Interactions Between SO$_3$, HCl, HBr, PM and Trona Injection in DSI

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Regulations

◆ MATS - coal-fired boilers
  ● HCl: 0.002 lb/mmBTU
  ● Mercury: 1.2 lb/TBTU
  ● PM: 0.03 lb/mmBTU

◆ Proposed Industrial Boiler MACT – solid fuel
  ● HCl: 0.022 lb/mmBTU
Trona Injection to Mitigate Acid Gases

Coal → Boiler → Economizer → SCR → Air Heater → ESP → Wet Scrubber

CaBr₂

SO₂, SO₃, HCl, HBr, NOₓ, Hg

NH₃

HBr

Trona
Chemical Reactions in Flue Gas

◆ Trona Calcination

\[2(\text{Na}_2\text{CO}_3 \cdot \text{NaHCO}_3 \cdot \text{2H}_2\text{O}) \text{(s)} \rightarrow 3\text{Na}_2\text{CO}_3\text{(s)} + 5\text{H}_2\text{O(g)} + \text{CO}_2\text{(g)}\]

◆ Acid Gas Neutralization Reactions

\[
\begin{align*}
\text{Na}_2\text{CO}_3 + \text{SO}_2 + \frac{1}{2}\text{O}_2 & \rightarrow \text{Na}_2\text{SO}_4 + \text{CO}_2 \\
\text{Na}_2\text{CO}_3 + \text{SO}_3 & \rightarrow \text{Na}_2\text{SO}_4 + \text{CO}_2 \\
\text{Na}_2\text{CO}_3 + 2\text{HCl} & \rightarrow 2\text{NaCl} + \text{H}_2\text{O} + \text{CO}_2 \\
\text{Na}_2\text{CO}_3 + 2\text{HBr} & \rightarrow 2\text{NaBr} + \text{H}_2\text{O} + \text{CO}_2
\end{align*}
\]
Chemical Reactions in Flue Gas

- $\text{Na}_2\text{CO}_3 + \text{SO}_3 \rightarrow \text{Na}_2\text{SO}_4 + \text{CO}_2$
  - Sometimes $\text{SO}_3$ is used to condition fly ashes to enhance ESP performance.
  - Trona is effective in mitigating $\text{SO}_3$ and can lower the ash resistivity thus conditioning the ESP. However trona does add the dust load for ESP and may cause a problem on undersized units.

- $\text{Na}_2\text{CO}_3 + 2\text{HCl} \rightarrow 2\text{NaCl} + \text{H}_2\text{O} + \text{CO}_2$
- $\text{Na}_2\text{CO}_3 + 2\text{HBr} \rightarrow 2\text{NaBr} + \text{H}_2\text{O} + \text{CO}_2$
  - HCl and HBr can oxidize mercury, thus enhance mercury removal.
  - HCl is the surrogate for all acid gases in both MATS (Utility MACT) and Boiler MACT.
Solution: Location!

- **Boiler**
  - Coal
  - $\text{CaBr}_2$

- **Economizer**
  - $\text{NH}_3$
  - $\text{SO}_2, \text{SO}_3, \text{HCl}, \text{HBr}, \text{NO}_x, \text{Hg}$

- **SCR**
  - $\text{HBr}$

- **Trona**

- **Air Heater**

- **ESP**

- **Wet Scrubber**

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Summary

- Flue gas treatment has become a chemical processing plant
  - Treating one component can affect others
  - Good understanding of chemistries helps
  - Apply system approach

- All parties need to work closely, especially the one who designs and integrates the system should involve all suppliers in the trial and design of permanent systems.
Questions?

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