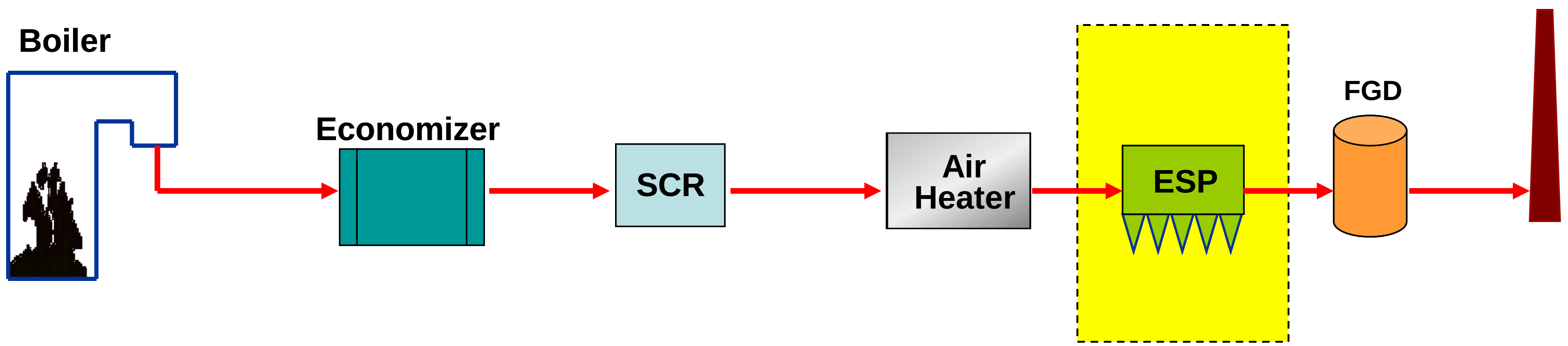
A Better Alternative to SO_3 for conditioning Electrostatic Precipitators (ESP)

Yougen Kong, Ph.D., P.E.
Solvay Chemicals, Inc.

McIlvaine Company Hot Topic Hour on
"Improving ESP Performance"
January 20, 2011

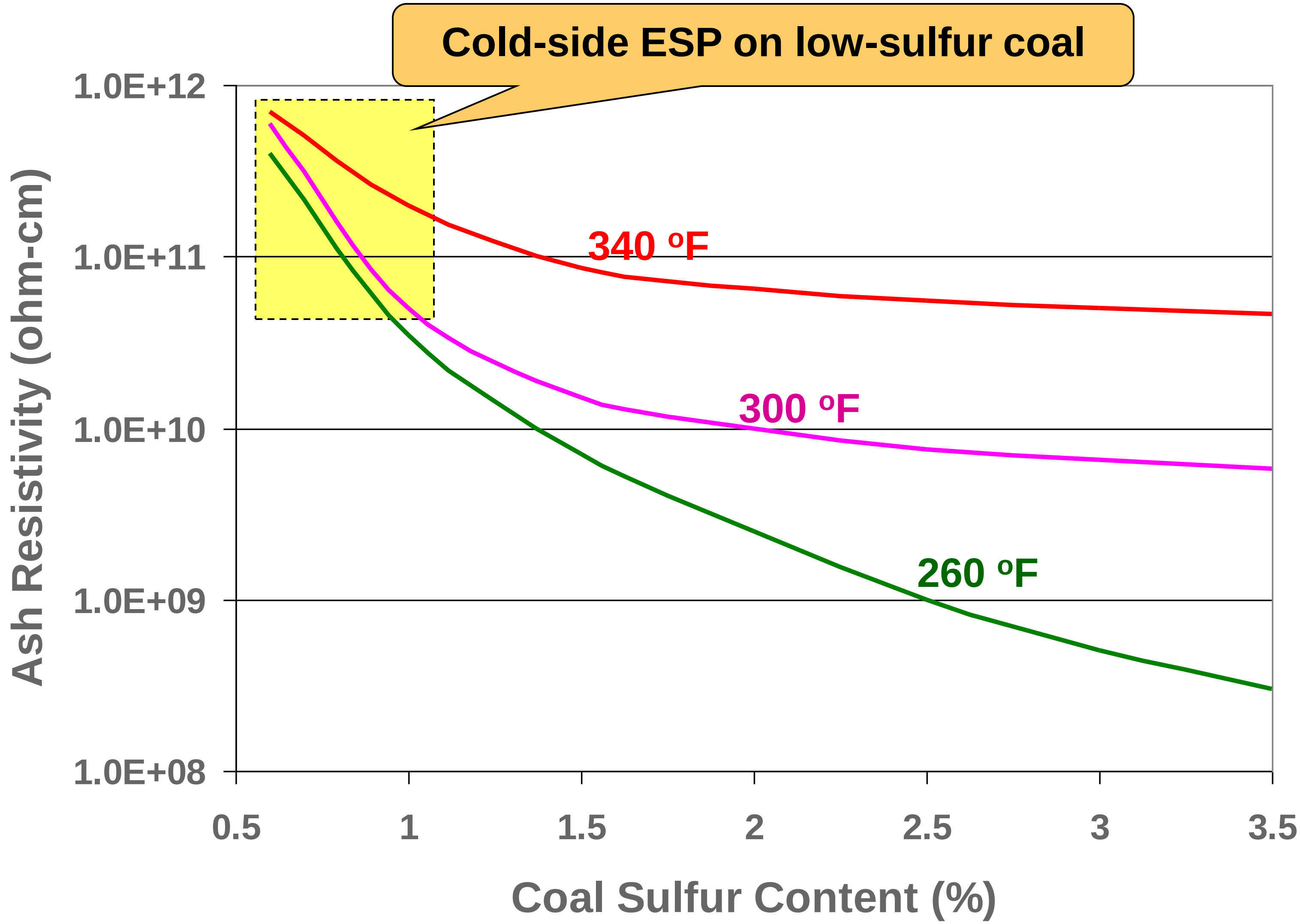
Solvay
Chemicals

Cold-side ESP Performance

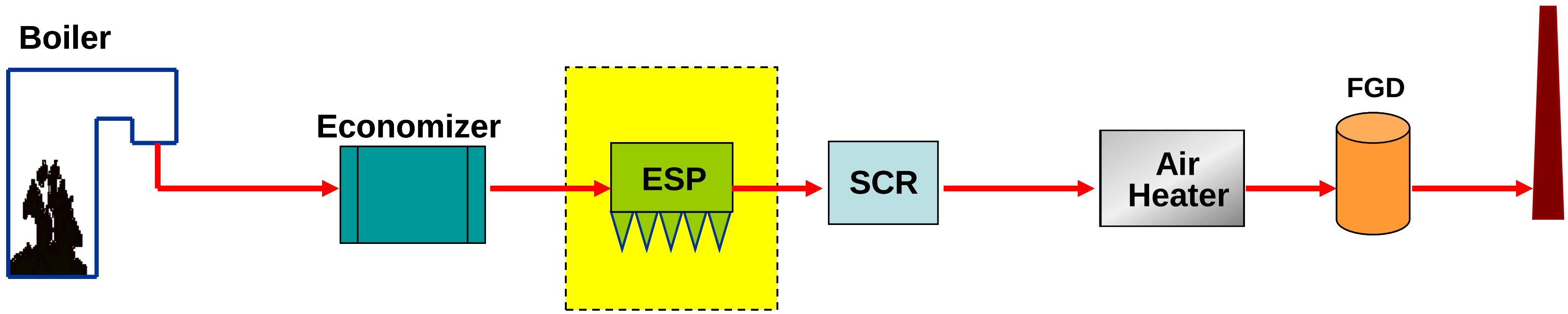


- High ash resistivity at typical cold-side ESP operating temperatures (250 – 350 ºF), especially with low-sulfur coal, causes poor ESP performance.
- PRB coal has high calcium content. Calcium and magnesium lower ESP performance through increased resistivity effects.

Effects of Sulfur and Temperature on Ash Resistivity



Hot-side ESP Performance



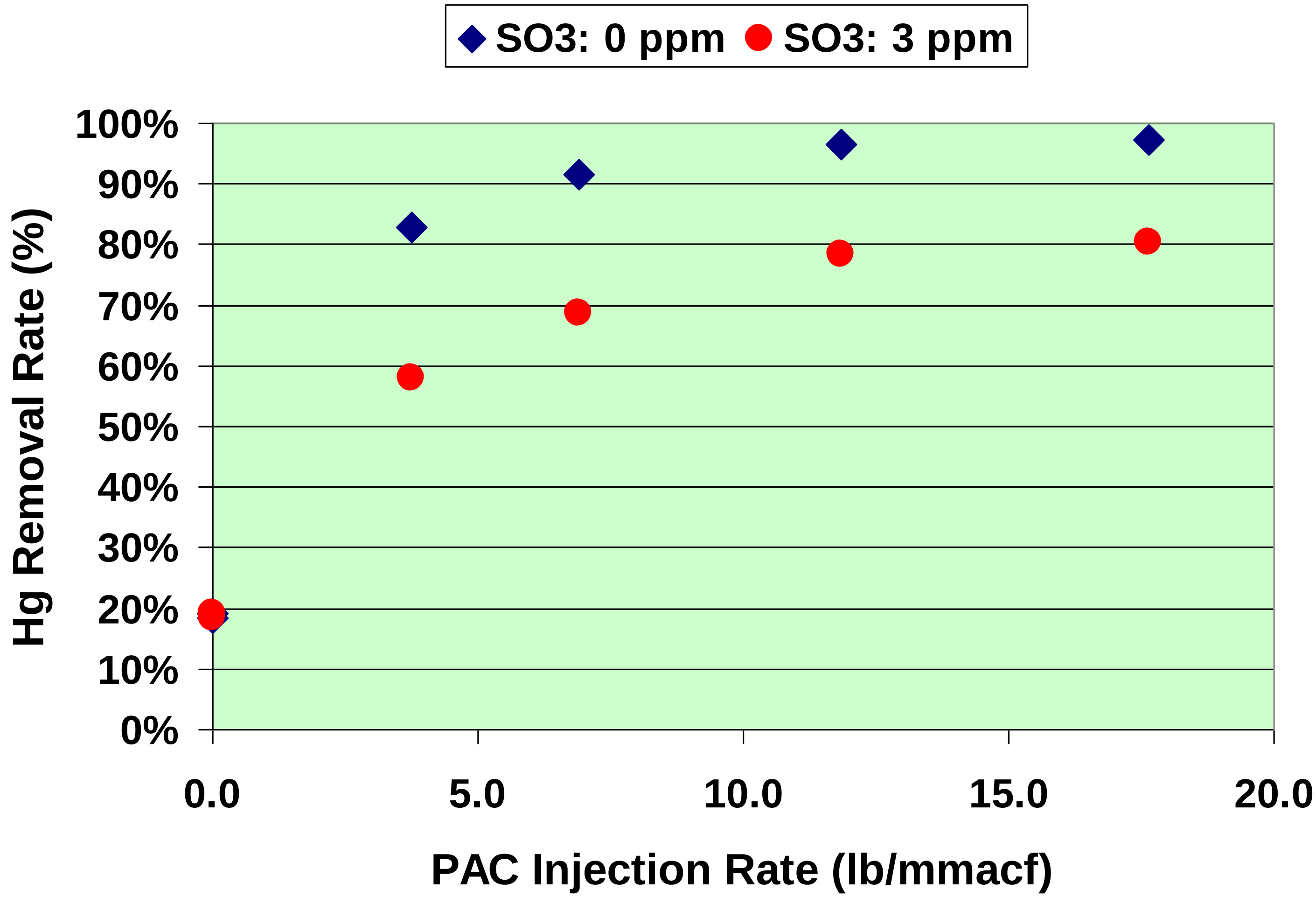
- Significant decrease in fly ash resistivity at flue gas temperatures above 600 ºF – good!
- However, back corona causes poor hot-side ESP performance in units treating both eastern and western low-sulfur coal ashes.
- Back corona is caused by "sodium depletion" that occurs in the layer of ash permanently residing on the collection plate. This depletion leads to an increase in the electrical resistivity of the ash to an unacceptable level (from $1 \times 10^9 \sim 5 \times 10^{10}$ to 1×10^{11} to 5×10^{12} ohm-cm) because sodium ions are the principal carriers of electrical charge in the ash at elevated temperatures, thus inhibiting normal ESP operation.

Increase sodium in fly ash is the solution!

Traditional Solution: Injecting SO_3

- Inject SO_3 to lower the ash resistivity for cold-side ESP.
- SO_3 concentration in flue gas @ 6 ~ 10 ppm is normally enough.
- Injecting SO_3 does NOT solve the problem of sodium depletion of hot-side ESP.

Negative Effect of SO_3 on Mercury Removal



- **350 MW boiler burning low-sulfur coal**
- **SO_3 measured at SCR Outlet**

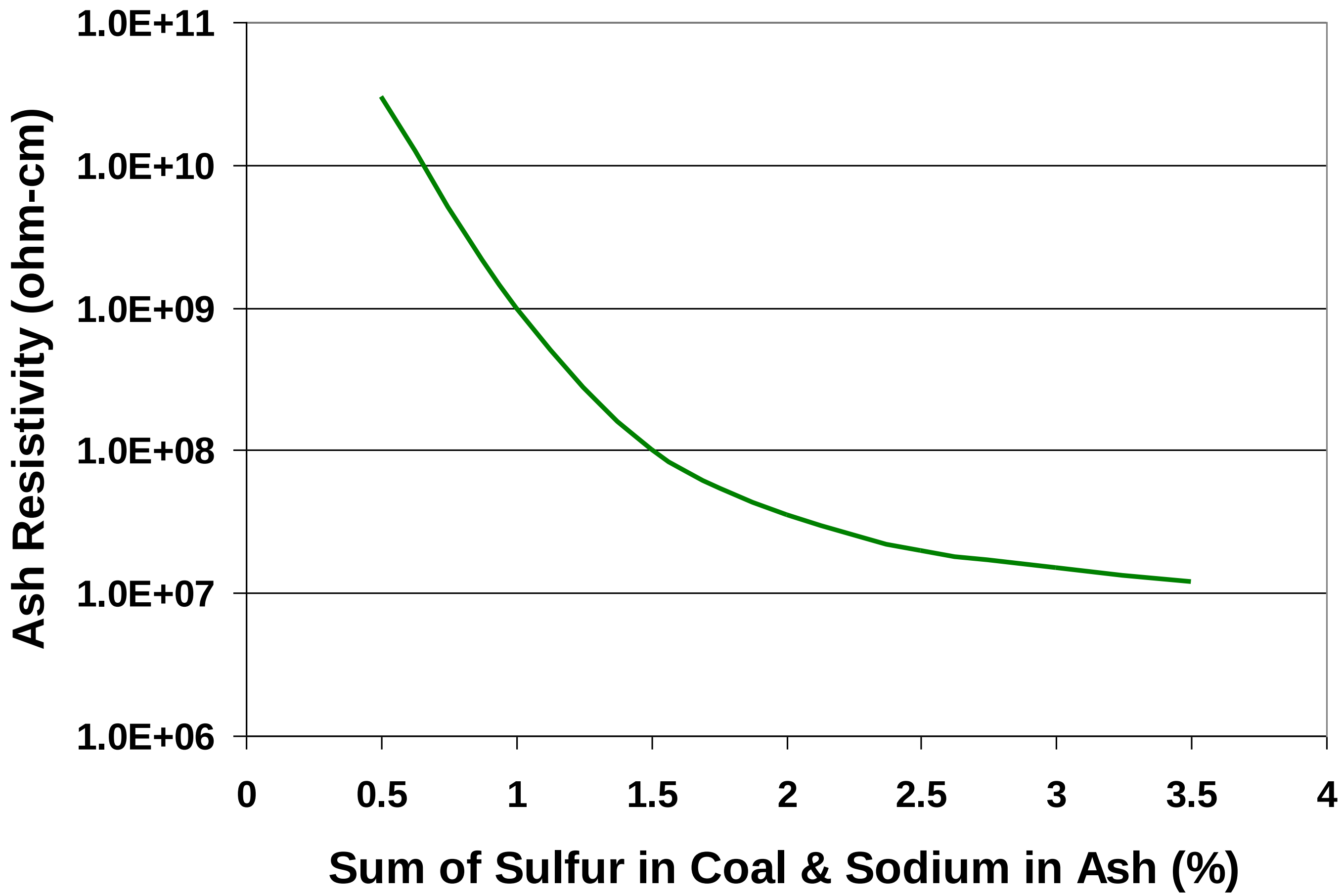
Problem: Mercury

- **EPA will set standards for mercury and a number of other toxics by late 2011.**
- **23 states require coal-fired utilities to reduce their mercury emissions by 80 ~ 90% (Michigan, New Jersey, Massachusetts, Illinois, …).**

Solution: Sodium

- **Use Sodium compounds to condition ESP and remove SO_3**
  - **One stone to hit two birds!**

Sodium Reduces Ash Resistivity



Effect of increasing sodium content in ash is same as sulfur in coal!

Traditional Sodium Addition

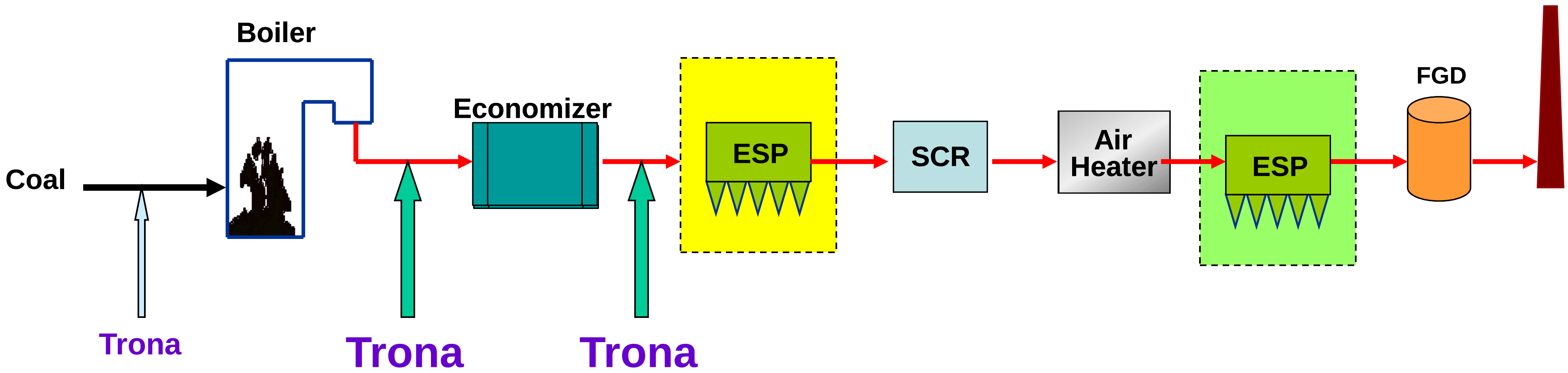
- The most common conditioning agents are sodium sulfate (Na_2SO_4) and sodium carbonate (Na_2CO_3).
- The material is spread on coal as the coal is being transported to the bunkers.
- Typical application rates:
  - Na_2SO_4: 5 lbs/ton of coal
  - Na_2CO_3: 3.75 lbs/ton of coal
  - These chemical addition rates will typically increase the magnitude of the ash sodium content by about 0.5%.

Issues with Na_2CO_3 and Na_2SO_4

- **Cost:**
  - **Na_2CO_3: ~ $200/t**
  - **Na_2SO_4: ~ $300/t**
- **Too much sodium in coal poses the risk of causing slagging in boilers.**
  - **Melting point of Na_2CO_3 : 1564 ^oF (851 ^oC)**
  - **Melting point of Na_2SO_4 : 1623 ^oF (884 ^oC)**

Solutions

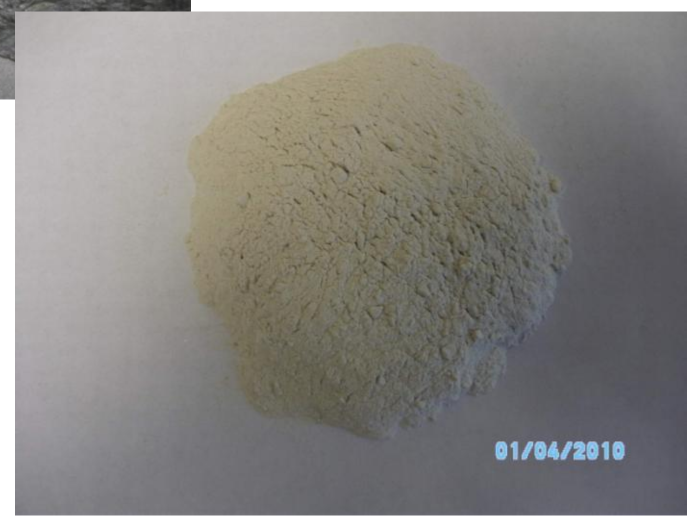
- Introduce a low-cost sodium compound downstream of combustion zone (< 1500 ºF).
- Use trona instead of Na_2CO_3 and Na_2SO_4 as the source of sodium.
- Spray trona onto coal only IF a small amount of additional sodium is needed.



Low capital and O&M costs!

What is Trona?

- Trona is an ore mined underground
- Trona is naturally formed sodium sesquicarbonate ($Na_2CO_3 \bullet NaHCO_3 \bullet 2H_2O$)
- Green River, Wyoming, has billions of tons of Trona



$$2(Na_2CO_3 \cdot NaHCO_3 \cdot 2H_2O)(s) + \text{heat} \rightarrow 3Na_2CO_3(s) + 5H_2O(g) + CO_2(g)$$

Trona Injection Test Results

- Trona was injected upstream of a hot-side ESP (100 MW boiler).
- 32 tests were conducted at various unit loads and on both Central Appalachian and Colombian coals (representing two different low-sulfur coals).
- Opacity was continuously monitored during the entire test period. It remained consistently below 4% with no spikes.
- Up to 80% SO_2 was removed.

	Baseline	Trona Injection
PM10 (lb/MBtu)	0.035	0.019

SOLVAir PRODUCTS

For more information, please contact:

Yougen Kong, P.E., Ph.D.
Solvay Chemicals, Inc.
3333 Richmond Avenue
Houston, TX 77098
Phone: 713-525-6890
Yougen.Kong@solvay.com

www.solvair.us