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FEATURES

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Alternatives to Activated Carbon for Mercury Control

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With the issuance of the Mercury Air Toxics Standards (MATS) in December 2011, the U.S. EPA has succeeded in passing lasting federal guidelines for mercury air emissions from coal-fired power plants. In the midst of all the legal wrangling and debate, the agency has maintained that much of the mercury control will be obtained as a co-benefit of existing and retrofitted air quality control devices (AQCDs) that were designed to control other pollutants such as particulate, sulfur oxides (SOx), and nitrogen oxides (NOx). While for some power plants this is indeed the case, for most plants, additional products and technologies will be necessary to boost the mercury control benefits of these devices in order to reach the 1.2 lb Hg/TBtu air emission limit specified in the MATS.

In the past, activated carbon, often in combination with halogen injection for mercury oxidation, has been the de facto industry standard for controlling mercury emissions; however, carbon has been shown to negatively impact the resale value of fly ash. This paper presents an overview and three case studies of cost-effective, low capital alternatives to activated carbon that lower overall mercury air and water emissions from coal-fired power plants.

EXAMPLES OF NON-CARBON MERCURY CONTROL TECHNOLOGIES

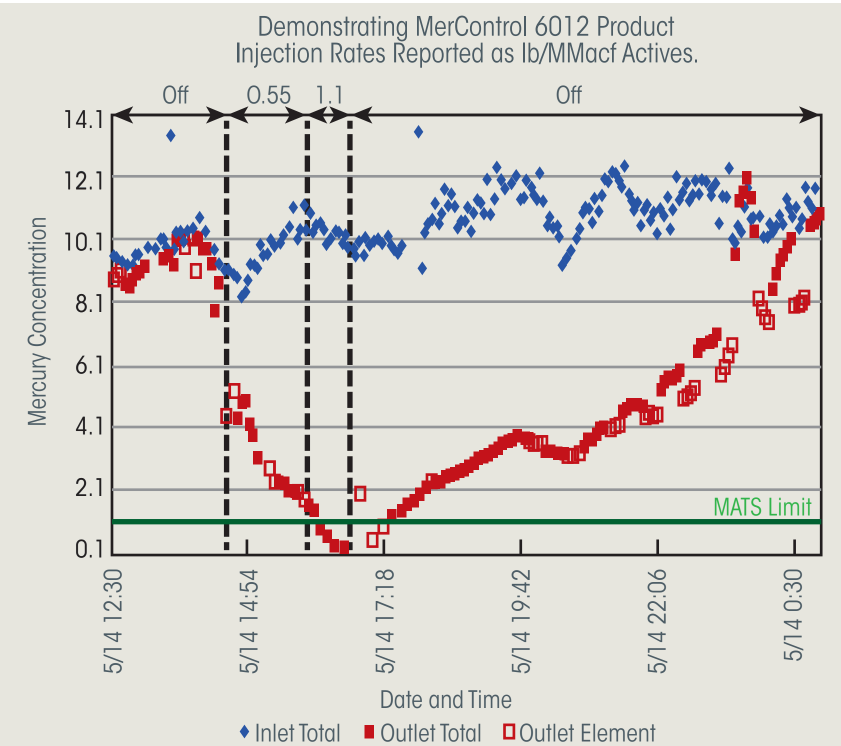
The four proprietary non-carbon mercury control technologies presented here are changing the way the industry approaches MATS compliance. These technologies are lower cost than capital projects and envelop the power plant from coal to wastewater to provide balance of plant mercury control.

The first mercury control product, MerControl 6012 technology, is a patented non-halogenated, non-carbon breakthrough sorbent for the capture of mercury in flue gas for plants with spray dry absorber (SDA) or circulating dry scrubber (CDS) AQCDs.

For those with downstream particulate control devices and scrubbers, mercury capture is greatly enhanced when the mercury is in the oxidized form (Hg2+) as opposed to the elemental form (Hg0). To facilitate the conversion to the oxidized state, the patented MerControl 7895 oxidant can be applied prior to combustion or injected directly into the furnace. In numerous commercial trials, the fraction of mercury in the oxidized form has exceeded 90 percent.

Because Hg2+ is highly soluble in water, application of MerControl 7895 technology is especially well-suited to those plants that have wet flue gas desulfurization (WFGD) scrubbers installed.

Mercury Concentrations at the Inlet & Outlet of the SDA 1



However, once absorbed into the WFGD liquor, ionic mercury can undergo chemical reduction to become insoluble and volatile elemental mercury, which is re-emitted into the scrubbed flue gas. MerControl 8034 technology can be added directly to the WFGD liquor to efficiently capture and precipitate ionic mercury without any impact on gypsum quality, thereby preventing it from being re-emitted into the flue gas and lowering overall mercury emission.

The last product, Nalmet 1689 technology, is a polymeric chelant designed to meet challenging industrial wastewater discharge limitations. It has an exceptionally high affinity for mercury and forms large precipitates that readily settle and filter to consistently attain extremely low mercury levels in the parts-per-trillion (ppt) range in wastewater effluents.

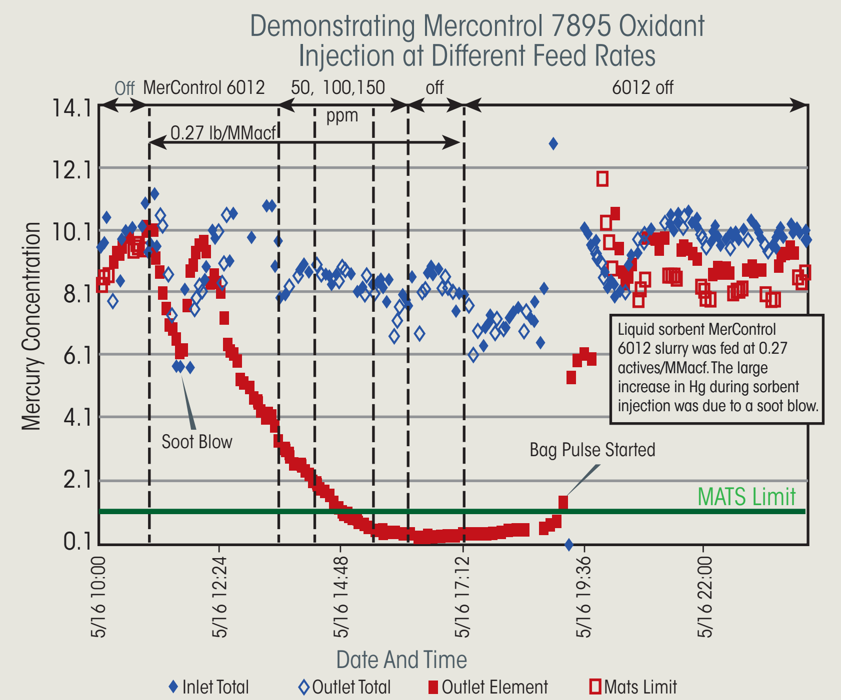
These non-carbon mercury control technologies can be applied individually or in concert to reduce and control mercury emissions. Three case studies are presented here demonstrating these mercury control strategies at coal-fired utilities in the US.

CASE STUDY #1: MERCURY CONTROL IN AN SDA

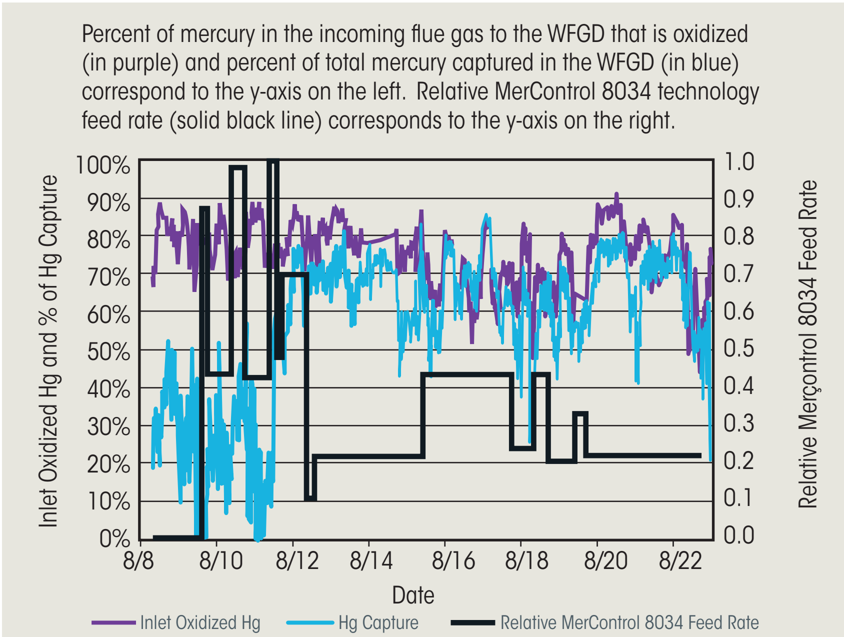
At Great River Energy Stanton Station in Stanton, N.D., the non-carbon, non-halogen MerControl 6012 mercury sorbent technology was demonstrated on flue gas from a 60 MW base-loaded, PRB-fired boiler. The liquid MerControl 6012 technology was injected directly into the spray dry absorber (SDA) along with the slaked lime used for SOx removal. Inlet mercury measurements were made upstream of the spray dryer, prior to the sorbent injection location at the scrubber inlet, and outlet mercury measurements were made downstream of the fabric filter baghouse, which follows the SDA unit. MerControl 6012 technology was demonstrated on its own, in combination with MerControl 7895 oxidant, and compared to commercially available brominated powdered activated carbon (PAC).

Figure 1 shows results from the demonstration of MerControl 6012 technology on its own. The initial flow rate was started at 0.55 lb actives/MMacf, at which point the outlet mercury dropped from about 8.5 mg/m3 to stabilize around 2.1 mg/m3. The flow rate was doubled to 1.1 lb actives/MMacf,

Mercury Concentration at the Inlet & Outlet of the SDA 2



Percent of Mercury in Incoming Flue Gas to WFGD that is Oxidized 3



bringing the mercury concentration down to approximately the limit of detection of the analyzer, around 0.4 mg/m3. This corresponds to a mercury air emission of 0.42 lb Hg/TBtu, a level significantly below the 1.2 lb Hg/TBtu MATS limit. After the MerControl 6012 feed was turned off, mercury emission slowly increased back to 4 mg/m3 over three hours.

In the second demonstration at Stanton Station, low dosages (<150 ppm) of MerControl 7895 oxidant were added to the coal at the same time the MerControl 6012 technology was injected into the SDA. It can be seen in Figure 2 that once again mercury emissions were held below the limit of detection of the analyzer (0.4 mg/m3), only this time the MerControl 6012 flowrate was only 0.28 lb actives/MMacf. The effect of the MerControl 7895 oxidant on the sorbent performance was observed after the oxidant and slurry feeds were turned off and the mercury emission remained below the MATS limit for greater than three hours, returning to baseline after bag cleaning.

For comparison, commercially available brominated PAC was injected into the duct prior to the SDA inlet. The brominated PAC was fed at 1 and 2 lb/MMacf and achieved mercury emission levels of 3.9 and 2.4 mg/m3, respectively, well above the MATS limit. Besides the disadvantages of dry sorbent injection including added capital equipment and difficulty in homogenous distribution of the sorbent, this benchmark technology was not able to meet the MATS limit at nearly double the highest dose of the MerControl 6012 technology tested. For this unit, MerControl 6012 technology provided better cost-performance than brominated PAC, and reduced the mercury concentration well below MATS limit.

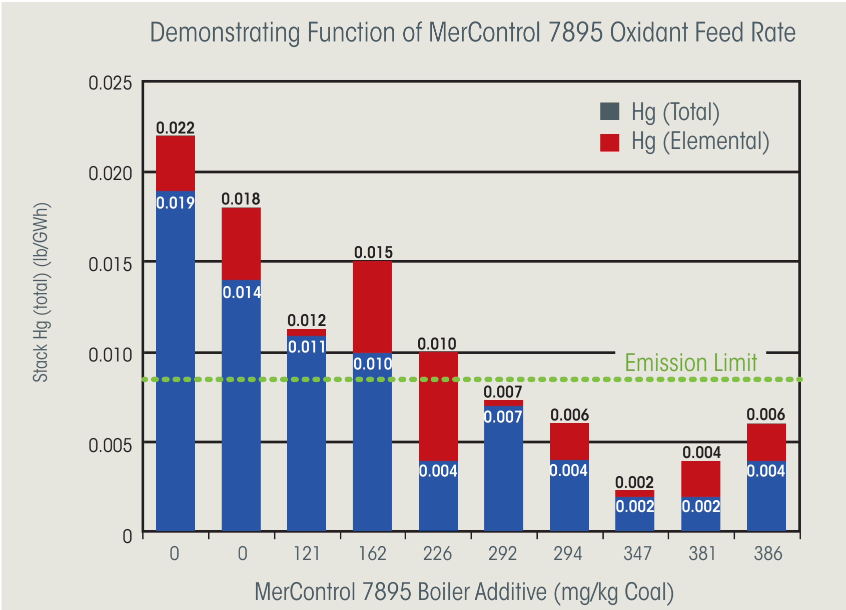
CASE STUDY #2: MERCURY CONTROL IN A WFGD

In Case Study #2, MerControl 8034 technology was demonstrated at a pulverized coal-fired utility power plant firing high sulfur bituminous coal with two identical units generating about 500 MWe each. The air pollution control devices present on each unit include a cold-side electrostatic precipitator (ESP) and a wet flue gas desulfurization (WFGD) scrubber.

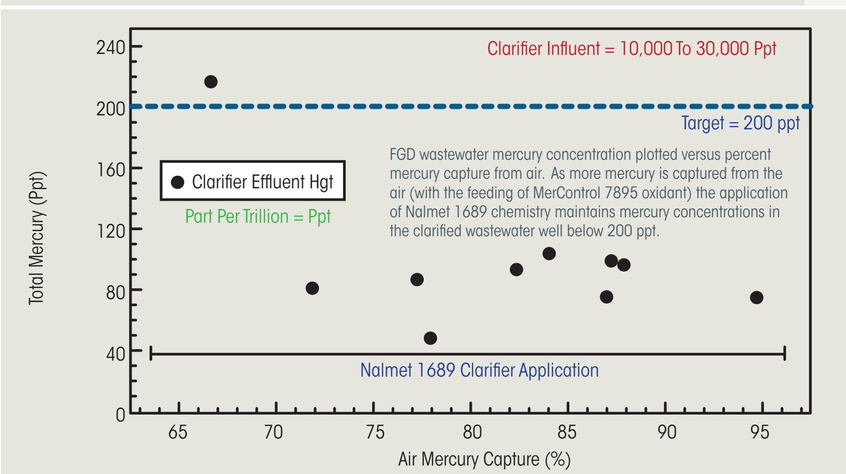
The plant was experiencing unexpectedly low mercury capture across their WFGD scrubbers due to the occurrence of "mercury re-emission," whereby soluble oxidized mercury undergoes chemical reduction back to the volatile and insoluble elemental state. Mercury in the flue gas coming into the WFGD scrubbers was approximately 80 percent oxidized yet the total mercury capture across the WFGD was much lower at approximately 20 to 40 percent. This difference indicated that the oxidized mercury was most likely being chemically reduced in solution and re-emitted out the stack.

In Figure 3, it can be seen that once

Stack Emissions of Total & Elemental Mercury 4



FGD Wastewater Mercury Concentration 5



the MerControl 8034 technology was applied (feed rate is shown in black), the amount of mercury captured increases and becomes equivalent to the amount of oxidized mercury entering the WFGD scrubber, indicating that MerControl 8034 technology leads to the complete capture of oxidized mercury from the flue gas. It was concluded from the data in Figure 3 that the amount of mercury re-emitted in the WFGD becomes negligible once the MerControl 8034 technology is fed into the system.

The successful prevention of mercury re-emission was also evident in the measurements of mercury concentrations in the WFGD liquors. Once the MerControl 8034 treatment began in Unit 1, the soluble mercury concentration dropped rapidly until it reached a steady state at nearly zero. The significant decrease in soluble mercury concentration in Unit 1, which was not observed in the untreated Unit 2, indicated that the MerControl 8034 technology was reacting and precipitating the soluble mercury out of solution before it could be re-emitted out the stack. These results demonstrate that the addition of MerControl 8034 technology effectively removes the soluble mercury from the WFGD and stops mercury re-emission from occurring, leading to the capture of all oxidized mercury in the flue gas.

CASE STUDY #3: MERCURY EMISSIONS CONTROL FOR AIR AND WATER

For compliance with state mercury limits of 0.008 lb Hg/GWh, City Water Light and Power Dallman Power Station, a 190 MWe coal-fired utility in Springfield, Ill., needed to reach greater than 85 percent flue gas mercury capture while maintaining mercury water discharge limits. The unit fires bituminous coal and has AQCDs including an SCR, a cold-side ESP, and a WFGD. The plant faced two major challenges. First, despite having an SCR and a WFGD scrubber to capture oxidized mercury, the plant was still unable to meet its emissions target. Therefore, to further enhance mercury oxidation and capture, MerControl 7895 oxidant was injected into the coal feeders. The second challenge the plant faced was that any changes to air mercury removal must result in wastewater effluent mercury concentrations remaining below existing mercury discharge limits. For this purpose, the polymeric chelant Nalmet 1689 solution was added to the WFGD wastewater treatment system.

Figure 4 shows the emissions of total and elemental mercury at the stack plotted against a range of feed rates of MerControl 7895 oxidant. Application at 265 mg MerControl 7895/kg of coal and above afforded greater than 85 percent mercury capture and achieved the target of 0.008 lb Hg/GWh. Treatment with MerControl 7895 oxidant successfully resulted in air emissions compliance by increasing efficiency of the WFGD and enabling the mercury to be captured in the WFGD liquor.

Historically at this plant, the mercury concentration in the WFGD wastewater was observed to be in the range of 10,000 – 30,000 ppt. Moreover, with the treatment of MerControl 7895 chemistry causing the oxidized mercury in the flue gas to increase, it would be expected that the amount of mercury in the wastewater would be substantially higher. Figure 5 shows that treatment of the WFGD wastewater with Nalmet 1689 chemistry lowered and maintained mercury concentrations in the clarifier effluent stream to well below 200 ppt. From other measurements performed, it was concluded that Nalmet 1689 technology shifts the captured mercury from the wastewater to the clarifier solids. With the mercury partitioned to the clarifier solids, it is then easily removed by standard wastewater treatment equipment and the solids can be safely landfilled.

For many coal-fired utilities in the U.S., achieving MATS compliance can seem complex and expensive. Back-end AQCDs require long lead times, are high capital cost, and can have inefficiencies that require additional mercury capture technology. Injection of brominated activated carbon is more capital intensive than the technologies presented here. Furthermore, it can have a negative effect on fly ash quality and thereby impact resale. Additionally, with current and anticipated mercury emissions limits for wastewater, it is critical for utilities to adjust their wastewater mercury removal plans when implementing any new air emissions technologies. pe

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The Nalco Air Protection Technologies (APT) family of mercury control products addresses the entire spectrum of mercury emissions compliance for coal fired power plants. The Nalco team boasts some of the industry's foremost mercury experts and leading-edge technologies that are changing the way the industry approaches mercury control for both air and water. Nalco solutions are customized to fit the needs of the plant, are lower cost than the industries other leading technologies, and envelop the power plant from the coal to the wastewater to provide balance of plant mercury control.

The proprietary line of MerControl® mercury control technologies includes: MerControl 7895 mercury oxidation catalyst, MerControl 8034 technology for mercury re-emission control, and MerControl 6012 sorbent, a non-halogen, non-carbon mercury sorbent used in spray dry absorber (SDA) or circulating dry scrubber (CDS). The Nalco Predict Hg line of technologies facilitates mercury removal in the wastewater effluent to meet challenging wastewater discharge limits. Our leading-edge technologies are changing the way the coal-fired power industry approaches mercury control.

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