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COVER MEMORANDUM

EPA's technical basis for the cost-effectiveness and achievability of the proposed MATS RTR relies on the following technical information.

The proposed rule discusses achievability and cost effectiveness of the proposed rule. This section cites to the EPA Memorandum that constitutes the Beyond the Floor Analysis for the 2012 MATS rule docket:

> In the beyond the-floor analysis in the 2012 MATS Final Rule, we noted that the results from various demonstration projects **suggests that greater than 90 percent Hg contro**l can be achieved at lignite-fired units using brominated activated carbon sorbent at an injection rate of 2.0 lb/ MMacf for units with installed FFs for PM control **and at an injection rate of 3.0 lb/MMacf for units with installed ESPs for PM control. As shown in Table 8 above, all units (in 2021) would have needed to control their Hg emissions to less than 92 percent to meet an emission standard of 1.2 lb/TBtu. Based on this, we expect that the units could meet the proposed, more stringent, emission standard of 1.2 lb/TBtu by utilizing brominated activated carbon at the injection rates suggested in the beyond-the-floor analysis.**
>
> Fn 46 See Docket ID No. EPA–HQ–OAR–2009–0234–20130 at regulations.gov.
>
> Fn 47 Ibid.

See 88 Fed. Reg. at 24881.

The Beyond the Floor Analysis bases its conclusions of greater than 90% Hg control on a 2009 Fuel Article (a trade publication, not peer reviewed), this article is attached to this Cover Memo and the Figure referenced in the EPA Beyond the Floor Analysis has been extracted from the article and inserted below for ease of review. This 2009 Fuel Article generalizes DOE Mercury control *pilot* study data, provides no emissions data, no inlet mercury data, and the only lignite unit able to meet a 90% removal has a Fabric Filter (Baghouse). The underlying technical data from the DOE study is not in the record to review and verify. In addition, the lignite dataset does not include lignite units with ESPs. The data set is also not complete because there is only 1 lignite datapoint.

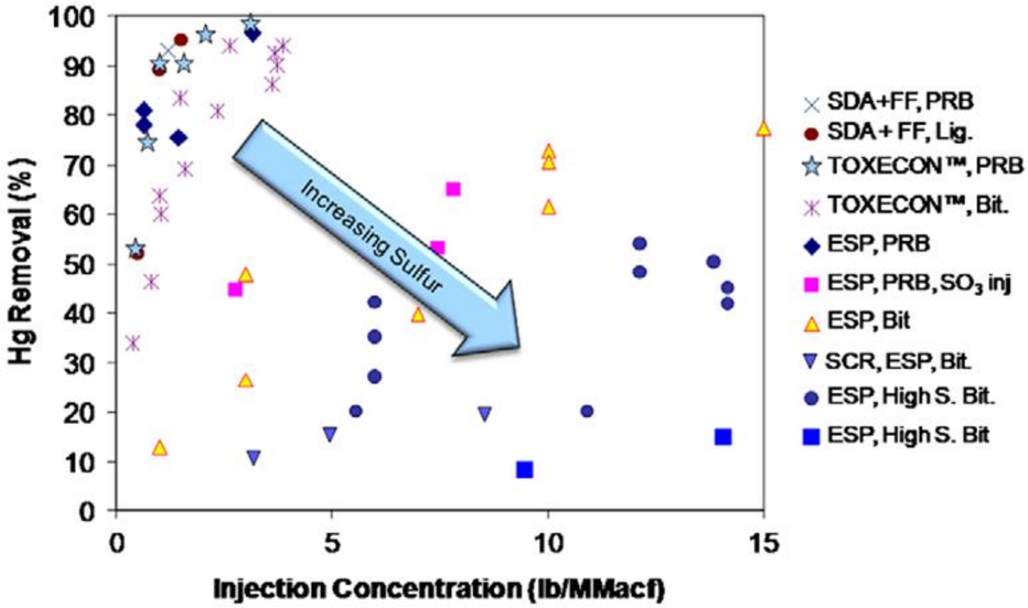

Fig. 1. Compilation of results from DOE mercury control programs.

in 2021, firing significant amounts of subbituminous coal. Firing high levels of non-lignite coal (in some cases greater than 99 percent non-lignite coal), while remaining subject to the less stringent Hg emission standard for the subcategory of lignite-fired EGUs seems to fit the scenario that the EPA expressed concern about in the 2012 MATS Final Rule preamble—that ''sources to potentially meet the definition by combusting very small amounts of low rank virgin coal [lignite].'' See 77 FR 9379.

iv. The Proposed More Stringent Hg Emission Standard Can Be Achieved, Cost-Effectively, Using Available Control Technology

For the 2012 MATS Final Rule, the EPA calculated beyond-the-floor costs for Hg controls by assuming injection of brominated activated carbon at a rate of 3.0 lb/MMacf for units with ESPs and injection rates of 2.0 lb/MMacf for units with baghouses (also known as FF). Yet, in responses to the CAA section 114 information survey, only one facility (Oak Grove) explicitly indicated use of brominated activated carbon. Oak Grove units #1 and #2 (both using FF for PM control) reported use of brominated activated carbon at an average injection rate of less than 0.5 lb/MMacf for operation at capacity factor greater than 70 percent. The Oak Grove units fired, in 2021, using mostly refined coal.[45] That injection rate is considerably less than the 2.0 lb/MMacf assumed.

From the CAA 114 information survey, the average injection rate reported for non-halogenated sorbents was 2.5 lb/MMacf. The average sorbent injection rate ranged from 10–65 percent of the maximum design sorbent injection rate (the average was 36 percent of the maximum design rate). As mentioned earlier, most sources utilized a control strategy of sorbent injection coupled with chemical (usually halogenated) additives. In the beyond-the-floor analysis in the 2012 MATS Final Rule, we noted that the results from various demonstration projects suggests that greater than 90 percent Hg control can be achieved at lignite-fired units using brominated activated carbon sorbent at an injection rate of 2.0 lb/MMacf for units with installed FFs for PM control and at an injection rate of 3.0 lb/MMacf for units with installed ESPs for PM control. As shown in Table 8 above, all units (in 2021) would have needed to control their Hg emissions to less than 92 percent to meet an emission standard of 1.2 lb/TBtu. Based on this, we expect that the units could meet the proposed, more stringent, emission standard of 1.2 lb/TBtu by utilizing brominated activated carbon at the injection rates suggested in the beyond-the-floor memo[46] from the 2012 MATS Final Rule.

To determine the cost-effectiveness of that strategy, we calculated the incremental cost-effectiveness (cost per lb of Hg controlled) for a model 800 MW lignite-fired EGU. We calculated the incremental cost of injecting non-brominated activated carbon sorbent at a sufficiently large injection rate of 5.0 lb/MMacf to achieve an emission rate of 1.2 lb/TBtu versus the cost to meet an emission rate of 4.0 lb/TBtu using non-brominated activated carbon sorbent at an emission rate of 2.5 lb/MMacf. For an 800 MW lignite-fired EGU, the incremental cost effectiveness was $8,703 per incremental lb of Hg removed. The actual cost-effectiveness is likely lower than this value as it is unlikely that sources will need to inject brominated activated carbon sorbent at rates as high as 5.0 lb/MMacf (the Oak Grove units were injecting less than 0.5 lb/MMacf) and is well below the cost that the EPA has found to be acceptable in previous rulemakings (*e.g.*, $27,500/lb Hg was proposed to be cost-effective for the Primary Copper RTR (87 FR 1616); approximately $27,000/lb Hg was found to be cost-effective in the beyond-the-floor analysis supporting the 2012 MATS Final Rule[47]).

In summary, the EPA is proposing to revise the Hg emission standard for lignite-fired EGUs from 4.0E–06 lb/MMBtu to 1.2E–06 lb/MMBtu, which is the same Hg emission limit that non-lignite-fired EGUs must meet. We are proposing to revise this emission standard while recognizing that Hg from the combustion of lignite is challenging to capture because of the lack of naturally occurring halogen in the fuel and because of the natural alkalinity of the resulting fly ash. However, Hg from the combustion of subbituminous coal is similarly challenging to capture for the same reasons. Yet, EGUs firing subbituminous coal in 2021 emitted Hg at an average rate of 0.6 lb/TBtu and some as low as 0.1 lb/TBtu. From the CAA section 114 information survey, very few lignite-fired EGUs are using the control technology that the EPA identified as the most effective for Hg control in the 2012 MATS Final Rule,

[45] EIA form 923 does not specify the rank of coal that is ''refined'' in boiler or generator fuel data. For this technology review, the EPA has assumed that facilities reporting the use of refined coal have utilized ''refined lignite,'' which was confirmed in EIA form 923 fuel receipts and costs.

[46] See Docket ID No. EPA–HQ–OAR–2009–0234–20130 at *regulations.gov*.

[47] *Ibid.*

MEMORANDUM

From: Nick Hutson
EPA/SPPD/ESG

To: Docket Number EPA-HQ-OAR-2018-0794

Date: December 3, 2018

Subject: Incorporation by reference of Docket Number EPA-HQ-OAR-2009-0234, Docket Number EPA-HQ-OAR-2002-0056, and Docket Number A-92-55 into Docket Number EPA-HQ-OAR-2018-0794

The docket for this action (EPA-HQ-OAR-2018-0794; National Emission Standards for Hazardous Air Pollutants: Coal- and Oil-Fired Electric Utility Steam Generating Units – Additional Post-Promulgation Actions) includes the documents and information, in whatever form, in dockets EPA-HQ-OAR-2009-0234 (National Emission Standards for Hazardous Air Pollutants for Coal- and Oil-fired Electric Utility Steam Generating Units), EPA-HQ-OAR-2002-0056 (National Emission Standards for Hazardous Air Pollutants for Utility Air Toxics; Clean Air Mercury Rule (CAMR)), and Docket Number A–92–55 (Electric Utility Hazardous Air Pollutant Emission Study).

MEMORANDUM

Date: December 16, 2011

Subject: Emission Reduction Costs for Beyond-the-floor Mercury Rate for Existing Units Designed to Burn Low Rank Virgin Coal

From: Kevin Culligan, SPPD/OAQPS

To: EPA-HQ-OAR-2009-0234

For the final rule, EPA has recalculated the beyond the floor control costs for existing units designed to burn low rank virgin coal using a methodology similar to that used in the IPM analysis done for the MATS proposal. In the final rule, we have not recalculated control costs based on the other methodology used in the proposal which used ACI capital and operating costs provided in the ICR. We have not used that approach because it was based upon an assumption that all units would need to have a baghouse (also known as a fabric filter – FF – either existing or newly installed) in order to meet the MACT PM standard and that the ACI would be used with the baghouse. EPA has considered and used additional information demonstrating that high levels of mercury removal can be achieved with injection of brominated activated carbon and the addition of a FF is not necessary. Furthermore, based on additional analysis related to the PM standard, EPA believes that most lignite units will not need to install new FF, therefore, EPA believes a costing methodology based on this assumption would be inappropriate.

For this analysis, EPA calculated beyond-the-floor costs for mercury controls by assuming injection of brominated activated carbon at a rate of 3.0 lb/MACF for units with ESPs and injection rates of 2.0 lb/MACF for units with baghouses (also known as fabric filters). The rate of 2.0 lb/MACF for fabric filters is consistent with the rate assumed in all other IPM analyses for this rule. The rate of 3.0 lb/MACF for units with ESPs is lower than the rate of 5.0 lb/MACF assumed in the IPM analysis. EPA believes that this rate is appropriate, because a higher rate would likely result in reductions beyond those needed to meet the BTF standard of 4.0 lb/TBtu. Figure 1 in "Activated Carbon Injection for Mercury: Overview"[1] suggests that > 90% control can be achieved at lignite-fired units at a < 2.0 lb/MACF injection rate for units with installed FF and using treated (i.e., brominated) AC. The figure also suggests that > 90% Hg control can be achieved at lignite-fired units at < 3.0 lb/MACF injection rate for units with installed ESPs and using treated AC. As Table 1 below shows, based on the IPM analysis, all units would need to achieve reductions of less than 90%, therefore lower assumed injection rates are appropriate.

[1] *Fuel Processing Technology* 89 (2010) 1310

Table 1 – Emission Reduction Rates Required to Meet Standard of 4 lb/TBtu.

Plant Name	Unit ID	Hg Controls	Existing Controls	Base Hg lbs/Tbtu	Reduction Required, %	Policy Hg lbs/Tbtu
Big Brown	1	ACI	Cold-side ESP + Fabric Filter + SNCR	9.09	55.98	1.01
Big Brown	2	ACI	Cold-side ESP + Fabric Filter + SNCR	9.09	55.98	1.01
Lewis & Clark	B1	ACI	Wet Scrubber	7.68	47.92	0.75
Martin Lake	1	ACI	Cold-side ESP + Wet Scrubber	5.41	26.09	0.56
Martin Lake	2	ACI	Cold-side ESP + Wet Scrubber	5.41	26.09	0.56
Martin Lake	3	ACI	Cold-side ESP + Wet Scrubber	5.41	26.09	0.56
Monticello	3	ACI	Cold-side ESP + SNCR + Wet Scrubber	6.30	36.53	0.96
R M Heskett	B1		Cold-side ESP	7.81	48.77	0.45
R M Heskett	B2		Cold-side ESP + Cyclone	4.76	16.00	0.75
Leland Olds	1		Cold-side ESP	7.68	47.93	0.77
Leland Olds	2		Cold-side ESP	7.81	48.77	0.78
Milton R Young	B1		Cold-side ESP + SCR + Wet Scrubber	4.21	4.93	0.75
Milton R Young	B2		Cold-side ESP + SCR + Wet Scrubber	4.21	4.93	0.75
Stanton	1		Cold-side ESP	7.81	48.77	0.78
Stanton	10		Fabric Filter + Dry Scrubber	7.51	46.76	0.75
Limestone	LIM1		Cold-side ESP + Wet Scrubber	6.75	40.76	1.13
Limestone	LIM2		Cold-side ESP + Wet Scrubber	6.75	40.76	1.13
Dolet Hills	1		Cold-side ESP + Wet Scrubber	8.33	51.98	1.35
Coal Creek	1		Cold-side ESP + Wet Scrubber	4.21	5.07	0.76
Coal Creek	2		Cold-side ESP + Wet Scrubber	4.21	5.07	0.76
Laramie River Station	1		Cold-side ESP + Wet Scrubber	5.31	24.71	0.56
Laramie River Station	2		Cold-side ESP + Wet Scrubber	5.31	24.71	0.56
Antelope Valley	B1		Fabric Filter + Dry Scrubber	7.51	46.76	0.75
Antelope Valley	B2		Fabric Filter + Dry Scrubber	7.51	46.76	0.75
Twin Oaks Power One	U1		Fabric Filter	5.82	31.33	1.35
Twin Oaks Power One	U2		Fabric Filter	5.82	31.33	1.35
Pirkey	1		Cold-side ESP + Wet Scrubber	7.59	47.27	1.35
Coyote	B1		Fabric Filter + Dry Scrubber	7.64	47.66	0.75
Great River Energy Spiritwood Station	1		Cold-side ESP + Fabric Filter + SNCR + Dry Scrubber	7.68	47.92	0.75

EPA also assumed a disposal cost of $25/ton for ash comingled with activated carbon. This cost is consistent with a range of studies. DOE/NETL, in a recent study examining the costs of ACI, assumed total disposal costs of $17/ton for non-hazardous fly ash. They assumed $35/ton for fly ash that would have otherwise been sold for beneficial reuse (lost revenue of $18/ton plus disposal costs of $17/ton for non-hazardous fly ash). [2] In an EPA study, $25 - $30 per ton were assumed as total disposal costs.[3]

EPA recently modeled site-specific disposal costs for the RIA[4] for the proposed rule regulating coal combustion residuals (CCRs), including fly ash. Those costs were examined for units burning low rank virgin coal. The disposal costs varied by state/region. For Texas the incremental costs attributable to Hg control were $18.13/ton, while for North Dakota and Montana, the incremental costs attributable to Hg control were $32.31/ton.

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[2] *Environmental Sci. Technol.* 2007, 41, 1365].

[3] *Environmental Sci. Technol.* 2006, 1385

[4] Regulatory Impact Analysis For EPA's Proposed RCRA Regulation Of Coal Combustion Residues (CCR) Generated by the Electric Utility Industry. Prepared by US Environmental Protection Agency Office of Resource Conservation & Recovery (ORCR) (formerly Office of Solid Waste) 1200 Pennsylvania Avenue NW (Mailstop 5305P) Washington DC, 20460 USA. Available at http://www.regulations.gov/ docket number EPA-HQ-RCRA-2009-0640-0003, Appendix H.

Based on these key assumptions, EPA projects an average reduction cost of $27,017 per pound of Hg removed. Unit by unit costs are provided in Table 2.

Table 2 – Unit by unit cost estimates for achieving an emission rate of 4 lb/TBtu Hg

Plant Name	Unit ID	Capacity (MW)	Heat Rate (Btu/kWh)	Existing PM Controls	(Base to Policy) Hg remv'd (lbm)	(2007$) unit S/lbm Hg	Total Cost
Big Brown	1	575	11001	Cold-side ESP + Fabric Filter + SNCR	-396	3954	1565723
Big Brown	2	575	10931	Cold-side ESP + Fabric Filter + SNCR	-393	3980	1565723
Lewis & Clark	B1	52.3	13787	Wet Scrubber	-31	22920	704682
Martin Lake	1	750	11512	Cold-side ESP + Wet Scrubber	-332	32175	10671737
Martin Lake	2	750	11202	Cold-side ESP + Wet Scrubber	-323	32174	10383770
Martin Lake	3	750	10784	Cold-side ESP + Wet Scrubber	-311	32309	10038209
Monticello	3	750	11246	Cold-side ESP + SNCR + Wet Scrubber	-359	29249	10487787
R M Heskett	B1	29.37	11985	Cold-side ESP	-17	38871	652353
R M Heskett	B2	75.5	11386	Cold-side ESP + Cyclone	-22	53992	1206545
Leland Olds	1	221	11404	Cold-side ESP	-109	25792	2812406
Leland Olds	2	448	11021	Cold-side ESP	-217	23822	5176973
Milton R Young	B1	250	10661	Cold-side ESP + SCR + Wet Scrubber	-64	51542	3272935
Milton R Young	B2	455	10661	Cold-side ESP + SCR + Wet Scrubber	-116	49018	5665257
Stanton	1	130.3472	10990	Cold-side ESP	-77	26601	2050240
Stanton	10	57.35278	10320	Fabric Filter + Dry Scrubber	-31	30538	935770.1
Limestone	LIM1	831	10102	Cold-side ESP + Wet Scrubber	-372	29034	10797351
Limestone	LIM2	858	10108	Cold-side ESP +	-384	28982	11134608

				Wet Scrubber			
Coal Creek	1	554	11219	Cold-side ESP + Wet Scrubber	-162	48056	7781365
Coal Creek	2	560.3	10818	Cold-side ESP + Wet Scrubber	-158	47982	7576786
Laramie River Station	1	565	11312	Cold-side ESP + Wet Scrubber	-235	34742	8170580
Laramie River Station	2	570	10953	Cold-side ESP + Wet Scrubber	-230	34737	7980115
Antelope Valley	B1	450	10988	Fabric Filter + Dry Scrubber	-264	22315	5888636
Antelope Valley	B2	450	11206	Fabric Filter + Dry Scrubber	-269	22269	5993120
Twin Oaks Power One	U1	152	9497	Fabric Filter	-50	38215	1900963
Twin Oaks Power One	U2	153	10364	Fabric Filter	-55	37778	2064287
Coyote	B1	427	11639	Fabric Filter + Dry Scrubber	-228	22122	5043515
Pirkey	1	675	10693	Cold-side ESP + Wet Scrubber	-349	26185	9140141
Great River Energy Spiritwood Station	1	99	8937	Cold-side ESP + Fabric Filter + SNCR + Dry Scrubber	-46	11694	535381.6
Dolet Hills	1	650	10674	Cold-side ESP + Wet Scrubber	-351	27064	9500464
				Total	-5948		1.61E+08
				Average		27016	

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Activated carbon injection for mercury control: Overview

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ABSTRACT

Full-scale evaluations of the commercial feasibility of activated carbon injection (ACI) for mercury control in coal-fired power plants have been underway in North America since 2001 through DOE, EPRI and industry-funded projects. Commercial injection systems began to be sold to the power generation industry in 2005 and ACI is now considered the most robust technology for mercury control at many coal-fired units. Successful widespread implementation of this technology throughout this industry will require continued development efforts including: (1) understanding the impacts of technologies to control other pollutants, such as SO_3, for the enhancement of particulate control or selective catalytic reduction (SCR) for NO_x control, (2) options to continue using ash containing activated carbon in concrete, (3) techniques to assure the quality of delivered carbon, (4) techniques to improve the effectiveness of activated carbon, and (5) facilities to produce additional carbon supply. An overview of activated carbon injection for mercury control will be presented including the range of expected control levels, costs, balance-of-plant issues, recent developments to reduce overall control costs for many common air pollution control configurations, and developments to overcome complications caused by some new control configurations. An update on carbon supply and progress on ADA's activated carbon manufacturing facility will also be provided.

1. Introduction

The power industry in the US is faced with meeting state imposed regulations, as well as expected federal legislation, to reduce the emissions of mercury compounds from coal-fired plants. In 2005 the Federal Clean Air Mercury Rule (CAMR) was signed into law and included mercury control requirements for new sources and a phased in implementation schedule for existing sources. Although the CAMR was vacated by the US District court in 2008, new plants permitted between 2005 and 2008 include mercury control equipment. In addition, over 100 existing plants have installed or are planning to install mercury control equipment in response to state regulations or consent decrees negotiated between a state and a power producer.

Several options have been considered to control mercury from coal-fired power plants. At some plants, effective mercury control is achieved as a result of synergistic effects with pollution control equipment designed primarily to remove other pollutants. For example, a plant firing bituminous coal with a selective catalytic reduction (SCR), which has been installed to reduce nitrogen oxides (NO_x) into N_2 and H_2O, can be effective at converting elemental mercury into oxidized mercury, which is water soluble. If the plant also uses a flue gas desulfurization (FGD) system where the flue gas contacts a wet alkaline slurry to remove sulfur dioxide (SO_2), a large fraction of the water-soluble mercury is also removed. However, plants firing western fuels that have SCRs and FGD systems do not achieve high mercury removal levels. Therefore, many plants, especially those firing western fuels, will need separate mercury removal systems to achieve the necessary emissions levels. For such plants, activated carbon injection (ACI) has been shown to be a cost-effective, reliable option.

In March 2009, the Institute of Clean Air Companies (ICAC) reported that mercury control systems had been ordered for 135 plants in the US and Canada, representing more than 55 GW of generation. Of these, 54 GW, or more than 98%, are ACI systems. The majority of the ACI systems ordered, 41 GW, were planned for units firing western coals (lignite or subbituminous) where ACI is most effective. It is expected that new federal regulations will be implemented in the future that will require mercury control systems on additional units.

2. Background: activated carbon injection for mercury control

Activated carbon is an effective sorbent for mercury capture from flue gas. Many years of research, development and over 50 full-scale demonstrations have shown that ACI can greatly reduce mercury emissions from most configurations, even where native mercury removal is low. ACI is the commercial mercury-specific air pollution control option of choice, but success at specific sites

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requires an understanding of factors that can impact effectiveness. Some of these can be addressed through careful system design, such as ensuring even distribution of the sorbent in the flues gas, providing sufficient time for the sorbent to contact and adsorb the mercury, and optimizing plant operation to maintain operating temperatures within an favorable range. Some challenges will require continued development efforts, such as improved sorbents, unless a change in fuel or the existing particulate control equipment can be implemented.

Activated carbon distribution is determined by the injection grid design, which requires access to ports in select locations, and is affected by mixing in the duct at the injection location, the particle size of the sorbent injected, and the amount of conveying air used to enhance distribution. Residence time varies with the configuration of the plant and distance to the particulate collection device as well as the type of particulate collection device (electrostatic precipitator (ESP) vs. fabric filter (FF)).

The effectiveness of activated carbon for mercury control is temperature dependent. Specifically, the mercury capacity of a particular sorbent typically increases as the flue gas temperature decreases. The flue gas temperature is primarily determined by plant design and operating factors. Depending on plant specifics such as flue gas constituents and operation of the particulate control device, mercury removal is relatively effective at temperatures below 350 °F. For most plants, typical air preheater outlet temperatures are between 250 and 400 °F and temperature can become a factor to consider when projecting mercury removal effectiveness.

Some flue gas constituents can aid mercury removal (i.e. halogens), while others can hinder it (i.e. SO_3 or NO_2). Halogens and hydrogen halides (primarily chlorine and bromine) are present in the flue gas from the coal or can be introduced through coal or flue gas additives. In low-halogen flue gas, halogen-treated activated carbon can be very effective at capturing mercury.

Examples of the impact of sulfur, specifically SO_3, on mercury control are presented in Fig. 1. This graph is a compilation of results from several activated carbon injection demonstration programs sponsored by the US DOE and industry. Several trends can be observed from the data in Fig. 1, including:

1. Fabric filters, including TOXECON™ units, which include fabric filters installed downstream of ESPs, are more effective when used in conjunction with activated carbon injection than ESPs alone.
2. Sites with low-halogen flue gas, including subbituminous coals from the Powder River Basin (PRB) and those with spray dryer absorbers (SDA) can achieve high levels of mercury removal using halogen-treated activated carbon.

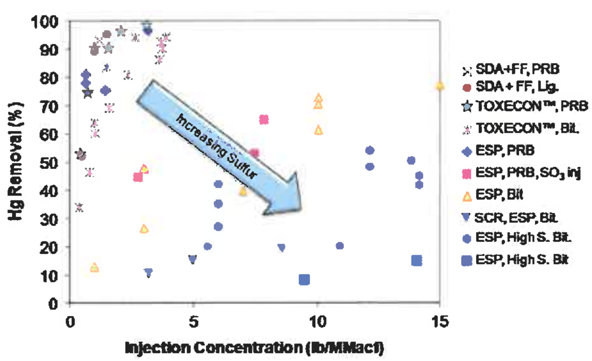

Fig. 1. Compilation of results from DOE mercury control programs.

3. ACI at sites firing western fuels, such as PRB coals or ligni (Lig.) coals, results in higher mercury removal than sites firi bituminous (Bit.) coals.
4. As the sulfur level of the coal increases, or when the SO_3 co centration is increased as a result of other pollution contr devices, as will be discussed in the next section, the effectiv ness of the activated carbon for mercury control decreases.

3. Industry-wide feasibility of activated carbon injection for mercury control

Although activated carbon injection is already a commerci mercury control option for many sites firing western fuels, conti ued development efforts have the potential to further expar implementation at sites where ACI is already an appropriate optic and to increase applicability for other sites. Continued improv ments in the technologies will involve: (1) reducing impacts cr ated by other air pollution control equipment and operations, (: continued improvements by activated manufacturers and equi ment designers, (3) additional solutions to eliminate the impa of activated carbon on fly ash sales for use in concrete productio (4) procedures to ensure the quality of delivered carbon, ar (5) increasing the production to sufficient quantities of activate carbon to meet industry-wide demand.

Interferences in the performance of ACI are often associate with increased levels of SO_3 and NO_2 created by equipment d signed to reduce the emissions of other flue gas constituents. F example, some older-generation catalysts in SCR systems conve SO_2 to SO_3, sufficient amounts of which have been observed to in pact the effectiveness of ACI for mercury control. These systems a being phased out and will not pose a problem for most sites. Hov ever, across the US, approximately 25 GW of power are produce from units firing PRB and low-sulfur bituminous coal that inje nominally 5–15 ppm SO_3 to improve ESP performance. SO_3 is use to "condition" the flue gas to improve particulate capture in ES on units firing low-sulfur coal. Chemicals to replace SO_3 for fl gas conditioning that do not detrimentally impact activated carbo performance are under evaluation. If such replacements are su cessfully utilized, it will increase the number of plants where A can be implemented.

The primary cost of mercury control with ACI is the sorbe Additional reductions in costs can be achieved through proper sy tem design, plant operation to maintain acceptable temperature and limiting SO_3 and NO_2 in the flue gas. Sorbent usage can be fu ther decreased by lowering the mass mean diameter, and th increasing the bulk surface area, of the activated carbon. During r cent tests on units firing western subbituminous coal from t Powder River Basin (PRB), milling activated carbon resulted in reduction of over 50% in activated carbon requirements [1,2]. Fu ther tests are necessary to determine if the activated carbon usa can be further reduced, and the resulting effect on mercu removal.

Many units firing western fuels sell their fly ash as a replac ment for Portland cement in the manufacture of concrete. 2006, over 72 million tons of fly ash were produced in the U 46% of which were used in concrete, concrete products, and gro [3]. Minute air bubbles entrained in the concrete matrix impro the durability of the concrete over freeze/thaw cycles. Carbon fly ash is typically not desirable because it adsorbs chemica designed to maintain air content in the concrete as it sets. Plan that sell their ash and choose to utilize ACI risk losing ash sal and potentially face landfilling the ash. Fly ash land filling cos are significant and can become one of the largest operating cos for plants after labor and fuel [4]. Options to preserve ash sale while using ACI for mercury control, include separating the act vated carbon-laden ash from the bulk of the fly ash by usi

EPRI-patented techniques such as TOXECON™ [5] or TOXECON II™ [6], reducing the amount of powdered activated carbon required through techniques such as on-site milling, or use of a specialized ash compatible activated carbon. These specialized activated carbon sorbents are fairly new to the market and are being evaluated for their mercury control effectiveness and their impact on concrete properties. Another option being evaluated is the use air entraining agents that are not impacted by activated carbon. In addition, there are groups evaluating the effectiveness of separating the carbon and the ash through novel means such as triboelectrostatic separation.

Widespread use of ACI in the power industry will require that sufficient quantities are available and the quality and consistency of delivered activated carbon is maintained. During demonstration programs from 2001 through 2009, activated carbon deliveries of consistent quality were typically experienced. In a few cases, as vendors responded to the increased demand, key characteristics of the activated carbon varied, such as the density of the bulk material, bromine level, particle size, or the abrasive qualities of the sorbent [7]. These changes often led on significant impacts to the mercury removal, quantity of sorbent required, calibration of the feed equipment, and/or conveying system operation.

ADA Environmental Solutions (ADA), a leading developer of activated carbon injection technology and commercial activated carbon equipment supplier, estimates that upcoming federal and state regulations will result in tripling of the annual US demand for activated carbon to nearly 1.5 billion pounds from approximately 450 million pounds, requiring rapid expansion of production capacity. This will exceed the existing supply because the US activated carbon production plants that are already operating at near-capacity. ADA is currently constructing the largest activated carbon production plant ever built using state-of-the art components. Other manufacturers are also discussing expansion of their existing production capability. As production expands, it will be critical to work with reputable vendors and to develop internal processes to assure the quality of the as-delivered product.

4. Summary

The development and commercialization of ACI is a clear example of the dedication of emissions control technology developers, the power generation industry, and the DOE working together to meet the challenge of reducing mercury emissions from coal-fired power plants. ACI offers promise as a primary mercury control technology option for many configurations and an important trim technology for others that are not able to achieve 90% mercury capture by other means. As state regulations are implemented and the potential for a federal rule becomes more imminent, technologies are being developed to further reduce costs and limit the balance-of-plant impacts associated with ACI. In conjunction with the technology development, additional activated production facilities and quality assurance procedures are being developed to assure that industries needs are met.

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