SO\textsubscript{2} Control Using Dry Sorbent Injection Technology with Hydrated Lime

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• Why Dry Sorbent Injection (DSI)?
• Hydrated Lime Sorbents
• DSI Case Studies
• Conclusions
• Summary
Why Dry Sorbent Injection (DSI)?
Why Dry Sorbent Injection (DSI)?

- Equipment is low installed capital cost
- System relatively easy to retrofit to most plants
- Small equipment footprint
- Mechanically simple system
- ~1 year schedule
  - ✓ award to installation
- Low consumable requirement
  - ✓ air, power
Hydrated Lime Sorbents
## Range of Products

<table>
<thead>
<tr>
<th>Sorbent</th>
<th>Standard Hydrated Lime</th>
<th>Sorbacal® H</th>
<th>Sorbacal® SP</th>
<th>Sorbacal® SPS</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure</td>
<td><img src="image" alt="Figure" /></td>
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<td><img src="image" alt="Figure" /></td>
<td><img src="image" alt="Figure" /></td>
<td>–</td>
</tr>
<tr>
<td>Typical Available Ca(OH)₂</td>
<td>92 – 95</td>
<td>93</td>
<td>93</td>
<td>93</td>
<td>%</td>
</tr>
<tr>
<td>Typical Surface Area</td>
<td>14 – 18</td>
<td>&gt; 20</td>
<td>~40</td>
<td>~40</td>
<td>m²/g</td>
</tr>
<tr>
<td>Typical Pore Volume</td>
<td>~0.07</td>
<td>0.08</td>
<td>~0.20</td>
<td>~0.20</td>
<td>cm³/g</td>
</tr>
</tbody>
</table>
DSI Case Studies
DSI Case Studies #1a and #1b

- **Application →** Industrial Manufacturing Process
- **Goal →** 95+% \( \text{SO}_2 \) Removal Efficiency
- **Why →** Meet Future \( \text{SO}_2 \) Permit Limit
- **Process →** SDA → Multi-Clone → DSI → FF
- **Flue gas temperature at DSI location** 300-350°F
- **DSI →** One (1) Injection Lance @ Fabric Filter Inlet
- **Sorbent →** Sorbacal® SPS

**Table:**

<table>
<thead>
<tr>
<th>Case</th>
<th>Flue Gas Volume</th>
<th>Moisture Content</th>
<th>Baseline SO(_2) Conc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a</td>
<td>10,000</td>
<td>~14 Vol. %</td>
<td>100 ppmv</td>
</tr>
<tr>
<td>1b</td>
<td>55,000</td>
<td>~36 Vol. %</td>
<td>300 ppmv</td>
</tr>
</tbody>
</table>
DSI Case Studies #1a and #1b

95% SO₂ Removal at Mass Ratio of ~16 lb sorbent / lb Inlet SO₂

95% SO₂ Removal at Mass Ratio of ~4 lb sorbent / lb Inlet SO₂
DSI Case Study #2

- Application → 500 MW Electric Generating Utility (EGU)
- Goal → Increase Overall SO$_2$ Reduction to ~70%
- Why → Meet Future SO$_2$ Limit

```
Low Sulfur Coal → Boiler → Air Heater → DSI → SDA → FF
```

- Process Conditions
  - Flue gas moisture ~20% relative humidity at stack
  - Baseline concentration ~225-250 ppmv SO$_2$
  - Flue gas temperature at DSI location 275-300°F

- DSI → Five (5) Injection Ports @ DSI Location

- Sorbent → Sorbacal® SPS
40-45% Overall SO₂ Removal at Mass Ratio of ~1.25 – 1.50 lb sorbent / lb Inlet SO₂ to achieve 70% SO₂ Removal Overall
DSI Case Study #3

- Application → 985,000 ACFM Cement Plant
- Goal → At Least 50% SO₂ Removal Efficiency
- Why → Comply with Future Permit SO₂ Limit
- Raw Feed & Fuel → Kiln → Pre-Heater → ID Fans → Raw Mill → Fabric Filter
- Process Conditions
  - Flue gas moisture unknown
  - Baseline concentration 15 ppmv SO₂ with Raw Mill on / 35 ppmv SO₂ with Raw Mill off
  - Flue gas temperature at DSI location
    - ID Fan Inlet 575-675°F / Fabric Filter Inlet 370-470°F
- DSI → Four (4) Injection Lances per Duct @ DSI Location
- Sorbent → Sorbacal® SPS
DSI Case Study #4

- Application → 580 SCFM Pilot Plant
- Goal → Compare Relative SO₂ Removal Efficiency
- PRB Coal → Boiler → DSI → Heat Exchanger → ESP

- Process Conditions
  - Flue gas moisture ~9% by Volume
  - Baseline concentration ~150 ppmv SO₂
  - Flue gas temperature at DSI location ~700-750°F

- DSI → One (1) Injection Lance @ DSI Location
- Sorbents → Standard Hydrated Lime & Sorbacal® SPS
DSI Case Study #4

50% SO₂ Removal at Mass Ratio of ~2.7 lb sorbent / lb Inlet SO₂

50% SO₂ Removal at Mass Ratio of ~4.5 lb sorbent / lb Inlet SO₂
Conclusions / Discussion
Conclusions

- All cases were successful in achieving target \( \text{SO}_2 \) removal efficiency using DSI technology with hydrated lime sorbent
- Cases 1a and 1b
  - DSI using Sorbacal\textsuperscript{®} SPS able to achieve high \( \text{SO}_2 \) removal efficiencies (> 95%)
  - Flue gas moisture content appears to be primary factor driving better performance in Case 1b
- Case 2
  - DSI using Sorbacal\textsuperscript{®} SPS effective solution for \( \text{SO}_2 \) trim application even on large scale
Conclusions

• Case 3
  ✓ DSI using Sorbacal® SPS able to achieve target SO$_2$ removal at various injection locations under varying conditions
  ✓ Demonstrated high SO$_2$ removal (85-90%) at three (3) injection locations
  ✓ Illustrates why each site must be evaluated on case by case basis

• Case 4
  ✓ DSI using Sorbacal® SPS was ~40% more efficient than standard hydrated lime for SO$_2$ control at 700-750°F injection temperature based on PRB coal
Summary
Summary

- DSI technology using hydrated lime sorbents viable SO$_2$ compliance solution
- Flue gas moisture important for performance
- Sorbent properties also important
  - standard hydrated lime vs. enhanced hydrated limes
- Path Forward:
  - Additional SO$_2$ trials to understand how different parameters impact performance
  - Improve flue gas to sorbent mixing
  - Improve understanding of impacts of competitive reactions, flue gas temperature, flue gas moisture, sorbents, etc. on SO$_2$ removal
  - High temperature applications (furnace injection)
Thank you!!

If you have any questions feel free to contact,

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