants.

Anticipated federal and state air quality requirements will require significant reductions in mercury emissions from most coal-fired power plants. For many fuel and boiler configurations, injection of activated carbon as a mercury sorbent just ahead of the particulate collector appears to represent the most viable retrofit control option. EPRI is developing an on-site sorbent activation process (SAP) that could reduce activated carbon mercury control costs at these plants by 50% or more.

Why are lower-cost mercury controls needed?

Conventional rotary kiln facilities for large-scale activated carbon manufacturing may cost several tens of millions of dollars, a capital expenditure that drives up the price of sorbent materials. Factoring in shipping, the delivered cost of activated carbon to the power plant site is estimated at \$0.75 to \$2 per lb. Preliminary analysis suggests that the annual cost of procuring sufficient sorbent to meet anticipated mercury limits could exceed \$1 billion across the U.S. coal generation fleet.

What is the sorbent activation process?

The conventional process for producing activated carbon involves crushing and coarse grinding of raw coal, slow cooking in oxidation and devolatilization kilns, heating in an activation furnace, and final cooling and pulverization stages. This seven-step process requires 3 to 9 hours due to the large size of the coal feed, the slow mass and heat transfer associated with coarse granules, the use of multiple reactors, and the need to prepare and store the final product prior to shipment.

SAP technology developed and patented by EPRI and Illinois State Geological Survey represents a simple and elegant alternative. Activated carbon is produced at power plants in a two-step process that takes maximum advantage of on-site coal supplies, handling facilities, and energy sources. Coal is pulverized and directly injected into a single-stage reactor, in which devolatilization, pyrolysis, and activation occur in just 1 to 3 seconds. The reactor—a long, refractory-lined pipe—is preheated by auxiliary gas firing or waste heat from flue gas, and liberated coal volatiles supply additional energy required to sustain the reaction. The overall process requires just a few minutes, and activated carbon leaving the SAP reactor is ready for direct introduction to the flue gas stream ahead of existing electrostatic precipitator (ESP) or baghouse devices.

Based on results from successful pilot-scale testing, EPRI's sorbent activation process could reduce mercury control costs by up to 50%.

What is EPRI's role?

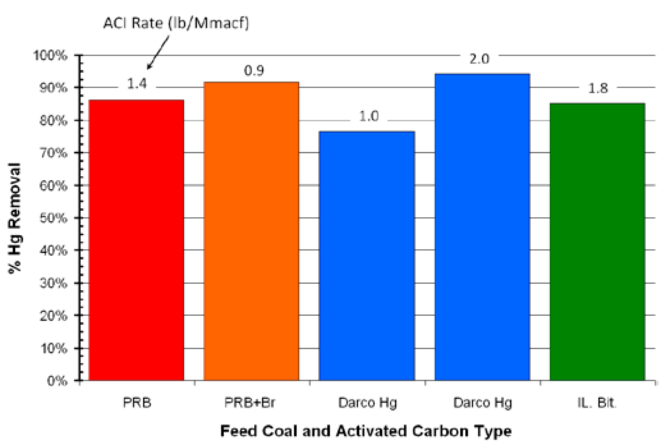
In EPRI's initial assessment of the SAP concept in 2007, a laboratory-scale reactor at the University of Illinois yielded activated carbon samples with high mercury adsorption capacity (EPRI Report1016797). Next, a prototype SAP reactor was evaluated at a 25-MWe unit at Ameren's Meredosia plant and at the 75-MWe Unit 1, fitted with a baghouse, at Dynegy's Hennepin Station. At Meredosia, activated carbon of acceptable reactivity was produced using Powder River Basin (PRB) and bituminous coal. In two weeks of slipstream testing at Hennepin, activated carbon from PRB and bituminous feedstocks achieved mercury removal efficiencies comparable to commercial sorbents, and enhanced control was demonstrated by adding a bromide salt to the SAP reactor.

What are next steps?

At Gulf Power's Mercury Research Center, the prototype reactor is being applied to support both process optimization studies and exploratory research on multipollutant control possibilities. In addition, a full-scale SAP system is being designed and fabricated for an initial 3- to 6-month field-testing campaign at Dynegy's Hennepin Unit 2—a 220 MWe PRB-fired boiler with baghouse following an ESP—scheduled to begin in early 2011. In the third quarter of 2011, the fully automated and instrumented SAP reactor will be moved to at least one other plant for further evaluation using a different fuel type.

Prototype and full-scale SAP reactors will be operated in parallel to examine and model the influence of coal type, particle size, and injection method and of temperature, residence time, airflow, quenching rate, and other reactor parameters on activated carbon characteristics. The effect of sorbent and flue gas characteristics and of bromide salt and other SAP additives on mercury absorption rates will be studied, and plant integration issues—including the turn-down capability and long-term operability of the reactor—will be examined.

Finally, the prototype reactor will be applied to explore the potential for modifying SAP conditions and using chemical additives to produce sorbents capable of capturing sulfur oxides and other trace metals such as selenium and arsenic. This could lead to a multipollutant control technology based on simultaneous introduction of multiple sorbents to the flue gas stream.



Activated carbon produced on site using pulverized coals offers mercury removal efficiencies comparable to those of commercial (Darco) sorbents.

What are anticipated benefits?

By 2013, EPRI expects to transfer SAP technology to a manufacturer for commercialization, to assist the industry in complying with new standards for mercury emissions. Applicable to plants firing bituminous, subbituminous, and lignite coals, the technology is expected to provide power producers with a lower-cost, lower-risk solution for reducing mercury releases by at least 90%.

SAP reactors are anticipated to cost less than $10 million and may be sized to supply activated carbon at a rate consistent with site-specific needs. Preliminary economic analyses suggest that the technology will allow on-site production of activated carbon at less than half the cost of purchasing sorbents manufactured using conventional processes. This could save a 500-MW power plant up to $2.5 million per year in procurement costs alone while avoiding the need for investment in activated carbon handling and storage facilities. If multipollutant control applications prove feasible, economic and environmental benefits could be even more significant.

For more information

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

Contact

Ramsay Chang, rchang@epri.com, 650-855-2535
Cassie Shaban, cshaban@epri.com, 650-855-2345

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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