Utilities are faced with many balance-of-plant challenges as retrofitted pollution control equipment begin operation in order to control Acid Gas and Mercury emissions as outlined in the EPA Mercury and Air Toxics Standards (MATS) rules. However, many techniques previously used to enhance plant performance in the end, might also hinder compliance strategies. Compliance strategies are dependent upon current and anticipated fuel types, as well as existing installed air pollution control systems. Additionally, many older, marginally sized electrostatic precipitators (ESPs) that rely on trace levels of SO$_3$ in the flue gas to maintain optimum particle resistivity ranges might have to use alternative methodologies, as a result, capturing mercury might come at a higher cost and with more complexities and potentially result in loss of fly ash sales as well.

Utilities are facing many challenges in order to achieve full compliance with the recently imposed EPA Mercury and Air Toxics Standards (MATS) rules, which are also dependent upon current and anticipated fuel types, as well as existing installed air pollution control systems. This could be especially difficult with many older, marginally sized electrostatic precipitators that rely on trace levels of SO$_3$ in the flue gas to maintain optimum particle resistivity ranges.

Activated carbon injection (ACI) is one of the leading and most accepted technologies utilized for controlling and maintaining mercury emission levels to required MATS levels. To date, greater than 288 systems have been installed or are under contract with another 247 systems out for bid. In the end, it is expected that over 55% of existing coal-fired power plants will have ACI installed for mercury control. The negative impact of SO$_3$ on activated carbon and mercury control is well documented.$^1$ At concentrations above 10 ppmv, especially when flue gas temperatures are above 320°F, the interference from SO$_3$ can result in dramatically reduced mercury removal levels.$^2$ MATS guarantees for mercury reduction with ACI or naturally occurring unburned carbon in fly ash (typically measured as loss on ignition or LOI) typically require SO$_3$ levels to be maintained at less than 5 ppmv.

Additionally, in order to achieve required MATS levels for HCl reduction, it often requires the injection of high levels of hydrated lime into the flue gas through use of a dry sorbent injection (DSI) system. Hydrated lime is also highly effective in capturing SO$_3$, thus lowering SO$_3$ levels and, as a result, increasing the effective ash resistivity levels. Injection of hydrated lime for compliance must be balanced with maintaining adequate SO$_3$ to maintain resistivity and ESP performance. This can be difficult as coal and operating conditions vary.

Figure 1 shows predicted fly ash resistivity for an Eastern high sulfur coal with a highlighted region where resistivity could be problematic. When there is no SO$_3$, the resistivity is very high at a typical ESP operating temperature range of 300 to 350°F.
Another factor associated with dry sorbent injection and activated carbon is the overall increase in particulate loading to the ESP, typically fine powdered sorbent. Many older or undersized ESPs were not designed to operate with this increased particulate loading while maintaining current modern ESP outlet emission rates.

As a result of a convergence of factors related to MATS compliance, there are now additional strains on ESP operation, even on units that traditionally have not experienced any problems in the past. Negative operating issues from use of dry sorbents such as hydrated lime have been demonstrated, including issues such as reduced power levels, increased spark rates, mainly due to the reduction of native SO₃ in the flue gas, plus an increase in the amount of total PM entering the ESP. What was once considered an easy ESP application for use on higher sulfur, bituminous coal installations, may now become more difficult as the SO₃ levels are significantly reduced entering the ESPs due to use of hydrated lime injection.

ADA® RESPond™ Flue Gas Conditioning Technology, formerly known as ADA® ATI-2001, is a non-SO₃-based flue gas conditioning product and, as such, is compatible with sorbents for both mercury and acid gas control, meaning that it does not interfere with activated carbon use for mercury control or be absorbed by alkaline sorbents. This is especially important for facilities that have existing SO₃ conditioning or traditionally have not required the use of external SO₃ conditioning due to the natural
SO$_3$ levels produced from firing higher sulfur coals, but now may need hydrated lime based, dry sorbent injection in order to achieve required MATS levels for HCl.

ADA has exclusively offered various liquid ESP flue gas conditioning technologies commercially for over 15 years. These products are specifically designed to modify ash resistivity and help increase ESP power levels and reduce sparking rates, thereby maintaining and/or increasing ESP collection efficiency.

To date, ADA has conducted numerous full-scale demonstrations utilizing our flue gas conditioning technology, in addition to its commercial installations.

**Case Study 1:**

In this case, the host unit was an older B&W PC fired boiler brought into commercial service prior to 1970 with a rating of approximately 300 MWG burning western sub-bituminous fuels. Two parallel gas ducts feed flue gas into a single, multi-chamber ESP casing. The ESP specific collection area (SCA) is 200 ft$^2$/kacfm. At full load, the host unit produces approximately 1.1 MMacfm of flue gas at 290°F going into the ESPs.

Testing was conducted with the simultaneous application of dry sorbent injection and activated carbon injection. The purpose of the testing was to determine if ADA’s® RESPond Technology would provide suitable conditioning of the fly ash to maintain the ESP’s electrical performance while injecting Trona and sodium bicarbonate for SO$_2$ and SO$_3$ reduction and improve performance of activated carbon for mercury control.

During host unit baseline operation, high levels of SO$_3$ conditioning (>20 ppmv) were required to maintain ESP electrical performance. SO$_3$ conditioning was discontinued and ADA’s RESPond was applied. The flue gas technology successfully maintained power levels to those experienced with SO$_3$ conditioning and there was no change in opacity levels, which remained well below permit limitations. The replacement of conventional SO$_3$ flue gas conditioning with RESPond at this facility greatly improved performance of the activated carbon for mercury capture across the existing ESP.

Over 90% mercury reduction was achieved at a greatly reduced rate of activated carbon injection. Figure 2 shows the performance of ADA’s non-SO$_3$ flue gas technology in comparison to conventional SO$_3$ with injection of activated carbon for mercury control. This client added CaBr$_2$ to the coal for additional Hg oxidation. Results show that with RESPond, activated carbon usage was reduced by over 80%, thus preserving ash sales and reducing operating costs.
Figure 2: Impact of Flue Gas Conditioning on Mercury Capture across the ESP casing.

**Case Study 2:**

In this case, the host unit was a CE tangential fired boiler brought into commercial service in 1976 with a rating of approximately 350 MWG burning western sub-bituminous fuels. ADA’s flue gas technology was used to improve overall ESP performance at this facility.

- This unit did not previously have SO₃ conditioning, therefore when RESPond was injected; there was an immediate improvement in ESP total power and a concurrent drop in average spark rate.
- In this case there was a reduction in opacity from 17% to 8% within two hours of the start of injection.

Impact on secondary current, spark rates in the front fields are illustrated in Figure 3. As can be seen from this chart, ESP response in terms of increased power and reduced sparking was seen within 15 minutes of the start of injection. Complete conditioning of the ESP typically takes longer than this, since RESPond co-precipitates with fly ash and requires time to achieve full penetration to the precipitator outlet.
Case Study 3:

Laboratory resistivity with RESPond Technology was evaluated for a client to determine the potential of the technology. Figure 4 presents the resistivity curves from these tests conducted on a western sub-bituminous coal fly ash. Two ascending temperature resistivity curves are shown; baseline ash with no conditioning and an ash sample treated with a typical level of ADA’s flue gas conditioning agent. Laboratory testing demonstrated two orders of magnitude improvement from baseline resistivity levels in the ash.
Figure 4: Example with a western subbituminous fly ash conditioned in a laboratory resistivity test cell with 10% moisture content using the IEEE 584 procedure.
ADA’s flue gas injection equipment is a low CAPEX investment. A typical ADA® RESPond™ Injection skid and lance is shown in Figures 5 and 6:

Figure 5: Typical FGC injection skid photo

Figure 6: Typical FGC injection lance

To ensure optimize mixing of the FGC chemical in the duct and injection lance numbers and spacing, ADA performs CFD modeling for each project. A typical model study is shown in Figure 6 below: 3
Conclusion:

ADA’s® RESPond™ Flue Gas Conditioning Technology has been proven to be an effective addition to MATS compliance strategies for units with ESPs, activated carbon for mercury control and dry sorbents for acid gas control. ADA’s flue gas conditioning technology does not interfere with the performance of activated carbon for mercury control, thus enabling optimum management of activated carbon usage and help preserve ash sales. RESPond can work in tandem with the injection of alkali sorbents to maintain ideal resistivity ranges even when SO₃ concentrations are significantly curtailed. RESPond may also provide significant benefits on higher sulfur coal units that now must inject high quantities of hydrated lime, required to achieve both mercury and HCl MATS emission levels. In its essence, RESPond works similar to conventional SO₃ conditioning by modifying ash resistivity resulting in improved power and reduced spark rates to maintain compliance opacity levels.

ADA can provide Clients with both full-scale demonstrations as well as commercial installations.

References