

REINHOLD ENVIRONMENTAL Ltd.



**2017 APC & Wastewater Round Table
& Expo Presentation**

July 17 & 18, 2017 in Charlotte, NC / Hosted by Duke Energy

All presentations posted on this website are copyrighted by Reinhold Environmental, Ltd (RE). Any unauthorized downloading, attempts to modify or to incorporate into other presentations, link to other websites, or obtain copies for any other uses than the training of attendees to RE's Conferences is expressly prohibited, unless approved in writing by RE or the original presenter. RE does not assume any liability for the accuracy or contents of any materials contained in this library which were presented and/or created by persons who were not employees of RE.



Update on Interactions Between DSI and ACI

Presented by Conner Cox

2017 APC & Wastewater / PCUG Conference

Presentation Agenda



Introduction

Selecting Injection Locations

Acid Gas Sorbent Injection

Hg Sorbent Injection

Summary

Questions

Presentation Agenda



Introduction

Selecting Injection Locations

Acid Gas Sorbent Injection

Hg Sorbent Injection

Summary

Questions

Introduction



- **Optimized plant operation and compliance often requires the use of both DSI for HCl, SO₃, or SO₂ and ACI for Hg reduction**
- **The choice of sorbents and injection locations for both the alkali and mercury sorbents depend on the coal type and APC equipment configuration for each unit**



Presentation Agenda



Introduction

Selecting Injection Locations

Acid Gas Sorbent Injection

Hg Sorbent Injection

Summary

Questions

Selecting Injection Locations



- **Combined DSI and ACI (historical)**
 - Low SO_3 (< 5 ppm): ACI before DSI
 - Minimizes impact of DSI on PAC performance
 - High SO_3 (> 5 ppm): DSI before ACI
 - Minimizes effects of SO_3 on PAC
 - Best if ACI prior to Air Pre-Heater
- **Update**
 - Typically still valid.
 - New sorbents may provide more tolerance
 - Testing recommended



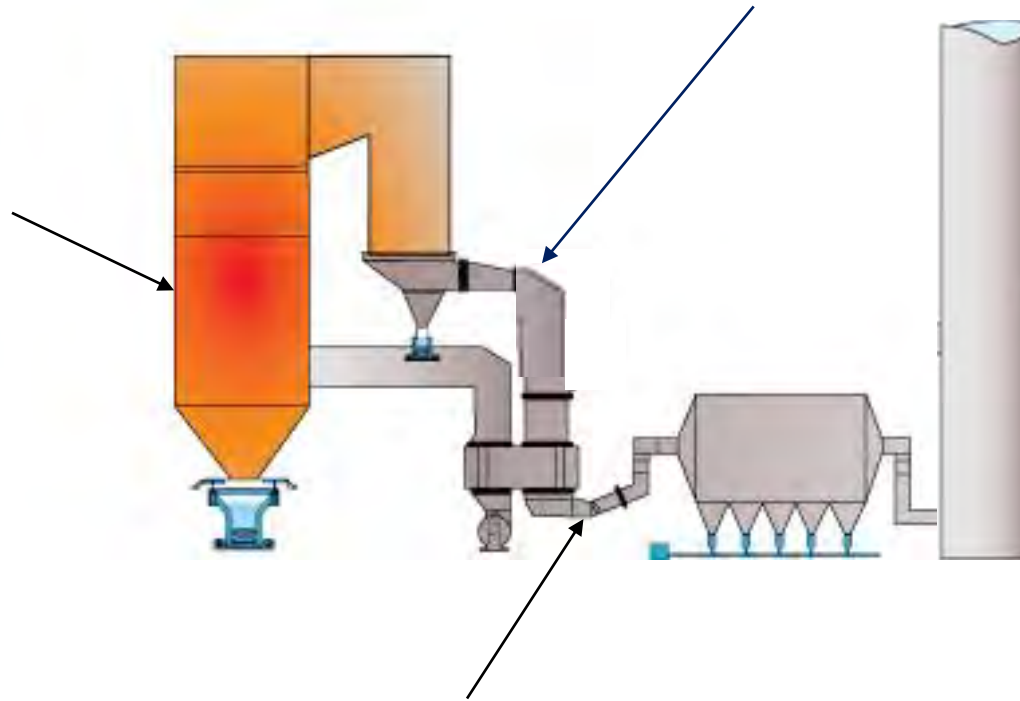
PRB Coal, ESP or Fabric Filter



Low SO₃ Case Study

ACI - Standard PAC (non-oxidizing) at air heater inlet
Or Oxidizing PAC, no fuel additive

Additive on fuel



DSI at air heater outlet

PRB Coal, ESP or Fabric Filter

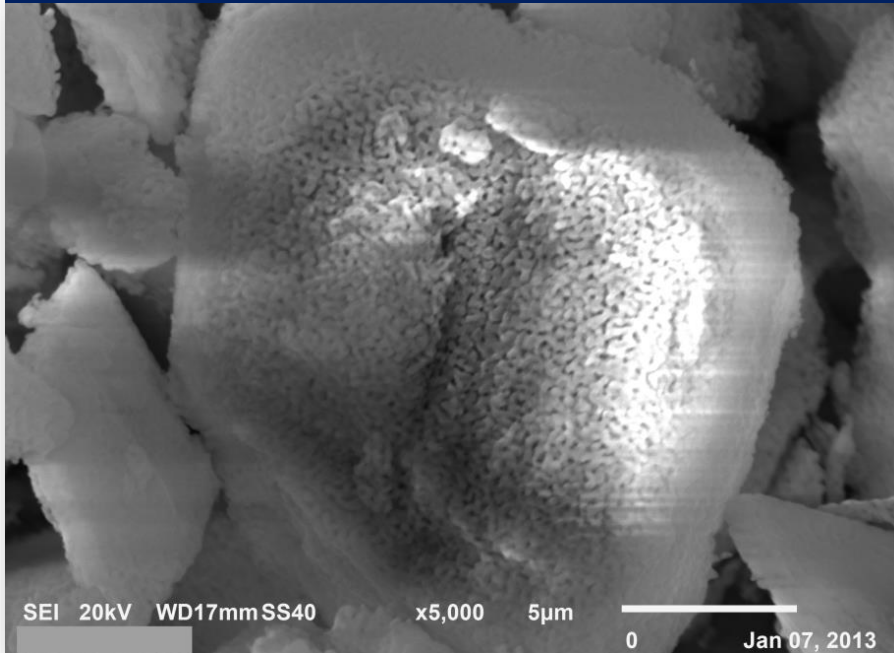


■ Results

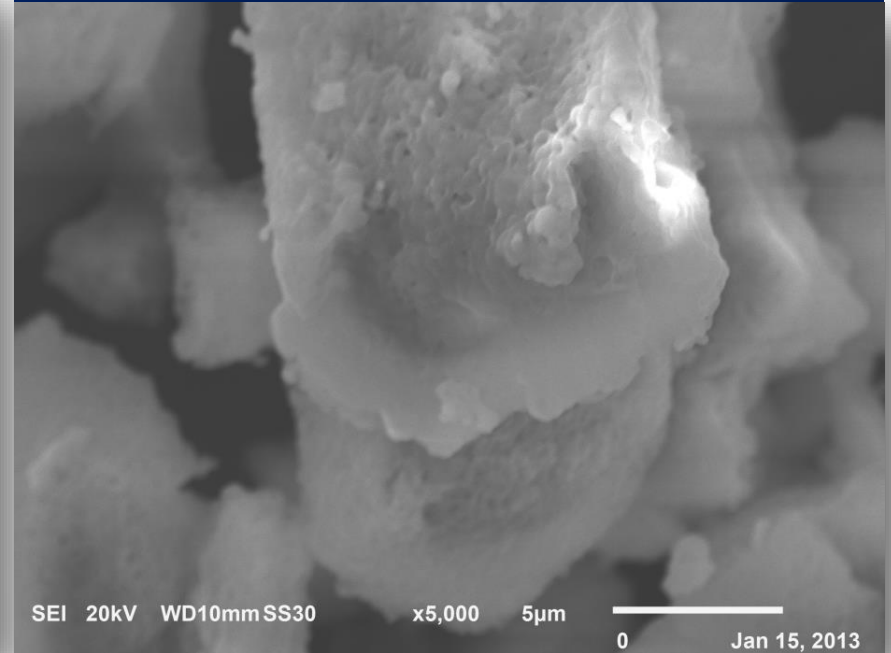
- Very good mercury removal since most Hg oxidation/removal will take place in air heater before alkali sorbent introduced
- Highest Hg removal performance of any scenario for PRB
- Optimum location for HCl removal with hydrated lime
- Typically, SBC used in this arrangement for SO₂ removal



SBC at 300 °F (AH Outlet)



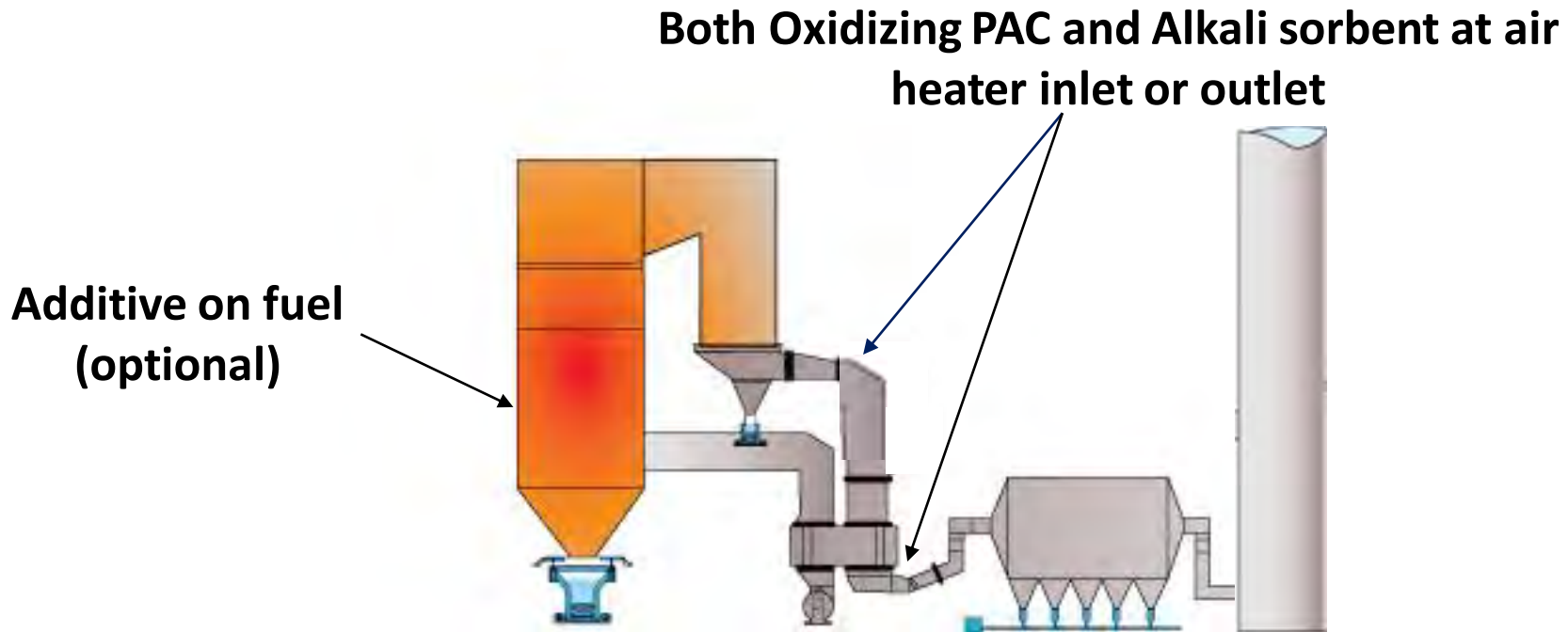
SBC at 700 °F (AH Inlet)



E. Bituminous Coal, ESP or Fabric Filter



High SO₃ Case Study



E. Bituminous Coal, ESP or Fabric Filter



■ Results

- Both alkali sorbent and oxidizing PAC at Air Heater Inlet
 - Good SO_3 , HCl removal with hydrate or trona
 - Inject alkali sorbent as far as possible upstream of mercury sorbent
- Both alkali sorbent and oxidizing PAC at Air Heater Outlet
 - Good HCl removal
 - Inject alkali sorbent as far as possible upstream of mercury sorbent



Presentation Agenda



Introduction

Selecting Injection Locations

Acid Gas Sorbent Injection

Hg Sorbent Injection

Summary

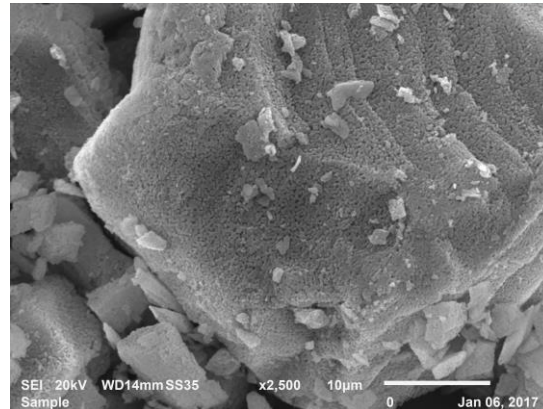
Questions

Selecting Acid Gas Sorbents



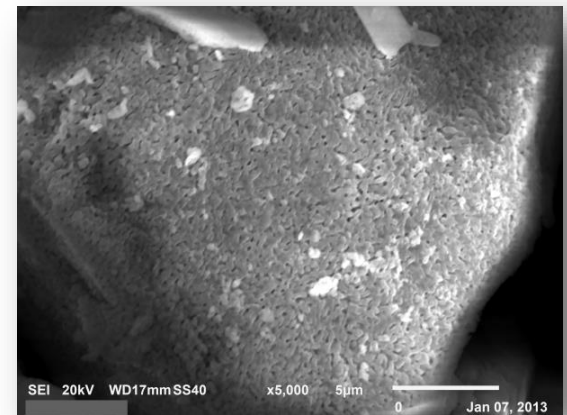
■ SO₂ (historical)

- SBC: 250 – 660 °F
- Trona: < 1000 °F
- Hydrate: minimal SO₂ removal



■ Update

- New hydrated lime products have shown ability to remove up to 60-70% with COBRA™ Lances and Fabric Filter

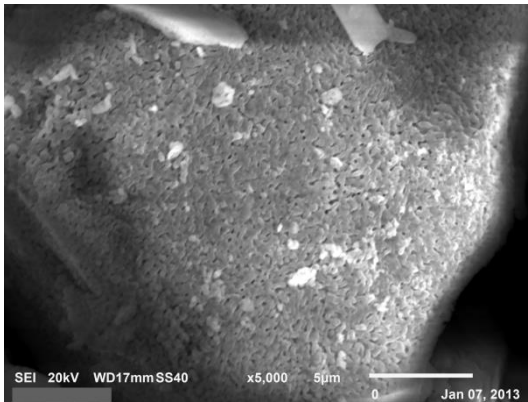


SO₂ Removal – Sorbent Choice



Trona

- Use when:
 - Moderate SO₂ removal needed (approx. 80% or less)
 - In almost all cases will be more economical to mill trona in-line



Sodium Bicarbonate

- Use when:
 - High removals needed (> 80%)
 - Want to minimize loading to ESP and/or ash removal systems
 - High SO₂ and Hg removal needed simultaneously on PRB units

Hydrated Lime

- Use when:
 - Moderate removals needed (70% or less)
 - Have fabric filter
 - Want to preserve ash sales
 - Possibly to avoid NO₂ plume (when have fabric filter)

Selecting Acid Gas Sorbents



■ SO₃

- Trona and Hydrate work well
- SBC typically not cost effective

■ Update

- For high removals, trona may have lower rate requirements
- Trona reduces resistivity of the ash, allowing for easier collection in ESPs
- Hydrate may interfere less with Hg capture
- Hydrate has lower risk of heavy metal leaching from ash



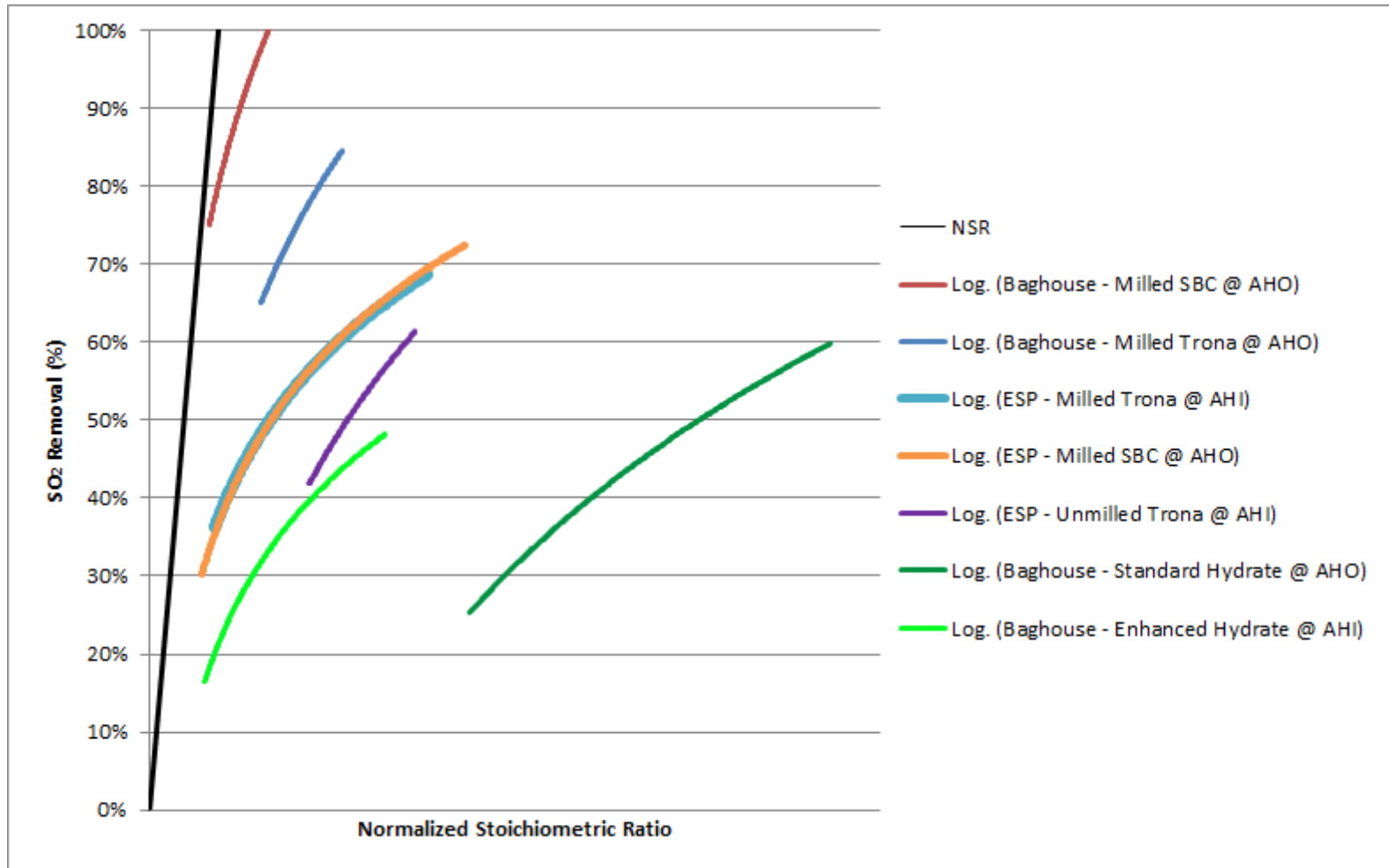
Selecting Acid Gas Sorbents



■ Technology Update

- Mixing devices (COBRA™ Lance)
 - Reduced injection rate: reduced BOP
 - Less interference with PAC
 - Less product in ash
- Injection Locations
 - Air Pre-Heater Inlet
 - Reduce/eliminate plugging and corrosion due to SO_3 /ABS
 - Scrubber Inlet
 - Eliminate blue plume without effects on fly ash

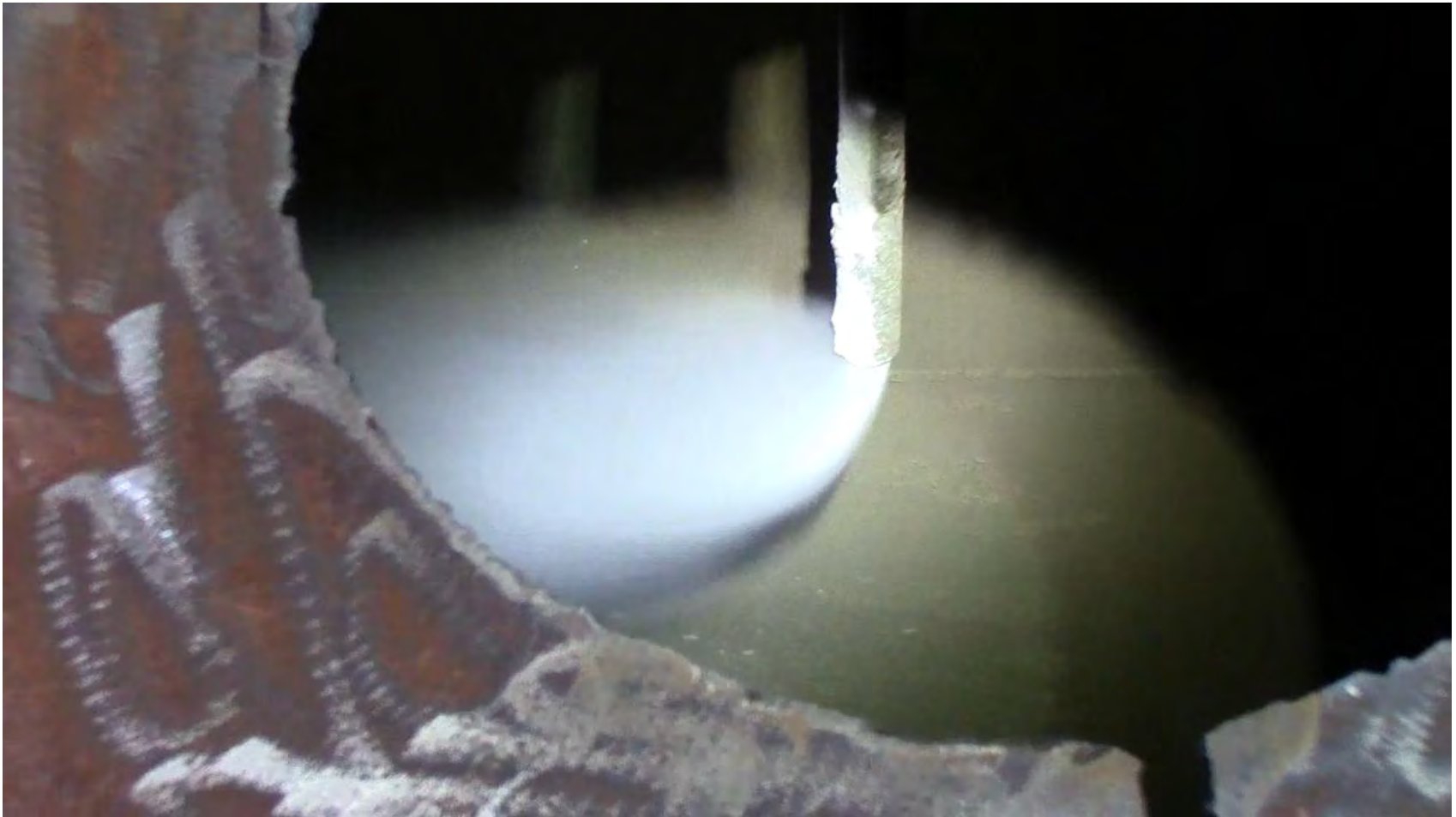
SO₂ Removal – SBC, Trona and Hydrate



COBRA™ Lance Installation



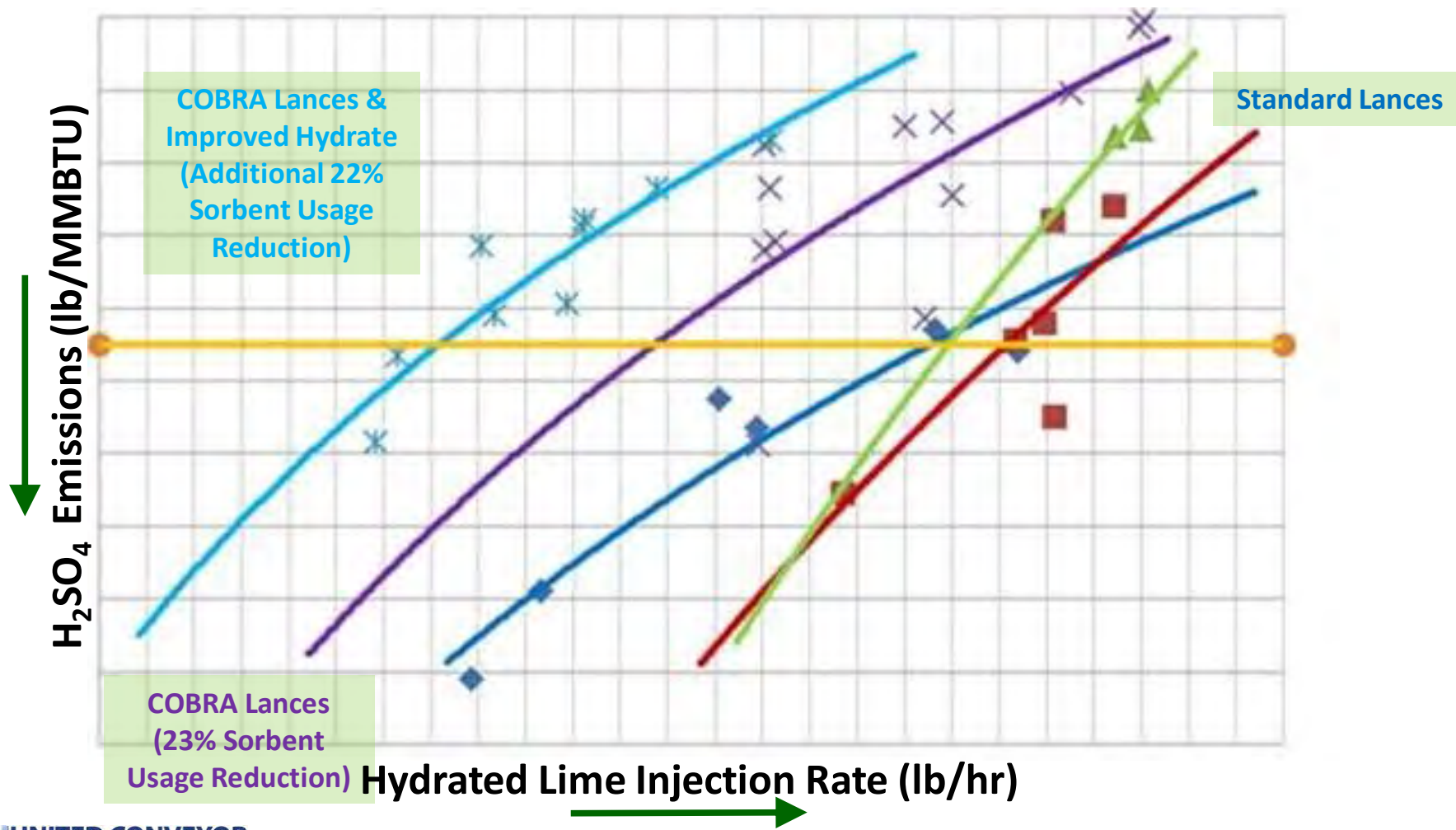
Standard Lance Installation



COBRA™ Lance Installation



COBRA Lance Performance



COBRA™ Lance Installation



Clean Duct Wall



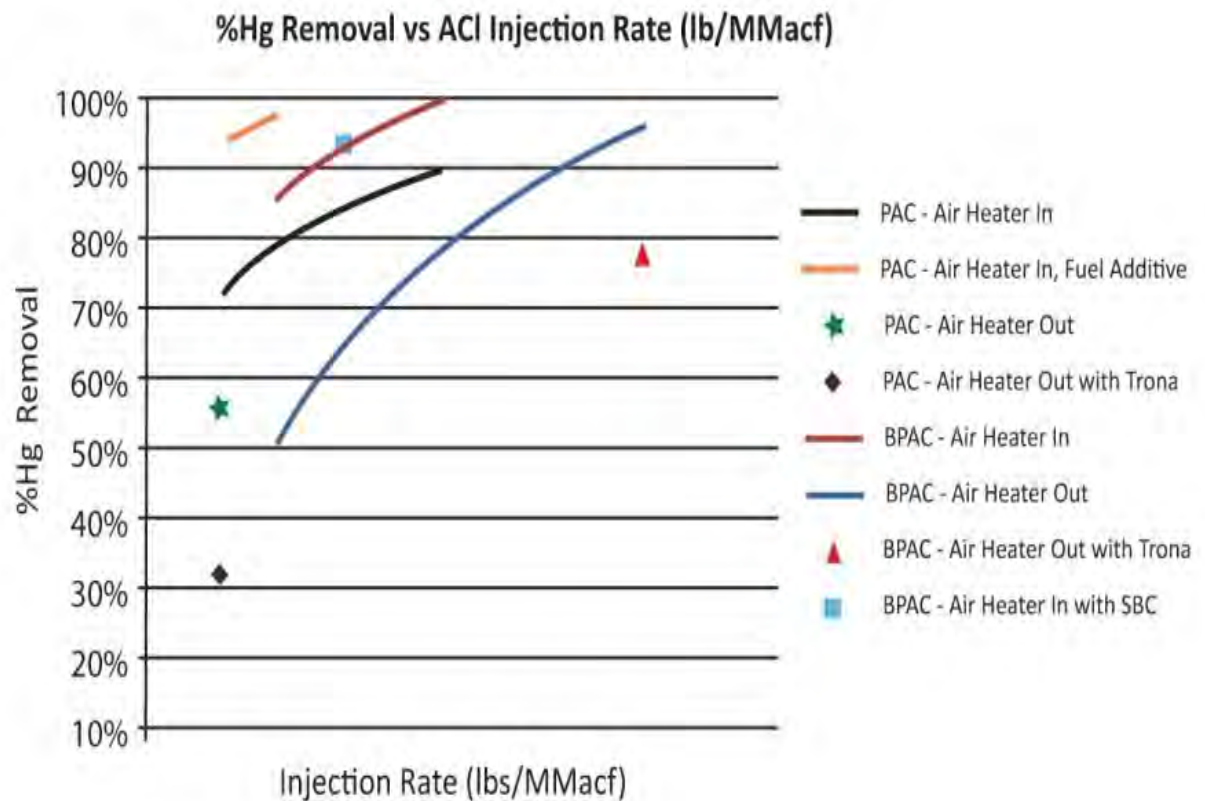
Sulfur Buildup



Effect on Hg Emissions



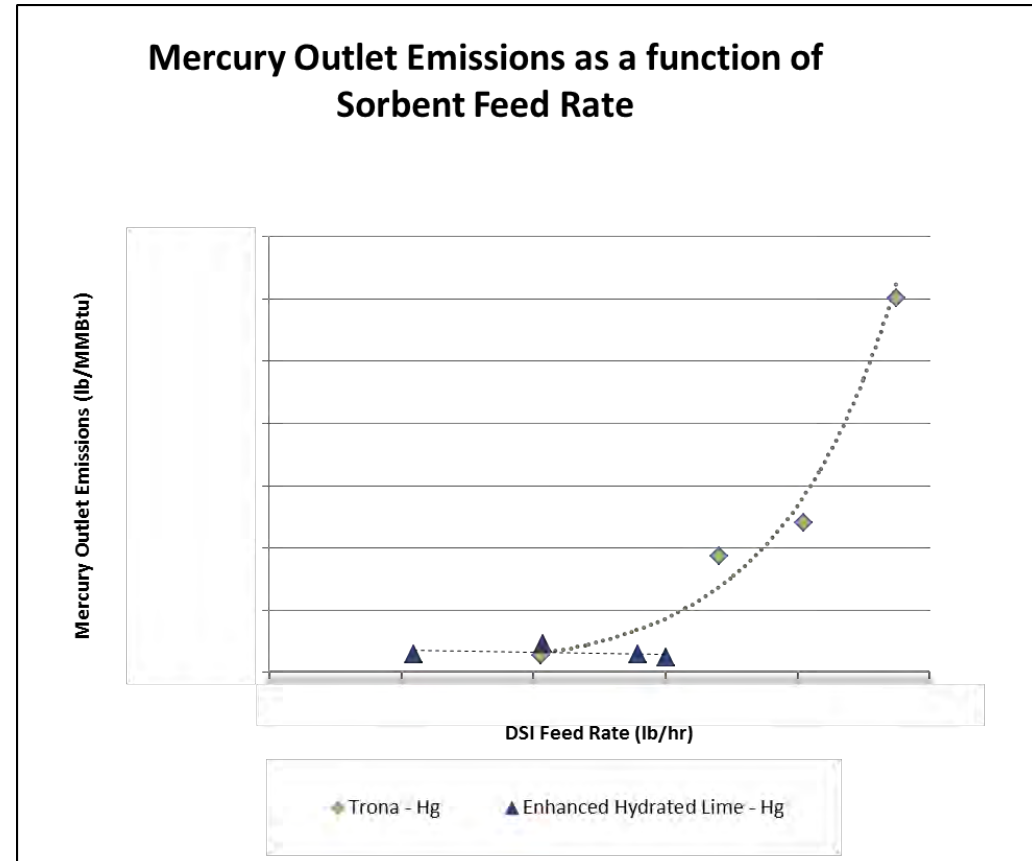
- Generally, neither sodium sorbents or hydrated lime injection for SO₂ removal significantly affects Hg emissions if ACI at air heater inlet and DSI at air heater outlet
- See large effect from sodium sorbents if injected upstream of PAC



Effect on Hg Emissions



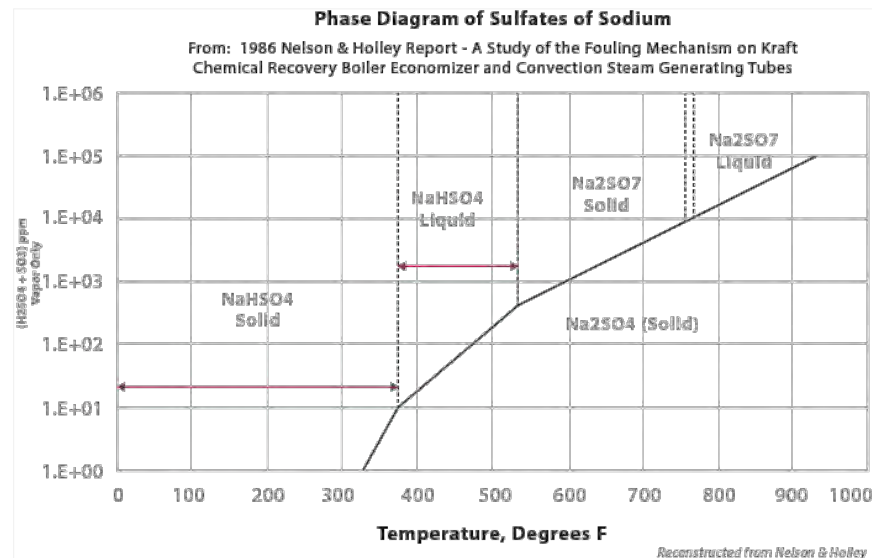
- Hydrated lime injection upstream of PAC sometimes has little effect if fabric filter
- Have found that Hg emissions can increase somewhat after period of time with fabric filter.



DSI Effects on Air Heater?



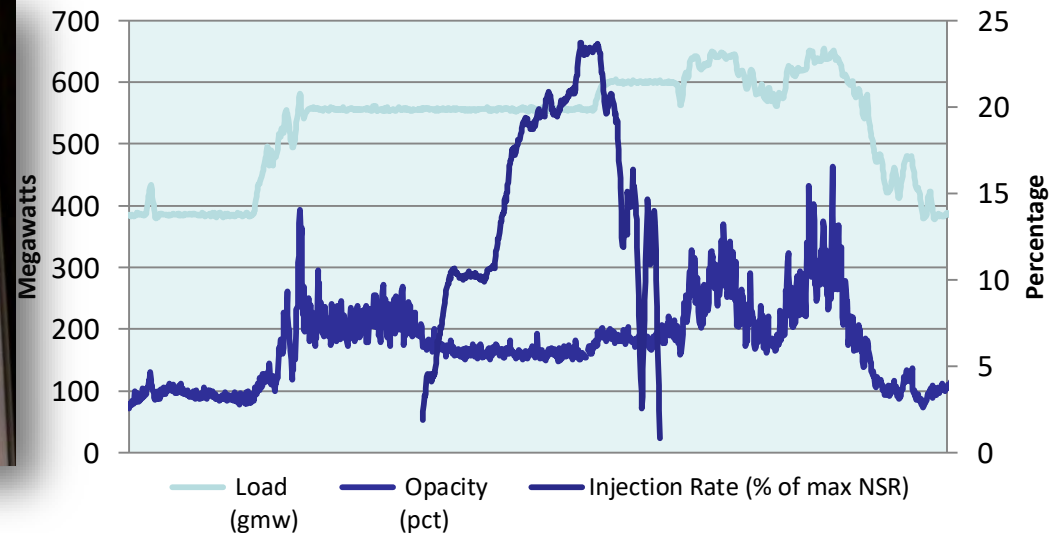
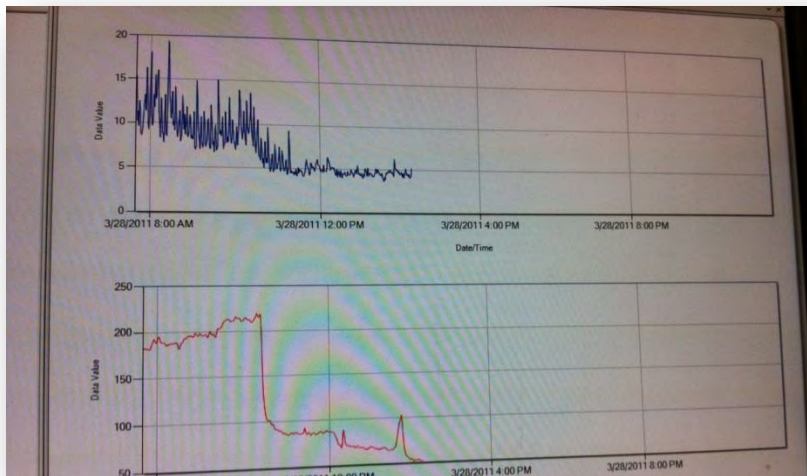
- No effect if used for HCl/SO₂ removal for any coal since rates high enough to prevent possible formation of sodium bisulfate
 - No SO₃ remaining prior to air heater
- SO₃ levels generally not high enough on PRB units to form sodium bisulfate
- No observed effects from hydrated lime injection upstream of air heater





Common Question:

- Will DSI increase opacity and/or particulate emissions?
 - Sodium injection has typically shown **neutral or positive effects** on opacity/particulate emissions
 - Hydrated lime injection can cause problems with under-sized ESPs



DSI Effects on Fabric Filter Performance



- Have not observed increase in particulate emissions in tests to date with either sorbent
- High injection rates may increase particulate emissions, however, depending on fabric filter design
- High air-to-cloth ratio, pulse cleaned fabric filter best suited for DSI
- NO to NO₂ oxidation (brown plume) can occur with high sodium rates





■ Ash Loading

- Ash loading is increased by approximately 70% of the mass of SBC injected,
- 78% of the mass of trona injected
- 180% the mass of hydrated lime injected

■ Ash Handling Characteristics

- Similar in most cases
- Can be more difficult to handle when moist with any of the sorbents



- **Beneficial Ash Use**

- Standard requires less than 5% Na_2O in ash for cement
- This is achievable only at low injection rates of SBC or trona
- Hydrated lime typically does not effect fly ash sales

- **Heavy Metal Leaching**

- Sodium sorbents have shown an increased amount of leaching of heavy metals from landfilled fly ash, although usually within limits
- Hydrated lime can reduce leaching

Presentation Agenda



Introduction

Selecting Injection Locations

Acid Gas Sorbent Injection

Hg Sorbent Injection

Summary

Questions

Selecting Hg Sorbents



■ Hg (historical)

- Brominated fuel additive + PAC (only before DSI)
- Br-PAC before or after air heater
- High LOI

■ Sorbent Update

- Commercial products aimed to solve problems
 - Corrosion: Brominated/Halogenated → Oxidizing
 - DSI and SO₃ tolerant PACs
 - Non-carbon sorbents
 - Fuel Additives

Effects of Other Pollutants on Hg Removal



- **Halogens – Primarily Cl**

- If lower sulfur unit, Cl will oxidize Hg, mostly in the air heater
- Therefore, on lower sulfur units, it is best to inject PAC at the air heater inlet
- Adding CaBr_2 to the coal, or other halogens or oxidizer compounds will increase Hg removal

- **NO_x**

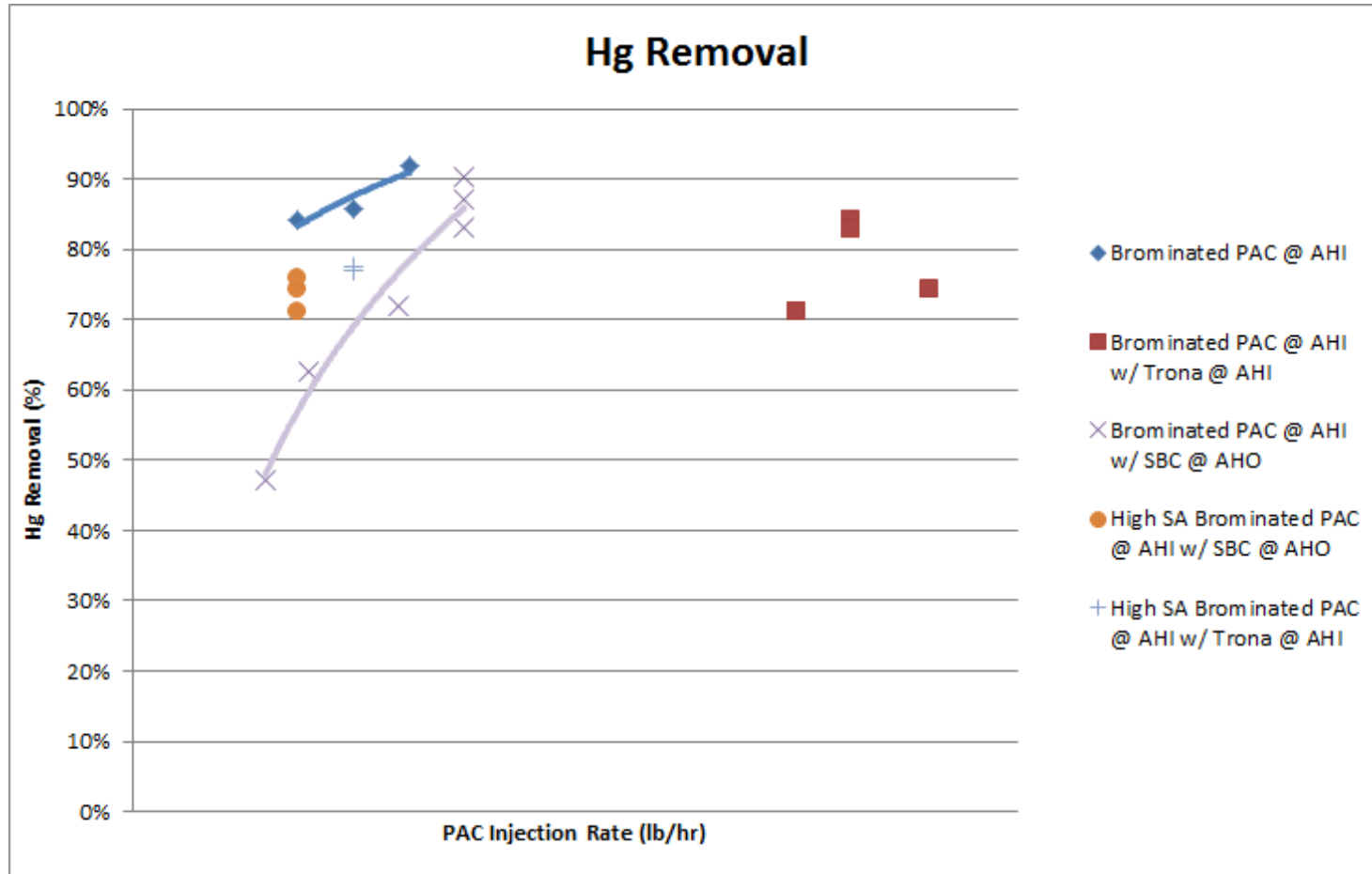
- The NO_2 fraction of NO_x will preferentially adsorb on PAC over oxidized mercury compounds

Effects of APC Equipment on Hg Removal

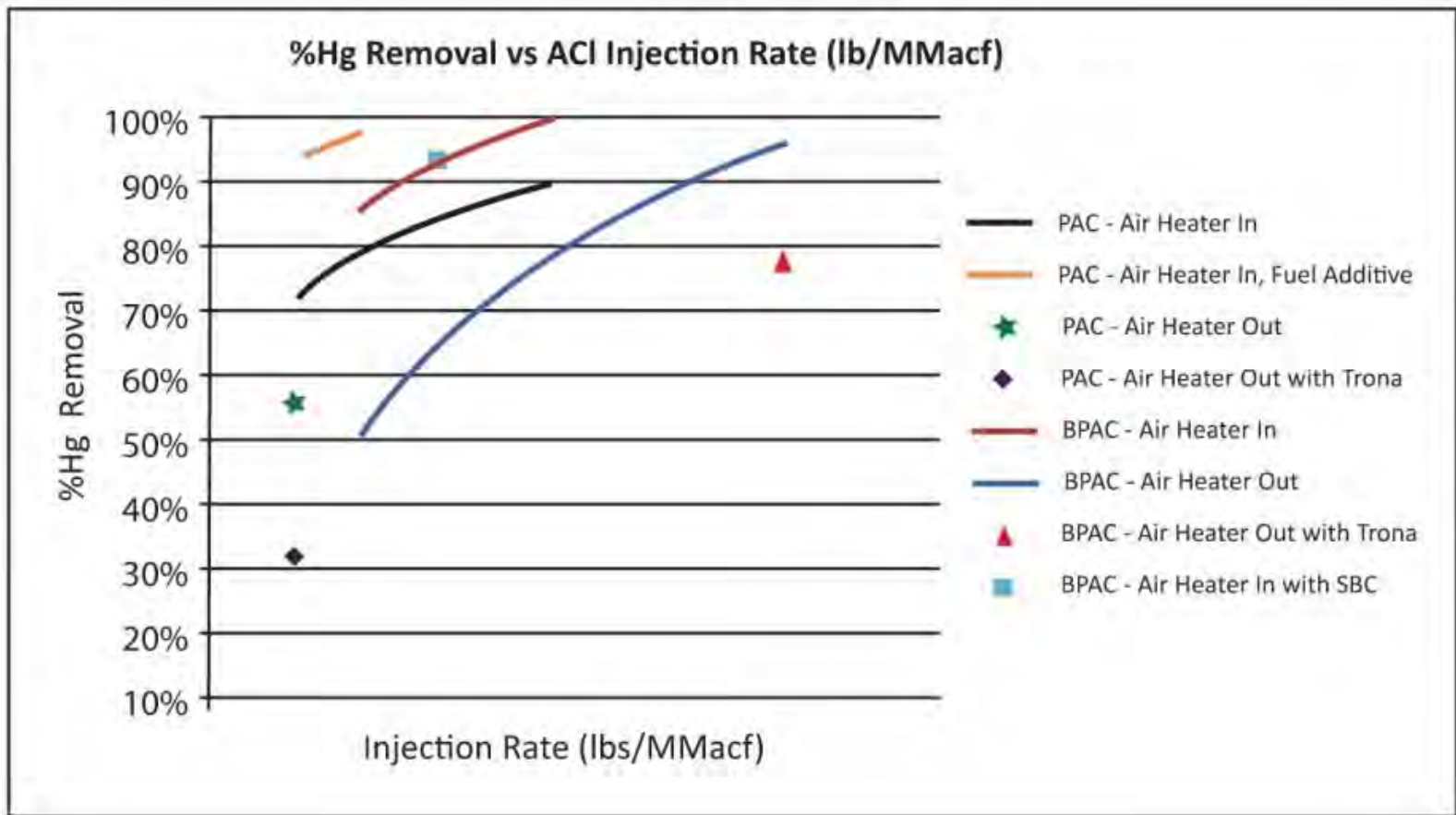


- **SCR**
 - Improves Hg removal by oxidizing Hg
- **ESP**
 - Additional Hg removal takes place due to residence time in ESP and adsorption on both PAC and unburned carbon
- **Fabric Filter**
 - Provides the residence time for excellent adsorption and Hg removal
- **FGD/Scrubber**
 - Can remove oxidized Hg
 - However, can also re-emit Hg under some conditions
 - Testing is needed to understand Hg re-emissions

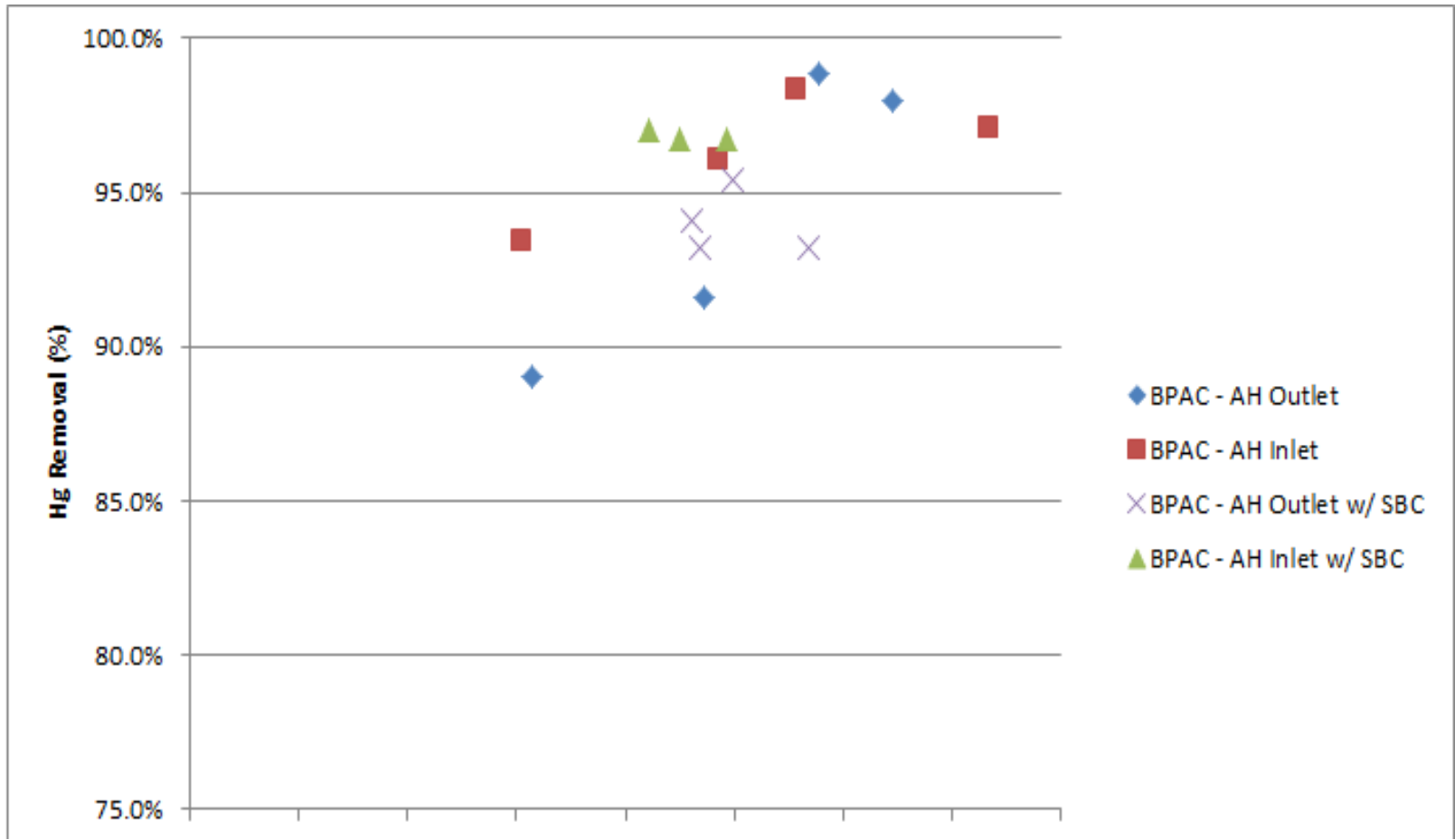
Typical Hg Removal Test Data



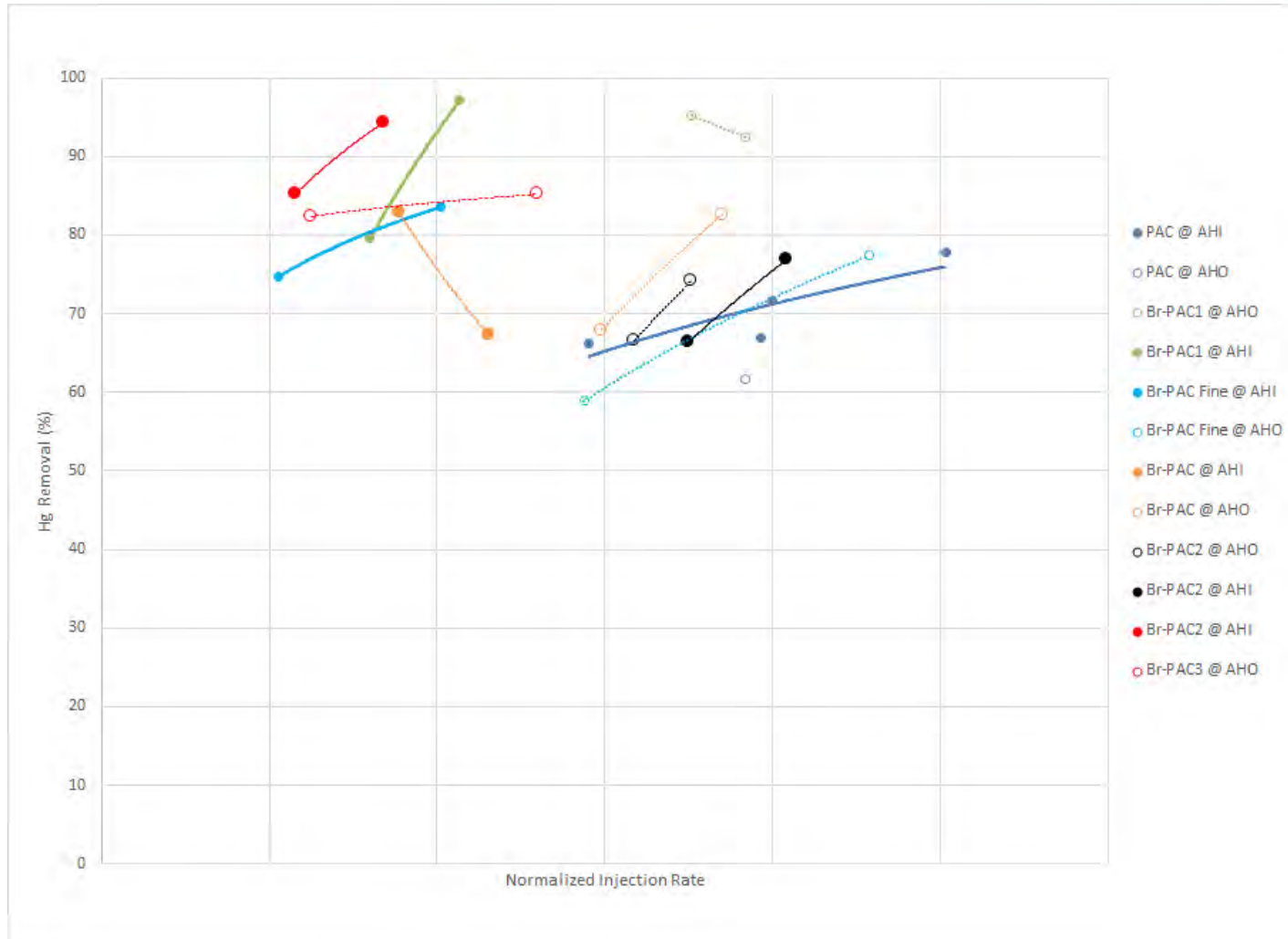
Typical Hg Removal Test Data – Low Sulfur Coal with ESP



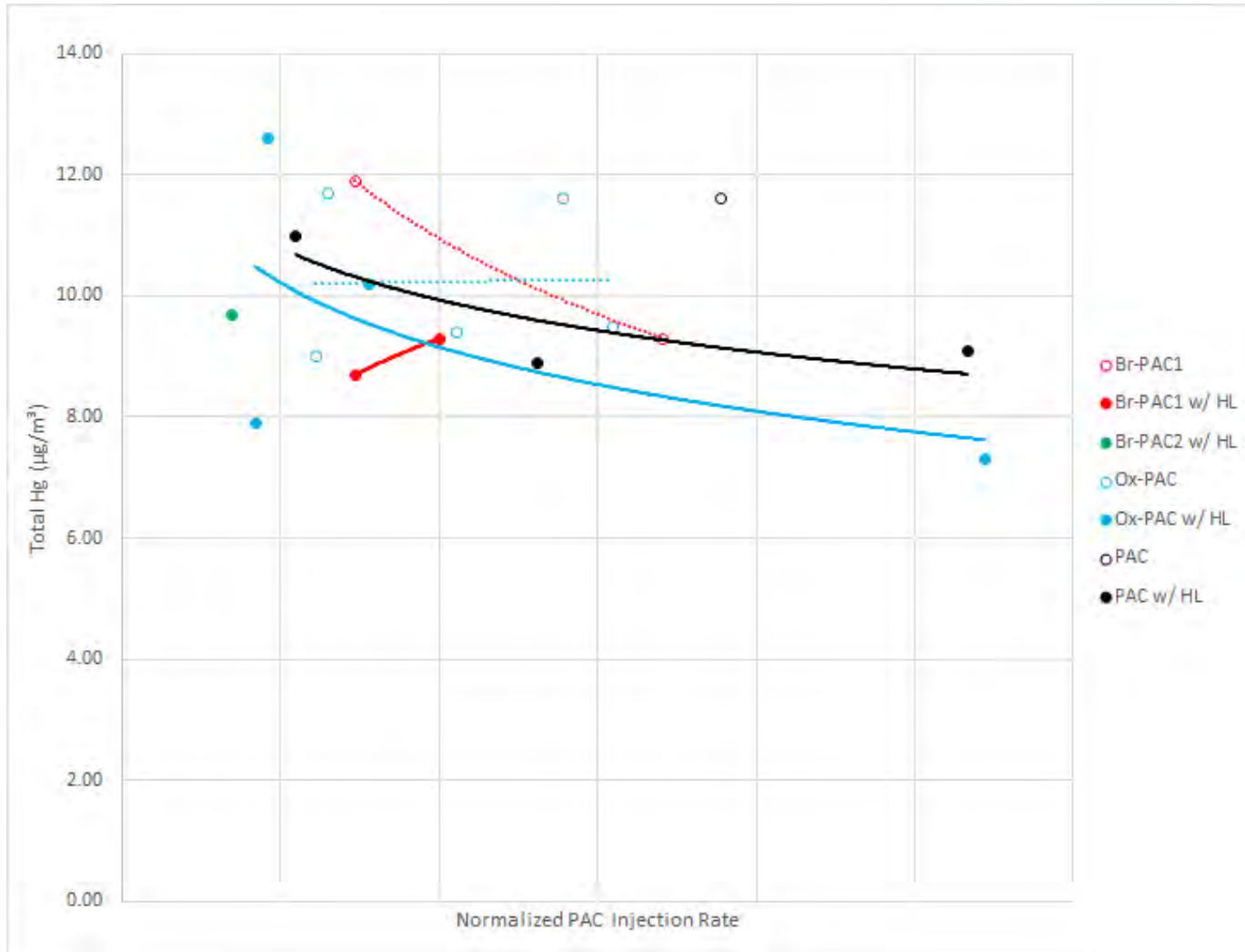
Typical Hg Removal Test Data – Low Sulfur Coal with Fabric Filter



Typical Hg Removal Test Data – Lignite Unit



Typical Hg Removal Test Data – Lignite Unit Air Heater Outlet Injection



PAC Injection – Effect on Ash



- Can affect ash sales for concrete applications in some cases
 - Consistent PAC feed rate is needed to ensure proper air entrainment additive amount
- Can affect color of ash
- In most cases, PAC injection can be managed so as to not affect ash sales
- Does not adversely affect ash landfilling
 - Mercury will not leach from PAC in landfill



■ New applications for Hg removal

- SCR/W-FGD
- W-FGD additives
 - Sulfides
 - PAC
- SDA chemical additives



Presentation Agenda



Introduction

Selecting Injection Locations

Selecting Acid Gas Sorbent

Selecting Hg Sorbent

Summary

Questions



- **New, creative solutions continuously arise**
 - Sorbents and additives
 - Oxidizing, non-halogenated PACs
 - DSI and SO₃ resistant Hg sorbents
 - Fuel additives with lower corrosive potential
 - Specialty hydrates
 - Locations and Technology
 - Increasing utility of APC equipment (W-FGD, SDA, SCR, etc)



Questions?

Contact Information



For more information on United Conveyor Corporation, please contact:

Conner Cox Project Manager

847-473-4900 ext 604

ConnerCox@unitedconveyor.com

