What is Trona?

- Trona is a ore that is mined underground
- Trona is naturally formed sodium sesquicarbonate
  \[ \text{Na}_2\text{CO}_3 \cdot \text{NaHCO}_3 \cdot 2\text{H}_2\text{O} \]
- Green River formation
- Numerous beds of Trona
- Contain billions of tons of Trona
Solvay Chemicals Operations

- Solvay Chemicals, Inc. Currently Mines Trona Ore at an Approximate Depth of 1500’ (457m)
- 12’ (3.67m) Thick and of Very High Quality
- Provide Ore for Many Years
- Use Both Longwall Mining and Bore Miners
Room and Pillar Mining
Trona Dry Sorbent Injection (DSI)

- “Popcorn Effect”
  - ...5 to 20 times the original surface area

- $2(\text{Na}_2\text{CO}_3 \cdot \text{NaHCO}_3 \cdot 2\text{H}_2\text{O}) \rightarrow$

  $3\text{Na}_2 \text{CO}_3 + \text{CO}_2 + 5\text{H}_2\text{O}$
Trona SEM After Calcination
Trona DSC

Sample: T-200
Size: 30.1090 mg
Method: 25 to 625 and back
Comment: 25-625 at 5C/min

DSC

File: C:\DSC\Solvay\T200.001
Operator: JM
Run Date: 11-Nov-03 10:03

113.00°C
863.0 J/g

321.75°C

247.74°C
98.91 J/g

128.64°C

Heat Flow (W/g)

Temperature (°C)

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Trona DSI Chemistry

2(Na₂CO₃•NaHCO₃•2H₂O) + 3SO₃ → 3NaSO₄ + 5H₂O + 4CO₂

2(Na₂CO₃•NaHCO₃•2H₂O) + 3SO₂ → 3Na₂SO₃ + 4CO₂ + 5H₂O

3Na₂SO₃ + 1.5O₂ → 3Na₂SO₄
Parameters - Constraints That Affect Sorbent Utilization:

- **Sorbent Injection Rate**
- **NSR (Normalized Stoichiometric Ratio)**
- **Sorbent Particle Size**
- **Sorbent Residence Time In The Flue Gas Stream**
- **Sorbent Penetration And Mixing Within The Flue Gas**
- **Particulate Control Device Used**
- **Other Acids**
Trona DSI with Baghouse

SO\textsubscript{2} Removal

% Removal

0% 20% 40% 60% 80% 100%

0 0.5 1 1.5 2 2.5

NSR

Trona  Soda Ash
Impact of Particle Size on Trona Performance @325°F

Effect of Sorbent Size @ NSR 1
Source: Solvay Chemicals

%SO2 Removal

microns

11 14 32 65 93
Trona DSI @ Baghouse Conditions

SO₂ Removal

% SO₂ Removal

NSR

- PSD is very important to SO₂ Removal Efficiency.

T200
<38 micron
Case Study at a Glass Furnace in California

- A Glass Plant Was Having Operational Problems With A Dry Sorbent $SO_x$ Mitigation System
- Sodium Bicarbonate Crystals Were Being Milled And Then Dry Injected Into The Duct From The Furnace Just Prior To The Hot Side ESP
- The Perf Plates Would Plug Quickly Causing Frequent Shutdowns
- After XRD And DSC Analyses They Lowered The Injection Temperature By Adding Outside Air.
- The Lower Injection Temperature Delayed The Pluggage By Several Days But Did Not Solve The Problem
ESP Perf Plates Using Sodium Bicarbonate

>700°F
Perf Plates Using Sodium Bicarbonate at 550°F
Sodium Sulphate III

Sample: CESP Inlet
Size: 19.5850 mg
Method: 25 to 625 and back
Comment: 25-625 at 5/min

DSC

File: C:\\Solx\CESP Inlet.001
Operator: JM
Run Date: 10-Nov-03 08:30

Heat Flow (mW/g)

Temperature (°C)

249.96 °C
314.44 °C
208.81 °C
26.33 J/g
4.941 J/g
238.65 °C

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Case Study at a Glass Plant in California (continued)

- The Glass Company Decided To Test Trona
- T200 Performed Much Better At The >700°F Injection Temperature Range
  - Higher SO\textsubscript{x} Removals
  - Higher Utilization Efficiency
  - Air Cooling At The Injection Point Is Not Necessary
  - Milling T200 Had Only A 5% Utilization Efficiency Improvement Over Sodium Bicarbonate
- No Plugging Occurred
SO2 Removal w/ Trona @ Glass Plant

SO2 Removal

NSR

50% 60% 70% 80% 90% 100%

1.05 1.05 1.19 1.40 1.50 1.50 1.50 1.50 1.50 1.50 1.50 2.74

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Trona DSI

SOx Removal w/ Trona @ Glass Plant

SOx Removal

% of 100%

50%

55%

60%

65%

70%

75%

80%

85%

90%

95%

100%

530 550 700 710 725 750 750 805 805

°F
Perf Plate Before Hot Side of ESP in Previous Slide After Two Weeks of T200 DSI and still “clean as a whistle”
Test Data, continued

Figure 5:
Gavin Unit 2: SO$_3$ Reduction
Lime and Trona Data: SCR Out of Service

% SO$_3$ Reduction Measured at ESP

Outlet

% SO$_3$ Reduction Measured at ESP

Moles Sorbent : Moles SO$_3$

- Trona - No ESP Conditioning
- Trona ESP Conditioned
- Lime

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Trona DSI Benefits

- High Removals With Low Cost Position
  - Low Initial Capital
  - Low Sorbent Cost
  - High SO\(_x\) Removal
- Saved The Glass Plant $$$/Ton Of SO\(_x\) Removal Costs Via SBC
- Milling Improved T200 SO\(_x\) Removal Efficiency By 5 - 10%
- Spent Sorbent And Unused Sorbent Can Be Sent Back To Furnace
Typical Trona DSI Loading/Storage System

TRONA INJECTION SYSTEM FOR SO2 REDUCTION
Dry Sorbent Injection (DSI)

- **Dry Sorbent Injection Of T200 Is A Very Cost Effective Way To Mitigate Acid Gas Emissions.**
  - Low Capital
  - Does Not Require Heating Of Tanks Or Lines
  - Requires Few Mechanical Parts
  - Compatible With ESPs, Baghouses And Most Wet Scrubbers
- **Will React With Acid Gases Over A Wide Temperature Range (275°F - 1800°F)**
- **Trona Sorbent Specifically Designed To Be Used For Neutralization Of Acid Gases That Can Be In Emissions From Boilers, Kilns, Combustors, Furnaces And Incinerators.**
DSI of Trona

- Because of the positive effect sodium has on the resistivity of particles, it is not detrimental to the operation of an ESP and can actually enhance its operation.
- Trona will act as a precoat on baghouse filter media.
- Trona for DSI is a fine ($D_{50}$ 30-35µ) material that can be easily aerated for pneumatic transfer.
- Trona for DSI can be used as is or milled to a smaller size.
The End