

REINHOLD ENVIRONMENTAL Ltd.



2011 APC Round Table & Expo Presentation

July 11-12, 2011, in Cleveland, OH / Hosted by FirstEnergy

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MACT Compliance

Adobe Photoshop CS3.Ink

Acid Gas Removal by Dry Sorbent Injection

Jim Dickermqn – Lhoist North America

Project Contributors

- Southern Company – Brandon Looney
- Breen Environmental Systems – Chetan Chothani
- Southern Research Institute – Tom Gale



- LIMB project – hydrated lime injection
 - ✓ Major R&D project from 1988 – 1992
 - ✓ Demonstrated SO₂ control capability of approx. 50%-60%
 - ✓ Performance was too low to compete with FGD scrubbers

- LNA pioneered use of calcium DSI for utility SO₃ control at TVA Widows Creek in 2004
 - ✓ Much more effective for aggressive acid gases (SO₃, HCl, HF)
 - ✓ Demonstrated control capability in excess of 95%
 - ✓ Calcium DSI now in use at well over 25 utility units

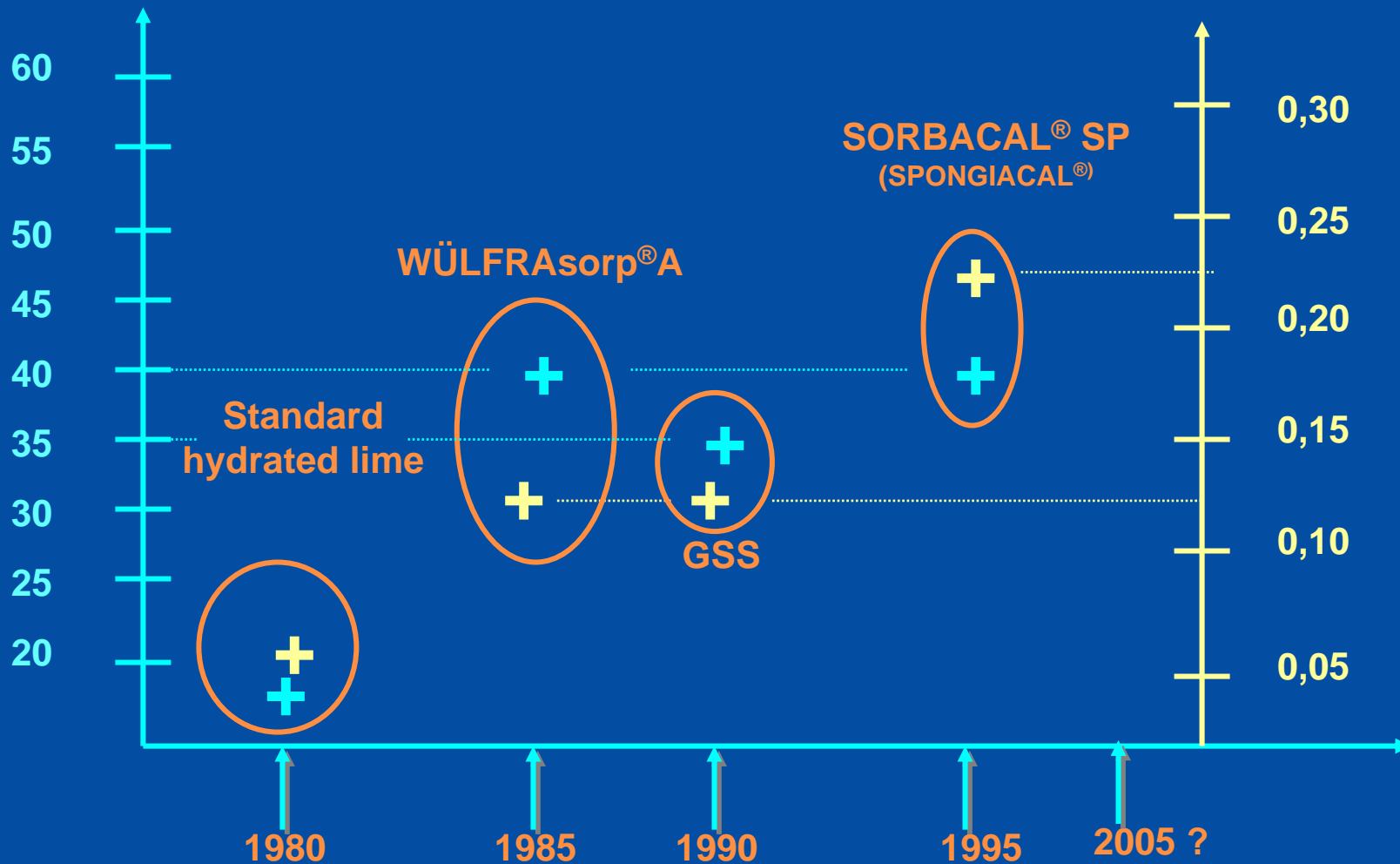
- Data on use of hydrated lime for HCl control comes from European experience
 - ✓ Demonstrated to capture over 95% of HCl in MSW acid gas control applications
 - ✓ Limited data on utility HCl control
 - ✓ Pilot combustor work to date indicates HCl MACT emission levels achievable for most facilities
 - ✓ Effectiveness impacted by many factors



History

Specific surface area
[m²/g]

Pore volume [cm³/g]



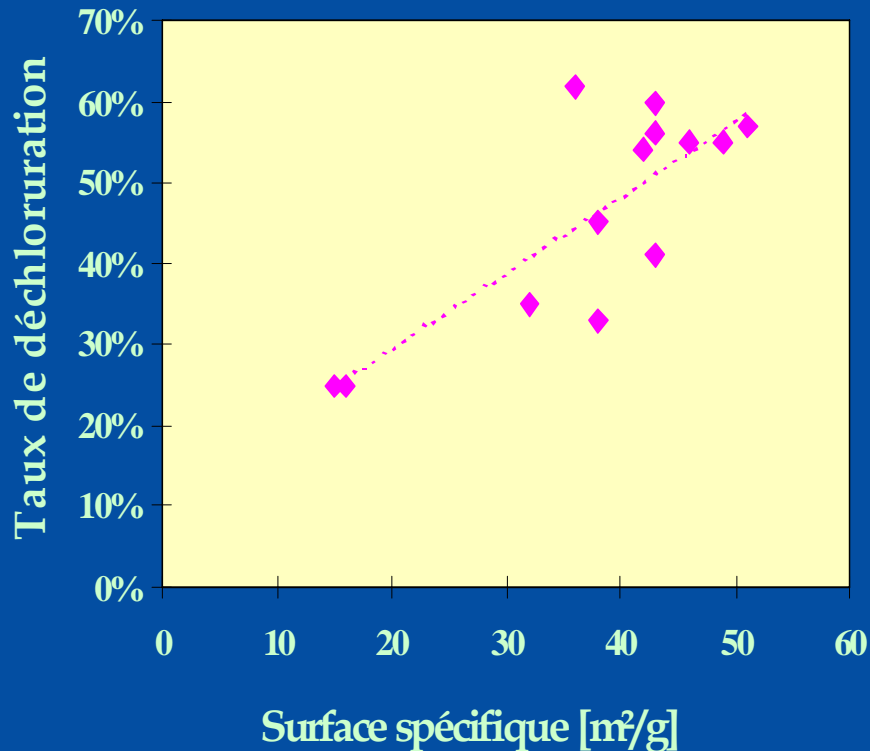
MSWI dry process

Specific surface
area concept

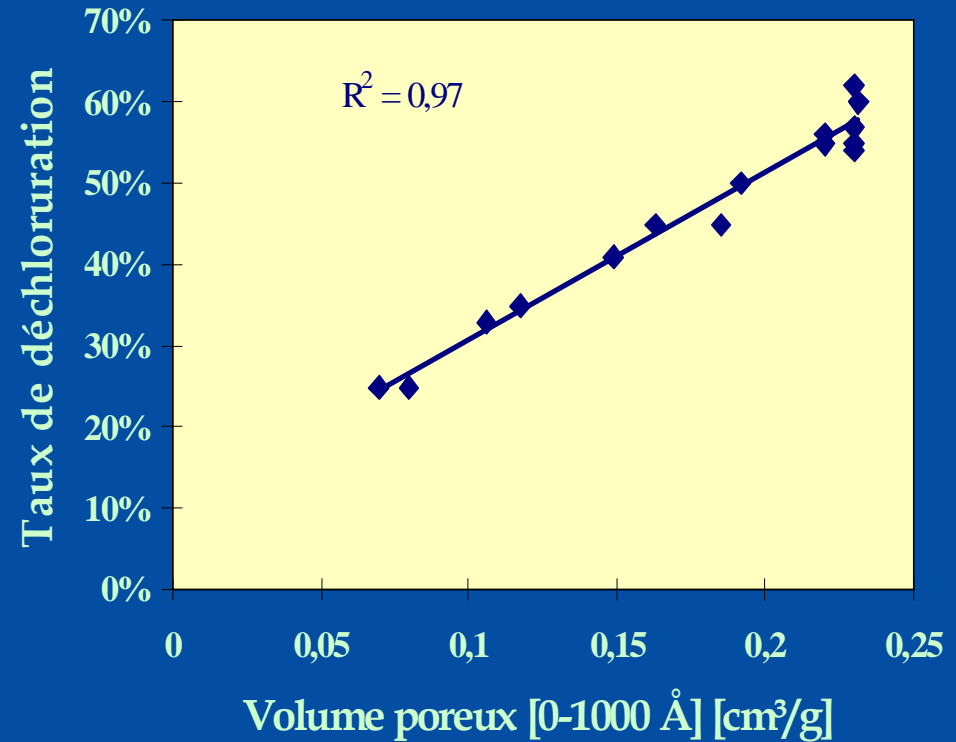
Pore volume
concept

Laboratory scale study HCl removal vs hydrated lime properties

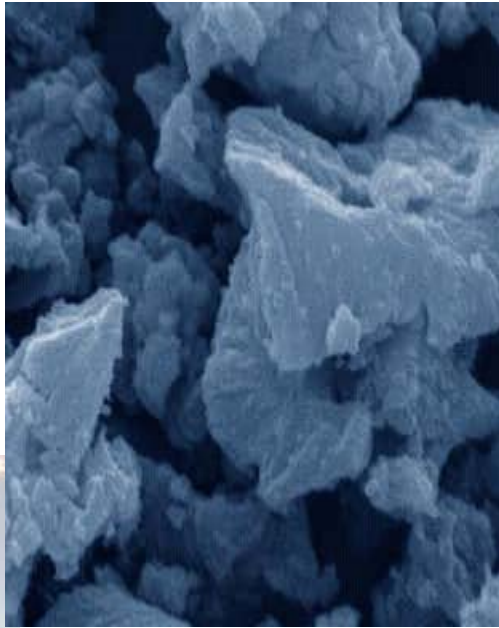
SSA / HCl removal rate



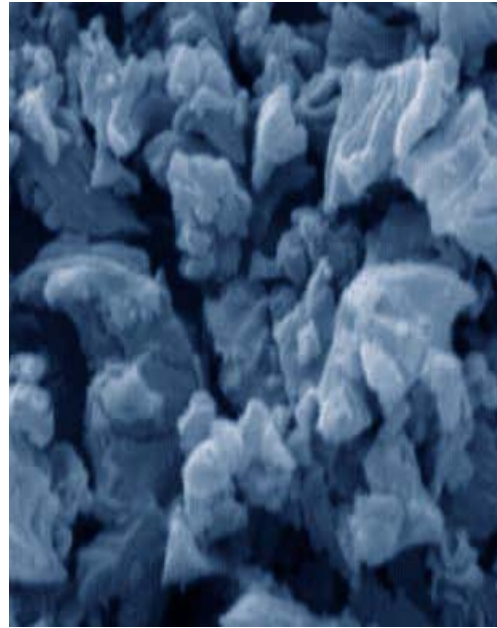
Pore volume / HCl removal rate



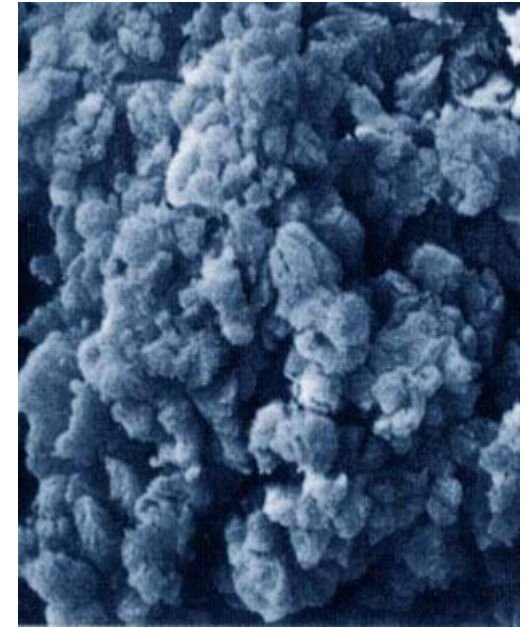
Evolution of the textural properties



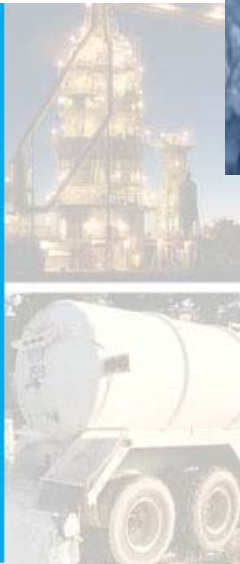
Sorbacal[®] H
Standard
Hydrated lime



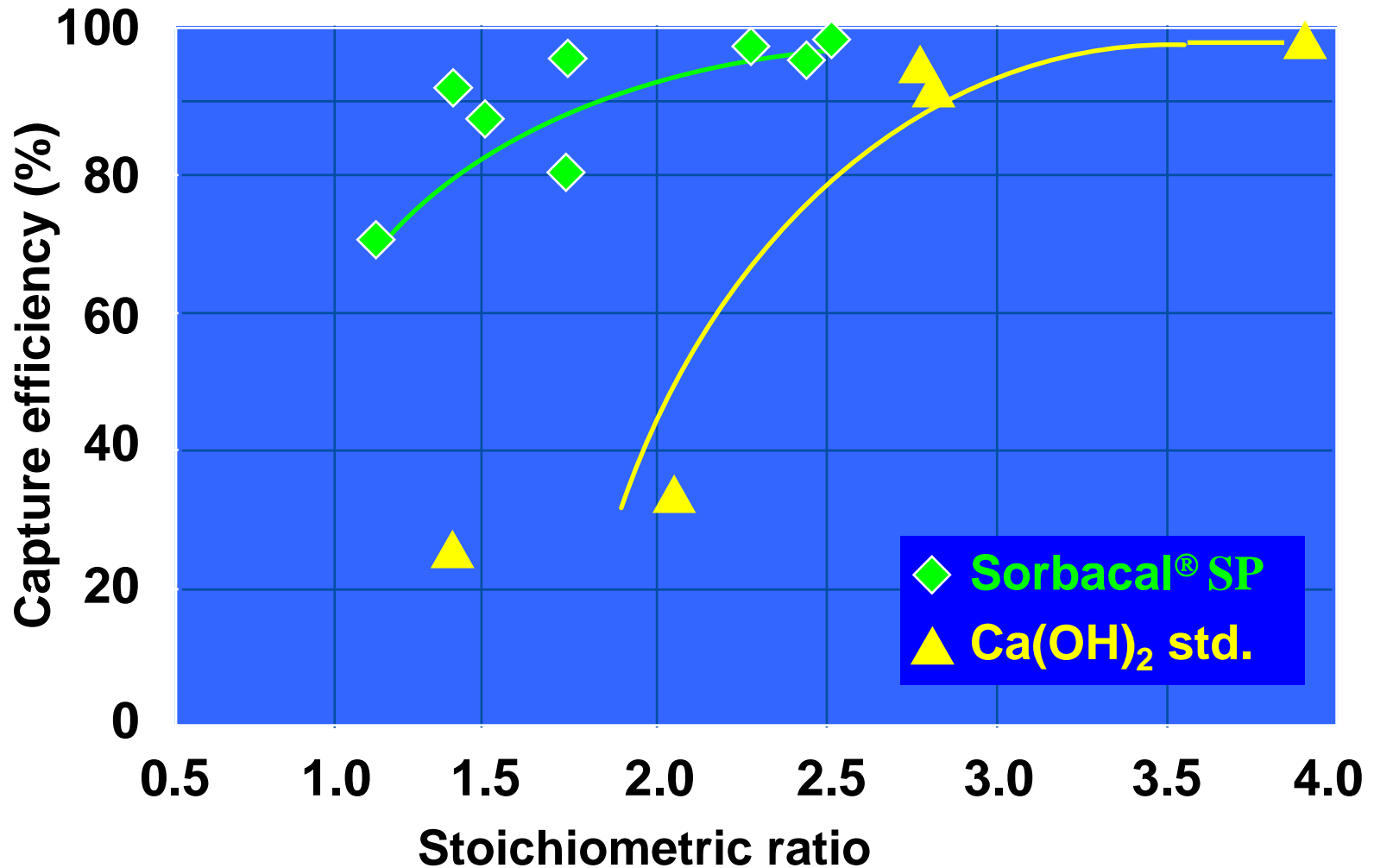
Sorbacal[®] A



Sorbacal[®] SP



HCl CAPTURE EFFICIENCY



Calcium DSI Effectiveness Factors

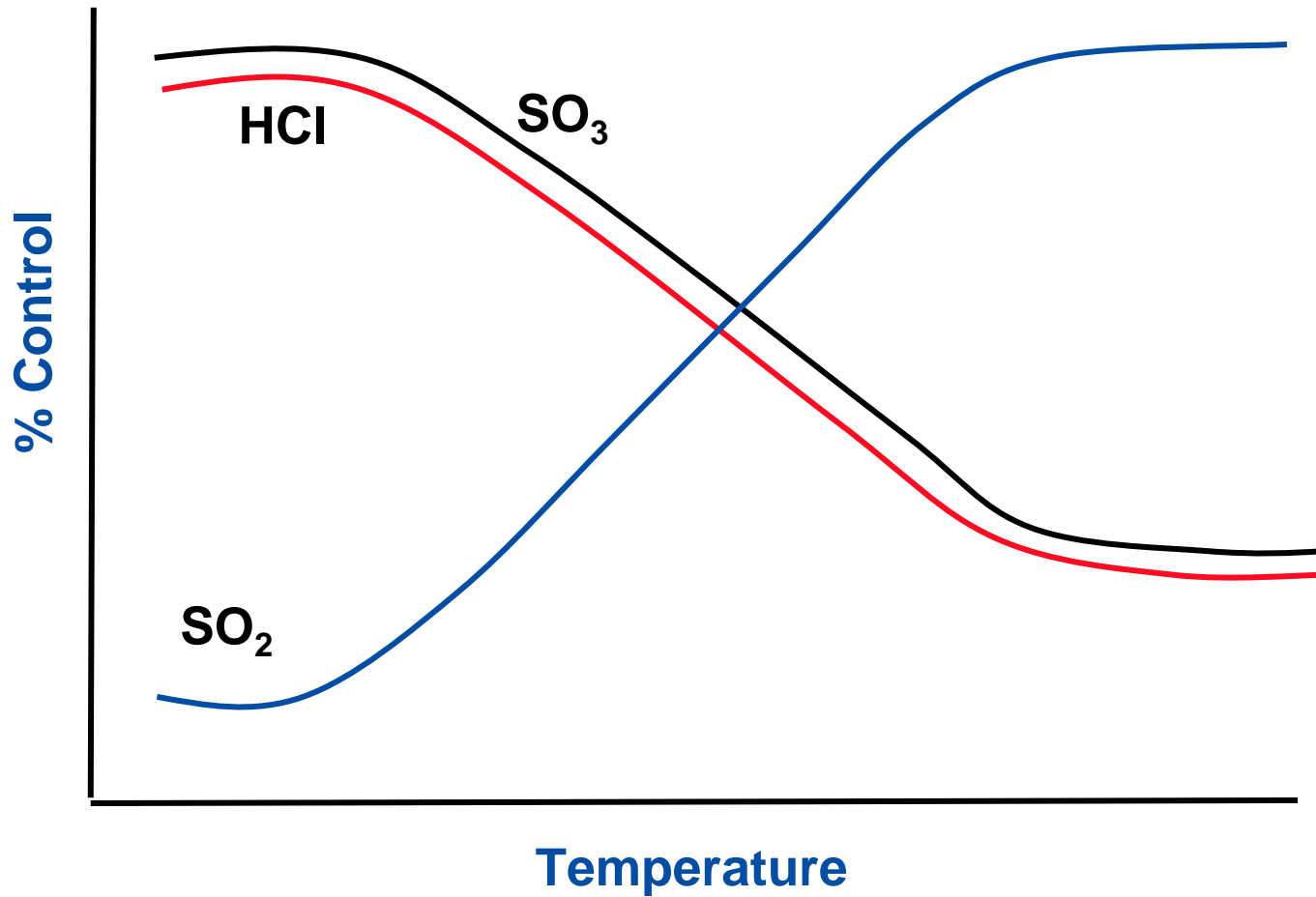
- Reagent Properties – physical and chemical
 - ✓ Relative Reagent Reactivity
 - ✓ Reagent surface area
 - ✓ Reagent porosity

- Flue Gas Properties
 - ✓ Temperature
 - ✓ Flue gas moisture
 - ✓ Other competing acid gases (SO_3 , HF and SO_2)

- Injection System Configuration
 - ✓ Particulate control device
 - ✓ In flight residence time
 - ✓ Reagent mixing
 - ✓ Injection location



Impact of competing acid gases



Why Do Pilot Testing?

- **MACT rules will require Emission limits for HCl**
- **Dry Sorbent Injection (DSI) offers low capital control approach**
- **US pilot tests and European experience show high HCl removals using hydrated lime**
- **DSI installed at over 25 systems for SO₃ control**
 - ✓ Several vendors offer commercial DSI systems
 - ✓ Initial operational issues are basically solved
- **There is limited data on DSI for HCl control from coal-fired boilers**
 - ✓ European data on MSW systems shows high HCl removals
 - ✓ Data from SO₂ injection pilot test showed >90% HCl capture

DSI is accepted for SO₃ control but needs to be demonstrated for HCl removal applications



Test Plan Overview

- Objective to evaluate Dry Sorbent Injection (DSI) effectiveness for HCl emission reduction
 - ✓ Evaluated 2 sorbents
 - Sorbacal[®]H
 - Sorbacal[®]SPS
 - ✓ Evaluated 2 Injection Temperatures – upstream and downstream of AH
 - ✓ Evaluated impact of SO₃
 - ✓ Evaluated ESP and Baghouse Operations
- Conducted at Southern Research Institute pilot coal combustor
- Method 29 samples collected to evaluate Selenium capture



SoRI trials - Description

- Operating conditions

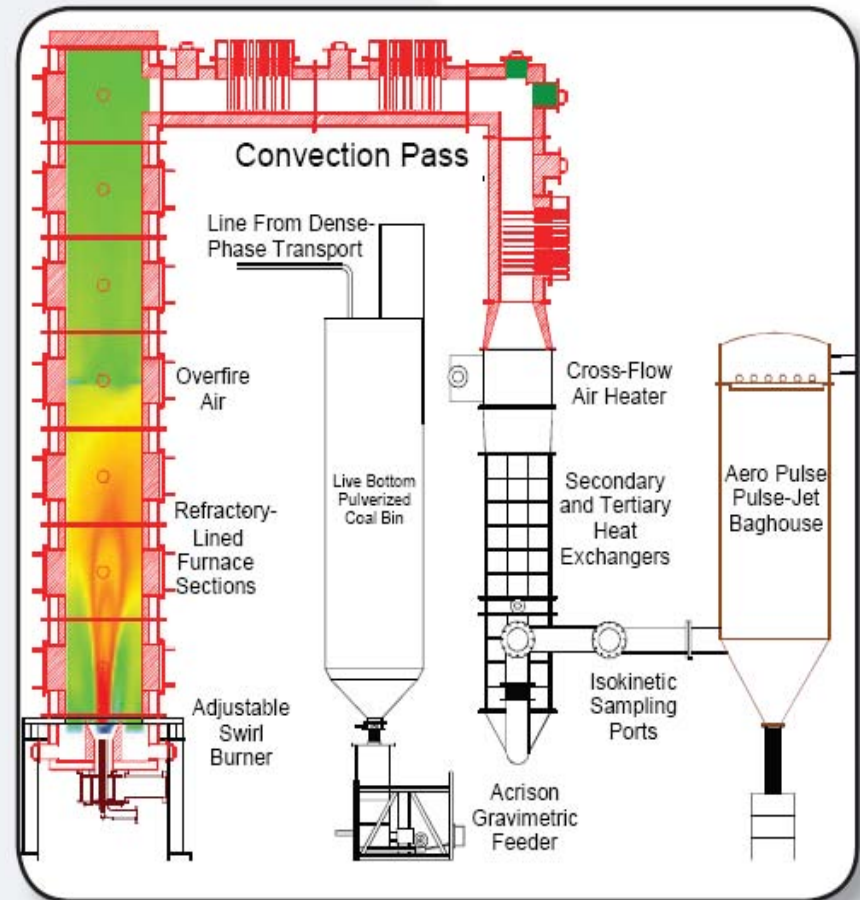
- ✓ SO₂ : 1800-1900 ppm
- ✓ HCl : 180-200 ppm
- ✓ O₂ : 4-8%
- ✓ CO₂ : ± 14.5%
- ✓ Water : 5-7%
- ✓ 600 ft³/min. at 60°F

- Dechlorination trials

- ✓ 700°F – 380°C (ESP)
- ✓ 350°F – 175°C (ESP + BH)
- ✓ Sorbacal[®]SPS and H
- ✓ Influence of SO₃



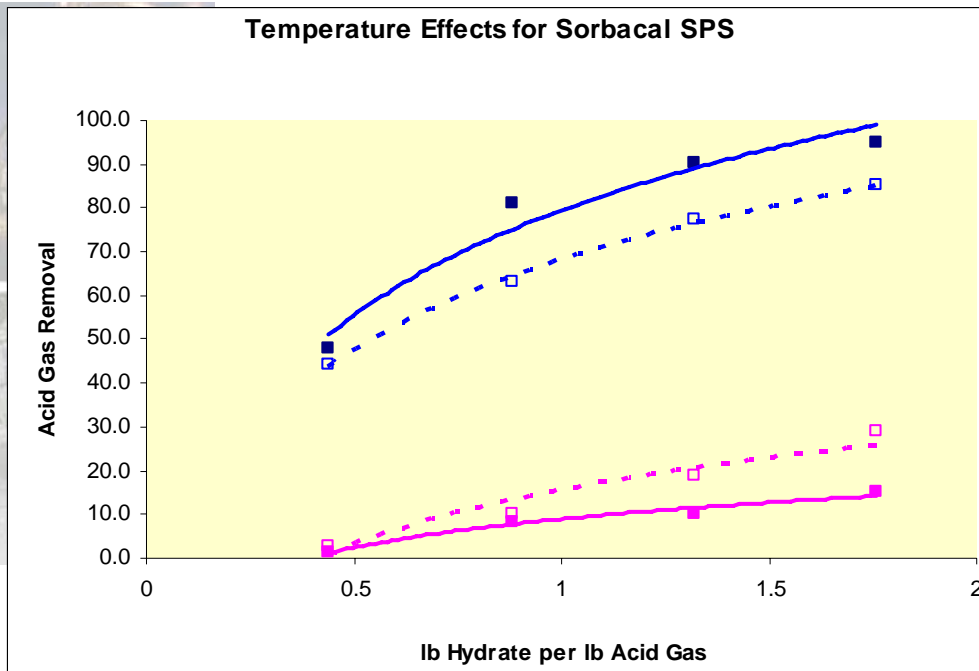
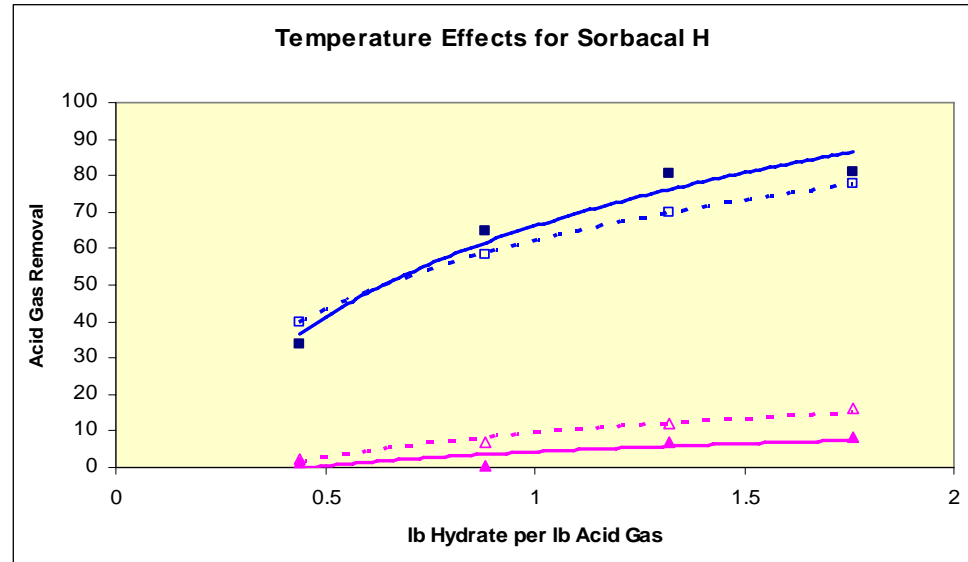
Depending on coal type / sulfur addition



Temperature Impacts on Removal

ESP Operations

HCl Removal Better at Low T
SO₂ Removal Better at High T

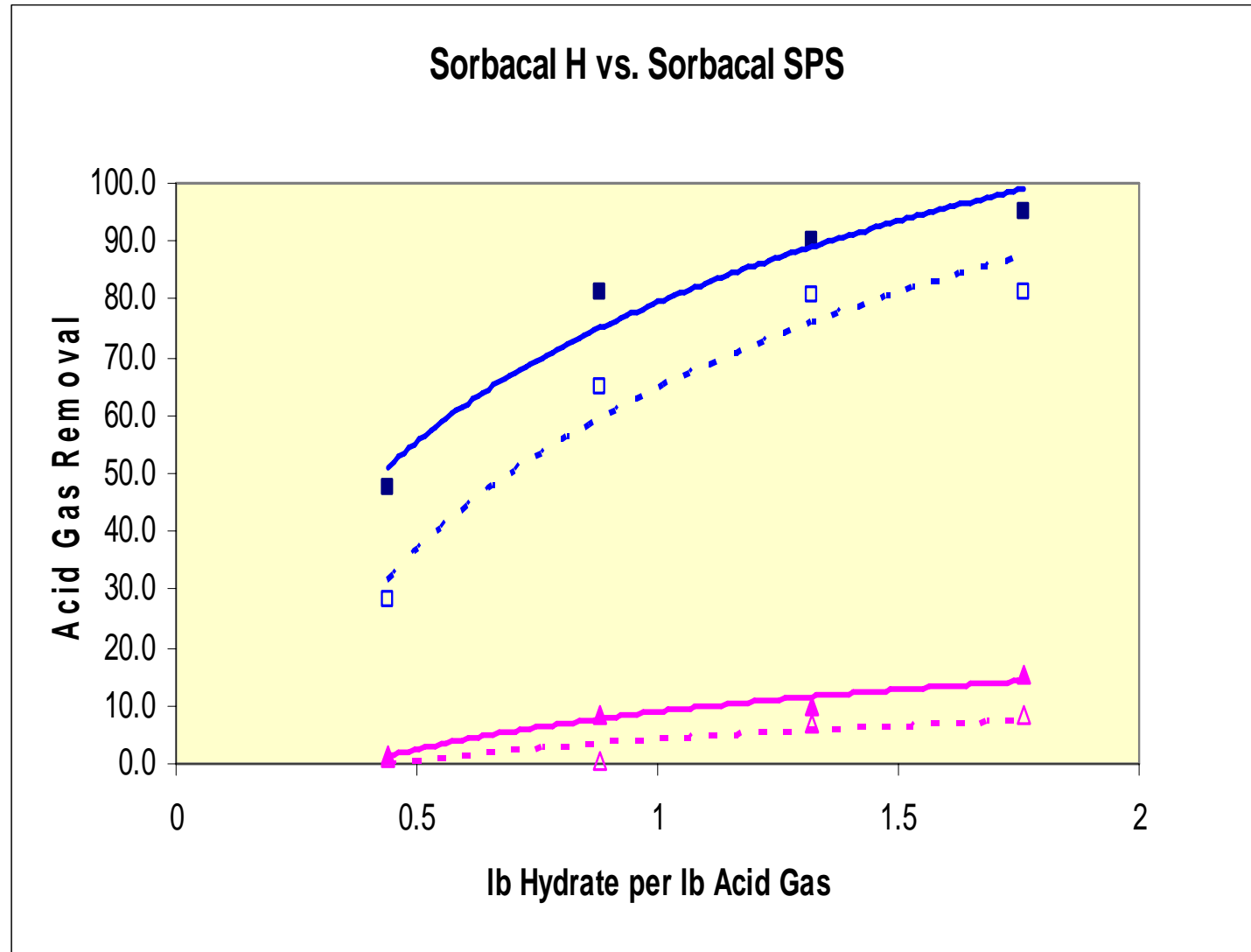


- HCl Removal - 350°F
- HCl Removal - 700°F
- SO₂ Removal - 350°F
- SO₂ Removal - 700°F

Sorbacal®H vs. Sorbacal®SPS

ESP Operations @ 350°F

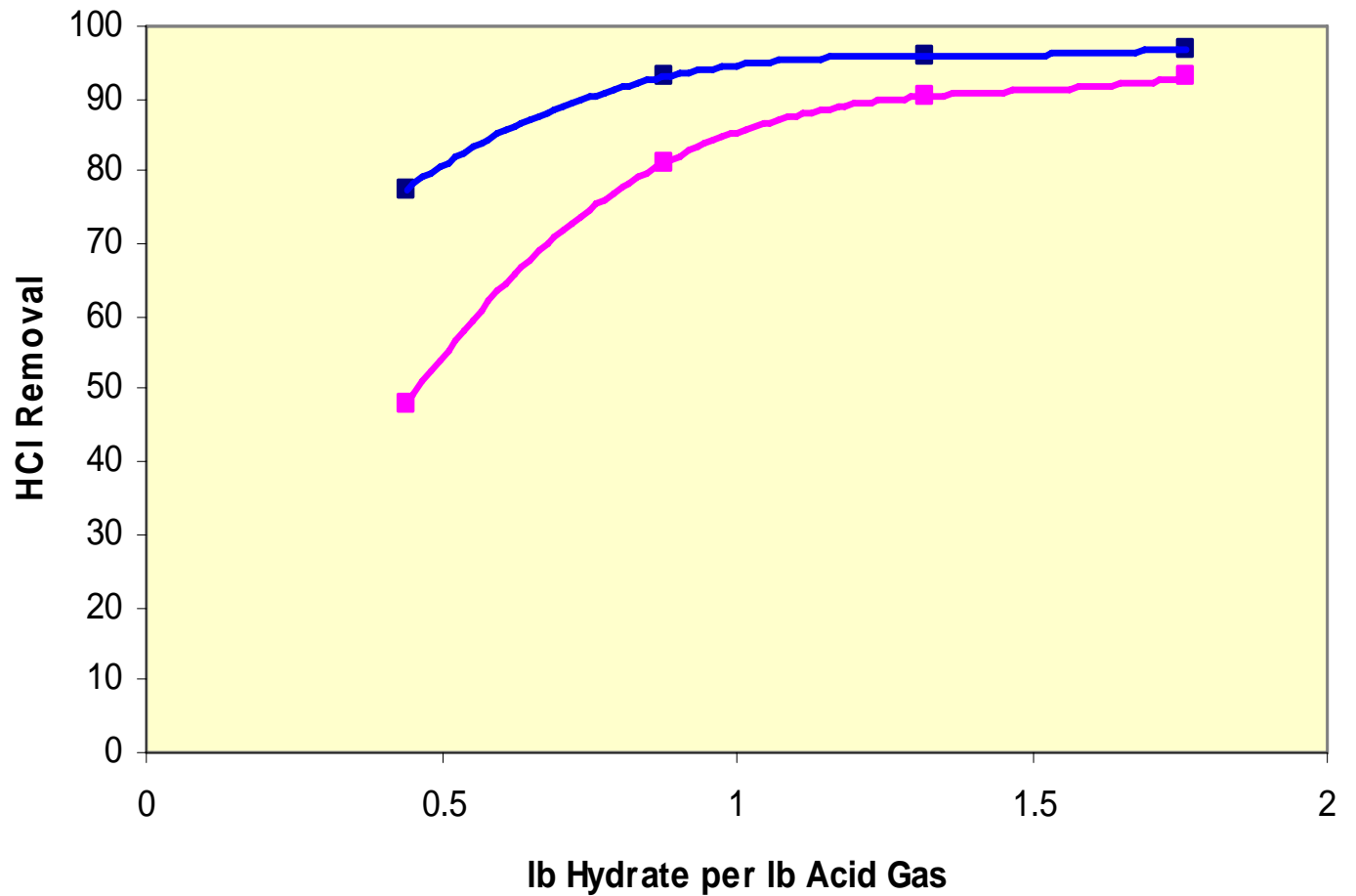
- HCl Removal Sorbacal®SPS
- HCl Removal Sorbacal®H
- ▲ SO₂ Removal Sorbacal®SPS
- △ SO₂ Removal Sorbacal®H



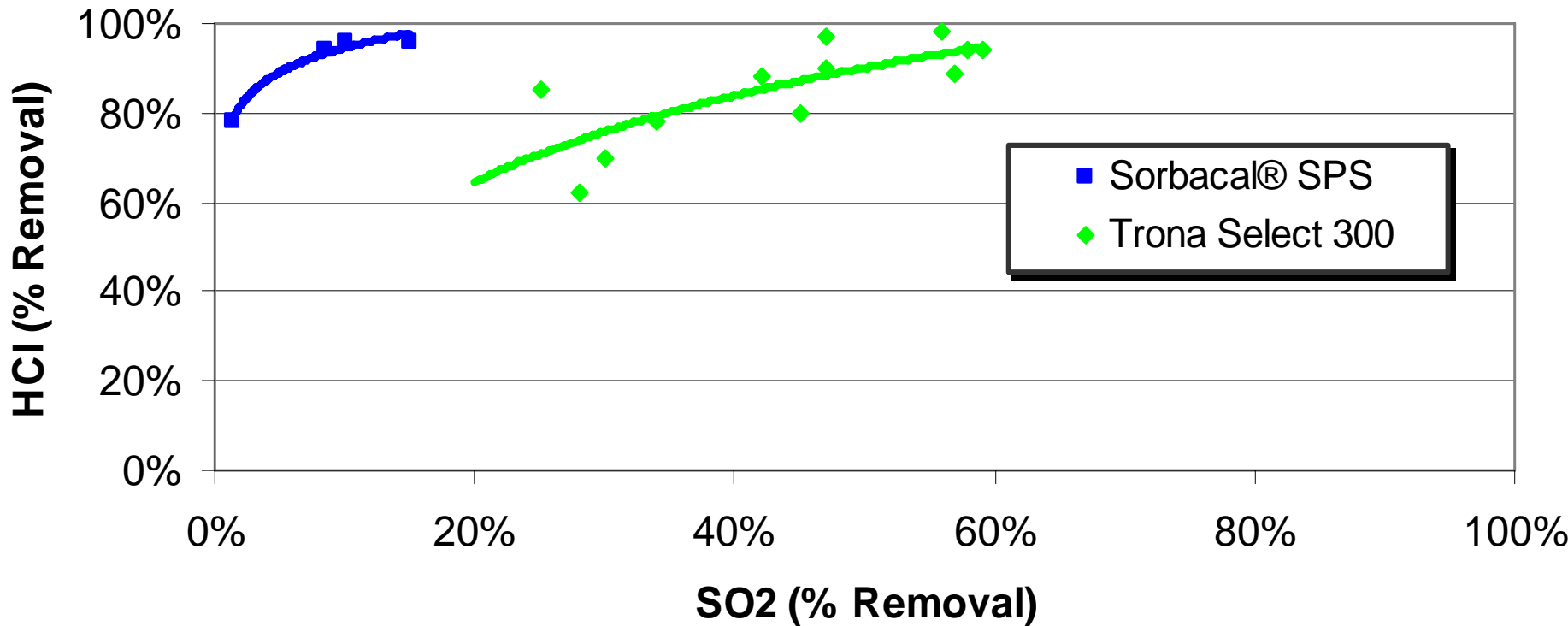
Impact of Particulate Collection Device

HCl Removal - Baghouse vs. ESP

- HCl Removal – BH
- HCl Removal - ESP



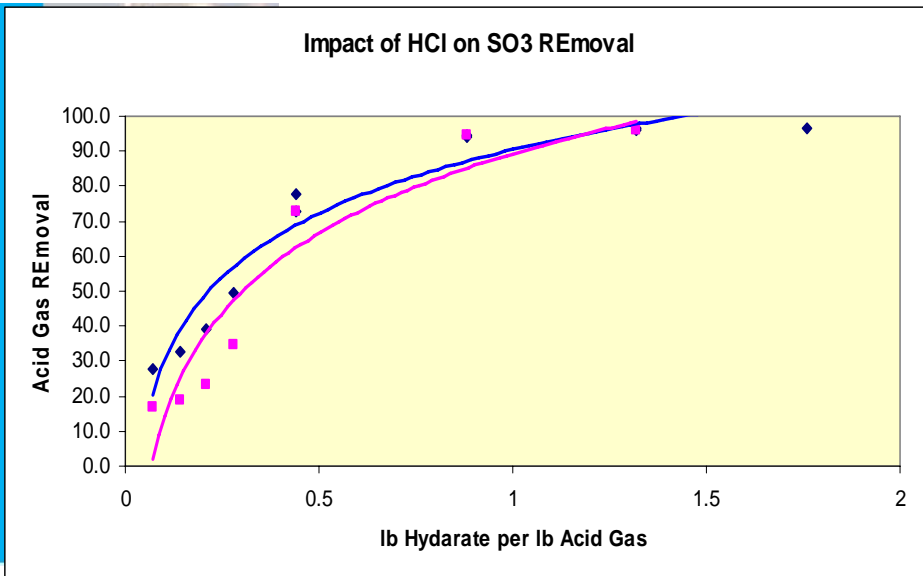
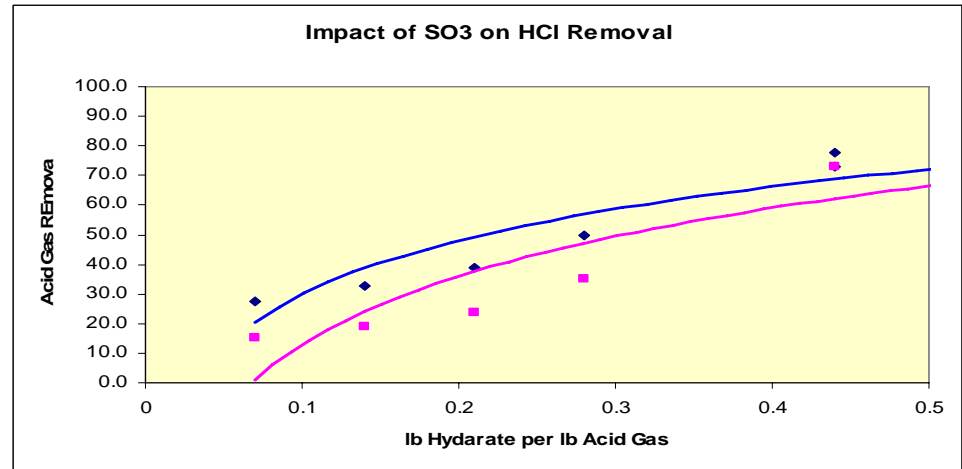
**SO₂ and HCl Interaction
Sorbacal® SPS vs. Trona Select 300
On an ESP (Temp 330 - 385° F)**



Source of Trona removal data from Solvay's MARMA presentation 5-2011

Impact of SO₃ on HCl Removal

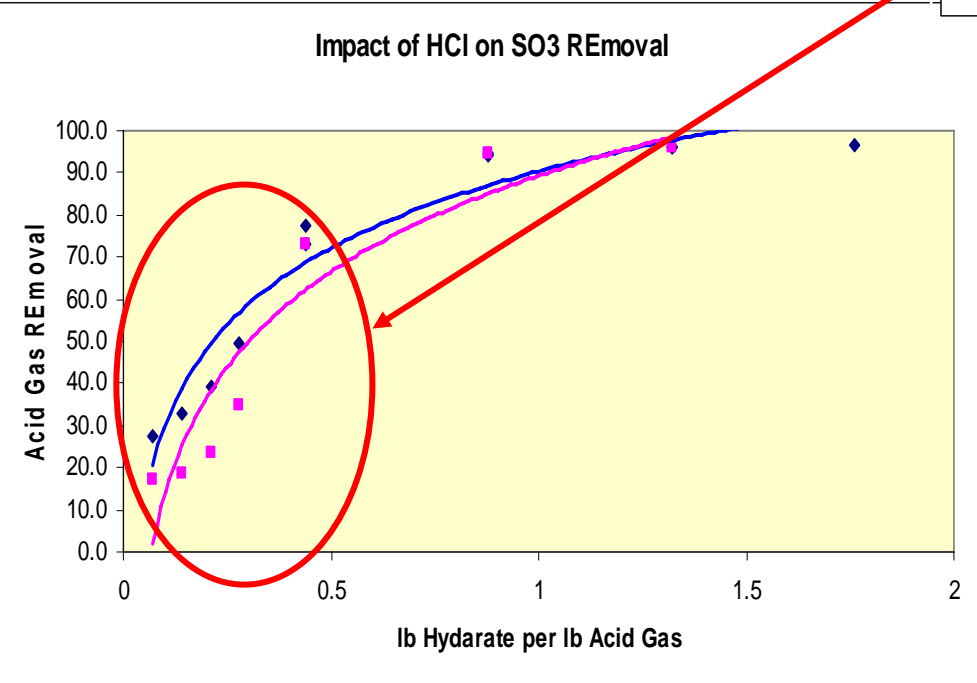
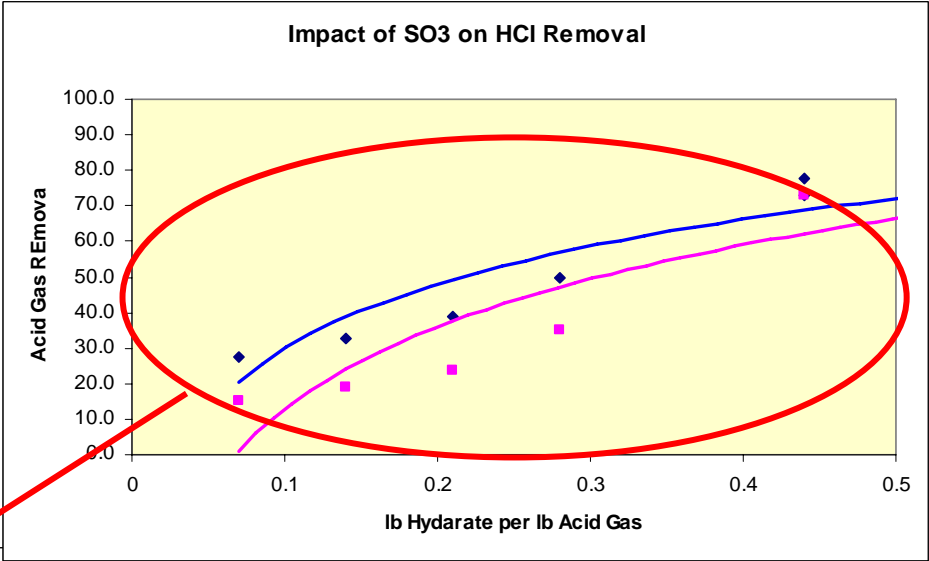
SO₃ interference only seen
At low sorbent feedrates



- HCl Removal with no SO₃
- HCl Removal with ~60 ppm SO₃

Impact of SO₃ on HCl Removal

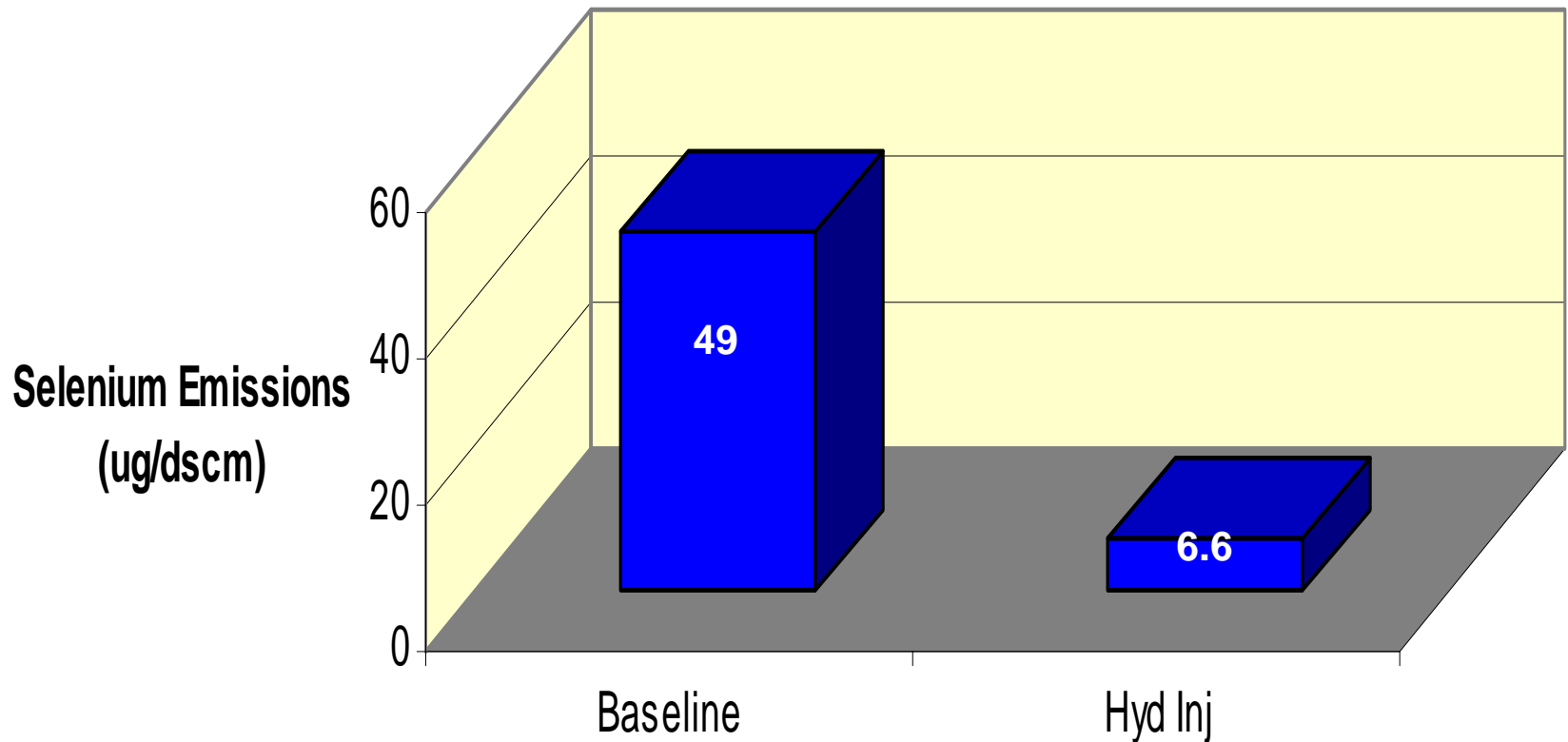
SO₃ interference only seen At low sorbent feedrates



- HCl Removal with no SO₃
- HCl Removal with ~60 ppm SO₃

Selenium Emission Data

Selenium Emission Levels



Conclusions

- Sorbacal[®]SPS performed up to 30% better than the standard hydrate (ESP conditions)
- Temperature Impacts
 - ✓ Better HCl removal @ 350°F
- For Sorbacal[®]SPS at 350°F
 - ✓ HCl removal better in baghouse than ESP
 - ✓ Limited SO₂ removal – <20%
 - ✓ SO₃ impact on HCl removal only at low sorbent feedrates
- HCl removals of 97% achievable with high Cl coals
- Significant Selenium emission reductions are achievable with hydrated lime
- Future testing to evaluate moderate Cl coals



