Impact of DSI on Mercury Removal

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Key Points to Consider

1. Relationship between ACI effectiveness and the presence of sulfuric acid vapor

2. DSI effectiveness on Sulfuric acid vapor removal

3. Acid Gas & DSI Stratification Issues as they relate to ACI effectiveness

4. Secondary Acid Gas Removal Effects: the good with the bad
The role of $\text{SO}_3$ in the process

Some want it and some don’t
Activated Carbon Injection
Summary of Mercury Control Results

Hg Removal (%)

SDA + FF
PRB ESP
ESP with SO₂ Conditioning
LS Bit ESP
HS Bit ESP

Injection Concentration (lb/MMacf)

0 5 10 15

Slide courtesy of ADA-ES
Examples of Full-Scale Hg Control Results at Bituminous Plants with SO₃

- **AEP Conesville Unit 6 (CV6), PC boiler, no SCR**
  - 3.5% to 4% sulfur coal. SO₃ ~ 20 to 30 ppm
  - No native removal across ESP
  - Mercury removal across ESP limited to 30% at ACI up to 20 lb/MMacf

- **PSNH Merrimak**
  - Low sulfur bituminous coal, cyclone boiler, high conversion SCR (> 10 ppm SO₃)
  - SO₃ > 10 ppm
    - No native mercury removal coal to stack
    - Maximum 20% mercury removal up to 10 lb/MMacf PAC
  - SO₃ > 5 ppm (6 – 7 ppm)
    - Hg removal 50% at 4.5 lb/MMacf PAC
  - SO₃ < 5 ppm (3 – 4 ppm),
    - Hg removal 70 – 75 % at 4.5 lb/MMacf, 80% at 6 lb/MMacf
SO$_3$ Injection and PAC Effectiveness

- SO$_3$ is used to condition fly ash for better capture in ESPs
- Typical injection targets < 10 ppm in gas phase
- Any SO$_3$ in gas phase appears to affect Hg capture

Slide courtesy of ADA-ES
SO3 vs Native Carbon

Slide courtesy of URS
Much has been observed and reported on the interplay between Sulfuric Acid Vapor, Activated Carbon Injection, Mercury Capture and ESP performance.

What is fairly clear, from all of the research, is that increasing levels of H\textsubscript{2}SO\textsubscript{4} have a negative, and costly, effect on the performance of the Mercury Capture process.

General rules of thumb suggest that maintenance of “SO\textsubscript{3}” levels below 5 ppm ahead of the ACI injection point can cut carbon costs in half.
DSI Effectiveness in Acid Gas Control
This is essentially an entire workshop in itself

Basically:

• Both Calcium and Sodium sorbents have been successfully applied to this application.
• There are pros and cons to both sorbents, depending on the plant specific needs
• As with ACI, distribution and residence time are critical
• A residence time of 1 second is generally desired to achieve desired acid gas removal for the purpose of Hg Capture enhancement.

So, given 10 minutes or so, what new information is worth covering:
Pre-AH Mitigation of Acid Gas:

- Improves residence time and acid gas capture
- Lowers the threat of AH fouling
- Is less efficient than Post-AH Injection
- May have downstream distribution impact

Currently more than 20 units are injecting sorbent at a location ahead of the AH for acid gas control (both Lime and Sodium)
Stratification Impacts
A Real World Study
One Plant’s experience

SO₃ Objective:

.009 #/mmBTU

Plant often experienced Stack SO₃ higher than FGD Inlet SO₃ without excessively high Sorbent NSRs
Horizontal Stratification
Acid Adsorption onto Flyash

Acid Adsorption on Fly Ash

Acid Adsorbed/Acid Produced vs Temperature, °F
Air Heater Concentration

High SO$_3$

Low SO$_3$
• The air heater is well known as a magnificent acid concentrator.

• However, acid concentrations follow the acid vaporization temperature that may, or may not, be at the far, hot, side of the duct.

• At this plant, horizontal traverses were conducted at the FGD Inlet location and no dramatic stratification was found (although the number of available ports was limited).
Vertical Stratification?
Vertical Stratification Theory

Sorbent Injection → Untreated Gas

M8A Test → Gas Flow
• Acid levels are higher at the top of the duct,
• Not enough data to project treatment sensitivity
• Acid levels are higher at the top of the duct,
• Material at bottom of duct seems more sensitive to sorbent
Top of duct acid levels are highly influenced by FGD Injection
Bottom of duct acid seems only mildly sensitive
This represents a clear indication of sorbent stratification at this location
Impact on Hg

- Clearly this discussion was focused on sulfuric acid distribution.

- But the impact of high sulfur levels of carbon capture of Hg is well documented.

- So, high levels of acid stratification are linked to less than optimum utilization of ACI for Hg capture.
HCl – The Other Acid Gas
Whether Intentional or due to SO2 Scrubbing
SO₃ or HCl – What Goes First?  
Baghouse Removal Data

- Midwestern Utility; med-high sulfur coal
- Hydrate injection post APH using temporary injection system
- Test runs measured at baghouse outlet
  - Controlled condensate (SO₃) and 26A (HCl)

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Reduced sorbent usages vs. ESP

Low emission capability

Slide courtesy of Mississippi Lime
Significant effort is being spent by many utilities to enhance capture of HCl prior to particulate capture. This provides significant improvement in FGD water chlorides.

Additionally, significant work is focused on sodium sorbent injection for SO2 control.
Milled Trona SO2/HCl Reduction

Slide courtesy of NatronX
HCl Reduction with Trona/SBC

Slide courtesy of NatronX
Re-emission?
A great deal of work is being done to optimize capture of HCl in dry flight.

Removal of Chlorides from the scrubber water has a significant commercial impact on the water treatment cost of the plant.

However, this data suggests that re-emissions of Hg are minimized in direct relation to the level of chlorides in the scrubber water.
Conclusions
1. There can be no doubt that DSI for mitigation of acid vapor dramatically improves both the technical and commercial aspects of Hg emissions compliance.

2. Maintenance of an acid vapor concentration at or near 5 ppm ahead of the ACI injection point is desired
1. DSI, ahead of the Air Heater can have significant positive effects on air heater fouling, ABS minimization and overall SO3 reduction residence time. This location is no longer new or unproven.

2. Natural gas movement through the Air Heater and the downstream ducts can dramatically skew gas and sorbent distribution. This needs close attention and periodic tuning.

3. DSI secondary capture of HCl may lower corrosion and water treatment costs, but may also increase Hg re-emission in the FGD.
Thank You