Enhancing Carbon Reactivity in Mercury Control in Lignite-Fired Systems
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The Energy & Environmental Research Center (EERC) conducted a consortium-based effort to resolve mercury (Hg) control issues facing the lignite industry under the U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL) Phase II Round 1 sponsored program. The EERC team, which included the Electric Power Research Institute; the URS Corporation; the Babcock & Wilcox Company; ADA-ES; Apogee; Basin Electric Power Cooperative; Otter Tail Power Company; Great River Energy; Texas Utilities; Montana–Dakota Utilities Co.; Minnkota Power Cooperative, Inc.; SaskPower; BNI Coal Ltd.; Dakota Westmoreland Corporation; the North American Coal Corporation; and the North Dakota Industrial Commission, demonstrated technology to substantially enhance the capability of carbon sorbents to remove Hg from lignite and subbituminous combustion gases. The four units tested included three lignite-fired units: Leland Olds Station Unit 1 (LOS) and Stanton Station Unit 10 (SS10) near Stanton and Antelope Valley Station Unit 1 (AVS) near Beulah and a subbituminous Powder River Basin (PRB)-fired unit: Stanton Station Unit 1 (SS1).

Carbon injection technologies have been shown to be the most viable commercial options for systems without SO_2 scrubbers, including those emitting primarily elemental mercury (Hg^0). Lignites, because of their low chlorine and high calcium contents, liberate mainly Hg^0 during combustion. Two technologies have been identified that overcome these problems by using additives in combination with sorbents to enhance mercury capture or treated carbons to significantly increase sorbent reactivity and Hg capture. Both technologies have been successfully demonstrated in pilot-scale and short-term field tests and were tested during a monthlong period on units configured with an ESP or SDA–FF combination.

Hg removal goals of monthlong testing varied from site to site. A target Hg removal for monthlong testing was determined by the EERC team for each individual site based on data gathered during parametric testing as well as other available mercury data. The monthlong results show that the actual average monthlong Hg removals for the four sites ranged from 58% to 91%. All four sites were able to meet or exceed their target Hg removals for the monthlong test period. The Hg emissions during the monthlong period were calculated based on the average outlet Hg concentration measured using CMMs. Table ES-1 compares the monthlong test results.

A detailed cost analysis was performed using the data gathered for tests conducted at the four sites. Several Hg removal scenarios were developed for each site, based on results from the program. The most significant operating cost item is sorbent. Therefore, technology that can minimize sorbent use can reduce the cost of control. There is a clear difference in cost for high levels of mercury control between those plants that have a spray dryer followed by a fabric filter (AVS and SS10) and those that have only an ESP for emission controls (LOS and SS1). At AVS and SS10, 80% Hg control can be achieved at a relatively low cost (<1 mill/kW) using enhanced mercury control methods. Based on the results from testing at AVS, it appears that PAC–SEA2 is more cost effective than halogenated carbon such as BPAC or Darco Hg-LH. In all cases, either halogenated carbons or PAC–SEA2 were more cost effective then using standard activated carbon. A cost comparison of control options for the four plants is provided in Table ES-2.

Table ES-1: Comparison of Monthlong Test Results for the Four Sites

	LOS	SS10	AVS	SS1
Technology Selected	Darco Hg & SEA1	Darco Hg-LH	Darco Hg & SEA2	BPAC
PAC Injection Rate, (lb/Macf)	2.7	0.7	0.81	1.6
SEA Addition Rate, (lb/Macf)	2.9	–	0.033	–
Target Hg Removal, %	55	60–75	90	70–80
Coal to Stack Average Total Hg Removal, %	58	63	91	81
Emissions				
lb/Tbtu	1.8	2.74	0.55	0.73
µg/dNm^3	3.2	3.7	0.69	1.03

Table ES-2. Comparison of Mercury Control Costs for Four North Dakota Power Plants

	Total Capital Req., $/kW		Total Annual Cost, $/MWh (mills/kWh)		Mercury Reduction, $/lb Hg removed	
ESP Only	*LOS*	*SS1*	*LOS*	*SS1*	*LOS*	*SS1*
50%/60% PAC Only	4.54	5.71	2.52	2.21	69,254	57,500
60% PAC + SEA1	5.13	–	0.46	–	10,451	–
70% Brominated PAC	–	5.71	–	0.76	–	16,998
70% PAC + SEA2	5.39	7.03	–	0.83	–	18,491
80% PAC + SEA2	5.39	7.03	–	1.23	–	23,939
80% PAC + SEA2 + FGD	5.39	–	–	–	–	–
80% Brominated PAC	–	5.71	–	0.94	–	18,234
90% Brominated PAC	–	5.71	–	1.61	–	27,914
SD/FF Combination	*AVS*	*SS10*	*AVS*	*SS10*	*AVS*	*SS10*
70% PAC Only	2.27	13.71	1.09	1.80	18,032	14,353
80% PAC + SEA2	2.69	7.07	0.36	0.93	5176	6475
80% Brominated PAC	2.27	7.53	0.55	0.99	7396	6897
90% PAC + SEA2	2.69	9.24	0.57	1.21	7307	7527
90% Brominated PAC	2.27	9.57	0.79	1.26	10,173	7789