REINHOLD ENVIRONMENTAL Ltd.

2013 APC Round Table & Expo Presentation

July 8-9, 2013, in St. Louis, MO / Hosted by Ameren

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SMART SCIENCE • CLEANER ENERGY

Acid Gas Stratification

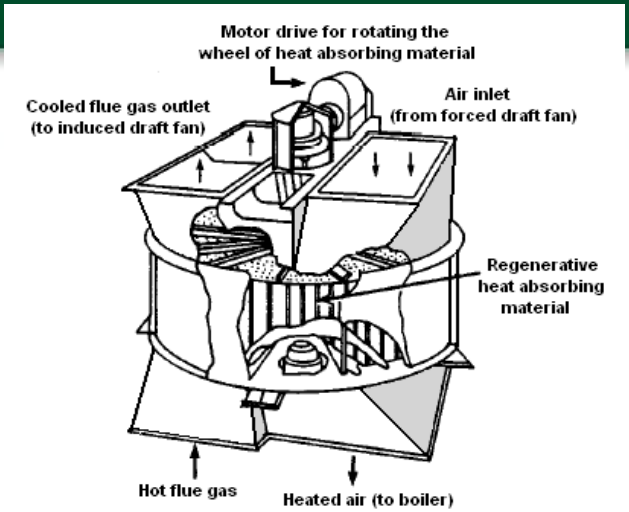
And its impact on DSI

Presented by:
Chetan Chothani

Presented to:
2013 APC/PCUG conference – Reinhold Environmental

July/2013

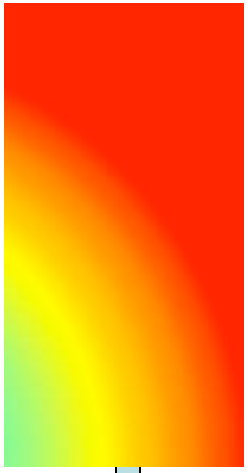
AH – Condense and Concentrate Device

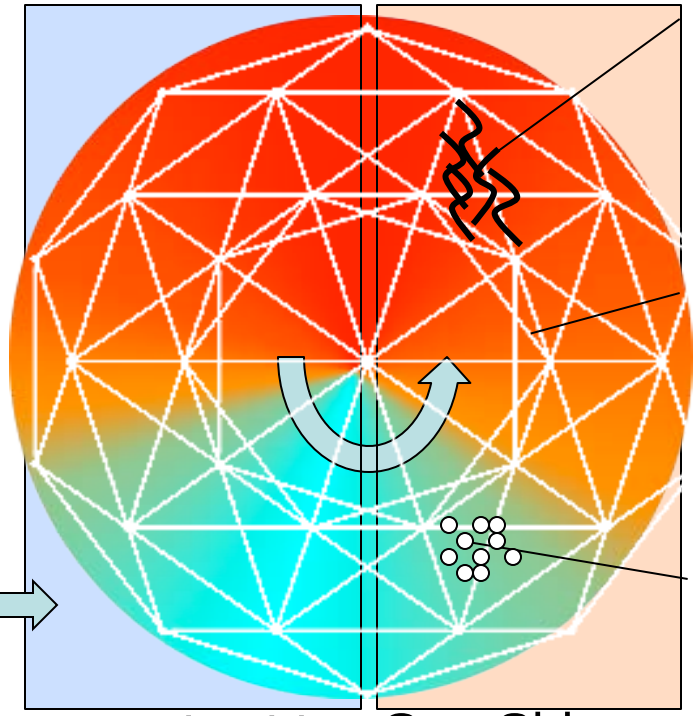


Rotating Lungstrom type Air heater (could be vertical or Horizontal Shaft)

Concentrate

Hot End





Condensed Acid Vaporizes on the Hot metal

Metal not cold enough to condense and not hot enough to vaporize. Acid passes through.

Acid condenses on the cold metal

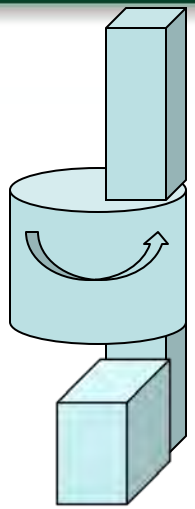
Condense

Cold End

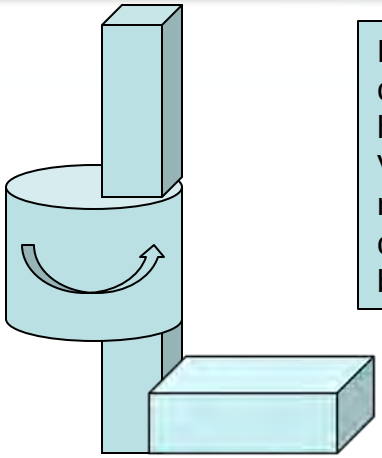
Air-Side

Gas-Side

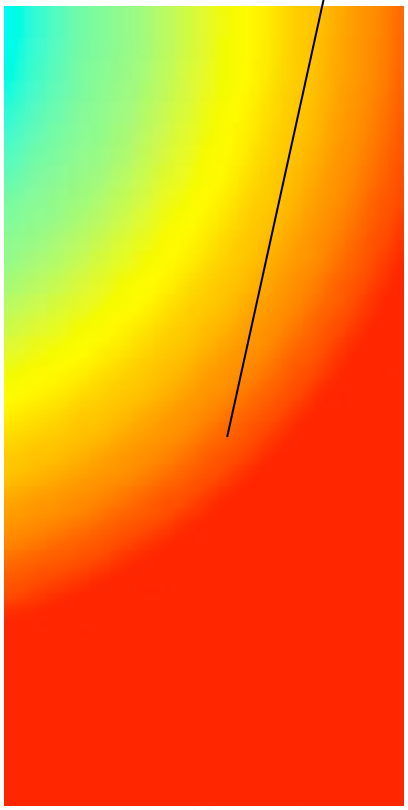
AH Outlet Duct Stratification

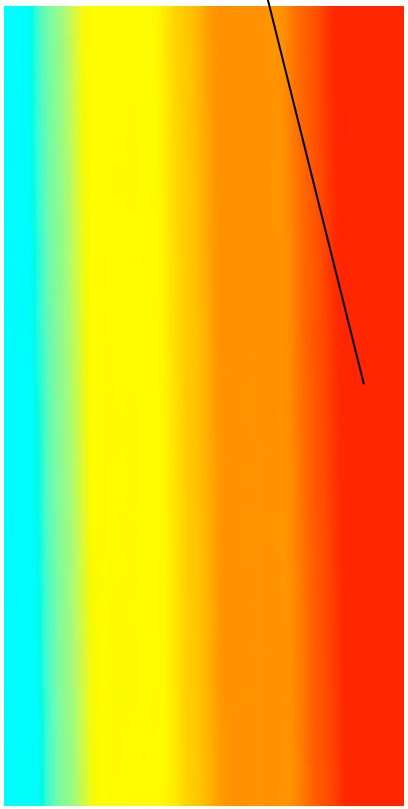


Low SO3 concentrations will have lower Vaporization Temp resulting in highest concentration in this band.



High SO3 concentrations will have higher Vaporization Temp resulting in highest concentration in this band.





Duct Orientation after the bend determines Temp stratification.

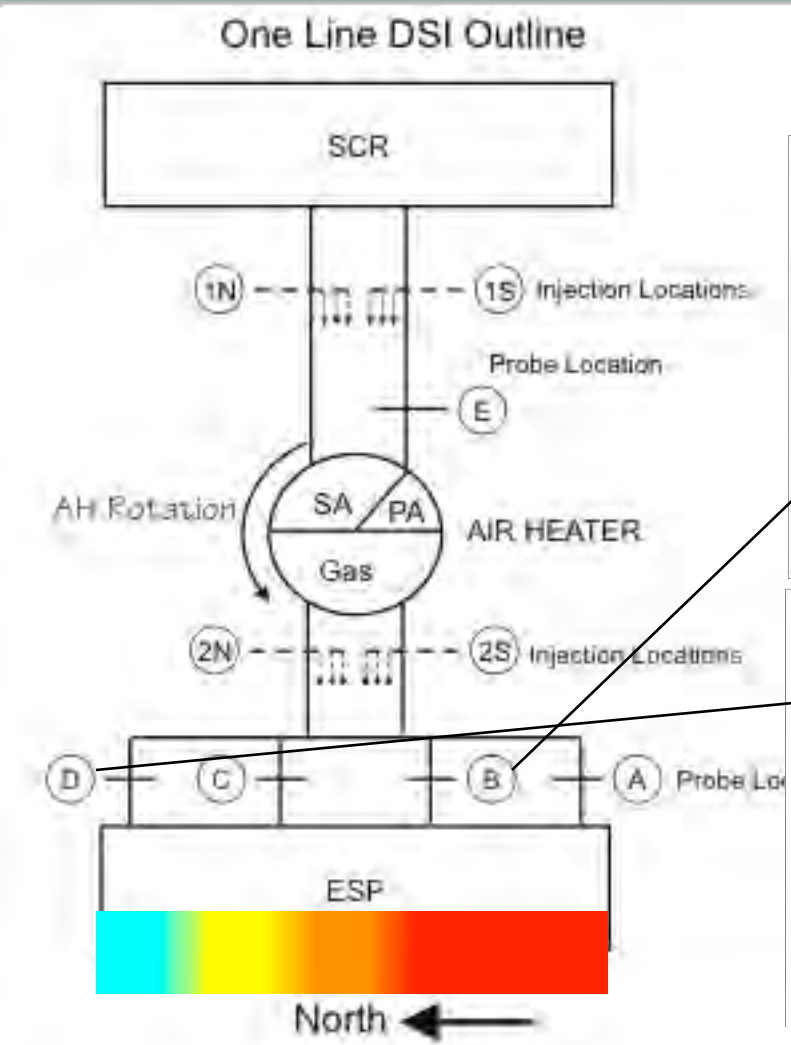
SO3 follows temp depending on SO3 concentration

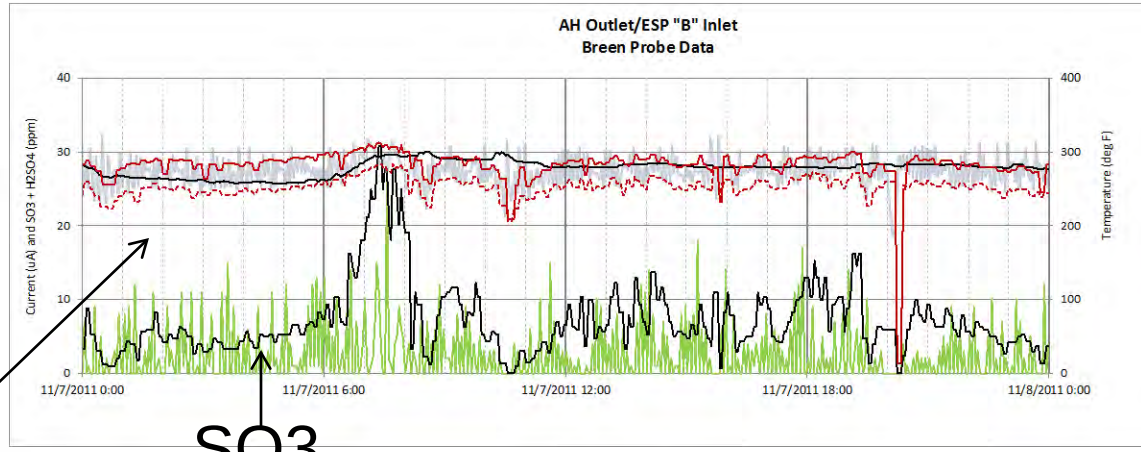
5 ppm SO3 – Evap Temp = 275 DegF

10 ppm SO3 – Evap Temp = 289 DegF

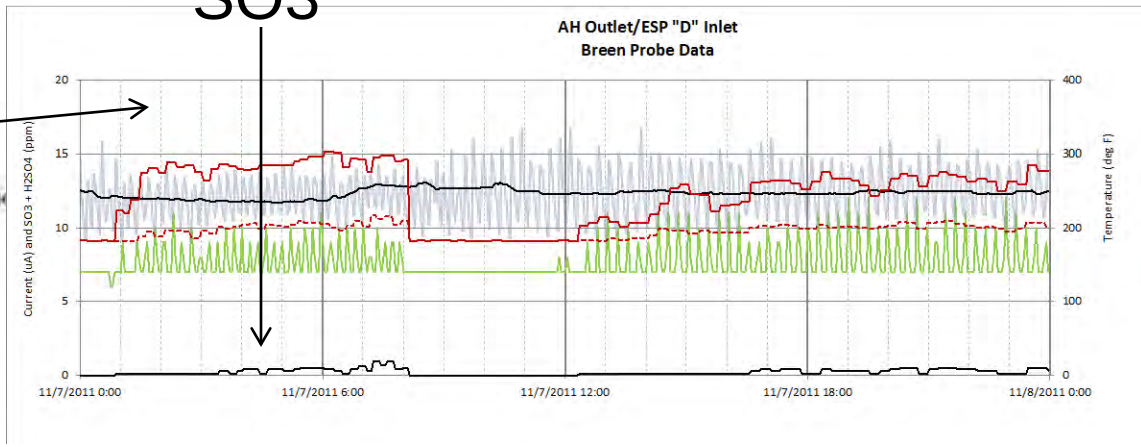
Some stratification may also result from capture of Acid Vapor on Flyash particles and Aerosol Formation

AH Out – ESP In - Stratification

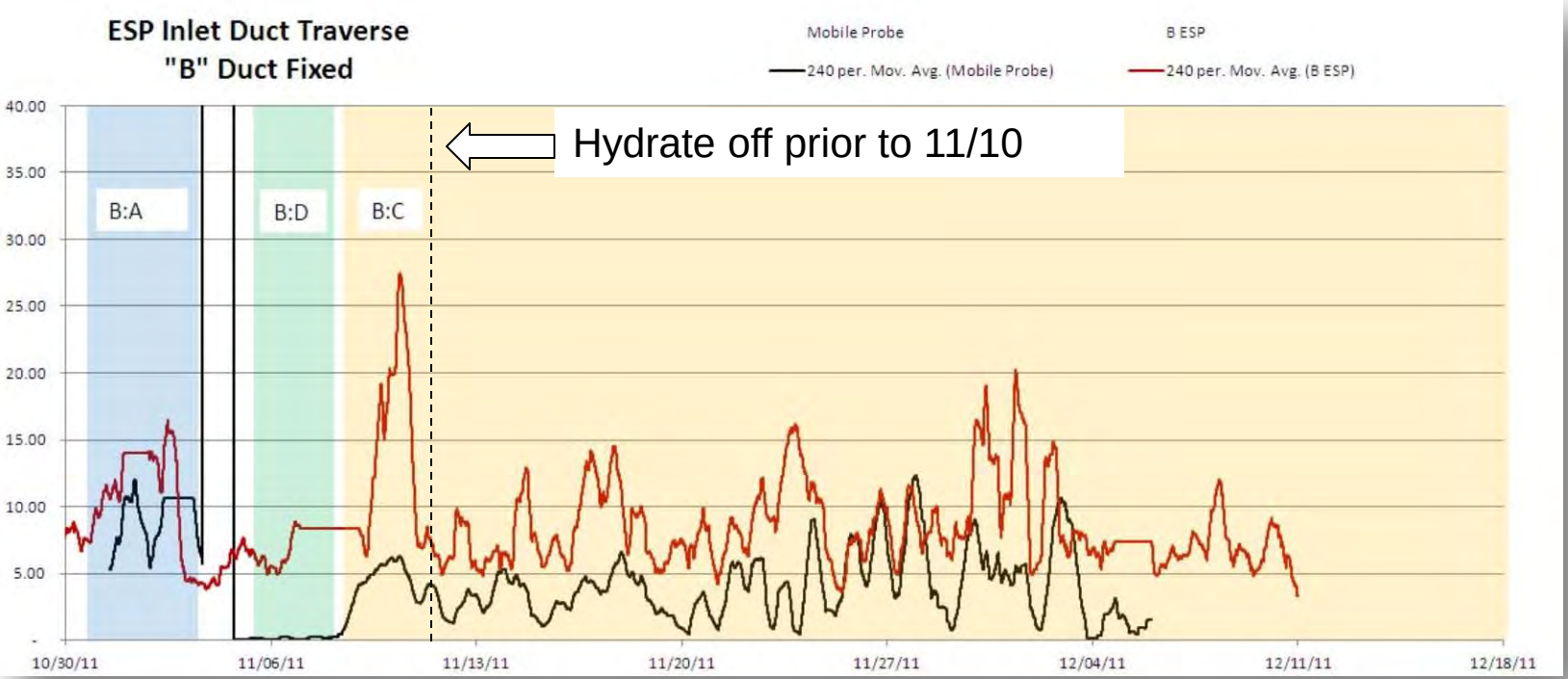




SO3



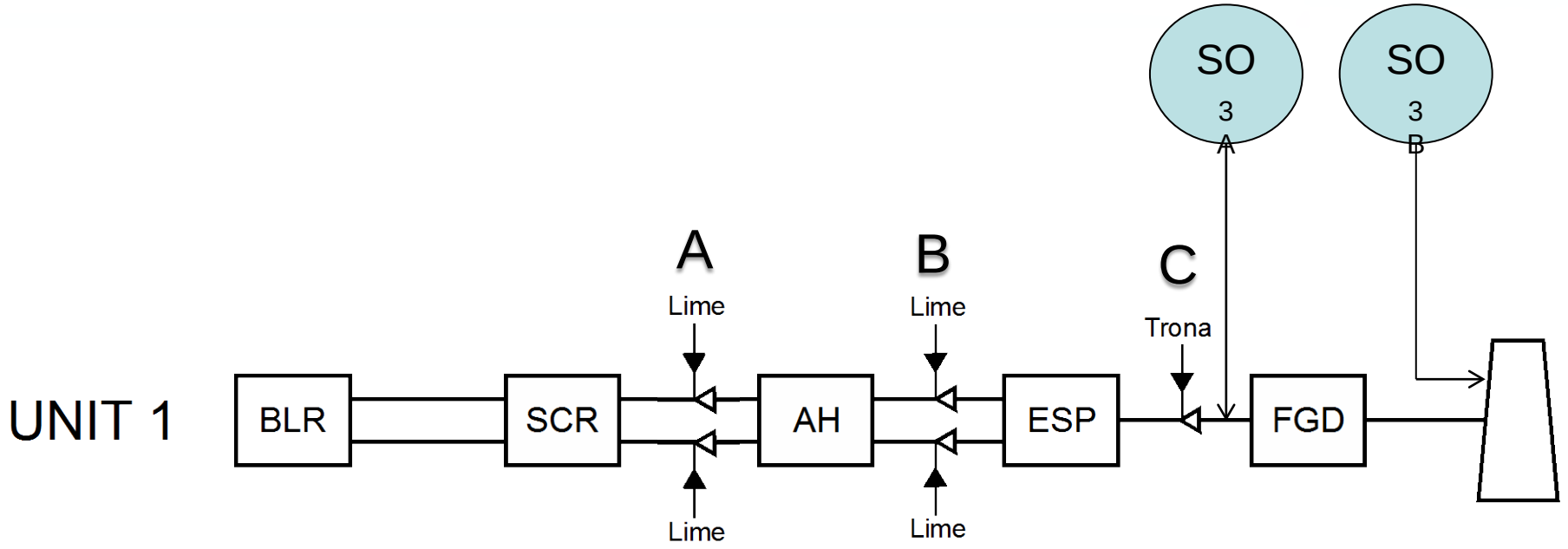
Breen Sorbent Injection Biasing



- **B Duct consistently showed higher condensable**
- **Inboard Ducts consistently showed higher condensable than outboard**

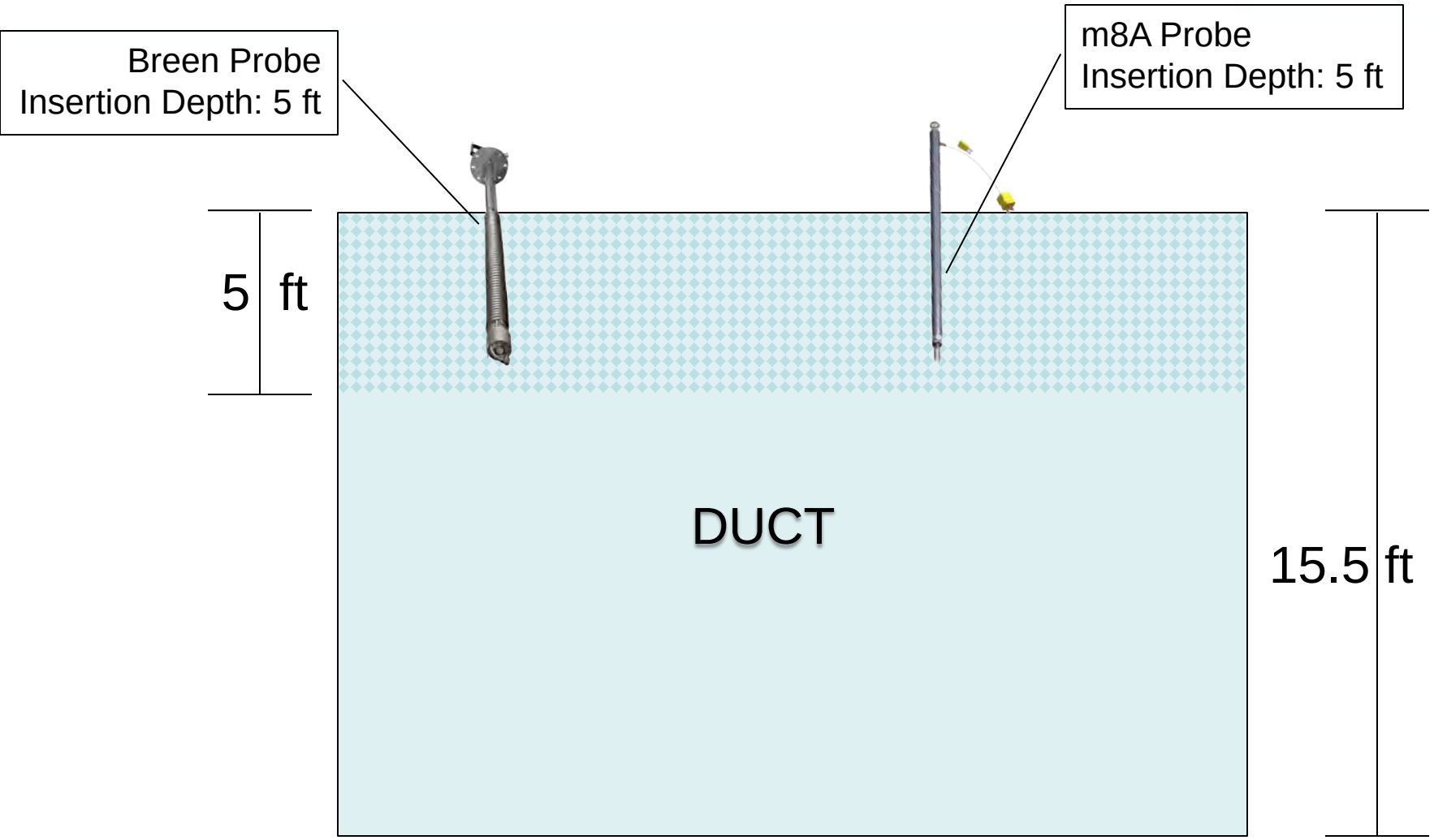
FGD Inlet Stratification

Conundrum !

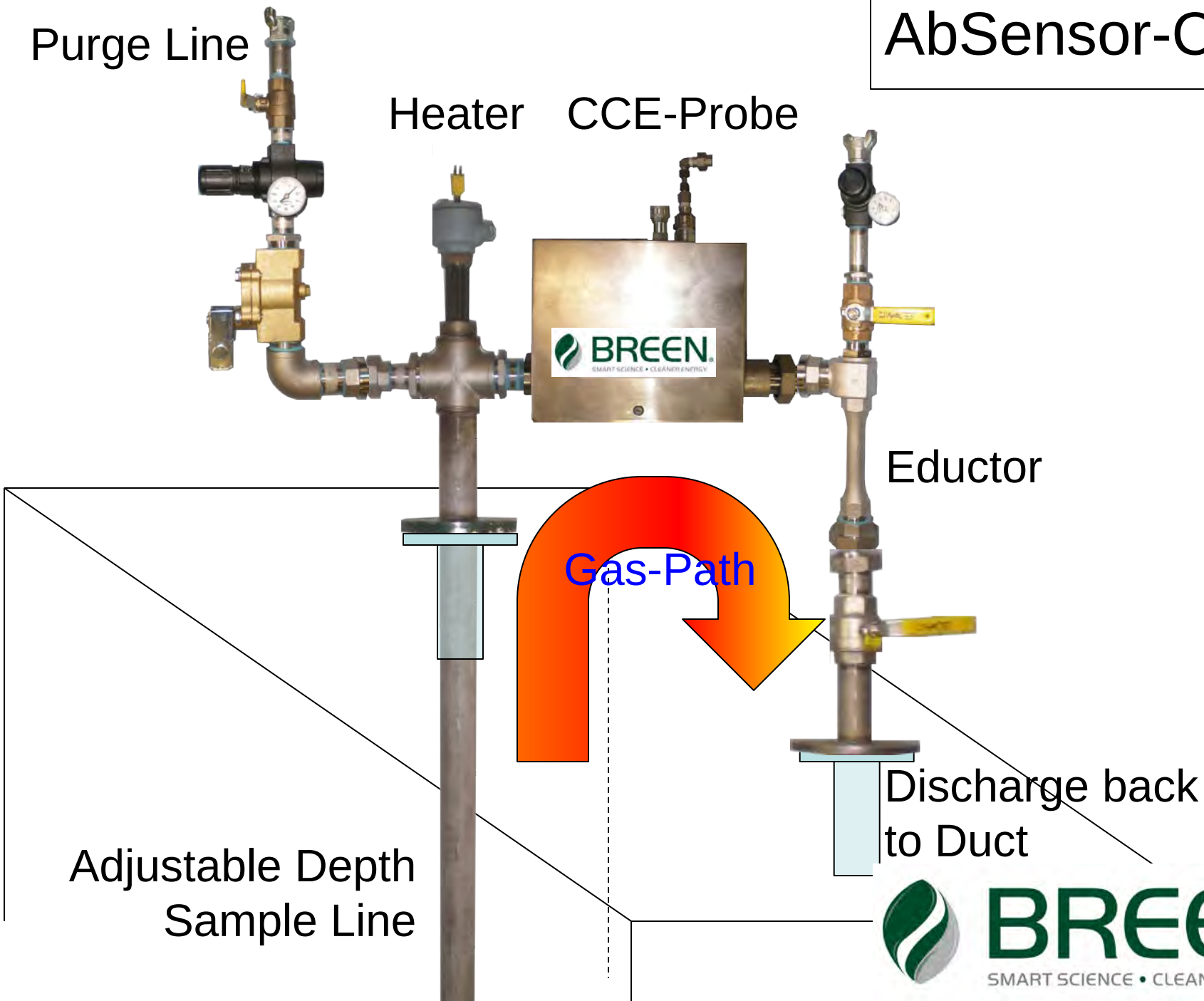


- **SO_3-B > SO_3-A** without Sorbent Injection @ C (FGD Inlet)
- **SO_3-B < SO_3-A** with Sorbent Injection @ C (FGD Inlet)

Measurement Depth



AbSensor-CCE



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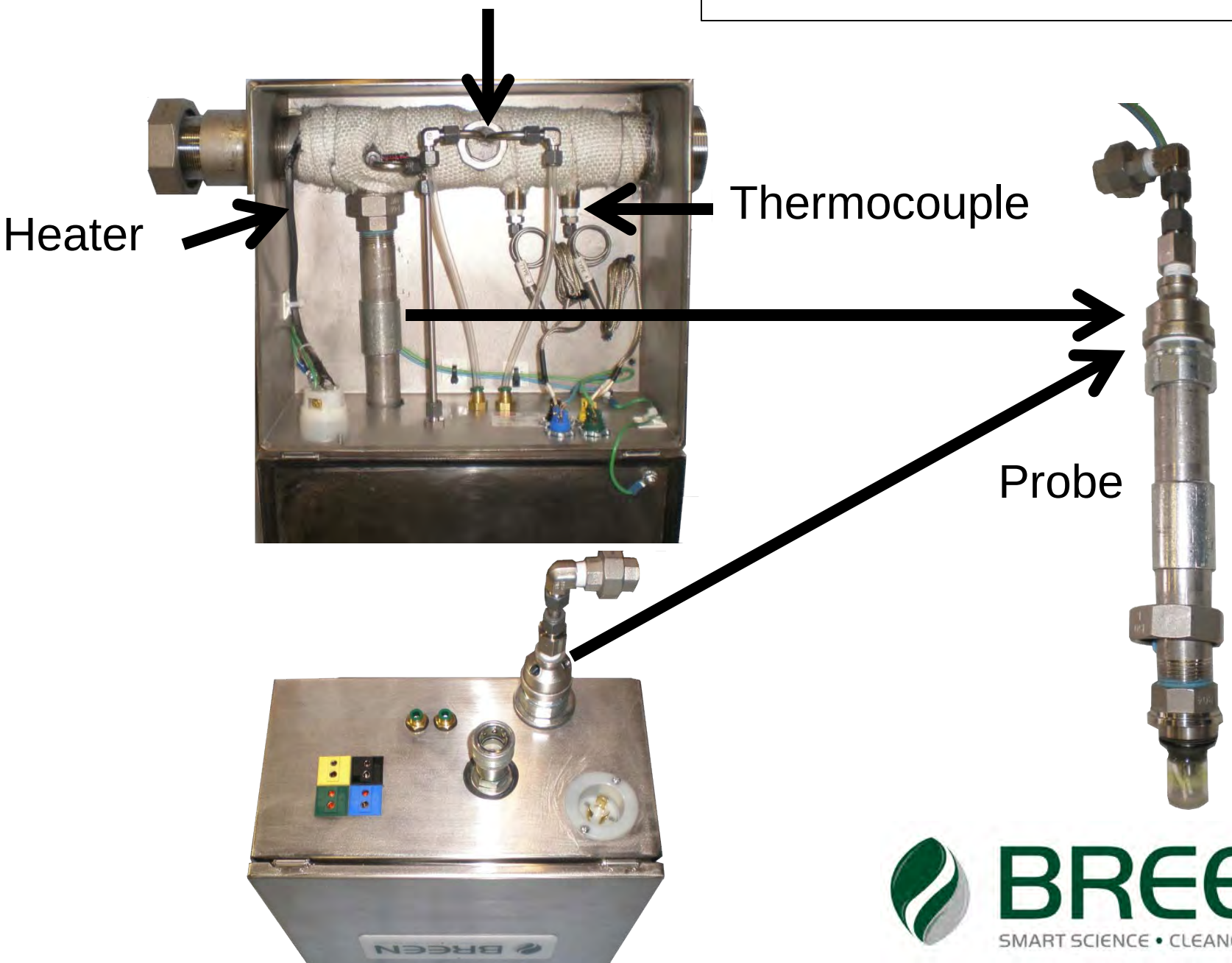
AbSensor-CCE-Probe



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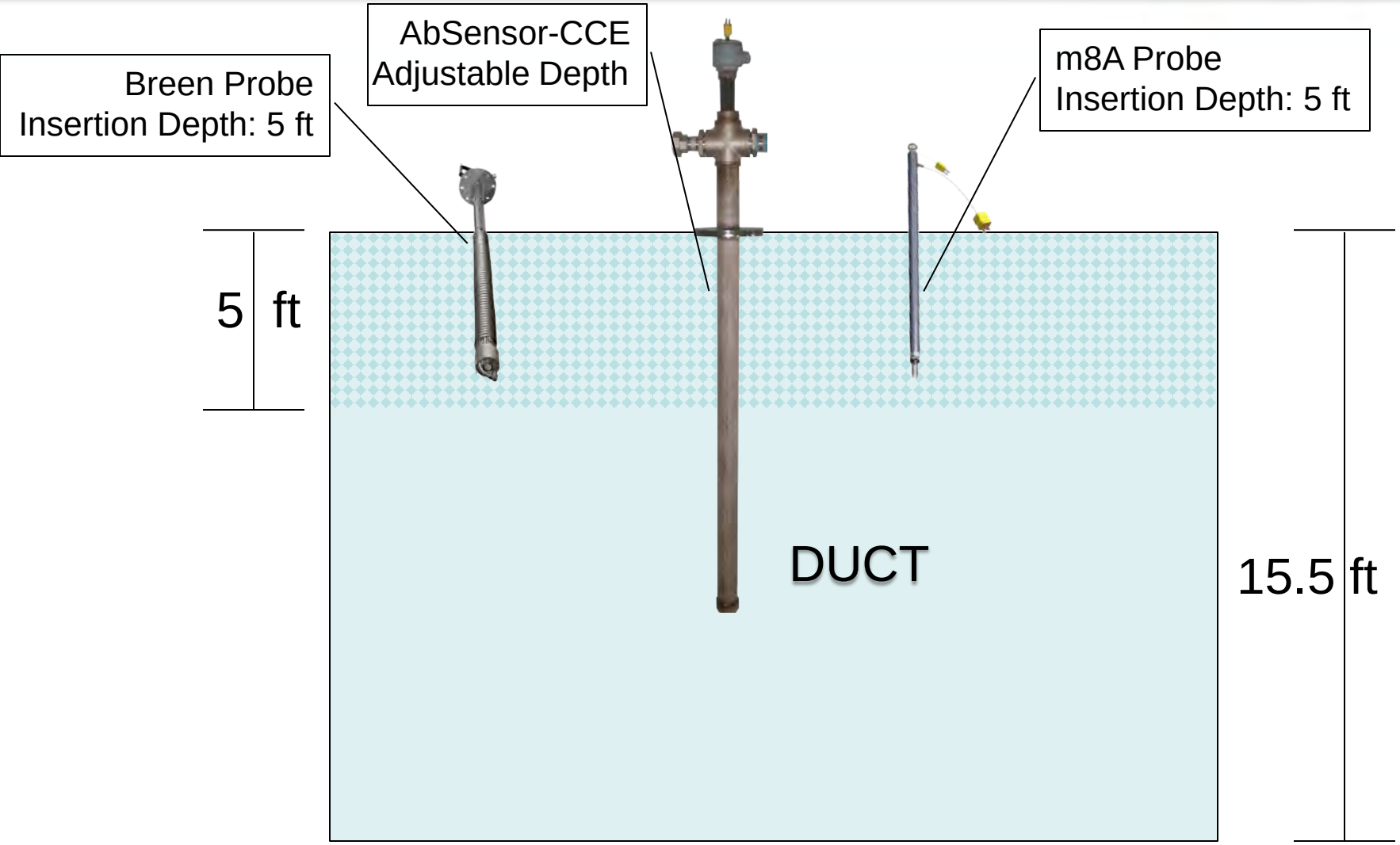
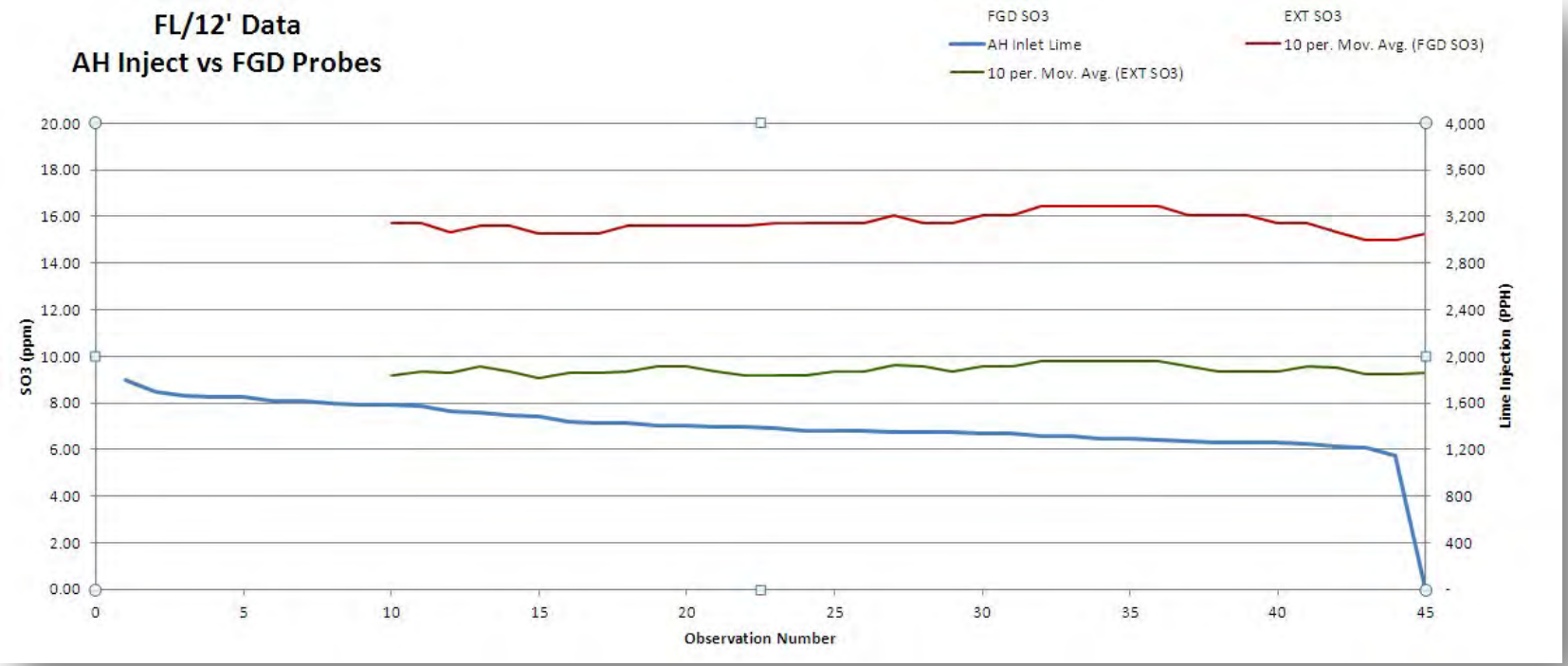
Measurement Depth

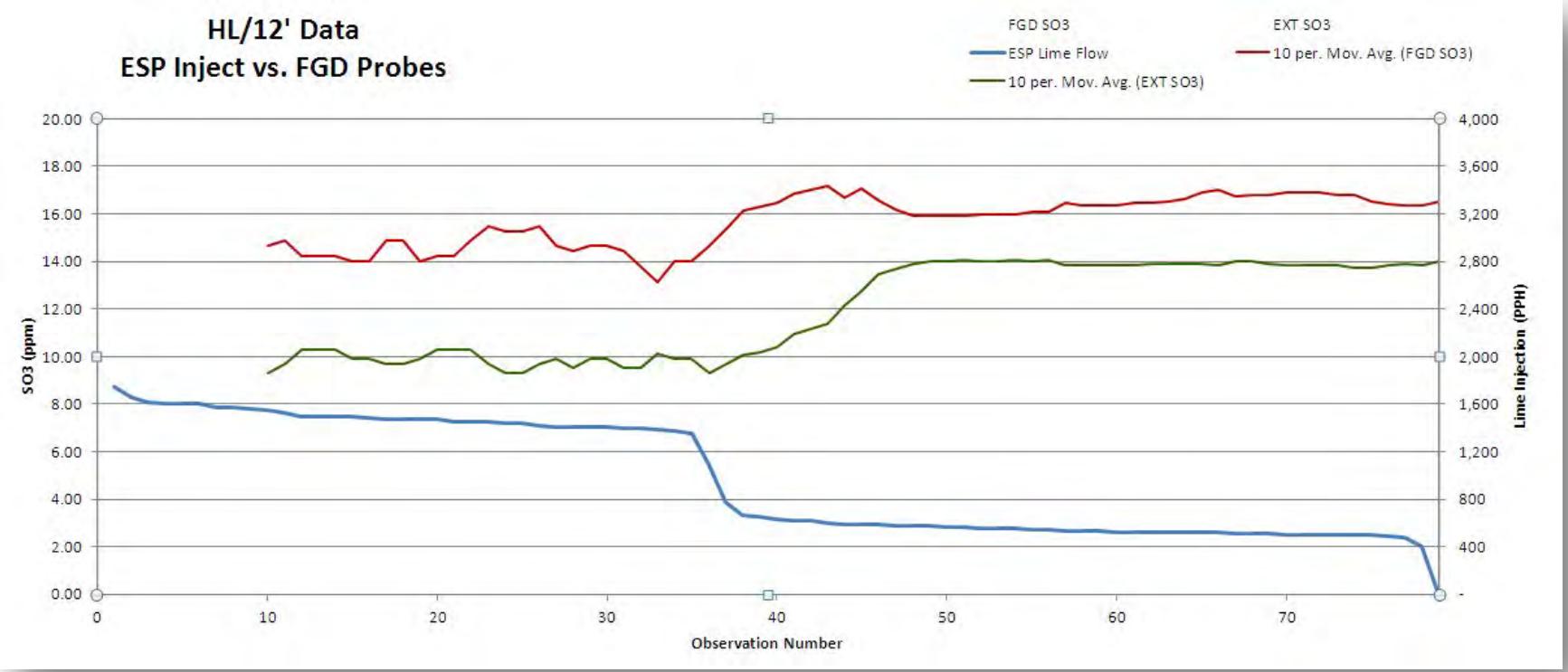


AH Inlet Injection Only



- Acid levels are higher at the top of the duct,
- Not enough data to project treatment sensitivity

ESP Inlet Injection Only

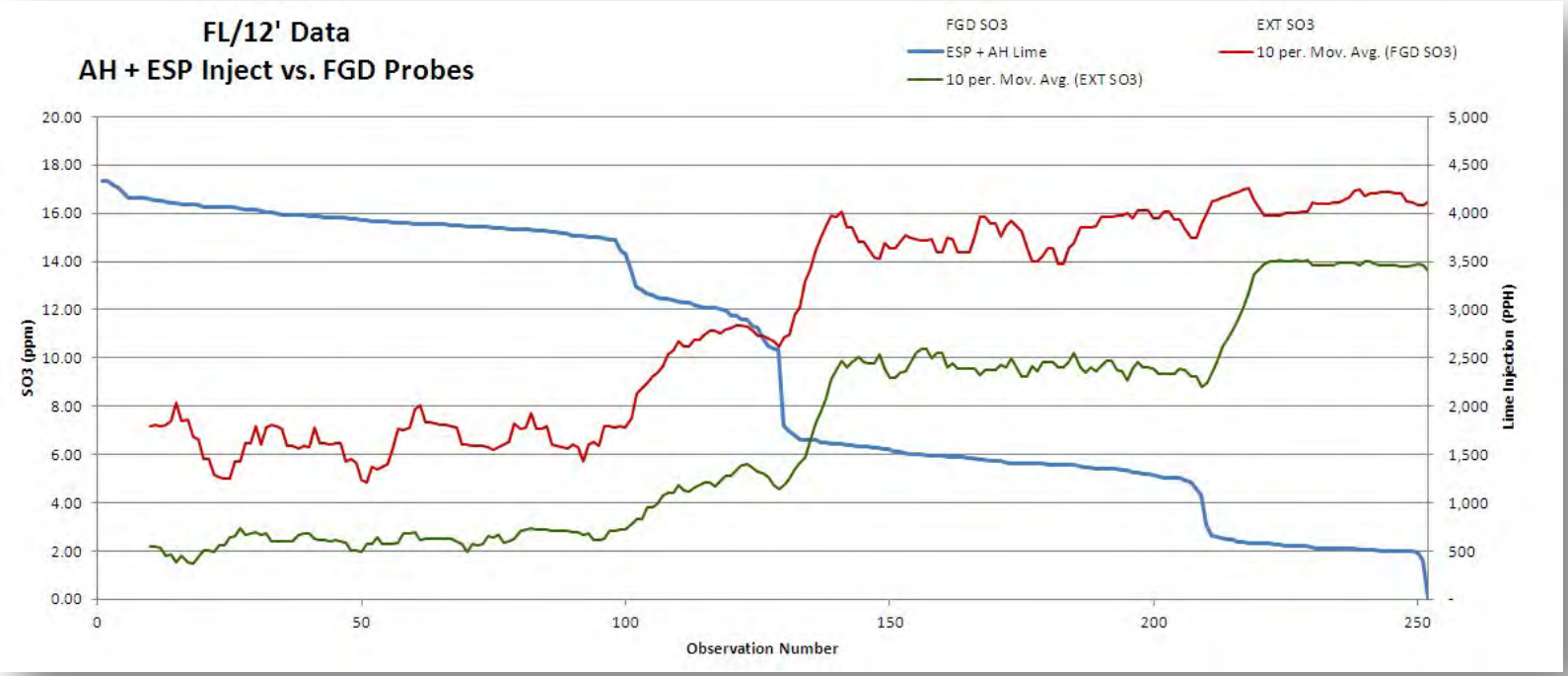


- Acid levels are higher at the top of the duct,
- Material at bottom of duct seems more sensitive to sorbent

FGD Inlet Injection Only

- Top of duct acid levels are highly influenced by FGD Injection
- Bottom of duct acid seems only mildly sensitive
- This represents a clear indication of sorbent stratification at this location

AH Inlet + ESP Inlet Injection



- Compliance is achieved at any injection rate above 3500 PPH
- Compliance is potentially achieved above 2500 PPH
- Process appears controllable

AH Inlet to Baghouse Inlet Stratification

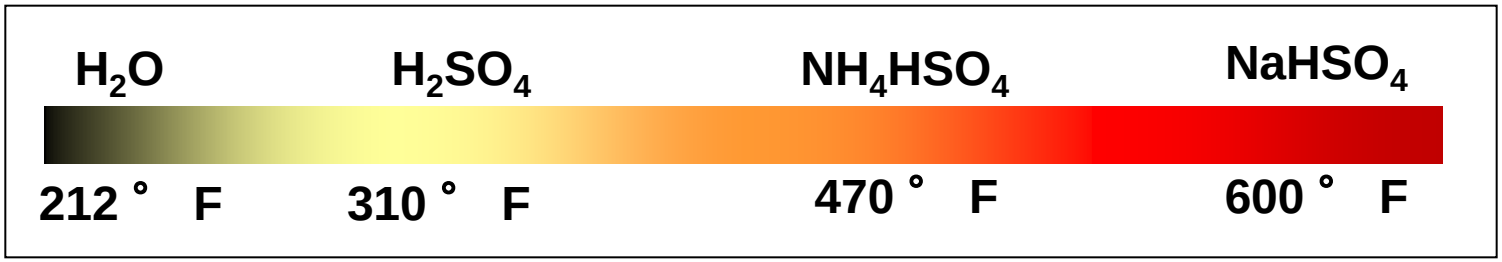
SPECIES AND DEPTH EFFECTS

What are Condensables?

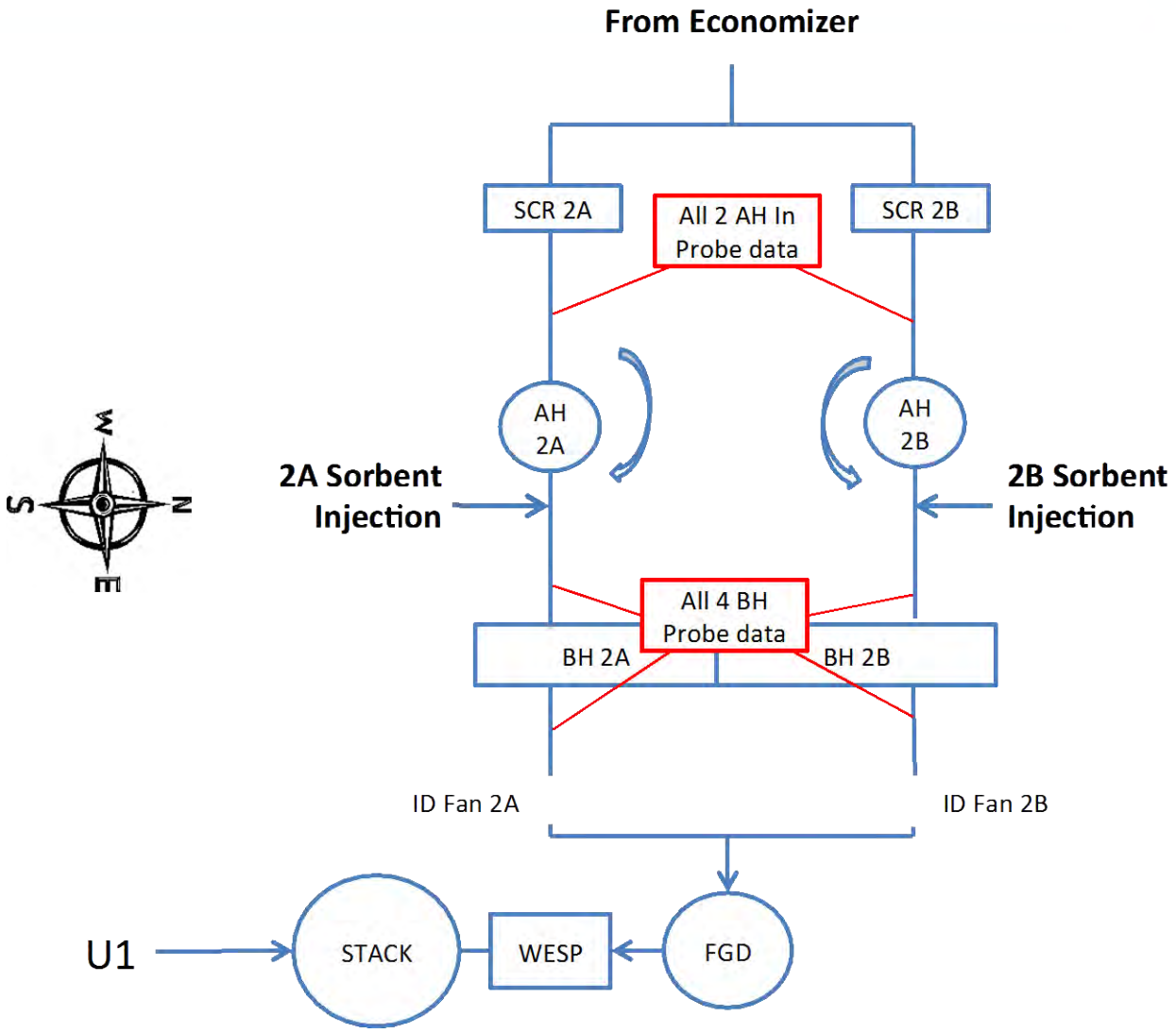
“Condensables” covers the broad continuum of material from water vapor to Sodium Bisulfate

This material could be:

- Moisture (H_2O),
- Sulfuric Acid (H_2SO_4) ($H_2O + SO_3$)
- Ammonium Sulfate $(NH_3)_2SO_4$
- Ammonium Bisulfate (NH_4HSO_4) ($NH_3 + H_2O + SO_3$)
- Sodium Bisulfate ($NaHSO_4$)



System Setup



Hydrate Impacts

Feb 11. Hydrate OFF, Full Load

		NH3 Normal
A side:	AH inlet	ABS
	BH inlet	Mixed, 14 ppm
	BH outlet	Mixed, 14
B side:	AH inlet	Mixed, 24
	BH inlet	Mixed, 23
	BH outlet	Acid, 15

Feb 12. Hydrate ON, Full Load

		NH3 Normal
A side:	AH inlet	ABS
	BH inlet	Mixed, 12
	BH outlet	Acid, 8
B side:	AH inlet	Mixed, 24
	BH inlet	Mixed, 17
	BH outlet	Acid, 4

1. A Side in ABS/B Side Mixed
2. ABS at AH Inlet translates to LOWER free acid at the BH Inlet
3. With Hydrate “OFF”, acid capture in the baghouse was minimal
4. Hydrate results in a MINOR drop in free acid at the BH Inlet (in-flight capture)
5. Hydrate results in a MAJOR drop at the BH Outlet

Explanation of Above

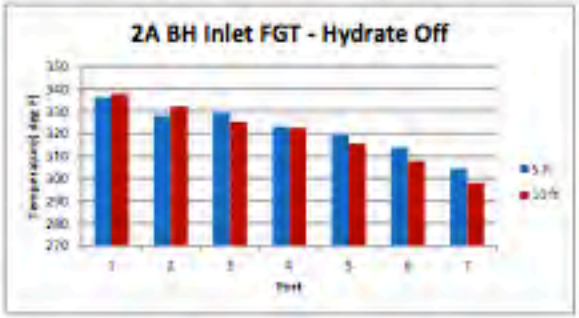
- **Ammonia acts as the initial acid absorption technology, creating ammonia salt species with the free acid.**
- **The lower the ammonia slip, the higher the free acid.**

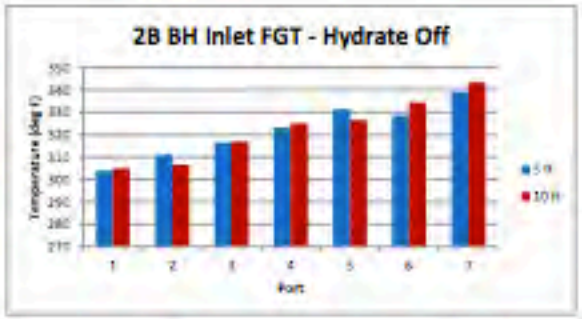
- **However, the ammonia salts will drop out on the bag filter if the gas temperatures are below the condensation point of the salt (generally 296F theoretical)**

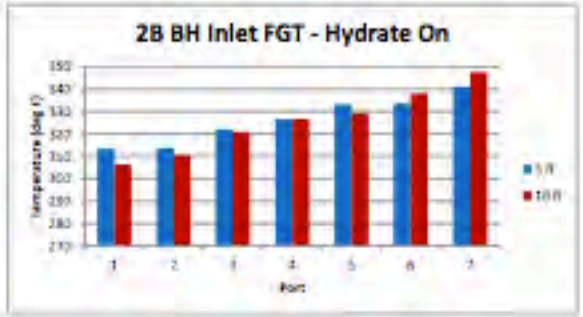
- **Hydrated Lime injection has the impact of lowering the acid dewpoint (in-flight capture) but at the low stoichiometric ratio employed here, the real capture is on the bag filter**

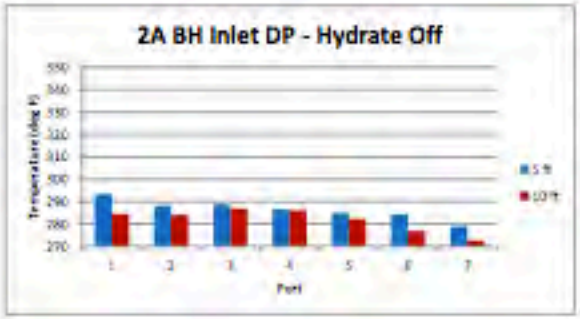
Stratification Testing

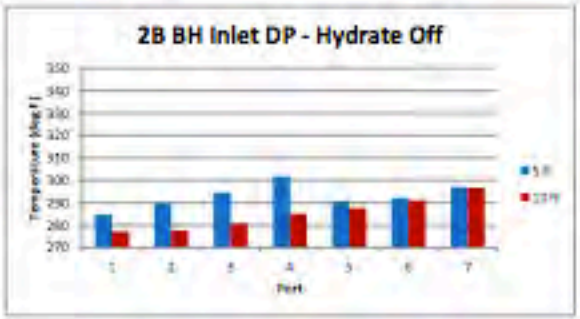
Traverse Data

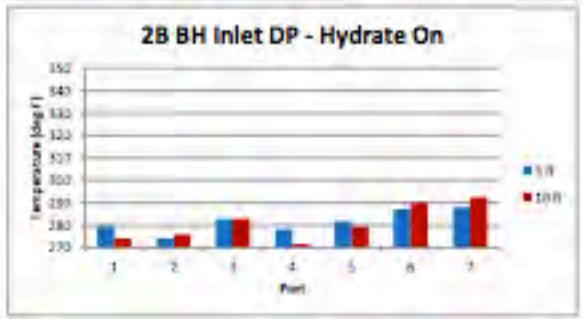


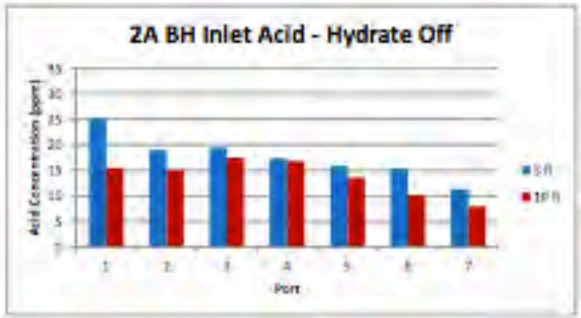


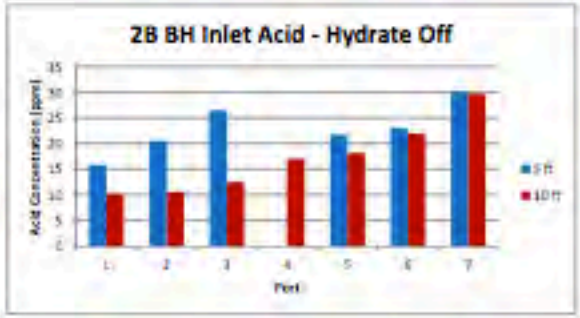


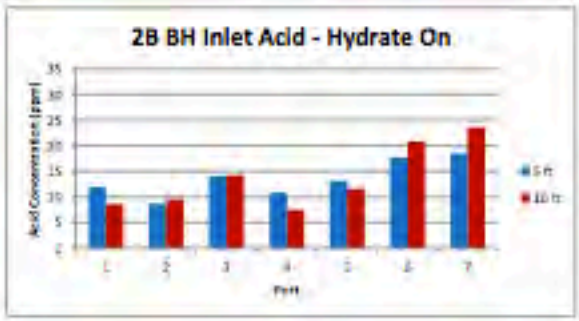






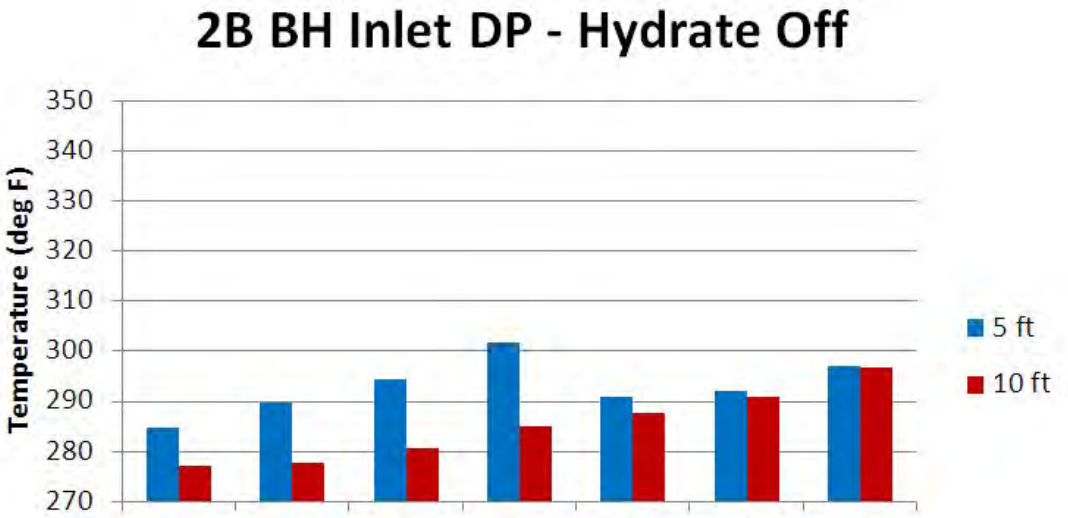


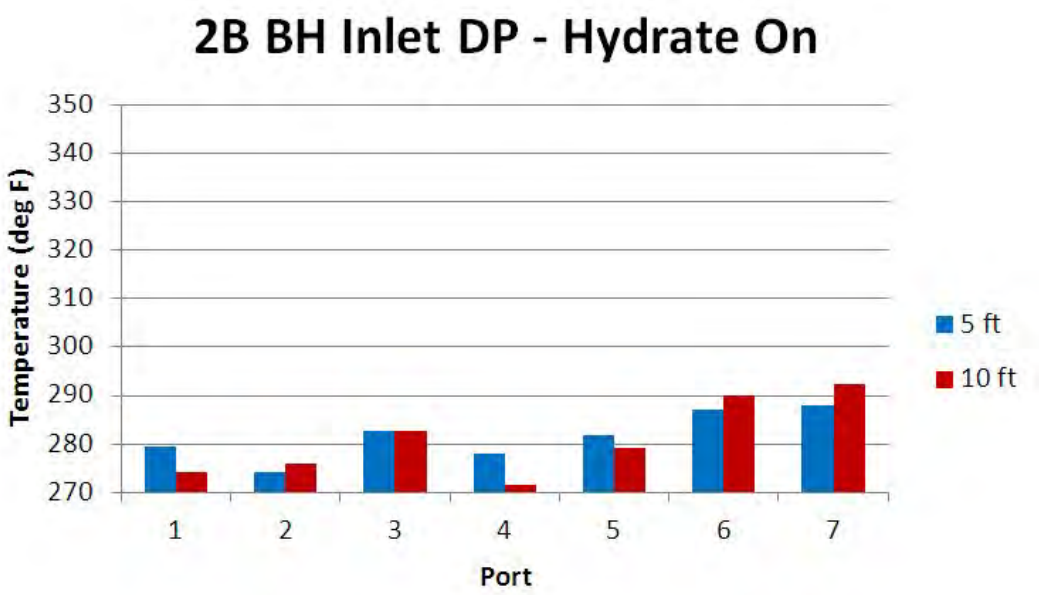




Duct depth – 17 ft

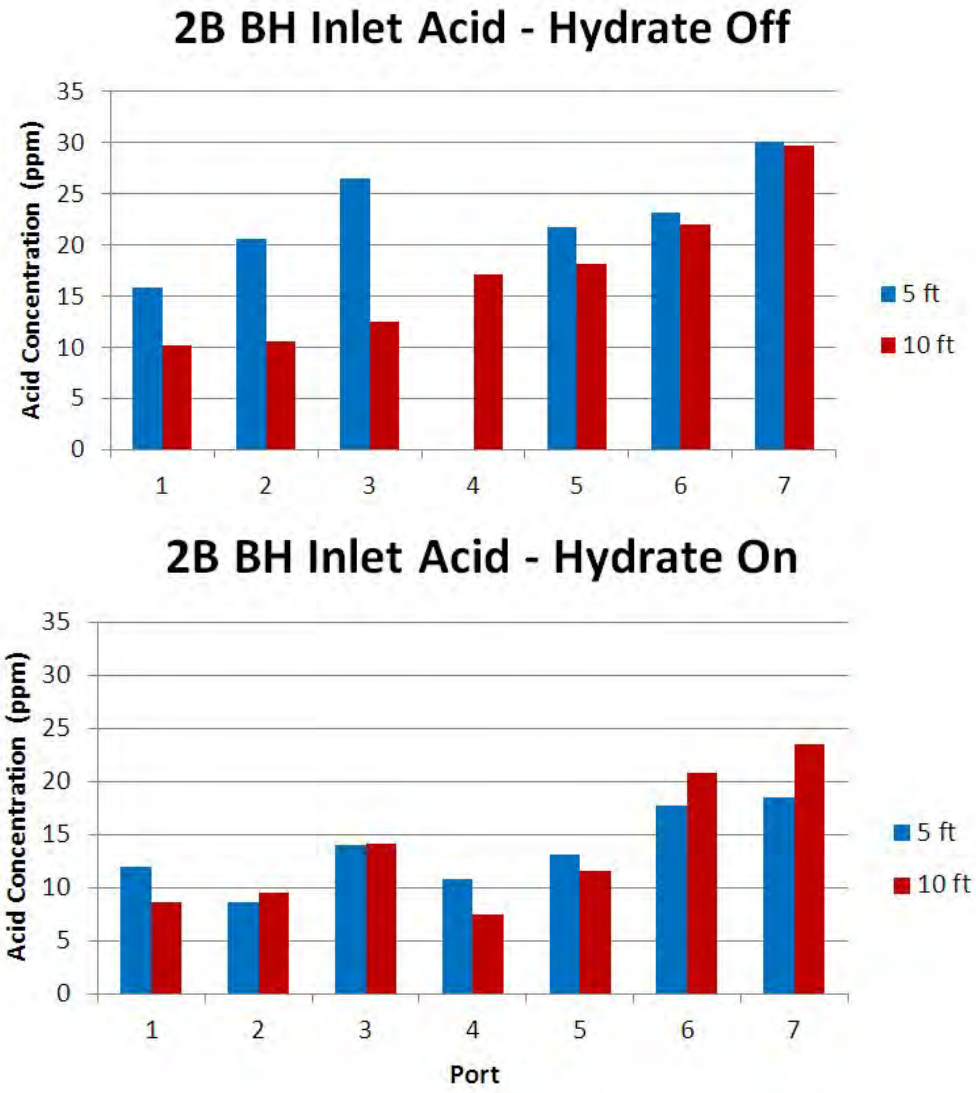
Hydrate Dewpoint Impact





1. Interesting upper level stratification pattern, not revealed at lower level
2. Maximum dewpoint of 302F observed at upper level, 297F at lower level
3. Hydrate dropped upper level dewpoint in ports 1-5 by as much as 20F.
4. Hydrate stratification patterns showing little effect on ports 6&7 at either level and less impact on lower level in general

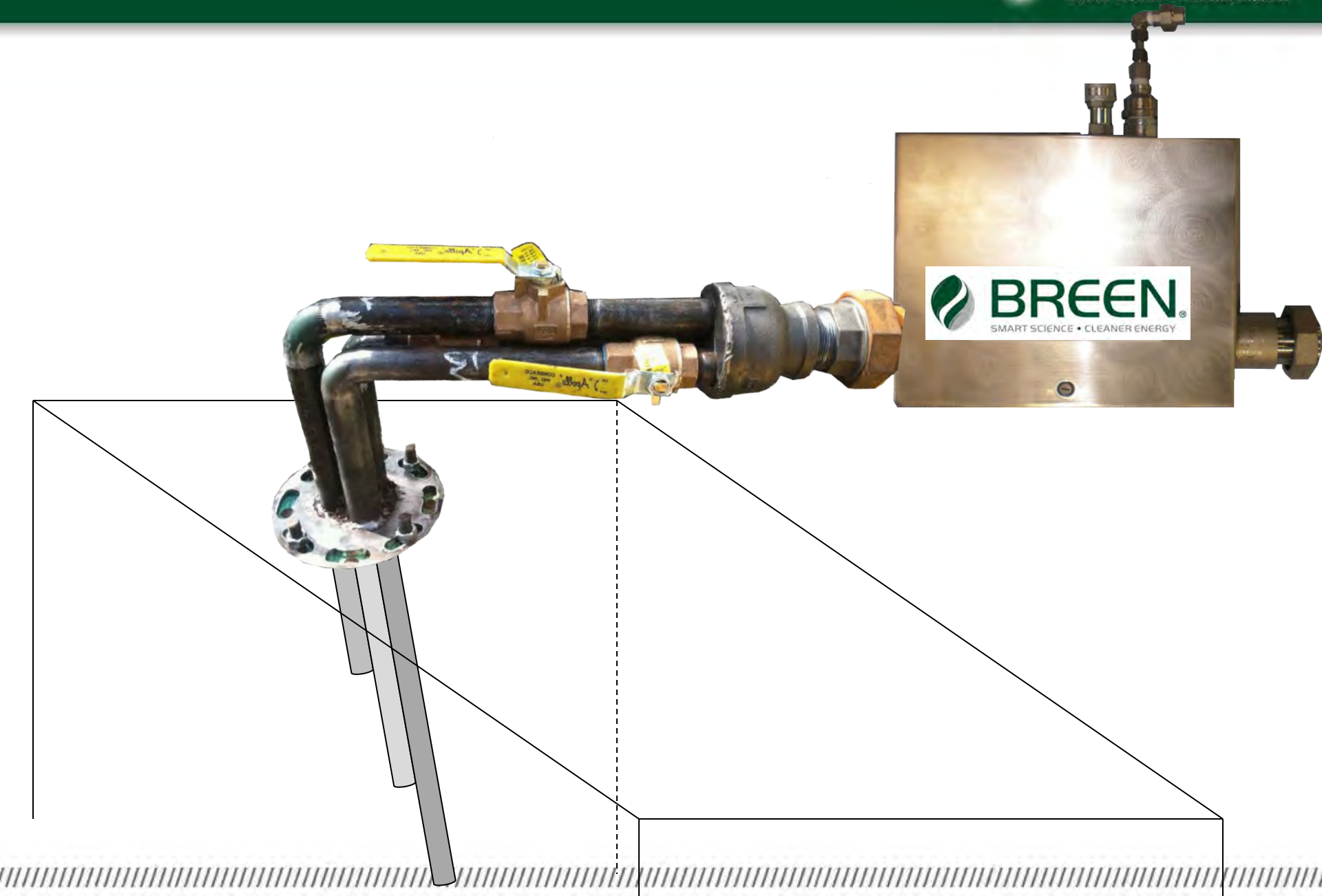
Acid ppm Data set



1. Prior data, and data not shown here for brevity, shows that with Hydrate “ON”, 20 ppm at the Inlet will translate to 4 – 8 ppm at the BH Outlet
2. Dewpoints consistent with 4 – 8 ppm are in the range of 259F – 271 F

1. ABS exhibits the similar pH level as sulfuric acid.
2. Reduction of the Baghouse Outlet temperature when ABS is detected should be considered

Multi-depth AbSensor-CCE



Questions?

Regulations:
MATS
(CSAPR)
NAAQS
Coal Residuals
Wastewater
GHG BACT

Economics:
Fuel Cost
Fuel Flexibility (Coal V/S Gas)
Cost of Compliance
Demand
Repower?
Retire Plants?

THE BALANCE OF POWER