Dry Injection of Trona and Sodium Bicarbonate for Multi-Emissions Control

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McIlvaine Company Hot Topic Hour on “Multi-Emissions Control”
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Test at EERC, University of North Dakota

- A pilot plant
- Central Appalachian Coal (CAPP)
- Two PM control devices
  - ESP
  - Bag house
- Four sodium sorbents and one hydrated lime
- Flue gas duct diameter: 6”. The small duct size results in almost perfect mixing between sorbent and flue gas, and consequently much better HCl and SO₂ mitigation performance than with utility boilers.
### CAPP Coal Analyses

<table>
<thead>
<tr>
<th></th>
<th>Sample I</th>
<th>Sample II</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Proximate Analysis, as Received,%</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moisture</td>
<td>2.79</td>
<td>2.64</td>
</tr>
<tr>
<td>Volatile Matter</td>
<td>33.76</td>
<td>33.24</td>
</tr>
<tr>
<td>Fixed Carbon</td>
<td>52.16</td>
<td>52.26</td>
</tr>
<tr>
<td>Ash</td>
<td>11.29</td>
<td>11.85</td>
</tr>
<tr>
<td><strong>Ultimate Analysis, as Received,%</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hydrogen</td>
<td>5.04</td>
<td>5.05</td>
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<tr>
<td>Carbon</td>
<td>71.63</td>
<td>72.63</td>
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<tr>
<td>Nitrogen</td>
<td>1.22</td>
<td>1.22</td>
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<tr>
<td>Sulfur</td>
<td>0.78</td>
<td>0.78</td>
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<tr>
<td>Oxygen (Ind)</td>
<td>10.05</td>
<td>8.48</td>
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<tr>
<td>Ash</td>
<td>11.28</td>
<td>11.85</td>
</tr>
<tr>
<td>Heat value (BTU/LB)</td>
<td>11496</td>
<td></td>
</tr>
<tr>
<td>Chlorine, µg/g</td>
<td>954-970</td>
<td></td>
</tr>
</tbody>
</table>
Sorbents

- **Trona (S200)**
  - $d_{50}$: 30 µm

- **Milled Trona (S250)**
  - $d_{50}$: 15 µm

- **Milled Sodium Bicarbonate (S350)**
  - $d_{90}$: 40 µm

- **Finely Milled Sodium Bicarbonate (S450)**
  - $d_{90}$: 17 µm

- **Hydrated Lime**
Injection Upstream of ESP

Coal

Sorbet injection @ 650°F

Residence Time: ~ 2.5 seconds

HCl, SO₂ NOx sampling

P T C

Esp

Stack
Injection Upstream of Baghouse

- Sorbet injection @ 325°F
- Residence Time in duct: ~ 1 second
- Baghouse was cleaned before each run
- HCl, SO₂ NOx sampling
HCl Removal with Sorbent Injected at ESP Inlet
SO$_2$ Removal with Sorbent Injected at ESP Inlet

![Graph showing SO$_2$ removal at ESP inlet with different NSR values and sorbents S200, S250, S350, S450.](image-url)
HCl Removal with Sorbent Injected at Baghouse Inlet

![Graph showing HCl at Stack (lb/MMBtu) vs NSR for different sorbents including S200, S250, S350, and Hydrated Lime. The EPA Limit is 0.002.](image)
SO$_2$ Removal with Sorbent Injected at Baghouse Inlet

![Graph showing SO$_2$ at Stack (lb/MMBtu) vs NSR for different sorbents: S200, S250, S350, and Hydrated Lime.](image-url)
HCl Removal vs. SO₂ Removal - ESP

Injection Upstream of ESP

S200  S250  S350  S450

SO₂ Removal Rate (%)  HCl Removal Rate (%)
HCl Removal vs. SO₂ Removal - Baghouse

Injection Upstream of Baghouse

- S200
- S250
- S350
- Hydrated Lime

SO₂ Removal Rate (%) vs. HCl Removal Rate (%)
Summary

- Dry Injection of trona or sodium bicarbonate is a cost effective way to mitigate HCl, SO$_2$ and SO$_3$.
  - Low capital cost.
  - Compatible with ESP and Baghouses.
- Able to achieve high removal rates for HCl (>99%) and SO$_2$ (>90%)
  - Able to meet the HCl limit in the proposed Utility MACT (0.002 lb/MMBtu)
- Effective over a wide temperature range (275 °F – 1500 °F)
- Has been implemented at many coal-fired power plants in the United States and waste incinerators in Europe.
Questions?

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