Reinhold Environmental Ltd.

2008 NOx-Combustion Round Table & Expo Presentation

February 4-5, 2008 in Richmond, VA

Breen Energy Solutions

Field Experience with Dewpoint based SO_3 and AbS Measurement

CCS vs. BES & Closed Loop Control Experience

EMISSIONS CONTROL PROCESS ENHANCEMENT

NOX | MERCURY | ASH QUALITY

Agenda

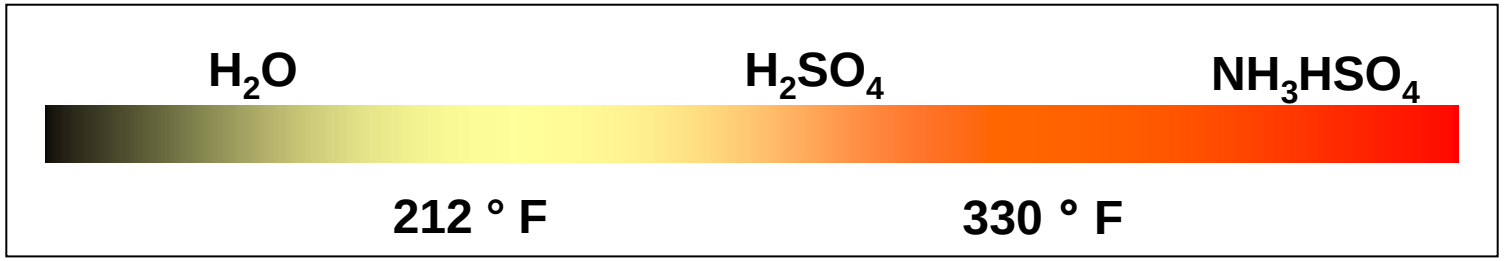
- **AbSensor – SO_3 measurement**
  - **What is it? What does it do? How does it work?**
- **SO_3 Measurement Experience**
  - **Comparison of CCS & AbSensor Principles**
  - **Comparative Testing Experience**
- **ABS Measurement & Closed Loop Control**
  - **Case Study/Experience**

AbSensor – AbS/SO3
What is it? What does it do?

- **In-Situ, Continuous measurement**
- **Temp at which material condenses out from flue gas**

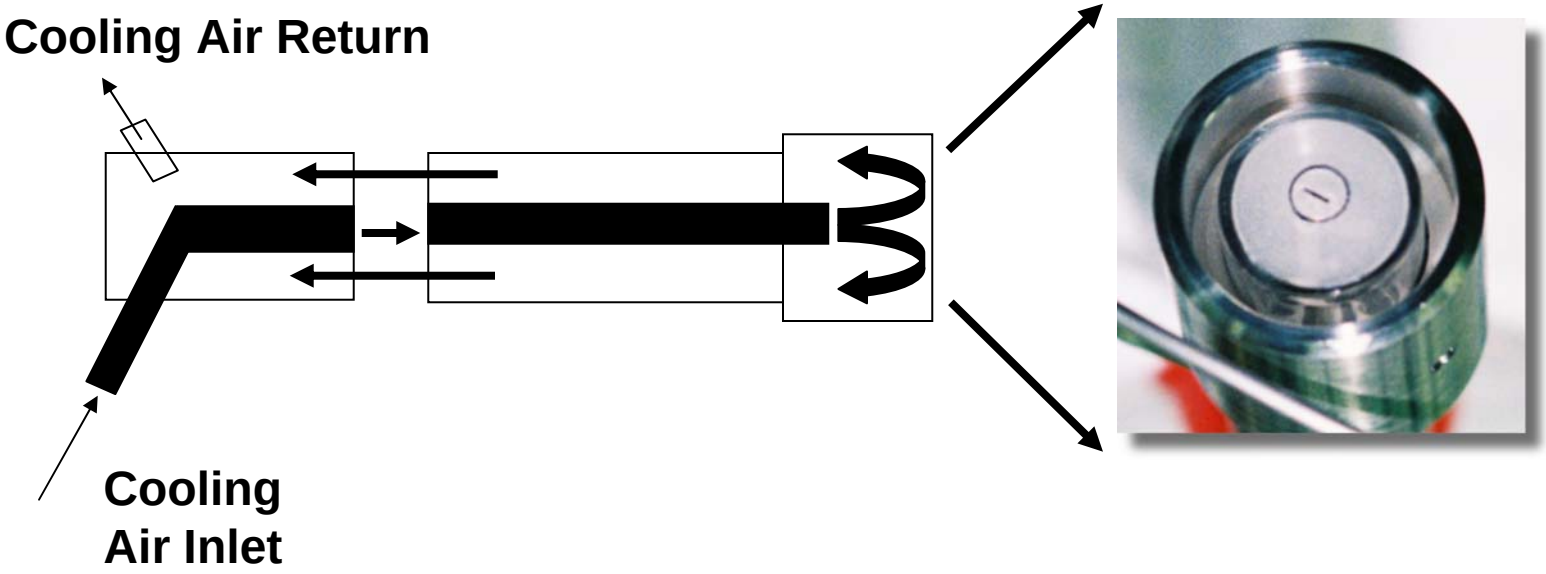
This material could be:

- **Moisture (H_2O),**
- **Sulfuric Acid (H_2SO_4) ($H_2O + SO_3$)**
- **Ammonium Bisulfate (NH_3HSO_4) ($NH_3 + H_2O + SO_3$)**



The same device measures condensables across the spectrum!

How does it work? - I

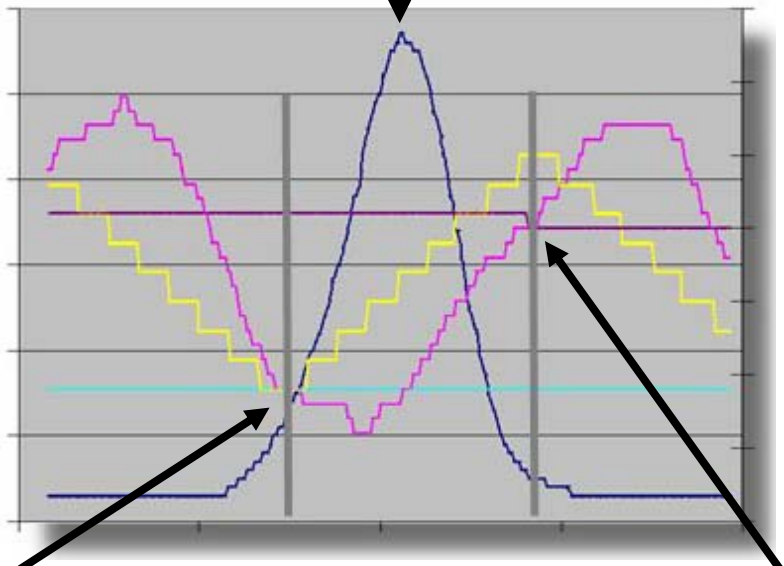


Cooling air flow to the probe tip is precisely controlled to induce condensation on the probe surface

How does it work? - II

Condensation = Evaporation

Equilibrium Dewpoint



A hot probe is precisely cooled until condensation current is detected. (Formation Point).

Condensation > Evaporation

The probe is allowed to heat in the Flue Gas until the current goes below a threshold (Evaporation Point).

Evaporation > Condensation

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Terminology

- ***Formation Temperature***
  - **The temperature at which condensation is first detected**
- ***Evaporation Temperature***
  - **The temperature at which condensed material on the instrument tip evaporates below the threshold current level**
- ***Dew Point***
  - **The temperature at which the current curve peaks. This is the temperature where evaporation from the probe is in equilibrium with the condensation onto the probe.**

AbSensor – AbS/SO3 System

- 4” 150 lb 8-bolt flanged port
- 50 psi service air
- 12 cfm air consumption
- 110 VAC power supply

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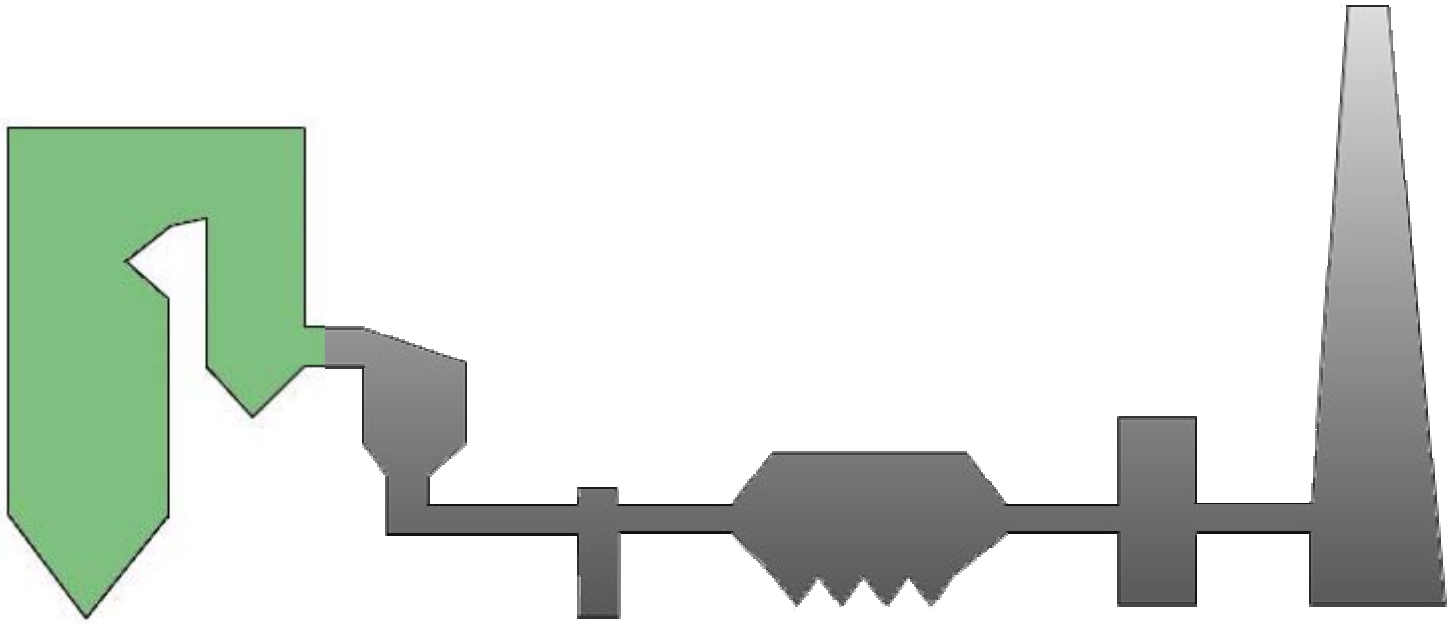
SO_3 Measurement

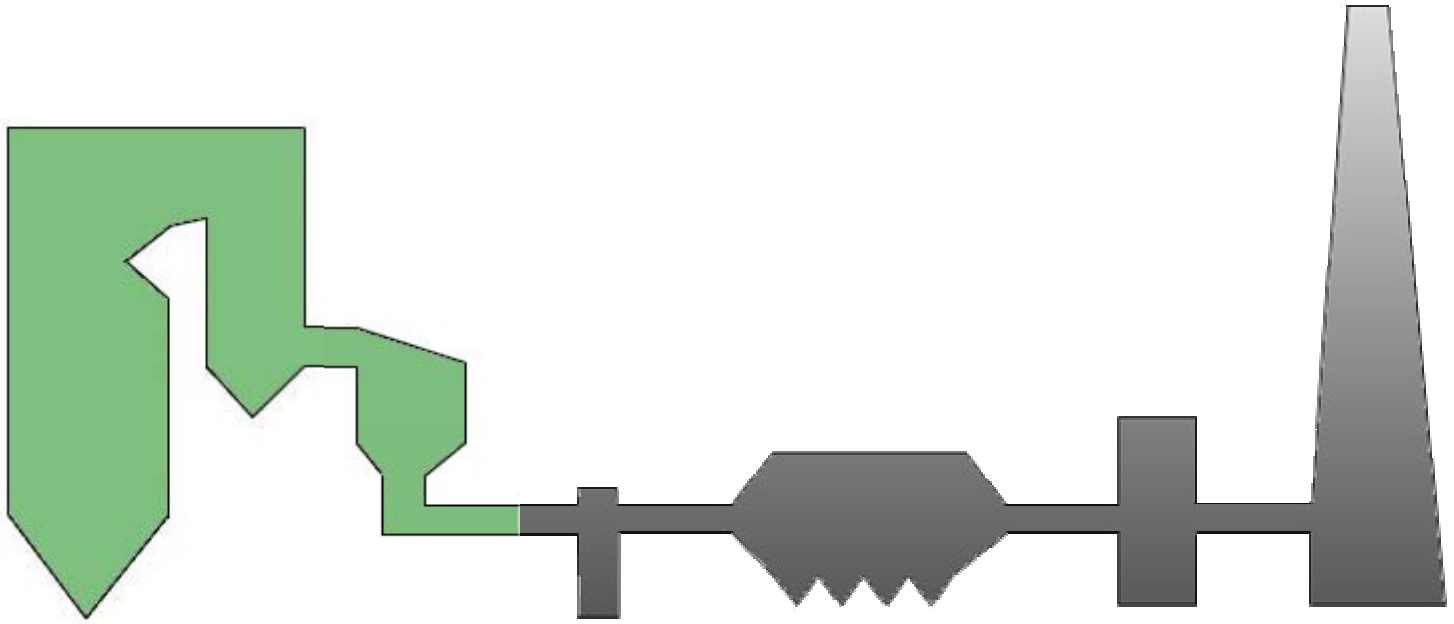
What is SO_3?

1. Sulfur in the fuel oxidizes to form SO_2 and SO_3 in gas form.



What is SO_3?

2. Further conversion of SO_2 to SO_3 occurs as the flue gas passes through the SCR!



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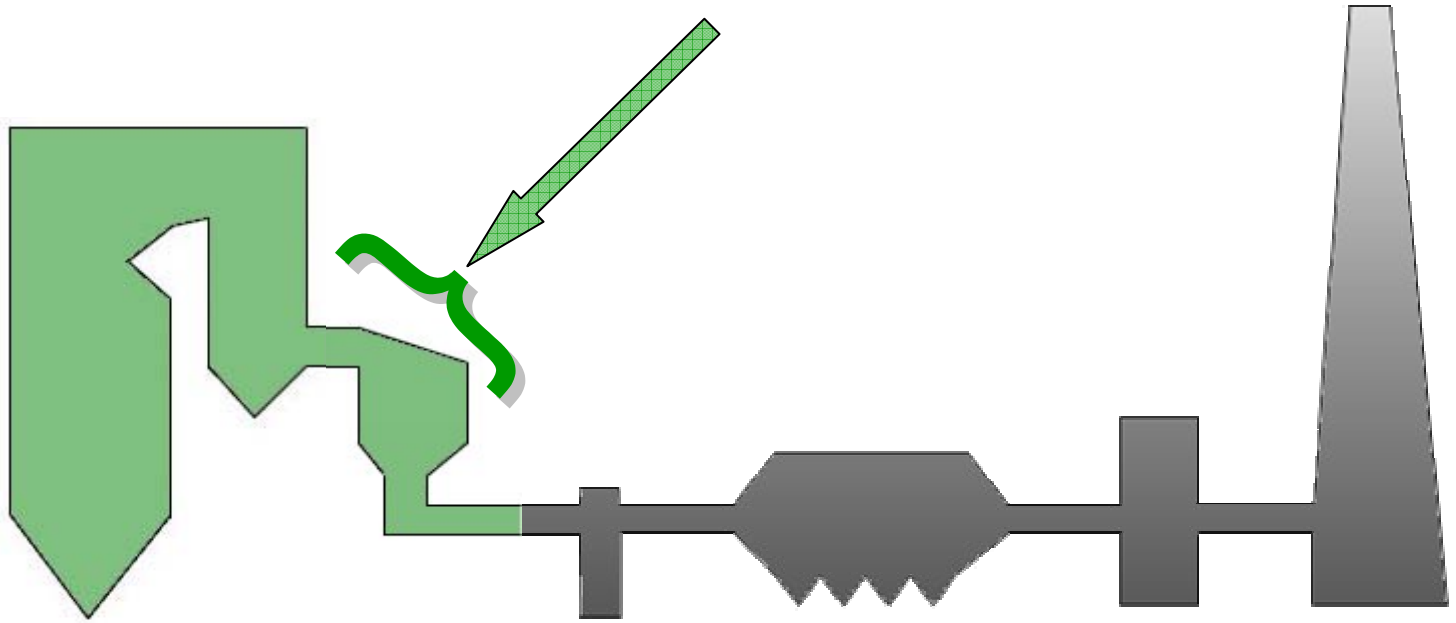
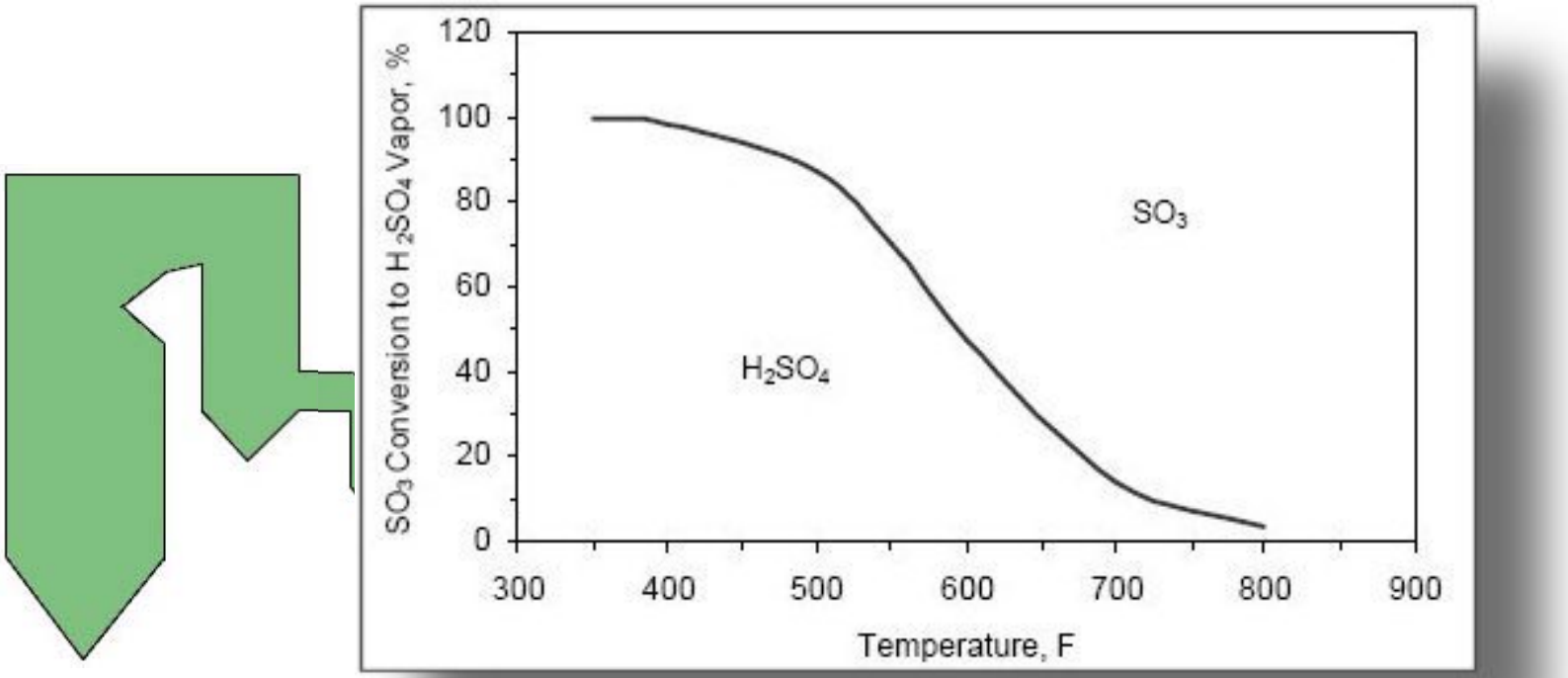
What is SO_3?

3. Between 800° F and 400° F the SO_3 gas combines with available water vapor to form H_2SO_4 Vapor.



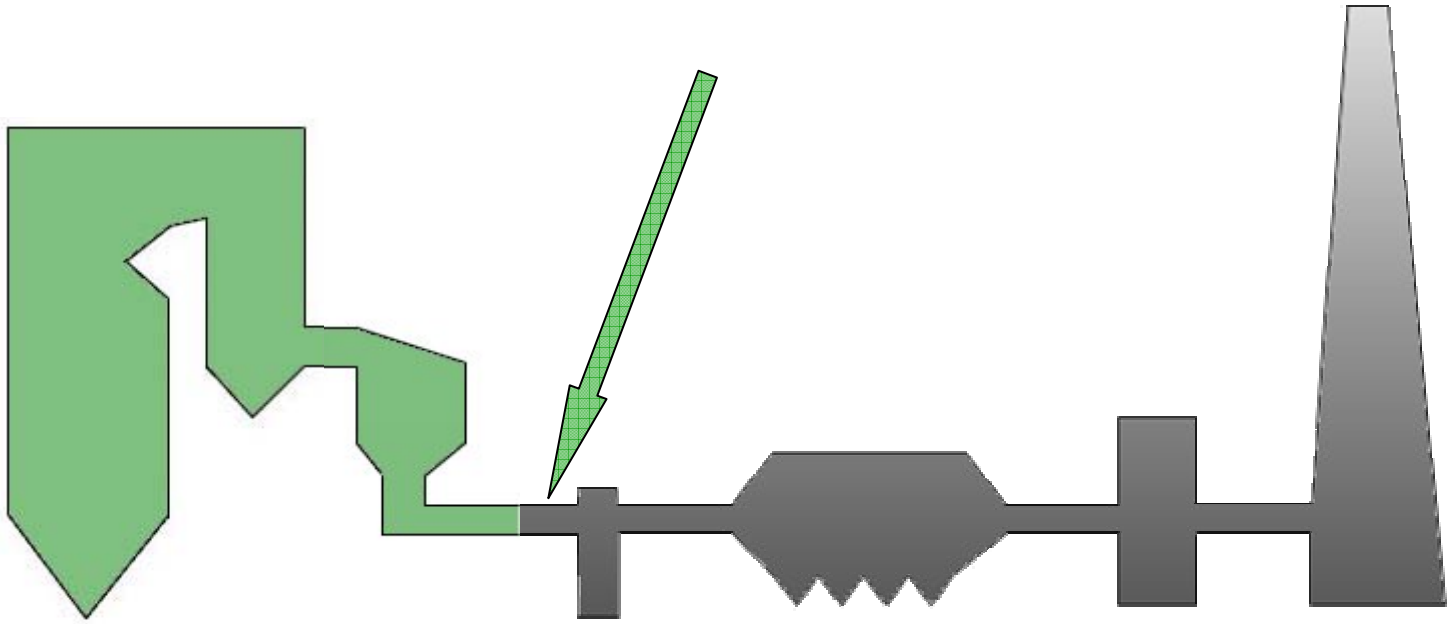
What is SO_3?

4. The rate of conversion is a well documented function of flue gas temperature.



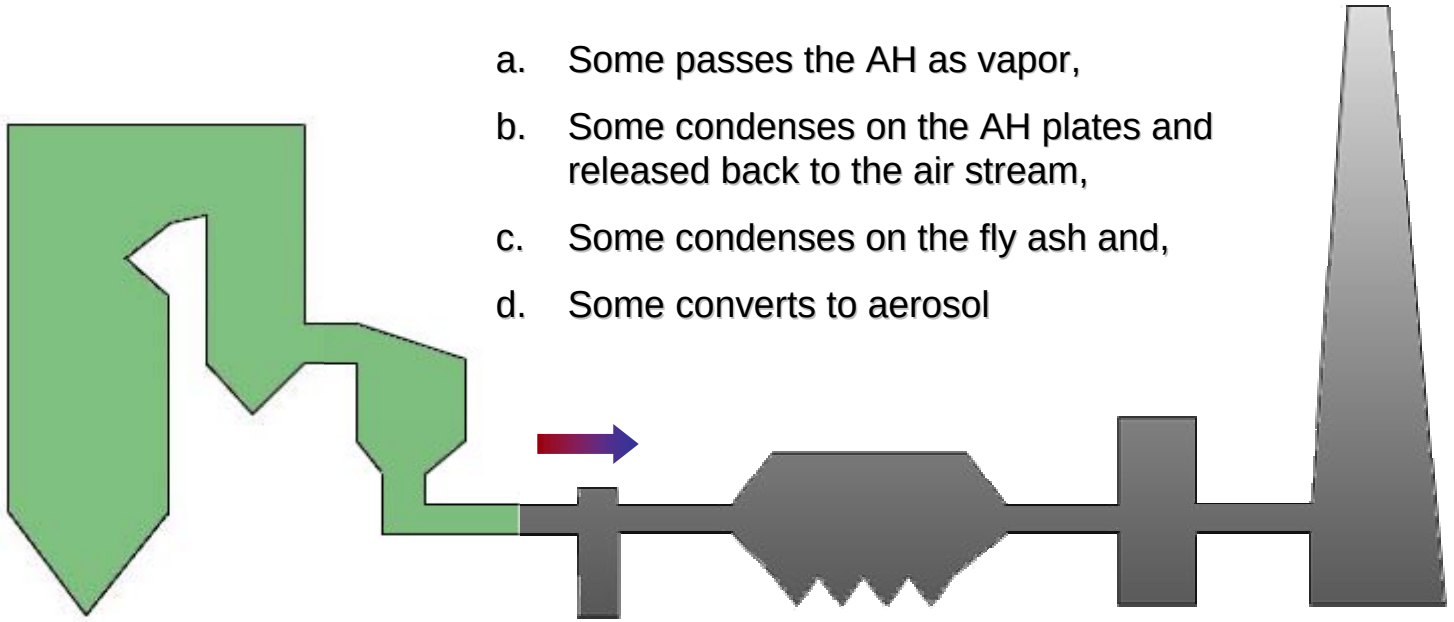
What is SO_3?

5. At the inlet to the Air Heater, then, there is a mixture of SO_3 gas, H_2SO_4 Vapor, and let's not forget about Ammonia byproducts



What is SO_3?

6. As the vapor mixture passes through the air heater, gas temperature drops and the vapor changes form.



a. Some passes the AH as vapor,

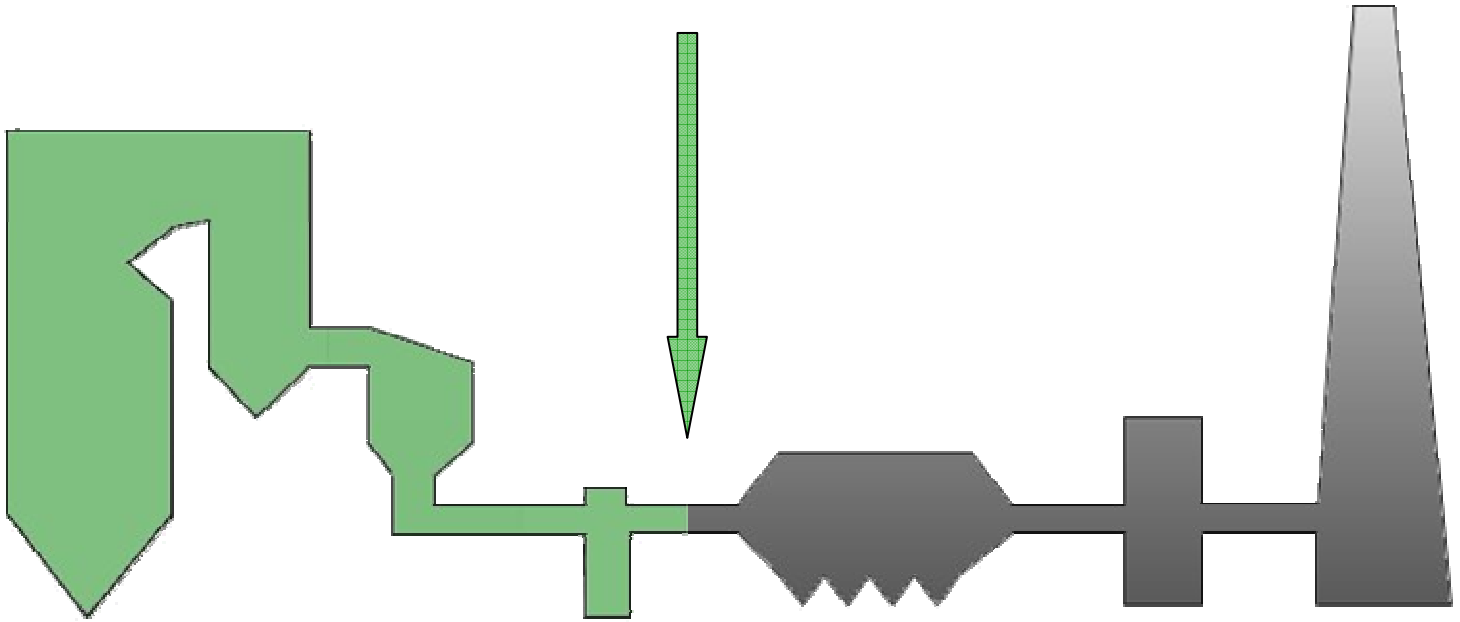
b. Some condenses on the AH plates and released back to the air stream,

c. Some condenses on the fly ash and,

d. Some converts to aerosol

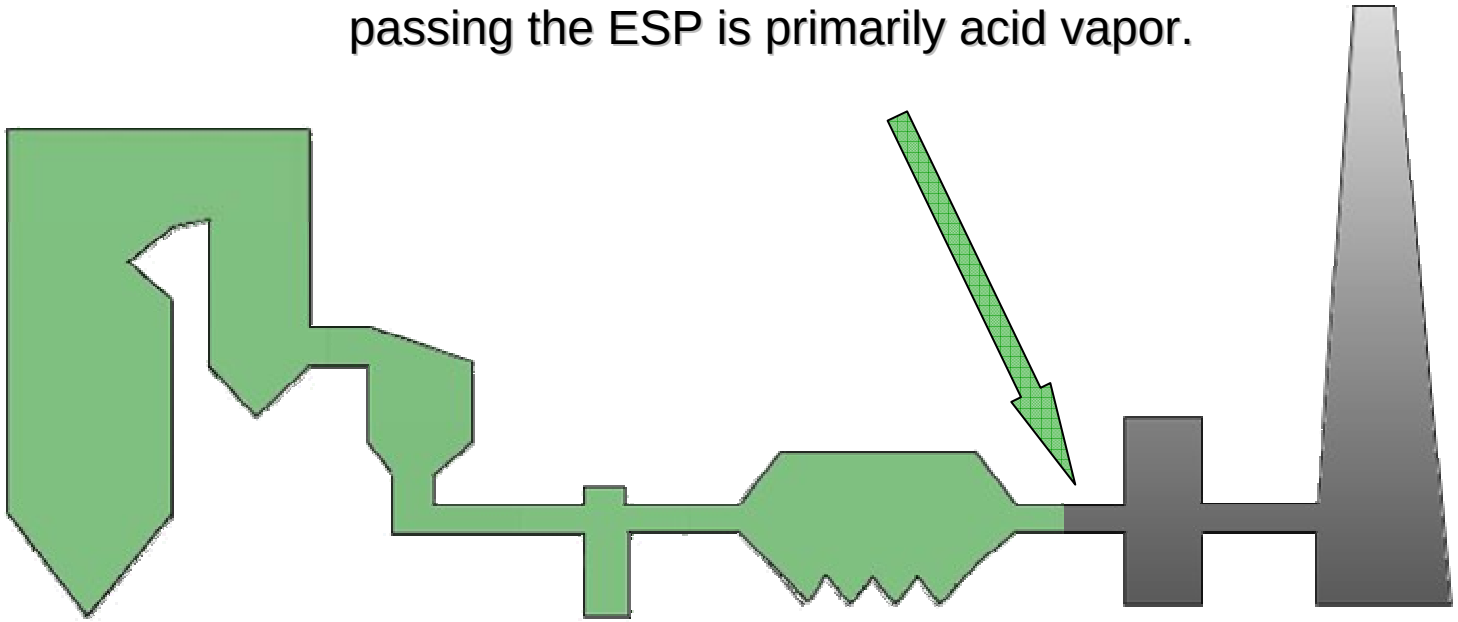
What is SO_3?

7. The amount of vapor that condenses onto the fly ash varies but seems to be strongly influenced by the ash alkalinity.



What is SO_3?

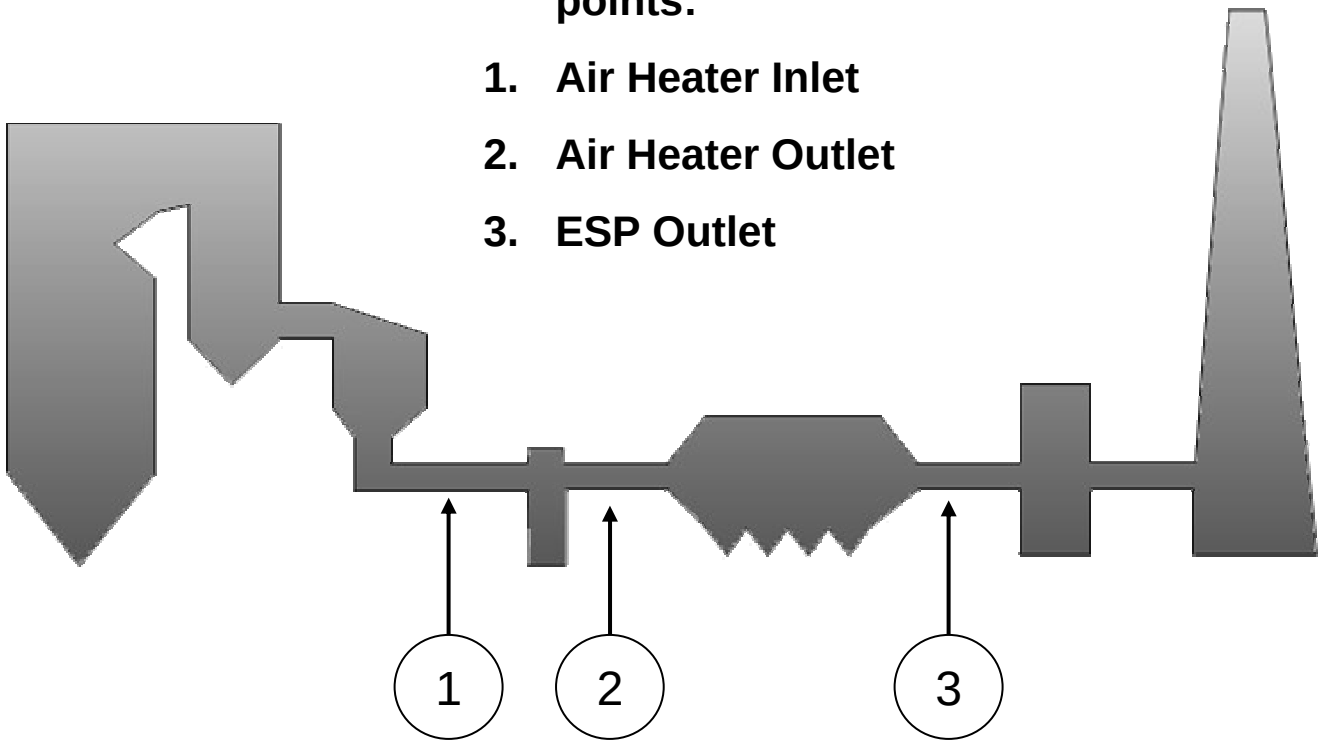
8. The ESP captures virtually all of the fly ash and the acid condensed on it, as well as some portion of the aerosol. The acid material passing the ESP is primarily acid vapor.



Vapor Measurement vs. CCS Measurement

The three typical measurement points:

1. **Air Heater Inlet**
2. **Air Heater Outlet**
3. **ESP Outlet**



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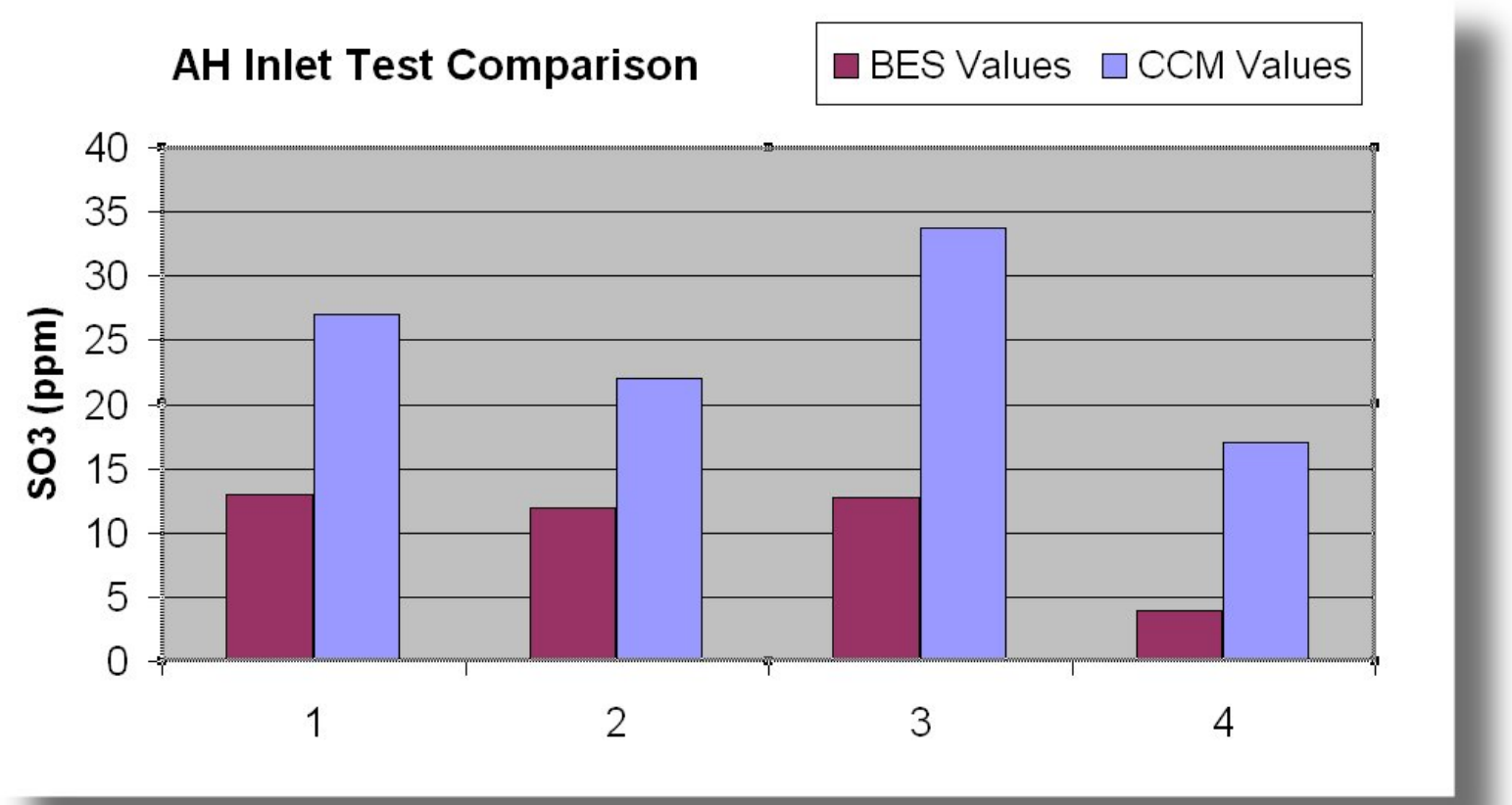
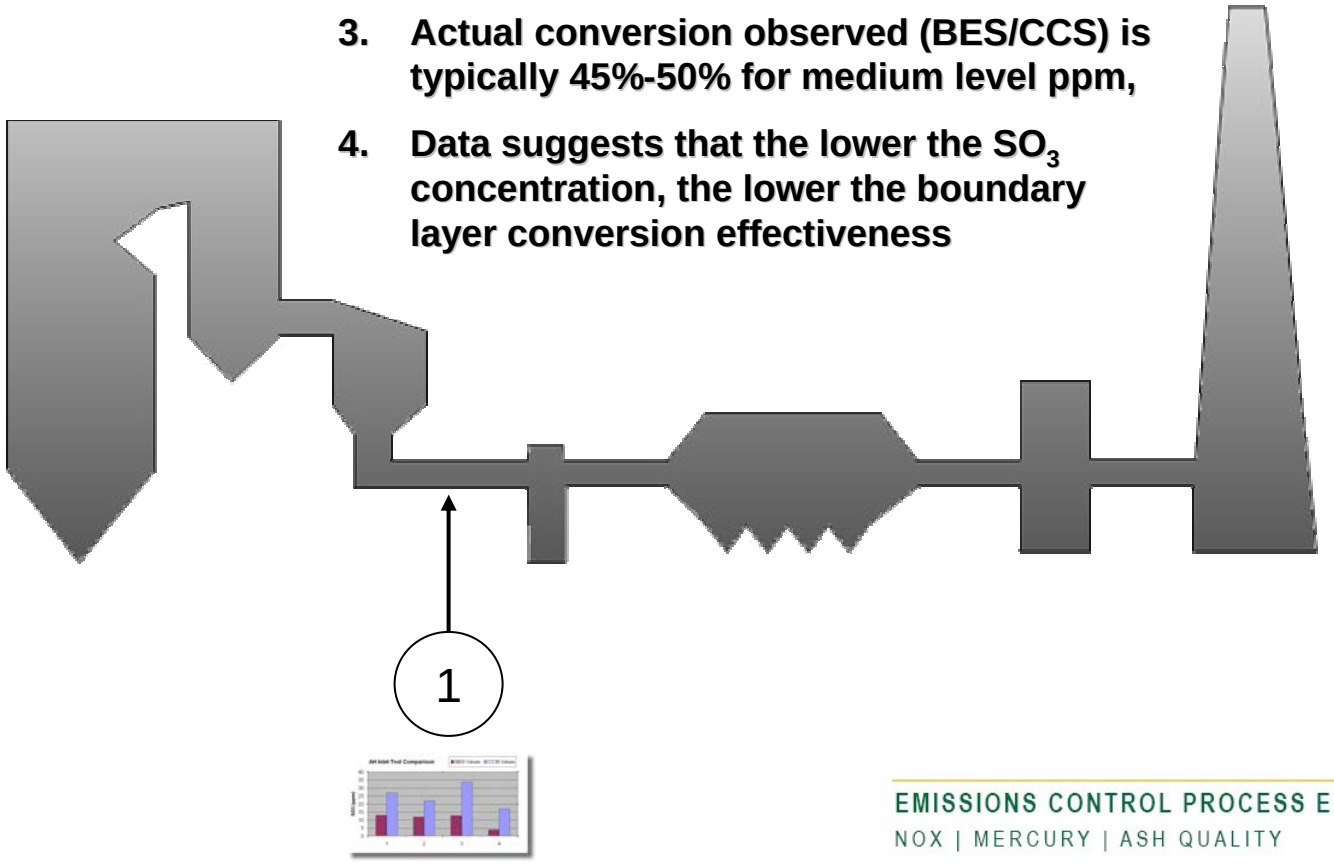
Air Heater Inlet Comparison



Air Heater Inlet Comparison

1. All material is in gas phase, but only partially converted to Acid/AbS vapor
2. Expected conversion based on gas temperature would be approximately 25%
3. Actual conversion observed (BES/CCS) is typically 45%-50% for medium level ppm,
4. Data suggests that the lower the SO_3 concentration, the lower the boundary layer conversion effectiveness



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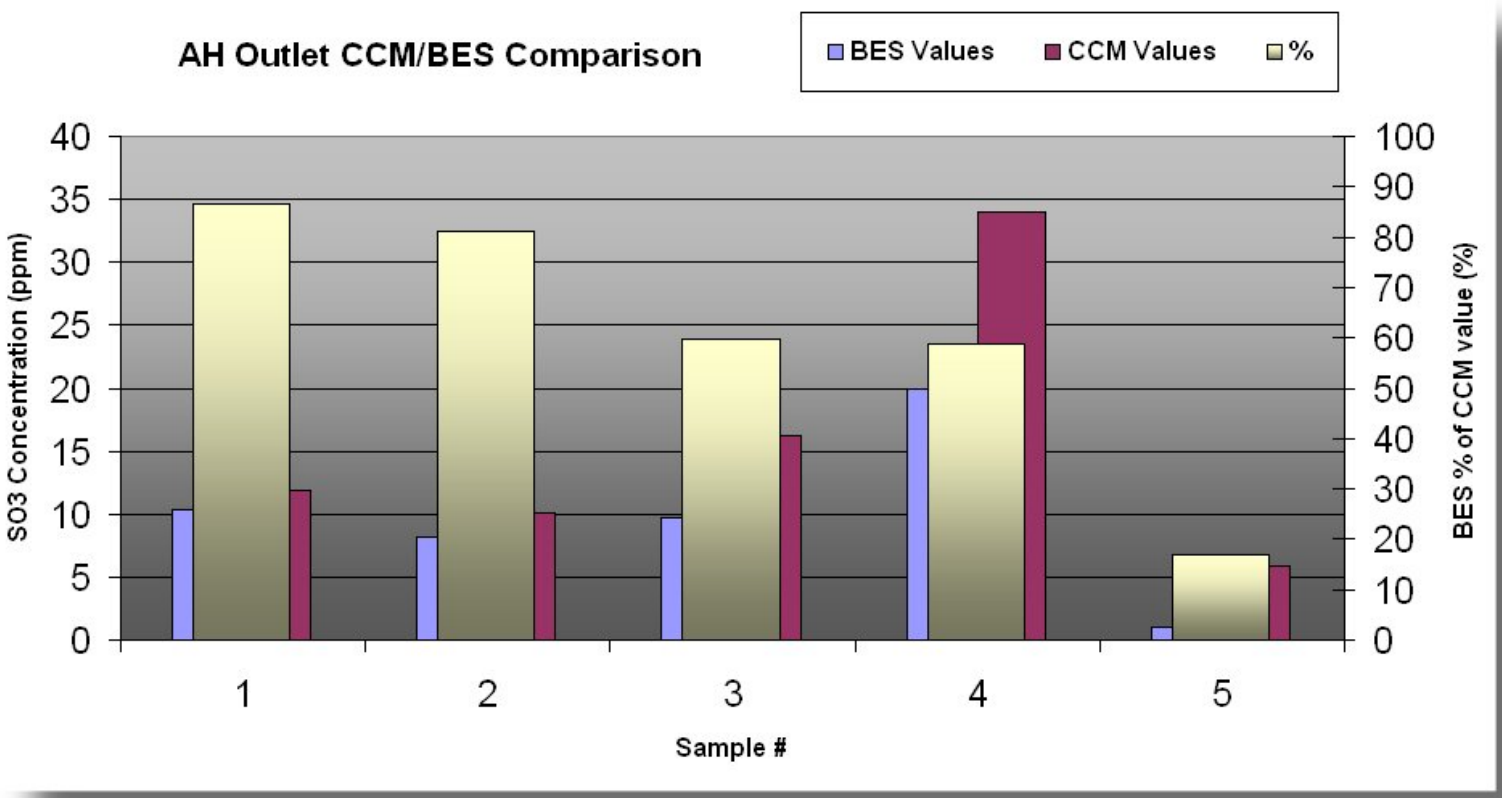
Air Heater Outlet Comparison



Air Heater Outlet Stratification Δ