Dry Sorbent Injection - Sodium

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Solvay Chemicals, Inc.

- SCI is headquartered in Houston, TX
- About 900 employees in the NA region
- Focus on soda ash and peroxides
- Other activities in North America include:
  - Plastics
  - Fluorinated products
SOLVAir® Solutions North America

- Chemical products for the air pollution control market
  - Bring expertise to customers, engineering companies, and many others
  - Consists of Sales, Marketing, and Technical support

**SOLVAir® Global Mission Statement:**

To offer and continuously develop competitive and sustainable environmental solutions used for air emissions control and associated waste, which includes a portfolio of products, services, technologies and treatment systems.
What Can DSI Achieve?

- SO$_2$ removal >98%
- SO$_3$ removal to less than measurable
- HCl removal >99%
- DSI is BACT in Europe

- Enhanced mercury removal
  - Better utilization of activated carbon
  - Removal of SO$_3$ interference
- ESP resistivity improvements
Parameters Affecting Performance

- Sorbent injection rate (NSR)
- Sorbent particle size
- Residence time in flue gas stream
- Dispersion and mixing with flue gas
- Particulate control device for capture (ESP vs. Baghouse)
- Flue gas temperature
  - Minimum of 275°F
- Other competing acids in the flue gas (e.g. HCl)
Primary SOLVAir Products for DSI

- **Trona (Select 150 and Select 200)**
  - Natural formed mineral, sodium sesquicarbonate ($\text{Na}_2\text{CO}_3\cdot\text{NaHCO}_3\cdot2\text{H}_2\text{O}$)
  - Mined and produced in Green River, WY
  - $d_{50}$: ~30 µm

- **Sodium bicarbonate (Select 300, Select 350)**
  - Baking soda ($\text{NaHCO}_3$)
  - Produced in Green River, WY and Parachute, CO
  - $d_{50}$: ~140 µm (un-milled Select 300)
  - $d_{50}$: ~15 µm (milled Select 350)
Trona Mining

- Mined underground in Green River WY
- Currently mine ore at depth of ~1500’ (457m)
- 12’ (3.67m) thick bed; very high quality
- Hundreds of years of reserves
  - 4.5 MM tons mined annually by Solvay Chemicals, over 14 MM tons mined in the area
  - Most extracted and converted to sodium carbonate
Current Customer Base

Industries using Sodium Sorbents include:

- Coal-fired Utilities
  - Treating SO$_3$ - “Blue Plume”
  - SO$_2$ control
- Glass Producers
- Industrial – Cement, Ceramic, Chemical, Ethanol
- HCl control
  - Medical Waste Incinerators
  - Secondary Metal Smelters
  - Biomass
- HF Control
  - Fluorine Processors
- Pulp and Paper
Reaction Chemistry
Sodium Sorbent Calcination

- **Trona**
  \[
  2(\text{Na}_2\text{CO}_3\cdot\text{NaHCO}_3\cdot 2\text{H}_2\text{O})_{(s)} + \text{heat (\triangle)} \rightarrow 3\text{Na}_2\text{CO}_3_{(s)} + 5\text{H}_2\text{O}_{(g)} + \text{CO}_2_{(g)}
  \]

- **Sodium Bicarbonate**
  \[
  2\text{NaHCO}_3_{(s)} + \text{heat (\triangle)} \rightarrow \text{Na}_2\text{CO}_3_{(s)} + \text{H}_2\text{O}_{(g)} + \text{CO}_2_{(g)}
  \]
SOLVAir® Select Products: Calcination at >275°F

Trona

Raw

Calcined

Sodium Bicarbonate
Molar & Mass Ratios

**Trona (MW = 226)**
- **Molar Ratios**
  - 2 mol trona/3 mol SO₂
  - 2 mol trona/3 mol SO₃
  - 1 mol trona/3 mol HCl

**Sodium Bicarbonate (MW = 84)**
- **Molar Ratios**
  - 2 mol SBC/1 mol SO₂
  - 1 mol SBC/1 mol HCl

**Mass Ratios**
- 2.35 lbs trona/lb SO₂
- 1.88 lbs trona/lb SO₃
- 2.09 lbs trona/lb HCl

**Mass Ratios**
- 2.63 lbs SBC/lb SO₂
- 2.30 lbs SBC/lb HCl

**Normalized Stoichiometric Ratio (NSR)**
- Actual usage needed accounting compared to the theoretical need

\[
NSR = \left( \frac{\text{Total Mass DSI}}{\text{Total Mass } SO_2} \right) / \text{Ideal Stoichiometric Ratio}
\]
Performance Curve for SO$_2$ Trona Used at ESP Installations

These curves are based on actual plant trials and are representative of systems with good design practices. Individual results will vary. Contact your SOLVAir Solutions representative for more information. All technical advice and recommendations provided, if any, are intended for use by persons having the appropriate education and skill. Solvay Chemicals, Inc. and its affiliates shall not be liable for any use or non-use of such advice and/or recommendations. Users of our products are solely responsible for the design, construction and operation of their own facilities.
Performance Curve for SO$_2$
Trona Used at BHF Applications

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Performance Curve for $\text{SO}_2$
Sodium Bicarbonate Used at ESP Applications

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Performance Curve for $\text{SO}_2$
Sodium Bicarbonate Used at BHF Applications

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SO$_2$ & HCl Interaction
Using Select 300 on an ESP

Test Information
Goal: Evaluate 3 levels of SO$_2$ removal (20%, 40%, 60%) and corresponding HCl removal
Temperature: 330-385$^\circ$F
SO$_2$: 330 lb/hr (avg)
HCl: 32 lb/hr (avg)
Fly Ash Considerations

- Higher sodium content in the fly ash
- Ash from SO$_3$ treatment may be okay to market
- Ash from SO$_2$ treatment typically not suitable for applications in concrete or structural fill
- Additional heavy metals capture in the ash
- Disposal issues should be investigated early in the process; check properties and work closely with ash marketers.
Typical Capital Costs

- Silo, blowers, controls, lines, splitters, lances, mill
- Large systems with rail unloading and milling about $10 to $15 million (8 – 10 TPH)
- Utility scale systems designed for truck unloading $3 to $8 million (1 – 5 TPH)
- Industrial scale systems $0.5 to $3 million (<1 TPH)
- Milling adds to the capital cost but reduces the operating cost
- May vary based on site installation costs
Summary

- Sodium sorbents are efficient at treating acid gases with other positive benefits
- Low capital investment
- Network of terminals and dedicated railcars for distribution
- Experience of over 20 years in the air pollution control market
- Additional information at www.solvair.us
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