REINHOLD ENVIRONMENTAL Ltd.

2015 APC Round Table & Expo Presentation

July 13 & 14, 2015, in Atlanta, GA / Hosted by Southern Company

Case Studies: Using Trona, SBC, and Hydrated Lime for High Level SO_2 Removal

Reinhold APC Conference

July 14, 2015

Topics

- Case Study 1 – 600 MW Unit Using Trona
  - Unit and DSI System Description
  - SO_2 Reduction Performance
  - Balance of Plant Effects
  - Lessons learned
- Case Study 2 – 400 MW Unit Using SBC
  - Unit and DSI System Description
  - SO_2 Reduction Performance
  - Balance of Plant Effects
  - Lessons learned
- Case Study 3 – 350 MW Unit Using Hydrated Lime
  - Unit and DSI System Description
  - SO_2 Reduction Performance

UCC Dry Sorbent Injection

CASE STUDY 1
LARGE SO_2 REDUCTION DSI SYSTEM USING TRONA

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Case Study 1 – Unit Description

- 600 MW Unit
- PRB Coal
- SCR, Cold Side ESP
- ACI System
- Ash Landfilled On-site

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Case Study 1 – DSI System Description

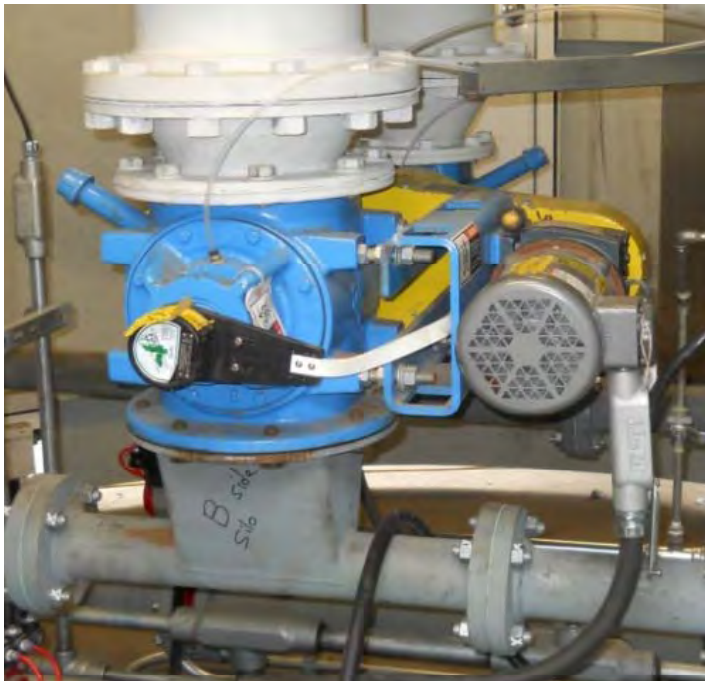
- In-line milled trona injection
- Injection at air heater inlet
- Four silos, over 120 feet tall, with common stair tower
- Rail unloading
- Screw feeder/rotary air lock design
- Conditioned rail unloading and conveying air
- Two VIPER® Mills
- Blower building
- Electrical building
- Mill building

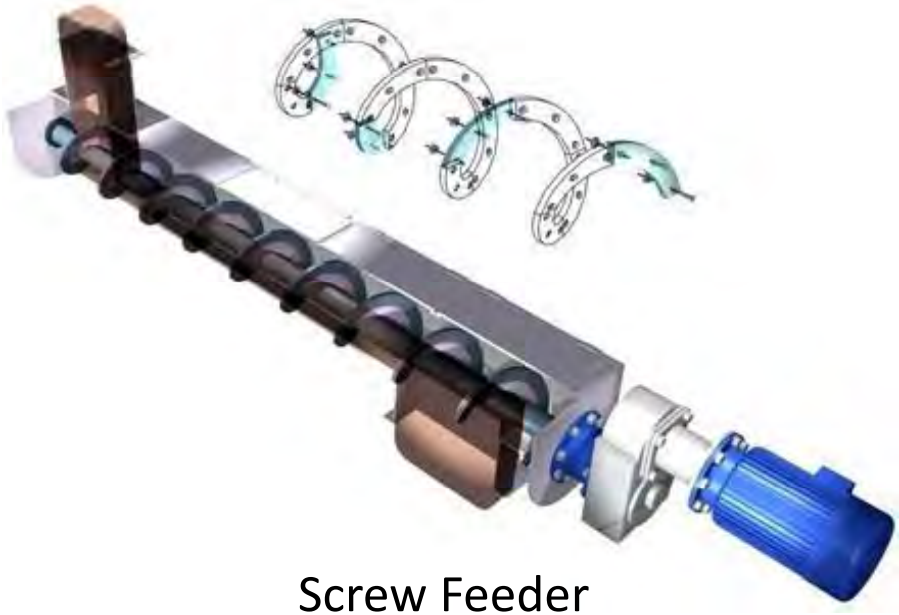
Case Study 1 – DSI System Description

- Silos
  - Two piece design
    - Welded on site
  - Bin Activators
  - All equipment Installed on site

Case Study 1 – DSI System Description

Rotary Airlock





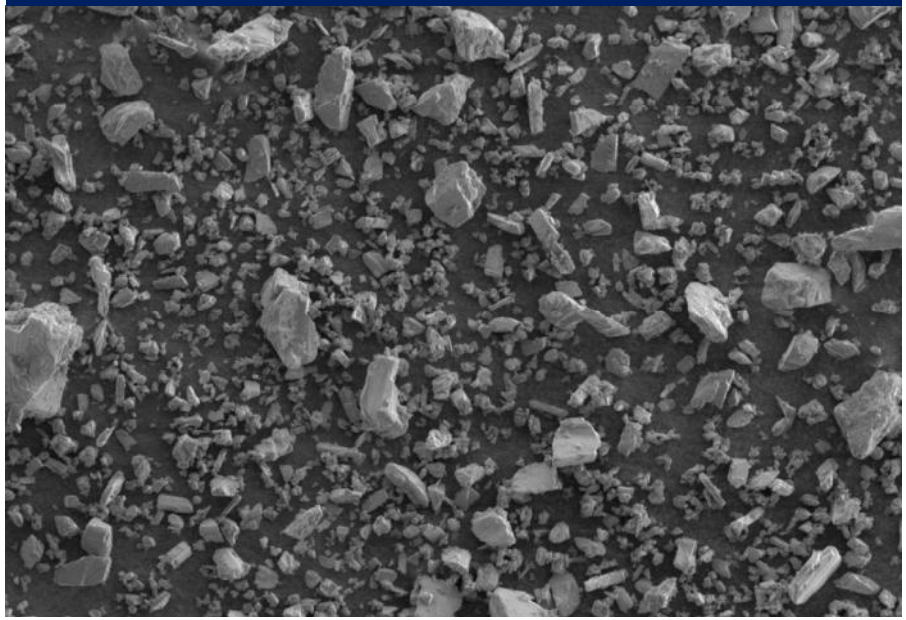
Screw Feeder

Case Study 1 – DSI System Description

- UCC VIPER Mills
  - Two mills with approximately 1 ½ years of run time
  - No wear issues observed and no downtime

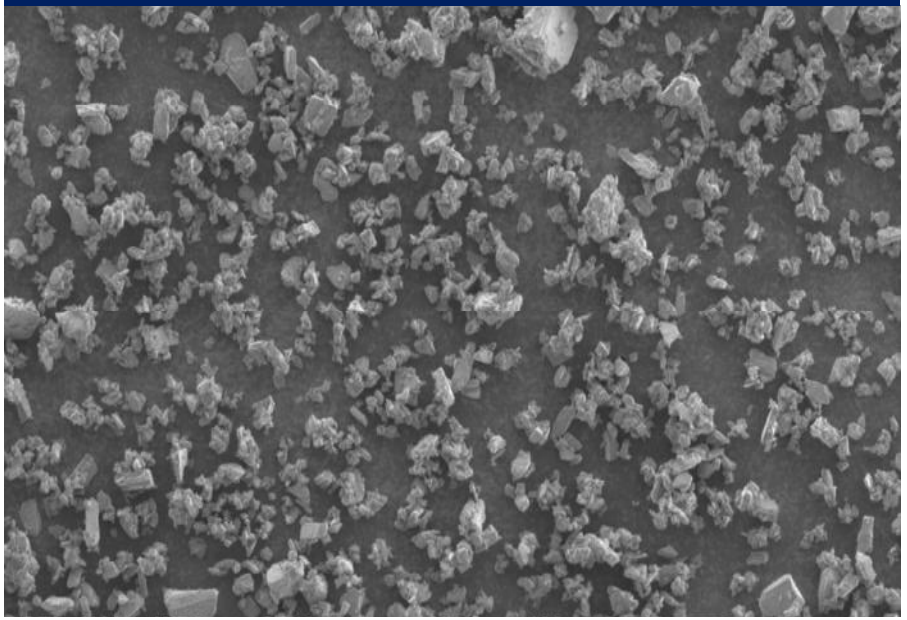
Case Study 1 – DSI System Description

Unmilled Trona



30-50 μm

Milled Trona



9 -15 μm

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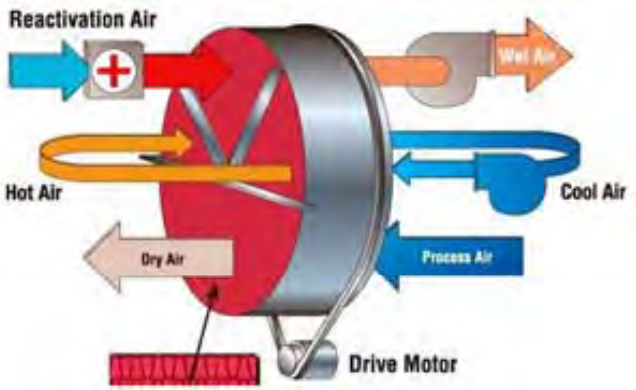
Case Study 1 – DSI System Description

Convey Air Conditioning



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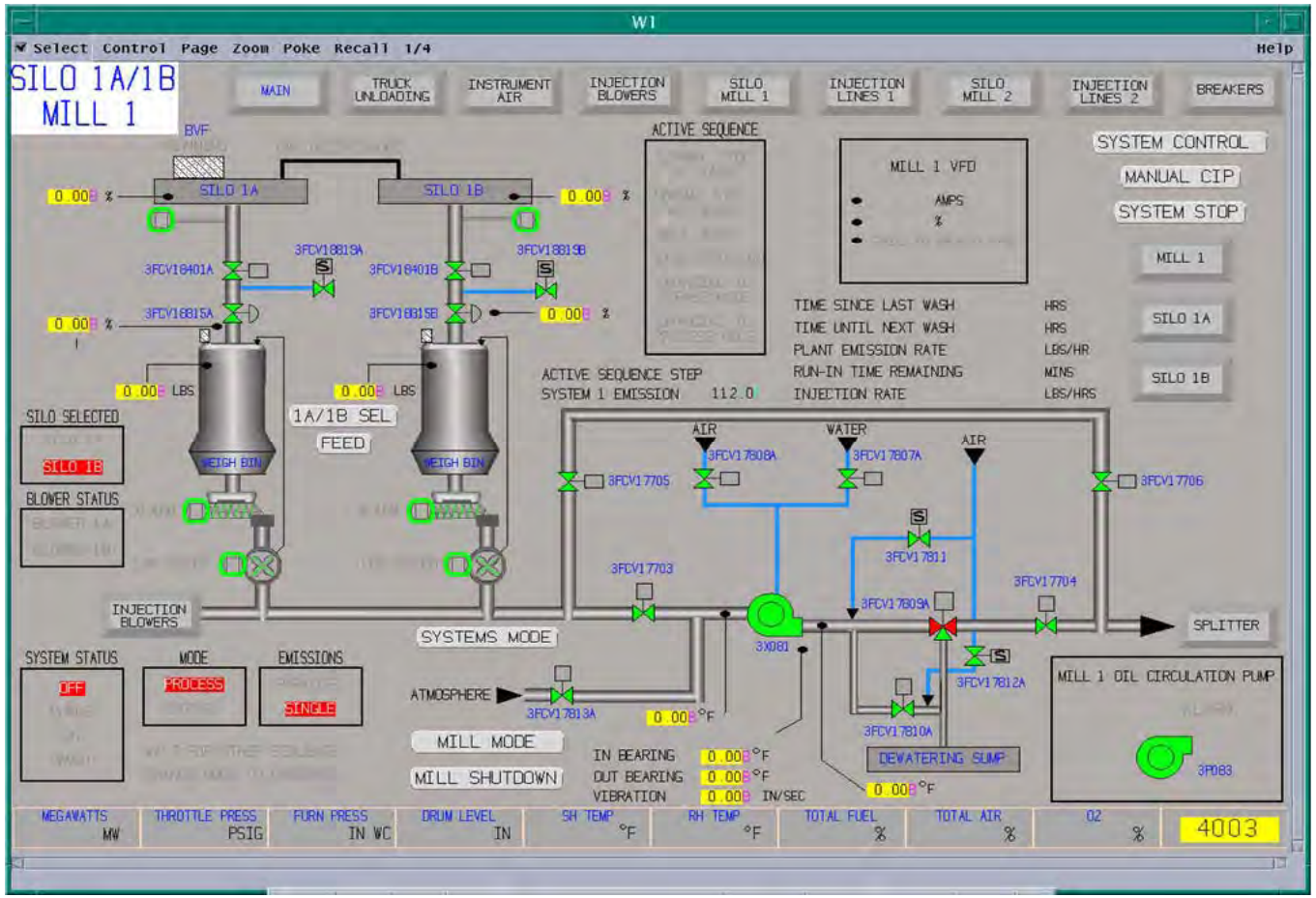
Case Study 1 – DSI System Description

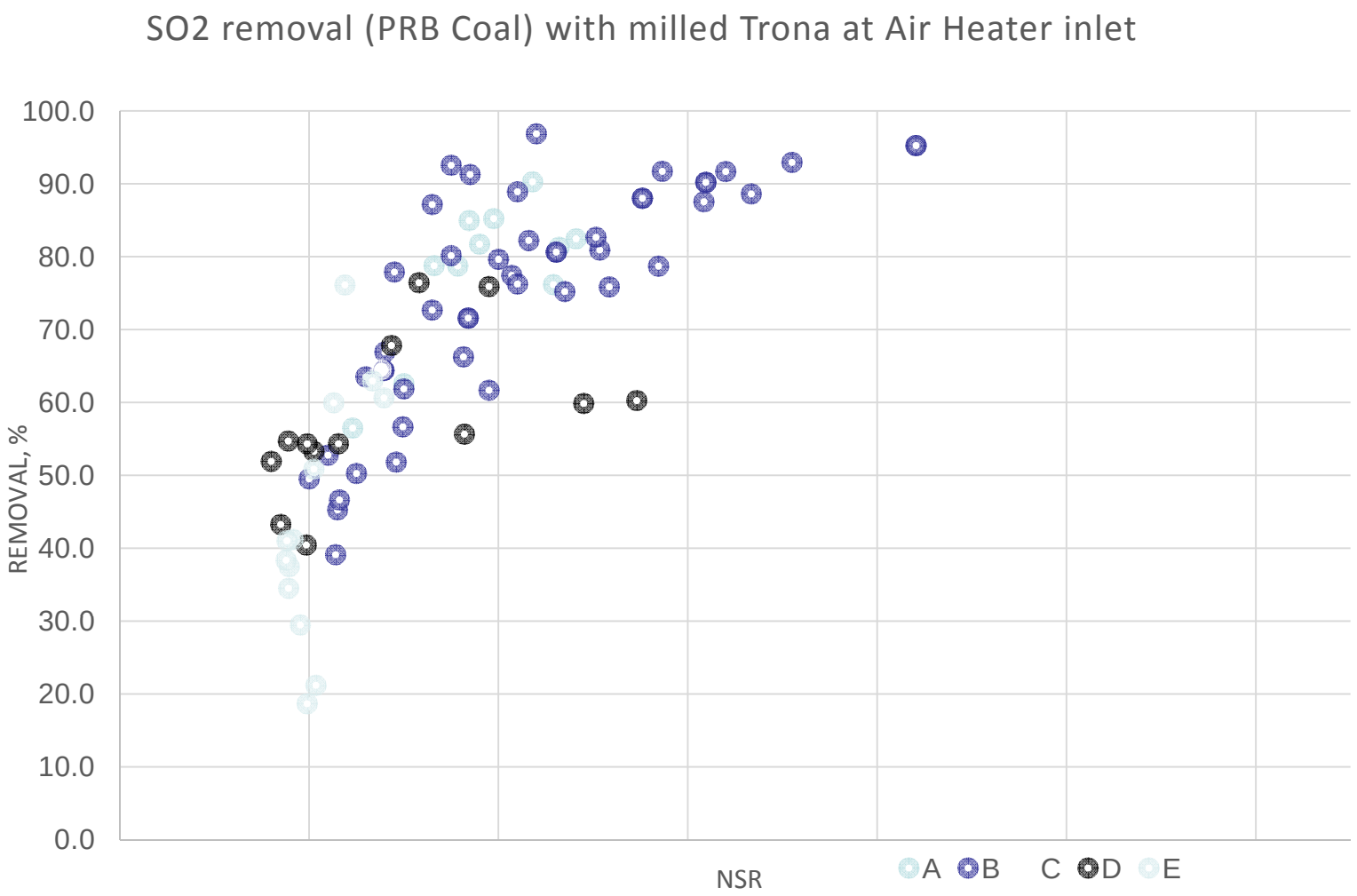
Injection Lances

Case Study 1 – DSI System Description

DCS Controls



Case Study 1 - SO_2 Reduction Performance



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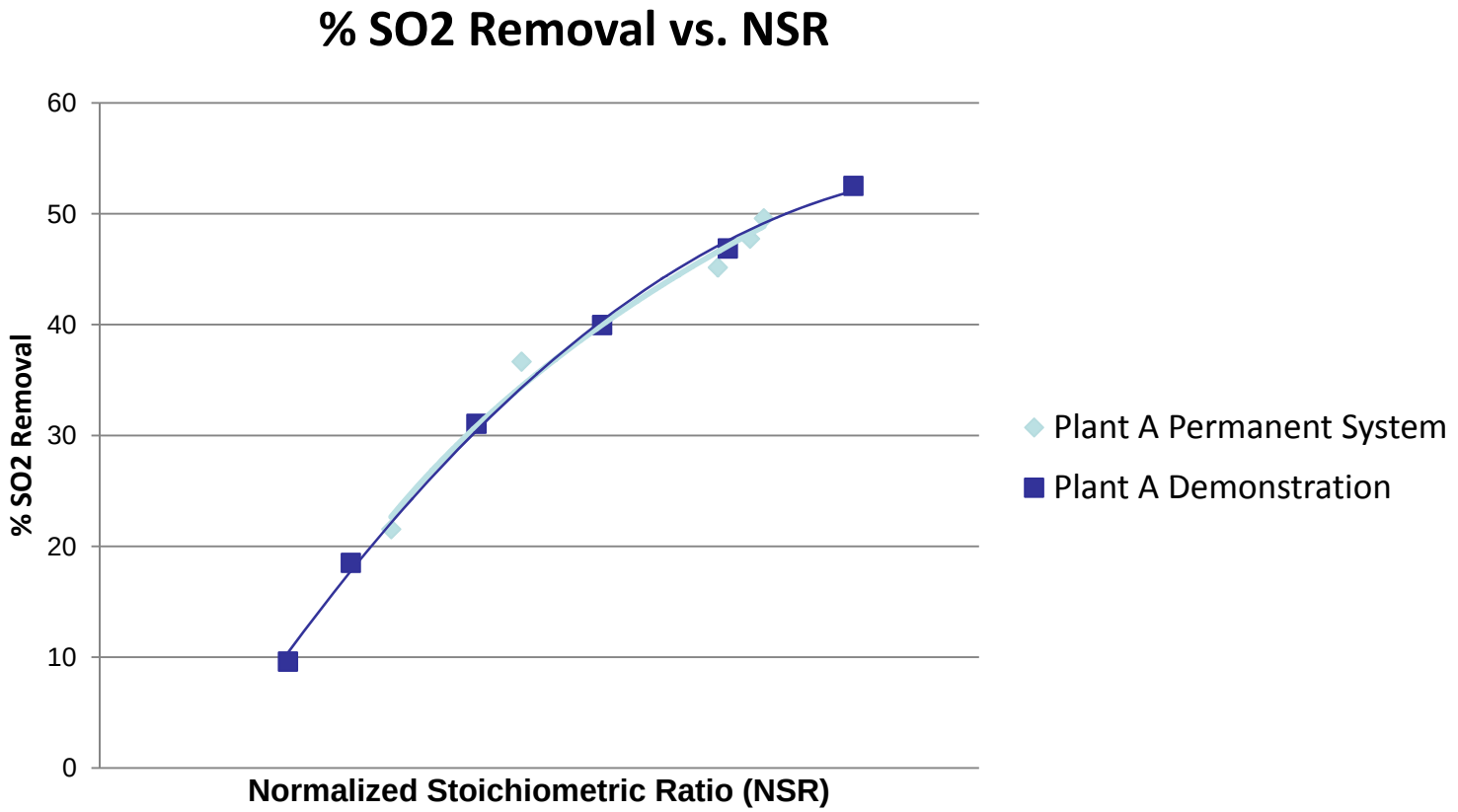
Case Study 1 - SO_2 Reduction Performance



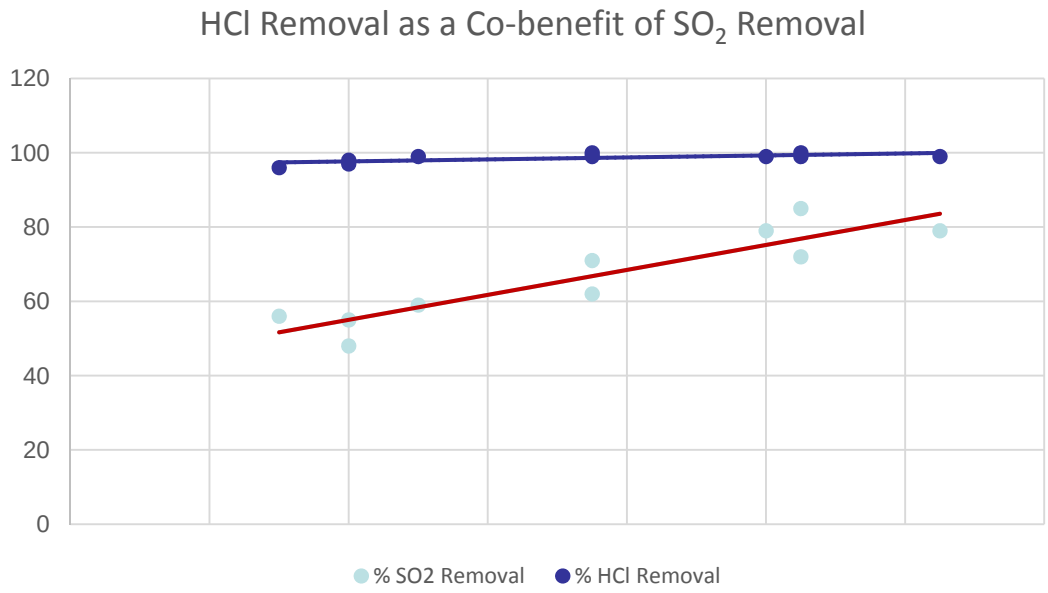
- CFD modeling was completed prior to demonstration to optimize results of test

Case Study 1 – Balance of Plant Effects

- Air Heater – No effect observed
  - Typical for SO2 reduction DSI systems
- ESP
  - Initially found ash build-up in ESP hoppers
    - Traced to leakage
    - Possibly made worse due to sodium content
  - No increase in particulate emissions or Opacity
    - Typical for sodium injection systems
- Ash Handling
  - Additional ash loading minimal
    - Ash loading increase approximately 75% of trona injected
  - No landfill issues reported

Case Study 1 – Balance of Plant Effects

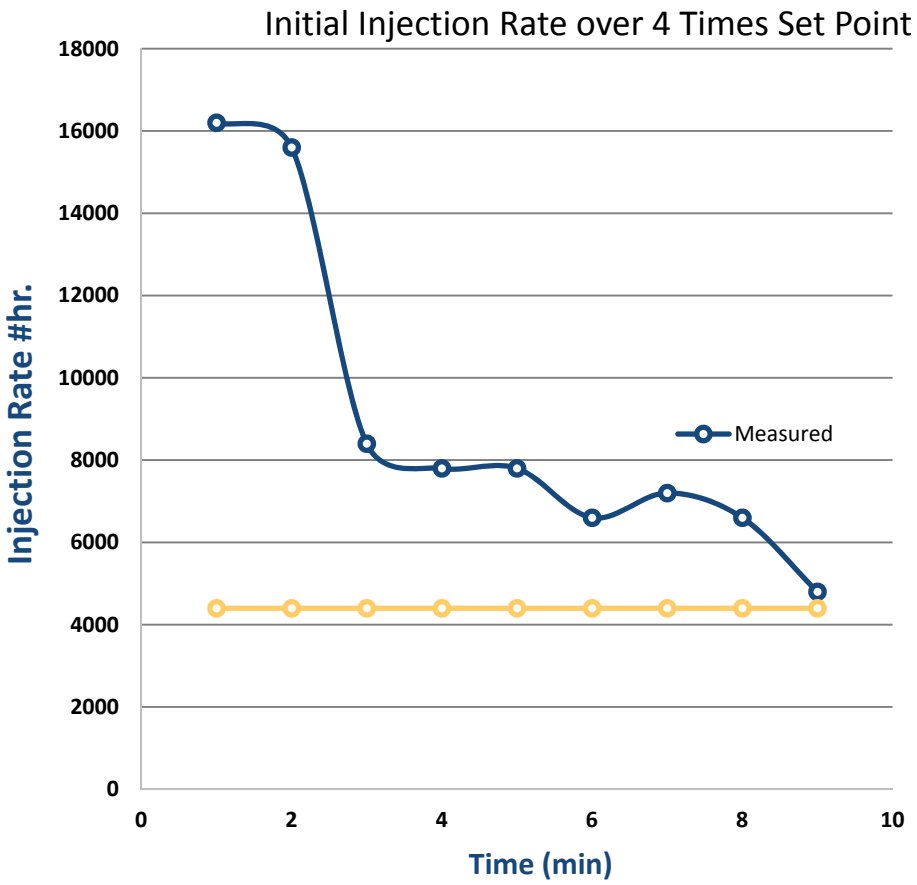
- Mercury Removal
  - Initially required up to 3X more PAC when trona used
  - Were able to nearly eliminate effects by separating trona and ACI
- HCl Removal as a Co-benefit



Case Study 1 – Lessons Learned

- Uncontrolled Trona Feed into System
  - Tightened screw clearances
- Over pressurization of Screw Feeders
  - Improved venting
- Control System / Loss in Weight System Tuning
  - Changed logic
- Because both ACI and DSI had to be at air heater inlet, separated by center vs outer edge of duct instead of upstream/downstream

Case Study 1 – Lessons Learned



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CASE STUDY 2
LARGE SO_2 REDUCTION DSI SYSTEM USING SBC

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Case Study 2 – Unit Description

- 400 MW Unit
- PRB Coal
- Hot Side ESP
- Fabric Filter
- ACI System
- Ash Landfilled after mixing with SBC byproduct

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Case Study 2 – DSI System Description

- In-line milled sodium bicarbonate injection
- Injection at air heater outlet
- Four silos, 100 feet tall, with common stair tower
- Truck unloading
- Screw feeder/rotary air lock design
- VIPER® Mills
- Blower/electrical building
- Mill building
- Conditioned truck unload and conveying air

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Case Study 2 – DSI System Description

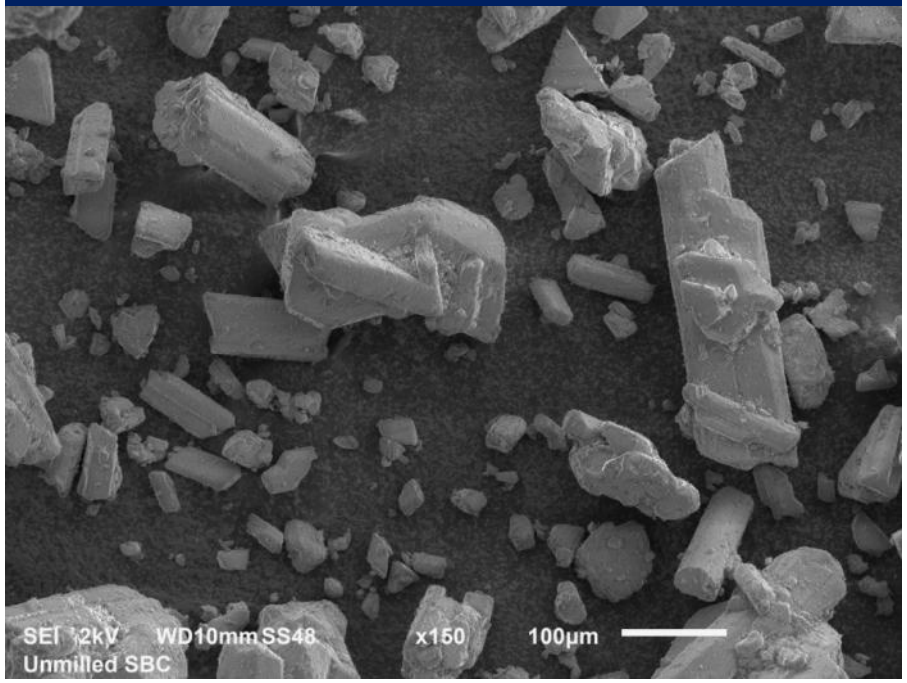
- Silos
  - One piece design
  - Chisel bottom
  - All equipment installed on site

Case Study 2 – DSI System Description

- UCC VIPER Mills
  - Three mills
  - Approx. 1-year run time to date

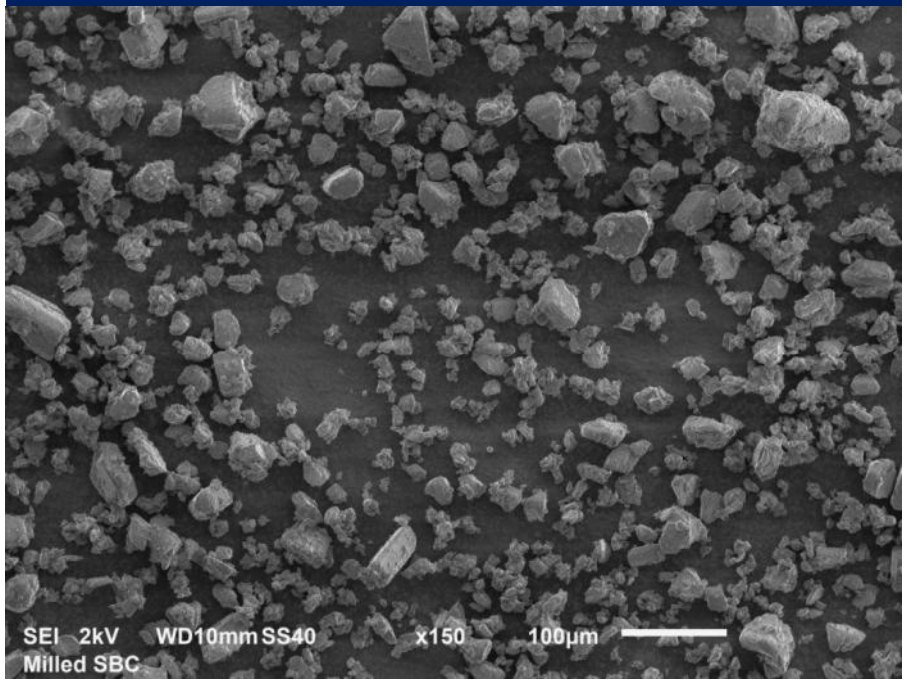
Case Study 2 – DSI System Description

Unmilled SBC



180-250 µm

Milled SBC



12-15 µm

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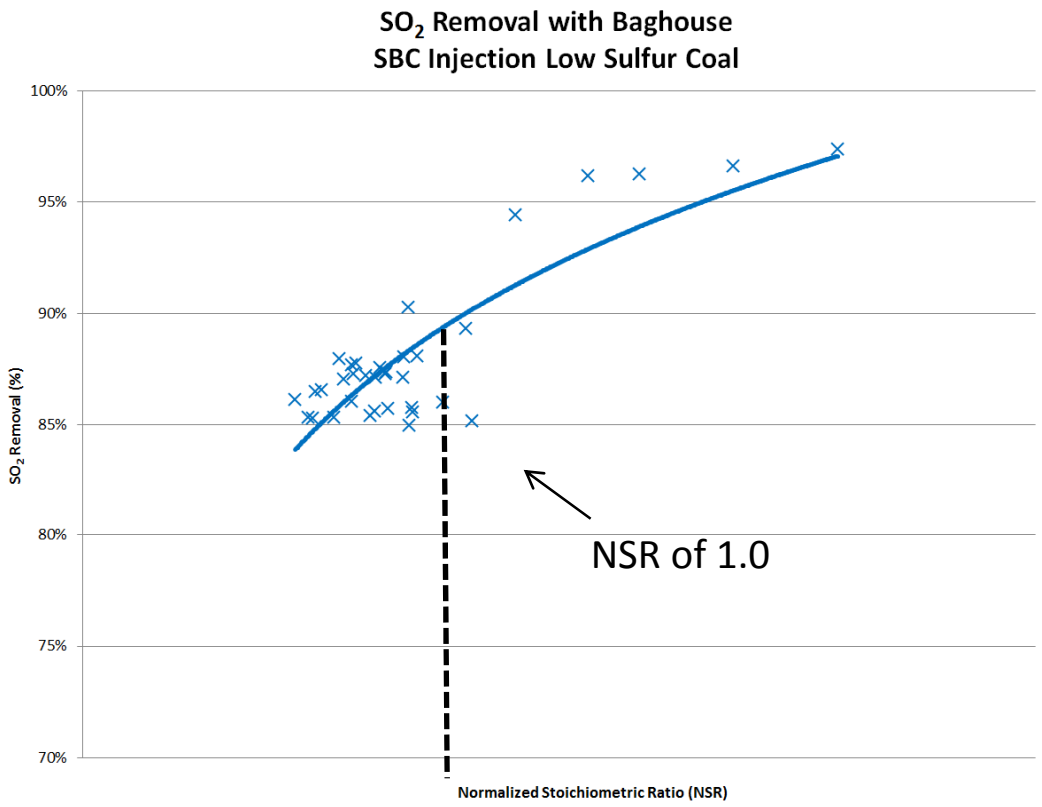
Case Study 2 – DSI System Description

Blower Building

Case Study 2 - SO_2 Reduction Performance



- Efficiencies compete with scrubbers on a 20-year life cycle
- In-line milled SBC <15 microns (from coarse SBC)

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Case Study 2 – Balance of Plant Effects

- Fabric Filter
  - No increase in particulate emissions or Opacity
- Ash Handling
  - Additional ash loading minimal
    - Ash loading increase approximately 70% of SBC injected
  - No landfill issues reported
- NO_2 Plume
  - Red/brown plume common with fabric filters
  - Plume eliminated with activated carbon injection
- Mercury Removal
  - Slightly more PAC required because of NO_2 adsorption
  - 95% Hg removal still easily achieved

Case Study 2 – Lessons Learned

- Filter and oil cooling design for mill lubrication system revised to avoid tripping out the mill, especially during extreme cold
- No other problems reported

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CASE STUDY 3
LARGE SO_2 REDUCTION DSI SYSTEM USING HYDRATED LIME

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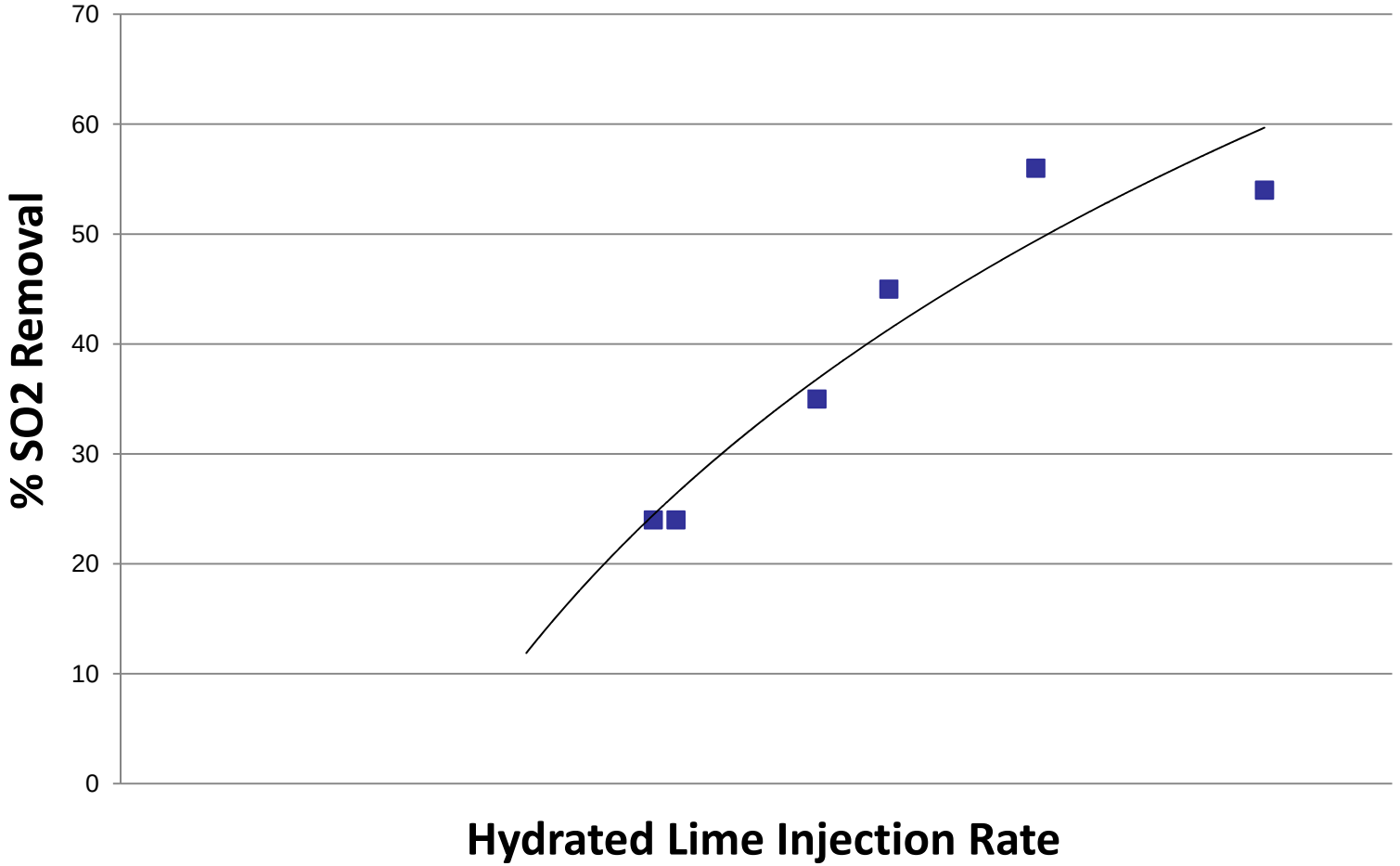
Case Study 3 – Unit Description

- 350 MW Unit
- PRB Coal
- Fabric Filter
- ACI System
- Ash Landfilled

Case Study 3 – DSI System Description

- Hydrated Lime Injection at air heater inlet
- Two silos, with common stair tower
- Truck unloading
- Screw feeder/rotary air lock design
- Conditioned truck unloading and conveying air
- Space reserved for future VIPER Mills
- Blower building and Electrical building
- Designed for high reactivity hydrated lime
  - Not a specific hydrated lime manufacturer

Case Study 3 - SO_2 Reduction Performance



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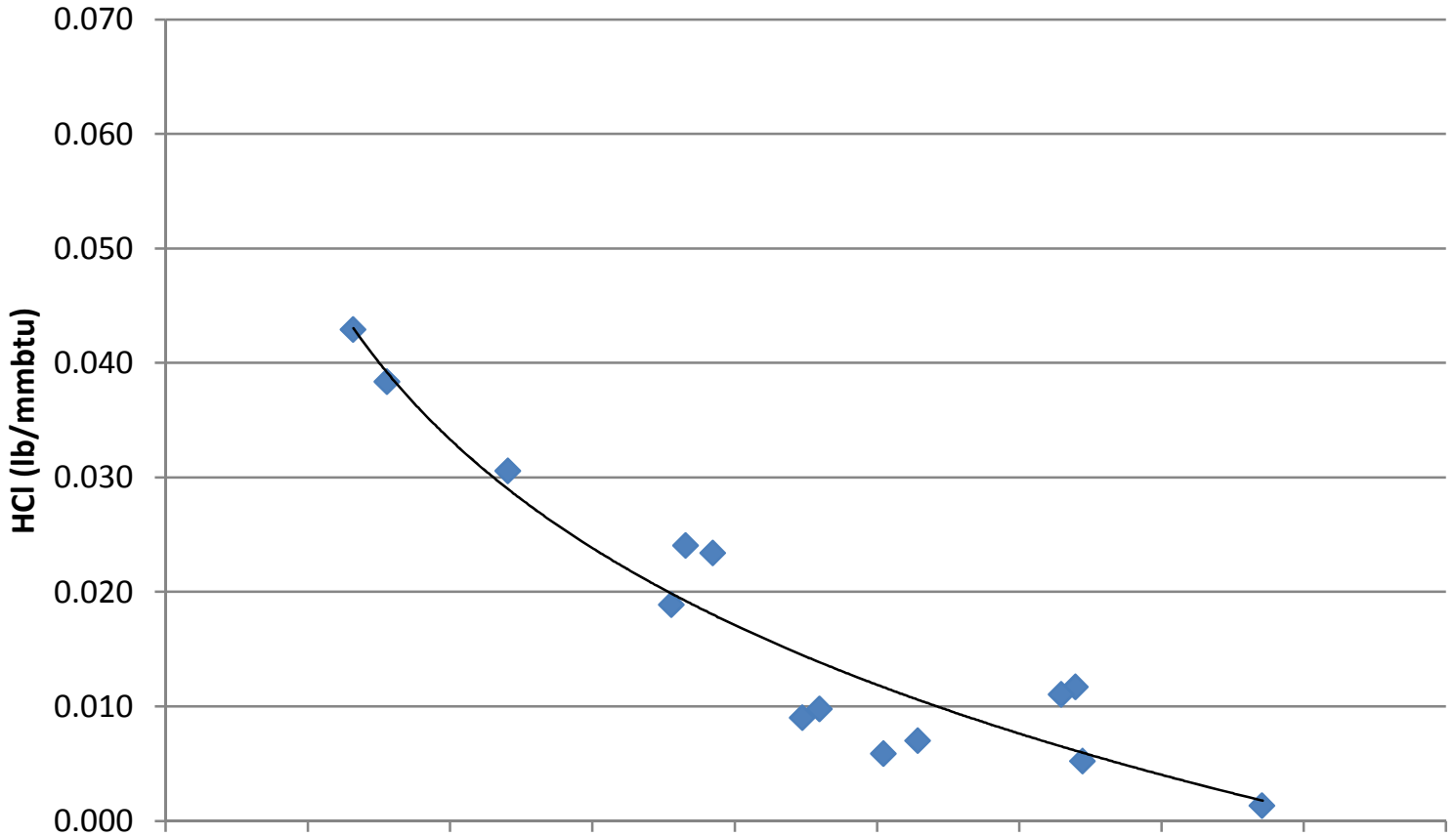
Case Study 3 –
HCl Removal with Hydrated Lime



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