Reinhold Environmental Ltd.

2007 NOx Round Table & Expo Presentation

February 5-6, 2007 in Cincinnati, OH

Breen Energy Solutions

AbSensor On-Line Condensables Measurement

Instrument & Applications

EMISSIONS CONTROL PROCESS ENHANCEMENT

NOX | MERCURY | ASH QUALITY

Agenda

- The Instrument
  - What is it?
  - What does it do?
  - How does it work?
- How can I use it?
- Experience

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What Is It?

What is it?

The AbSensor – Condensables probe is an

in-situ, continuous

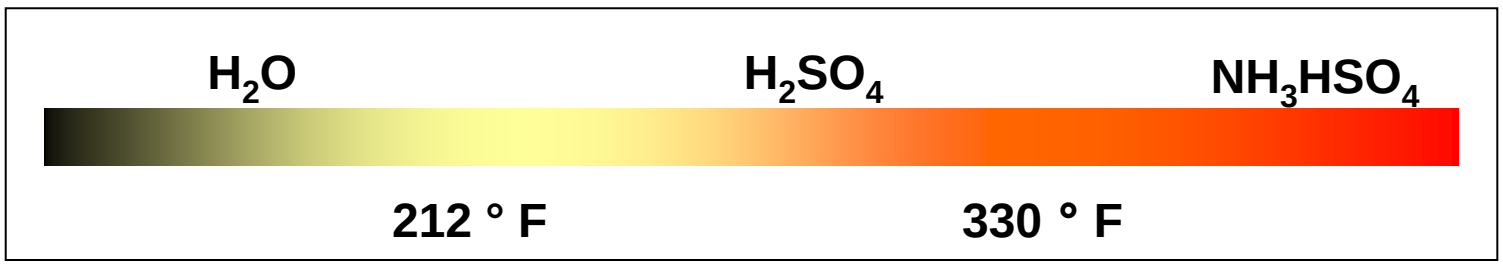
condensables measurement device

What does it do?

The AbSensor condensables probes measures the temperature at which material condenses out from the 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!

System Installation

- **The probes are installed in 4” flanged ports**
- **Installation can be:**
  - **Ahead of the air heater,**
  - **Behind the air heater,**
  - **Behind the ESP/FF**
- **Once service air and 120 volt power are at location, the total installation requires less than 4 hours.**

Probe Construction Upgrades

- The primary air tube is insulated to improve cooling air quality
- A Heat exchanger coil terminating in a tip cleaner assures all residual material is removed with no thermal shock
- The inlet orifice to the detection cell is enlarged to allow more cooling air at a lower pressure

Probe Installation

- **The probe is constructed with a split ring flange to allow for variable depth insertion**
- **Probe installation, inspection time is less than 15 minutes.**

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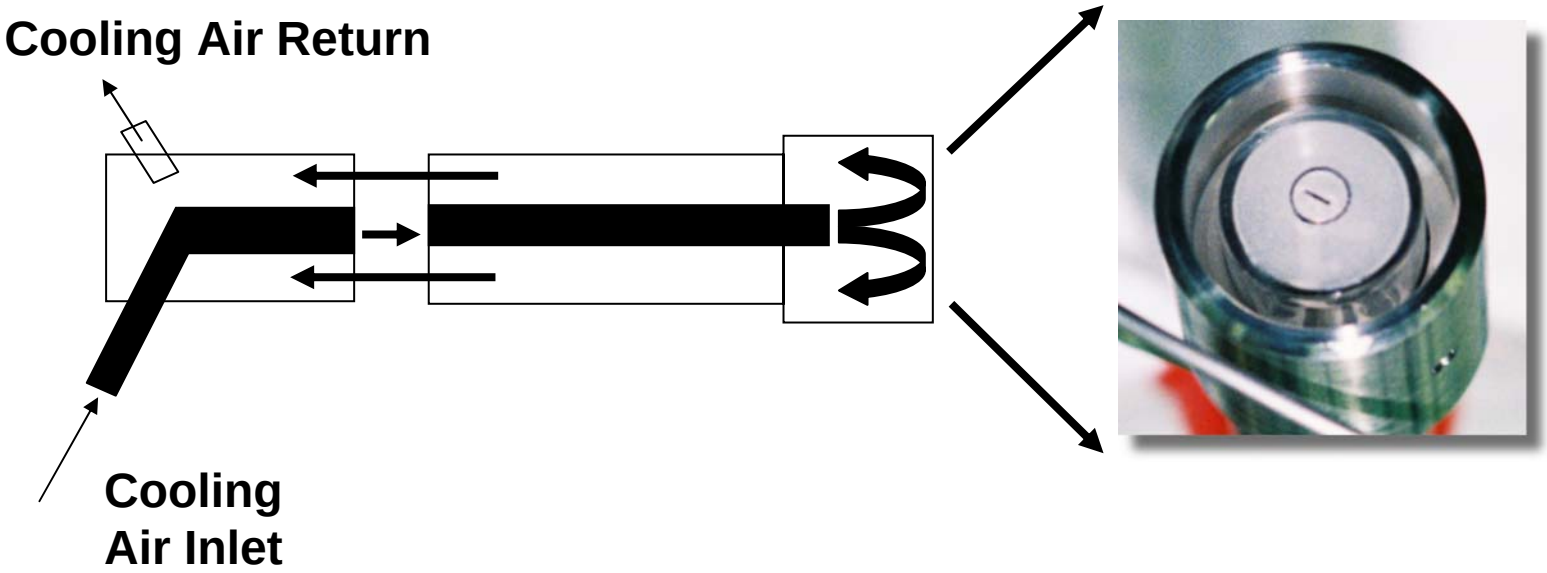
How Does it Work?

How does it work? - I

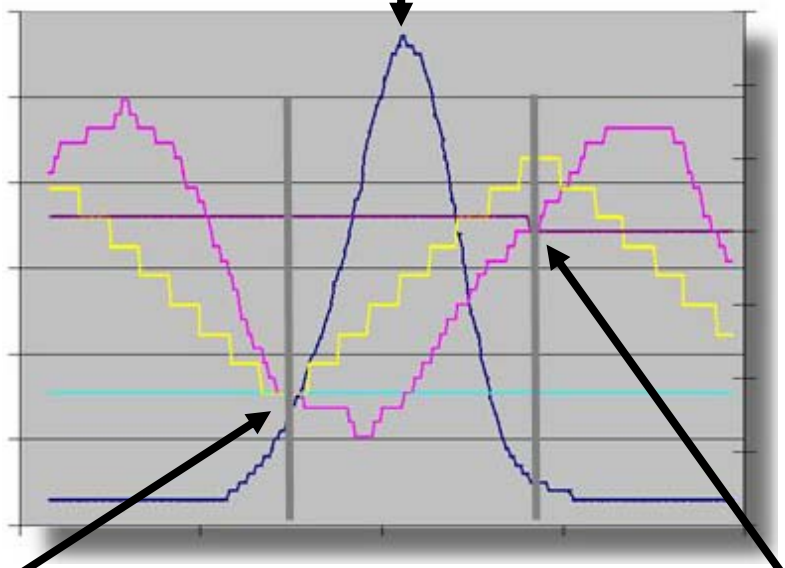


Cooling air flow to the probe tip is precisely controlled to induce condensation on the probe surface

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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How Can I Use it?

How Can I Use It?
Ammonium Bisulfate (AbS) measurement

- **The AbSensor - AFP Instrument has been applied to:**
  - **Closed-Loop SCR/SNCR reagent injection control to maximize NO_x reduction and minimize Air Heater Fouling**
  - **Air Heater temperature control to minimize Air Heater Fouling and improve Heat Rate**

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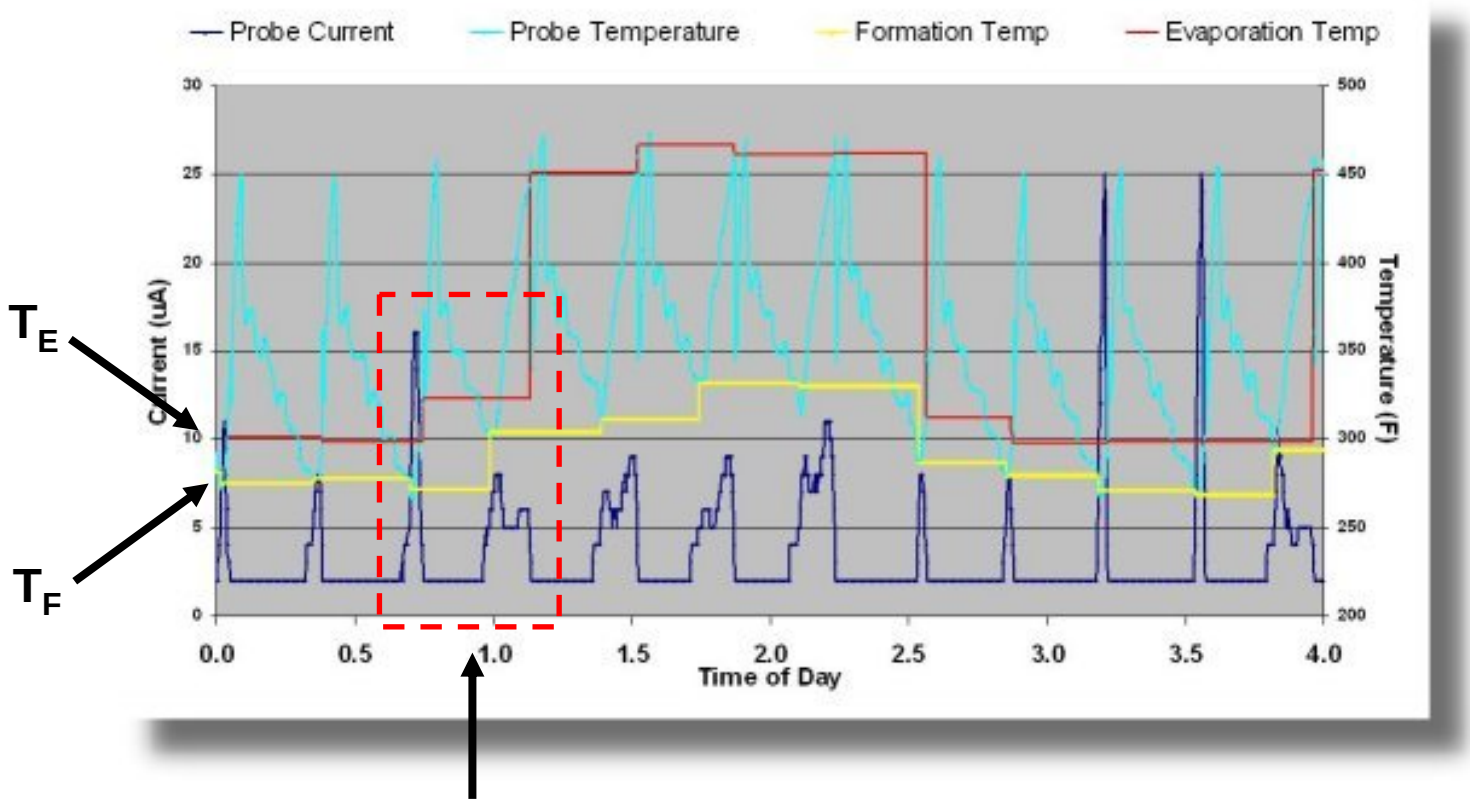
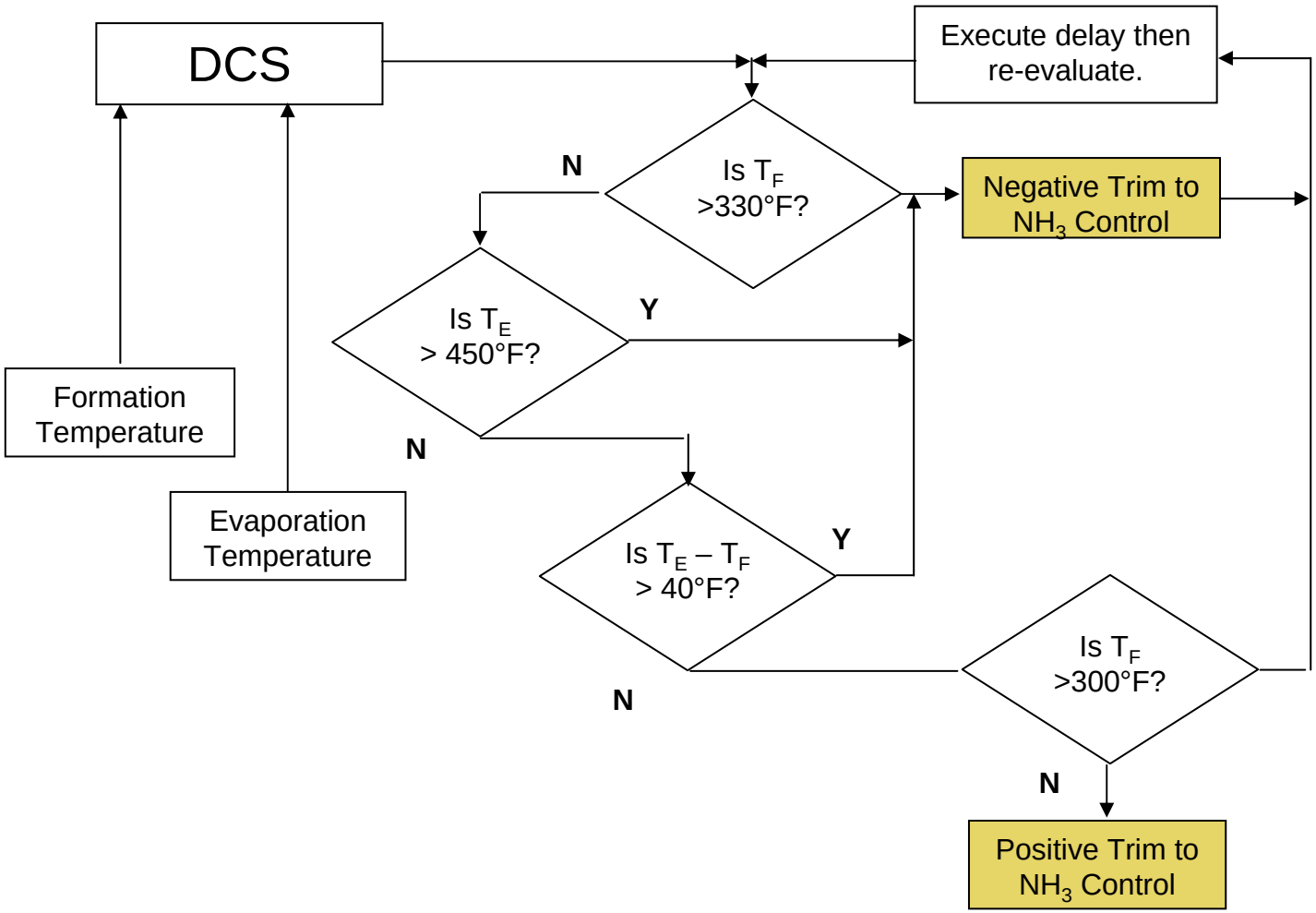
How Can I Use It?
Sulphuric Acid (SO3) measurement

- **The AbSensor – SO3 Instrument has been applied to:**
  - **Closed loop control of SO3 Mitigation systems for Blue Plume and Mercury Control**
  - **Closed loop control of Air Heater Outlet temperatures for:**
    - **Heat Rate Improvement**
    - **Air Heater Acid Deposition Avoidance**
    - **ESP Inlet Temperature control for ESP performance improvement and corrosion avoidance**
  - **Control of SO3 based flue gas conditioning systems for ESP performance improvement and Blue Plume Avoidance**

AbS Deposition

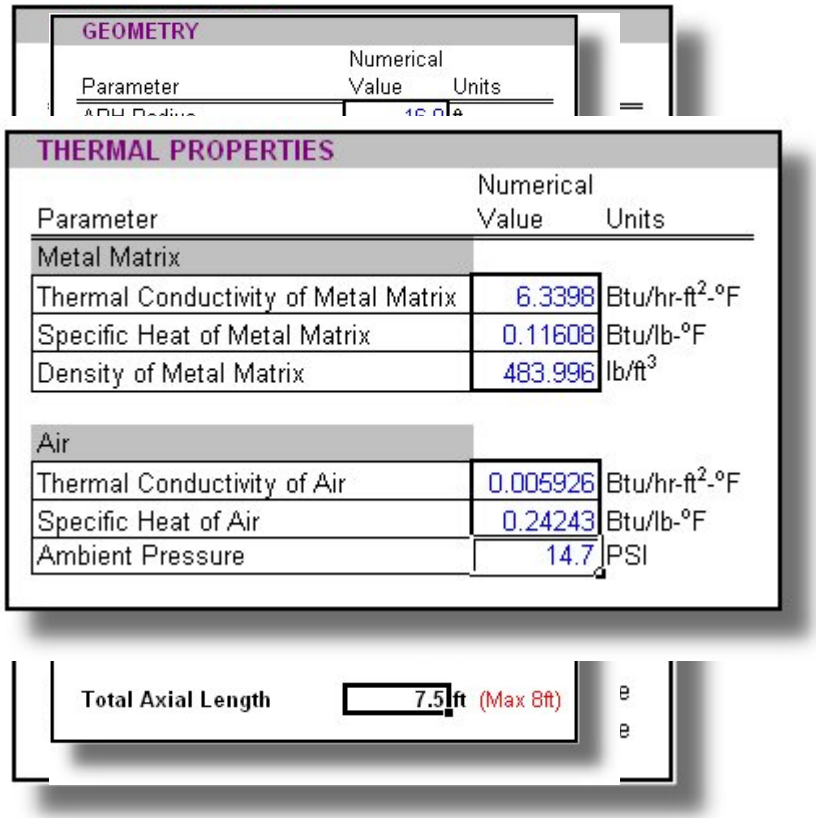


NH_3/Urea Trim Alarm/Control Logic



Air Heater Temp Control
EPRI APFG

- **Initial work funded by EPRI and executed by Lehigh Univ. in the mid 1980s**
- **Additional expansion by EPRI with work done by S. Tavoulareas and R. Afonso in the 1990s.**
- **The comprehensive heat transfer model for rotating air heaters was released for commercial use between 2000 and 2004 as the EPRI Air Preheater Fouling Guidelines (APFG).**



GEOMETRY

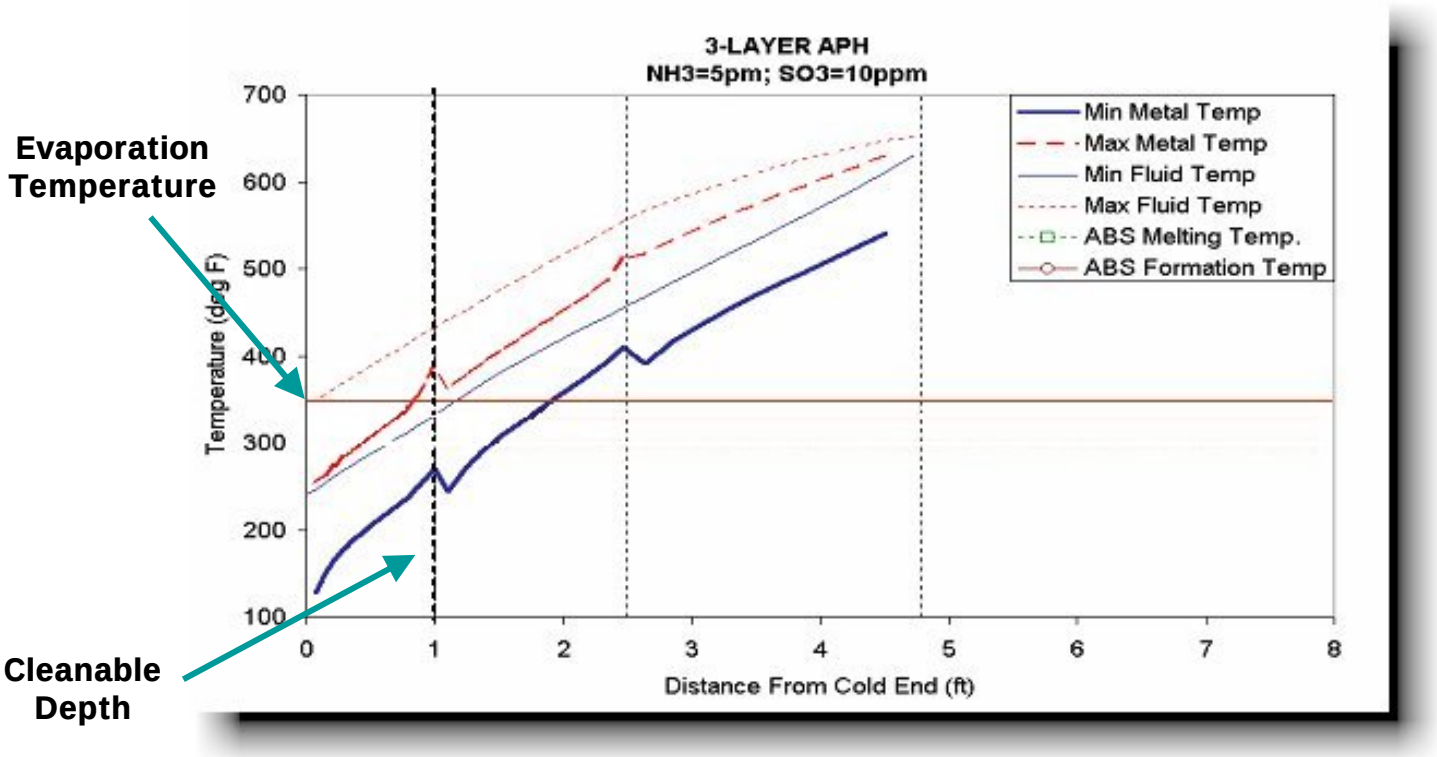
Parameter	Numerical Value	Units

THERMAL PROPERTIES

Parameter	Numerical Value	Units
Metal Matrix		
Thermal Conductivity of Metal Matrix	6.3398	Btu/hr-ft^2-°F
Specific Heat of Metal Matrix	0.11608	Btu/lb-°F
Density of Metal Matrix	483.996	lb/ft^3
Air		
Thermal Conductivity of Air	0.005926	Btu/hr-ft^2-°F
Specific Heat of Air	0.24243	Btu/lb-°F
Ambient Pressure	14.7	PSI

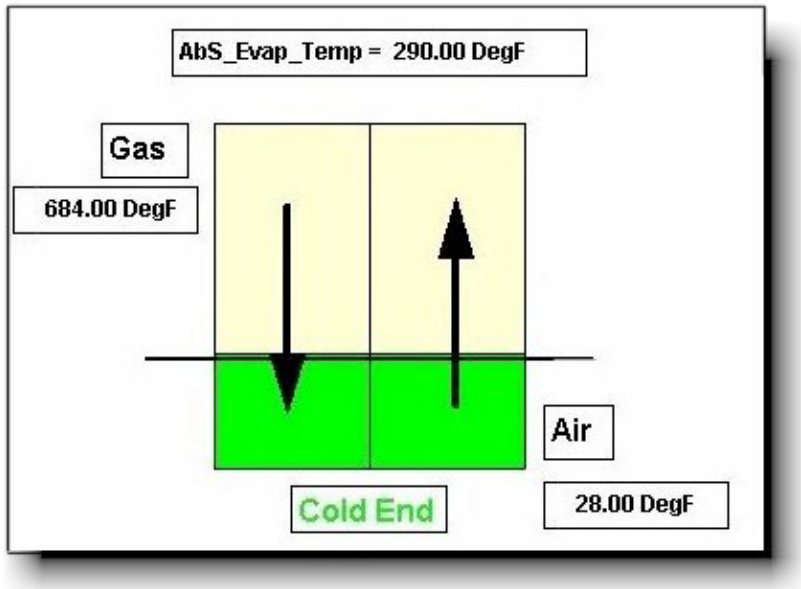
Total Axial Length 7.5 ft (Max 8ft)

The Process Parameters

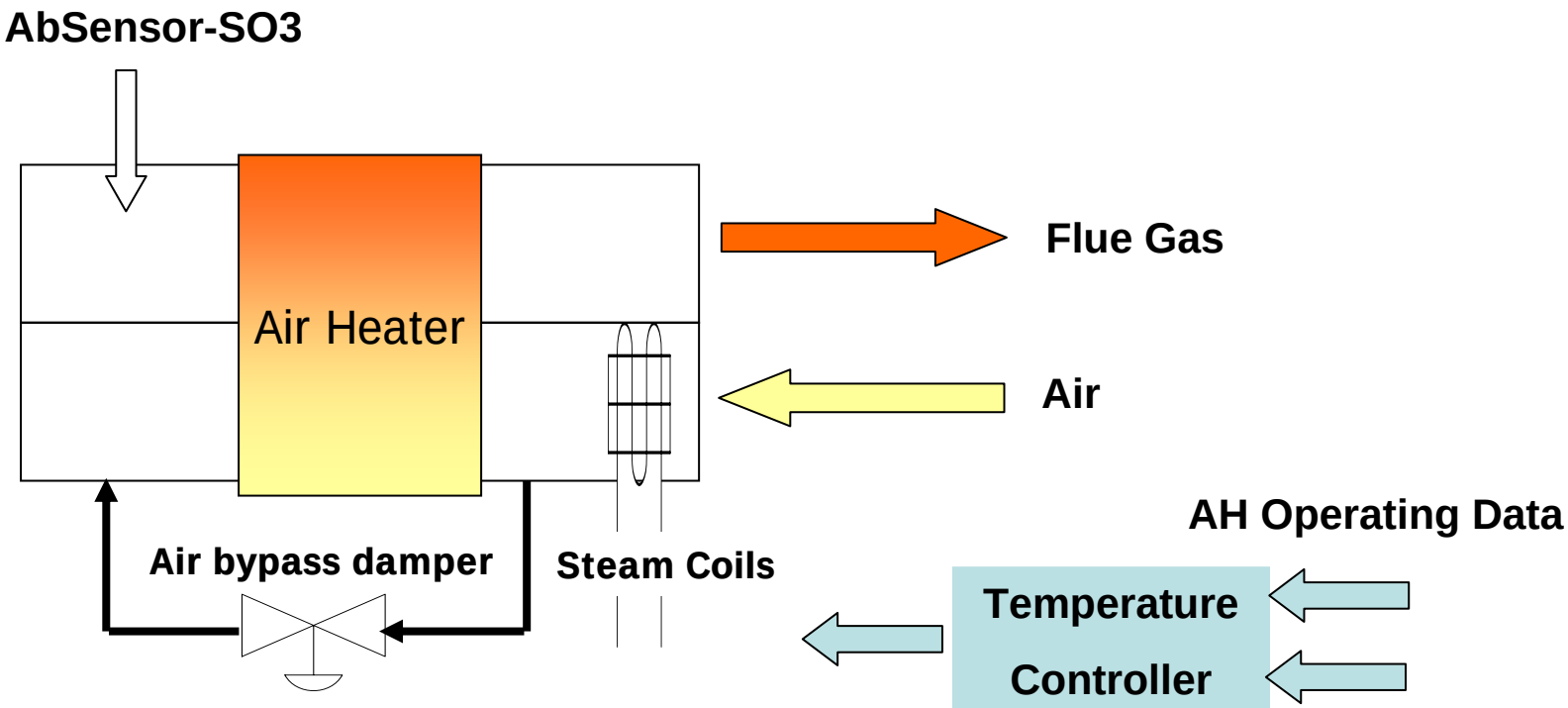


Operator Display

The operator display clearly shows the formation depth compared to the cleanable depth by numerical display and color.

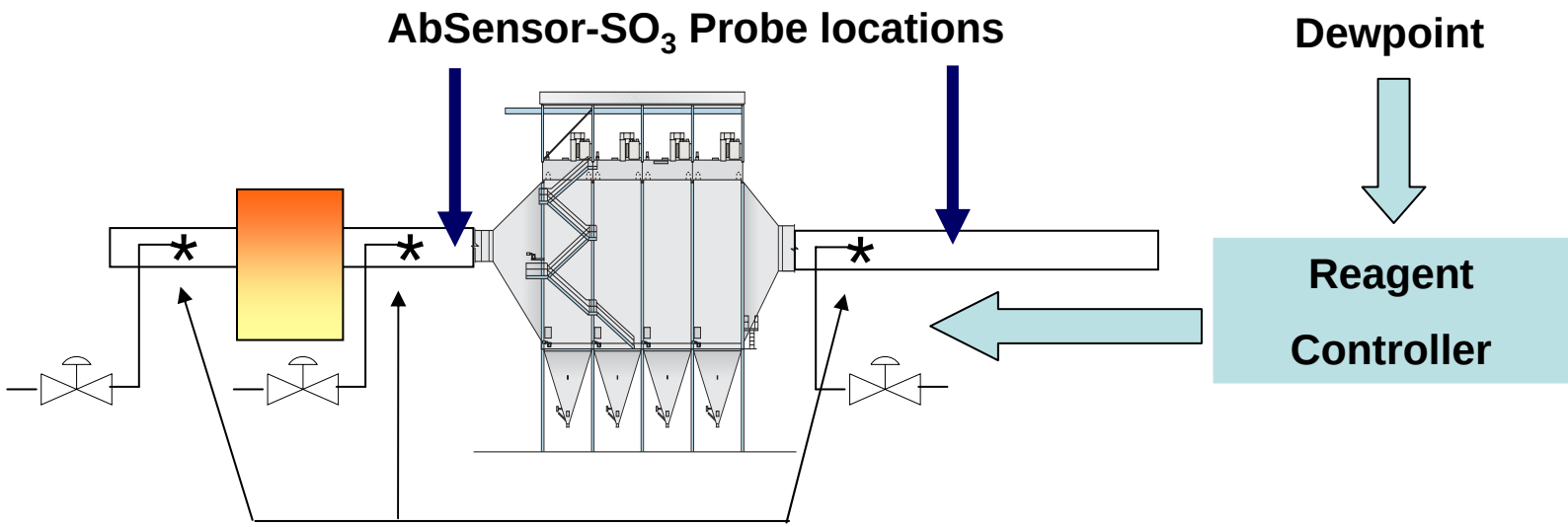


Integrated Air Heater Temperature Controller



Adjust Air Heater temperature to prevent consistent AbS/Sulfuric Acid deposition

SO_3 Mitigation Reagent Control



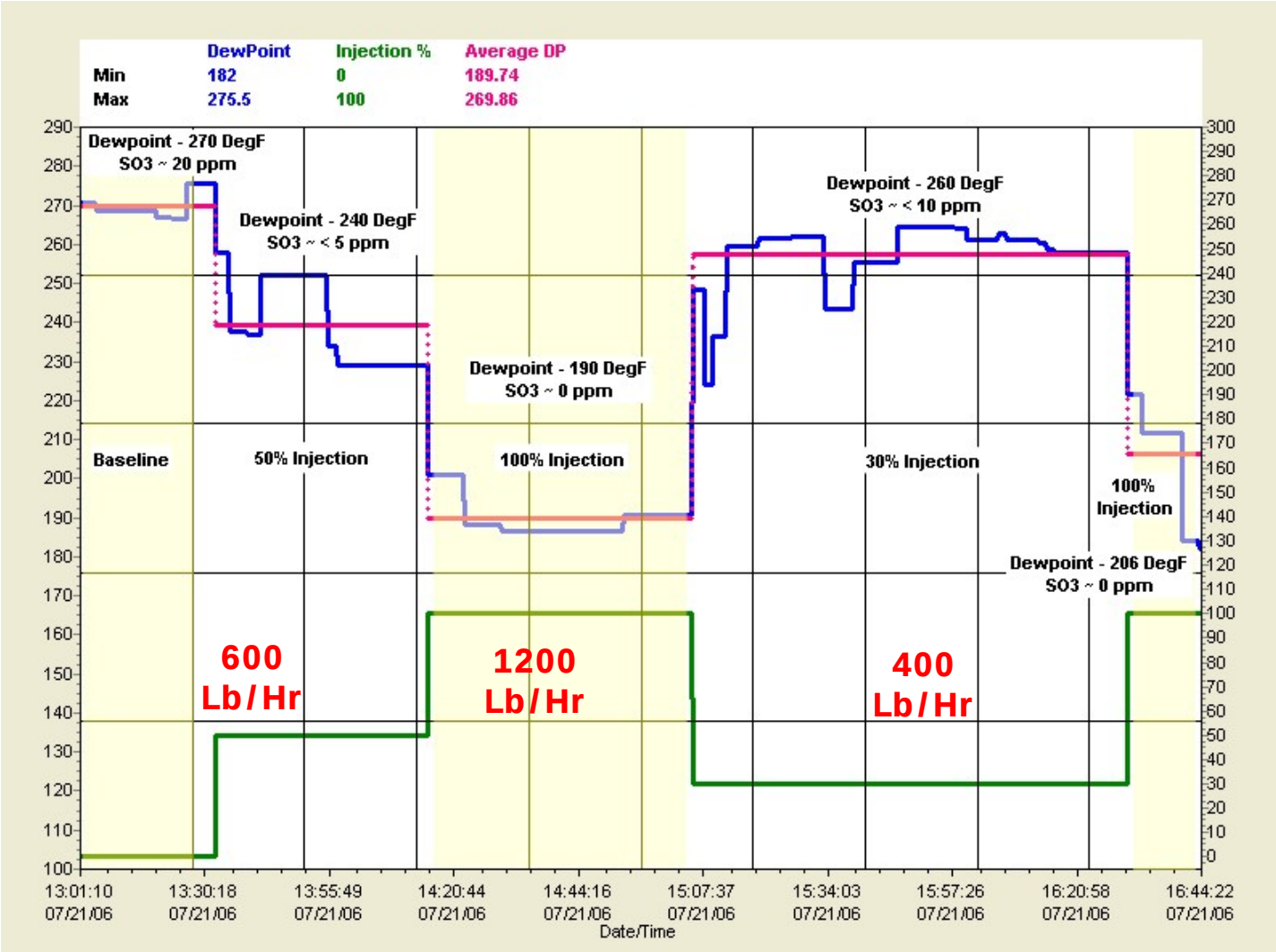
Reagent Injection Points

- Hydrated Lime,
- Trona,
- MgOH
- Ammonia

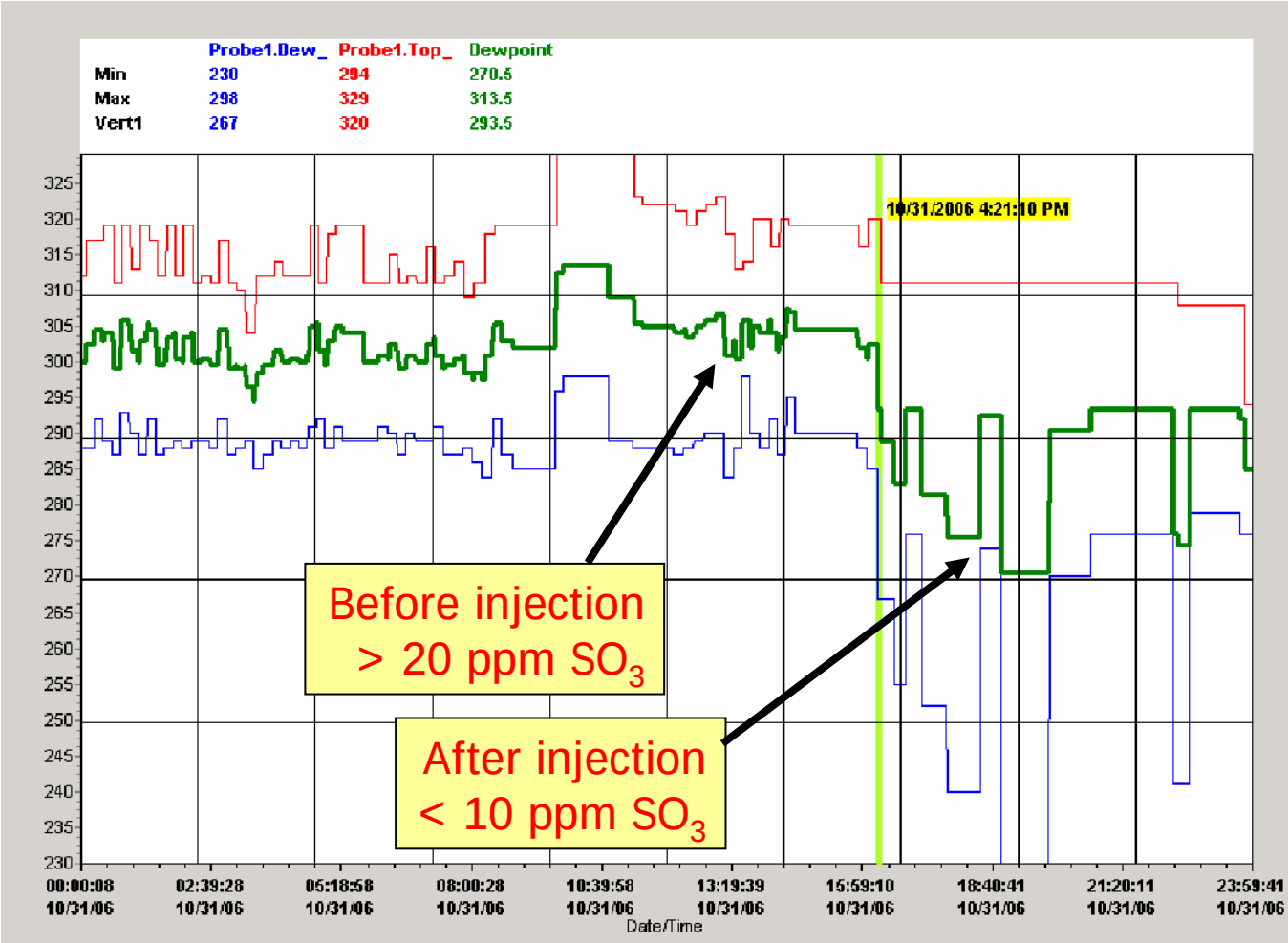
Measure Sulfuric Acid Dewpoint post-reagent injection and control reagent flow

- Back-end corrosion mitigation
- Blue Plume mitigation
- Active Carbon for Hg reduction enhancement

SO_3 mitigation with Hydrated Lime



SO_3 mitigation with Trona



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Experience

Ammonia based NOx Control

EMISSIONS CONTROL PROCESS ENHANCEMENT

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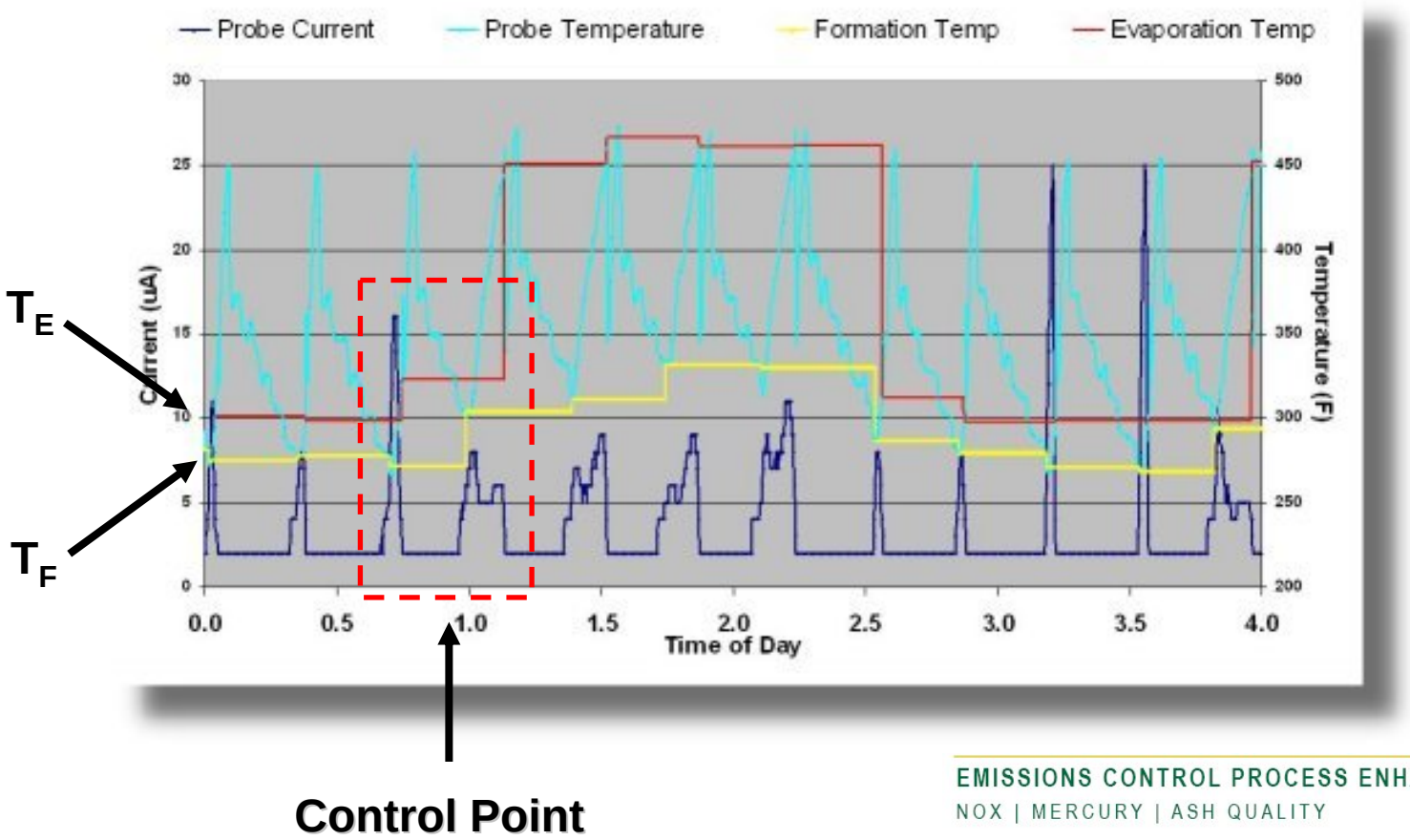
Experience - I

Double Peak Transition - SNCR



Experience – II
Double-Peak SCR

Probe 1 – Circumference

Probe 2 - Center

1 and 2 – Sulfuric Acid

1 – Sulfuric Acid

2 – Double Peak

1 – Sulfuric Acid

2 – AbS

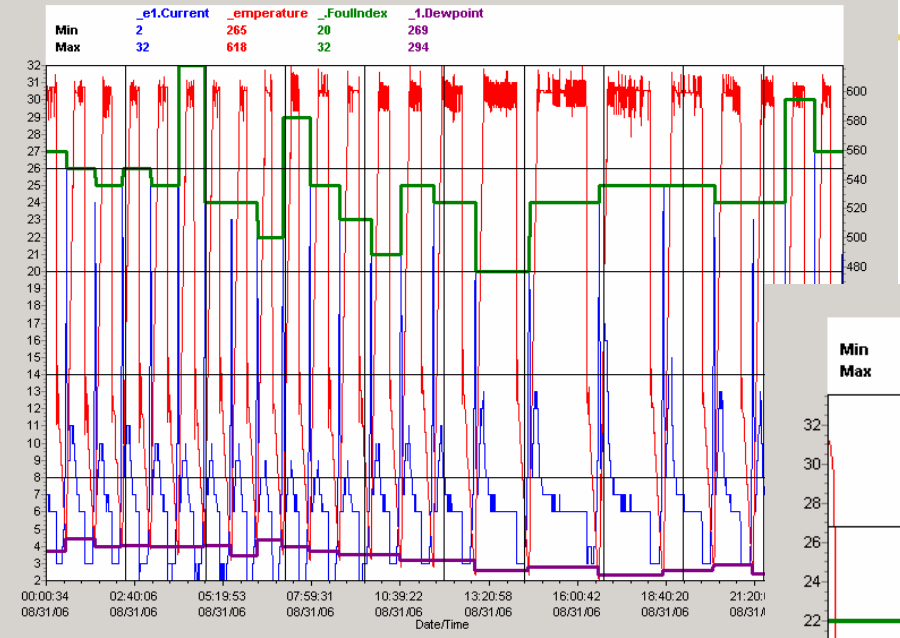
1 and 2 – AbS

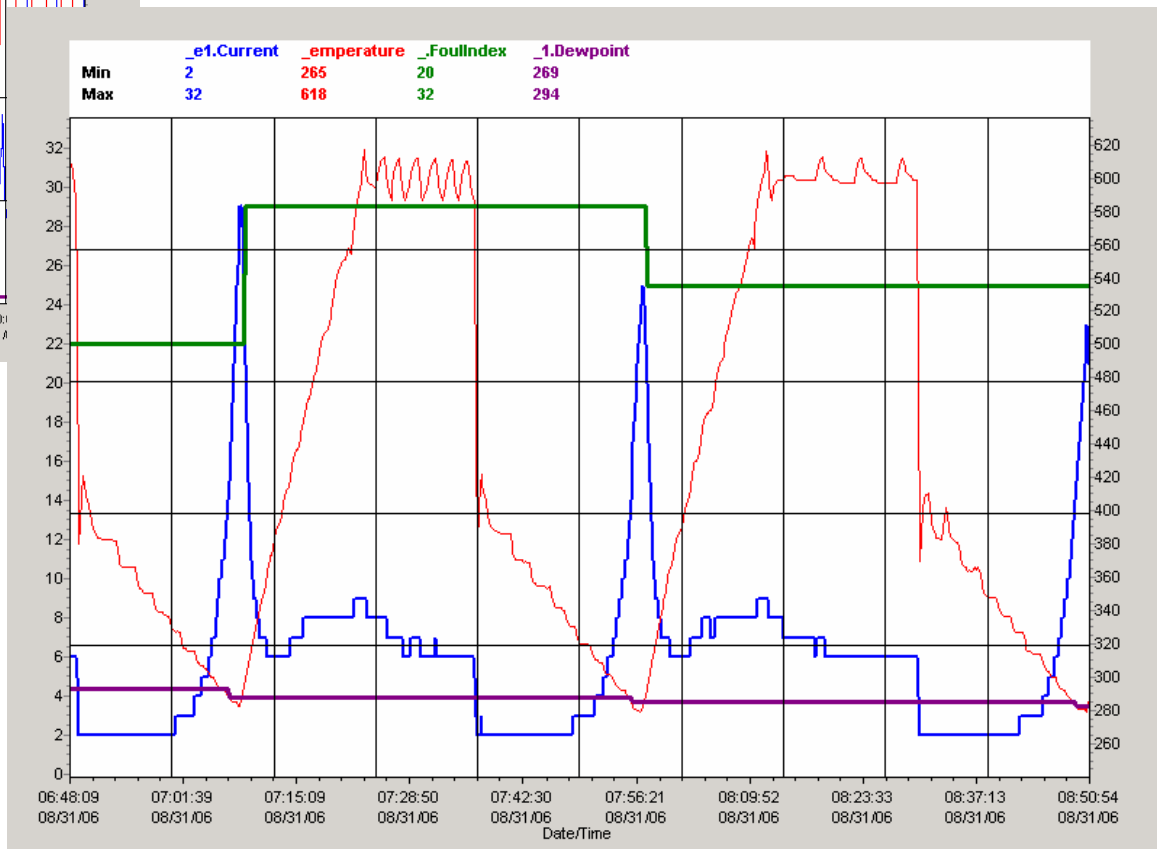
Time Span – 4 Hours

Experience – III
SCR – Consistent Double Peak operation

Double peak operation.

All day, every day!



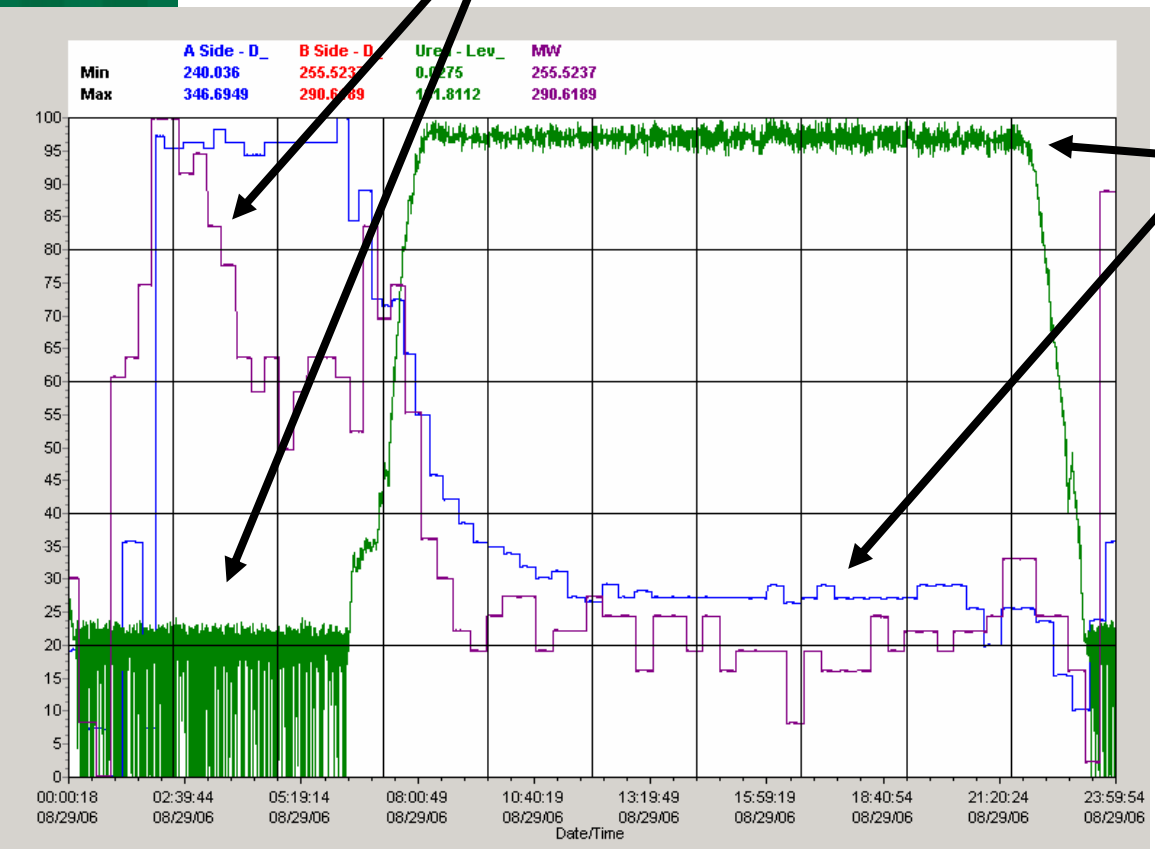


Air Heater plugs due to AbS parasitically attaching to H_2SO_4 deposition.

Adjusting Air bypass dampers helps recover DeltaP

Experience – IV
SNCR – Reagent Flow Slugs

Low-flow Reagent flow slugs causes AbS formation



Better flow control at normal load/flow leads to alleviation AbS formation

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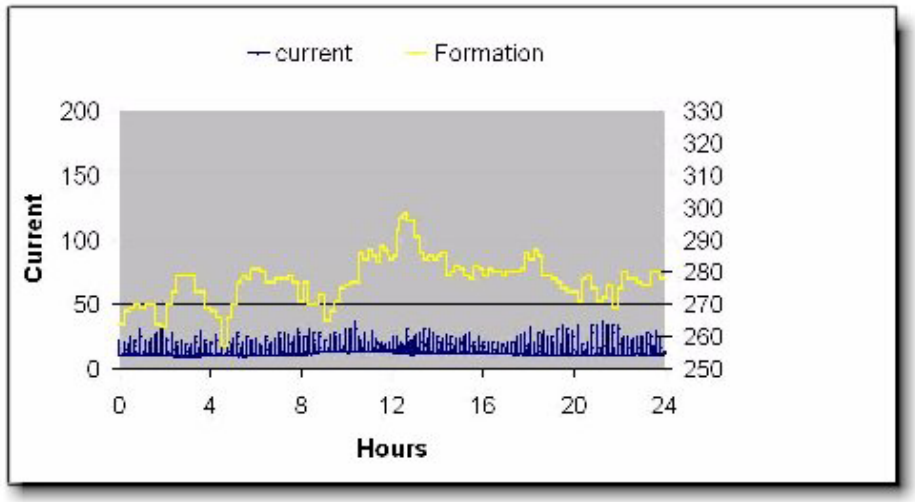
SO_3 Experiences in progress

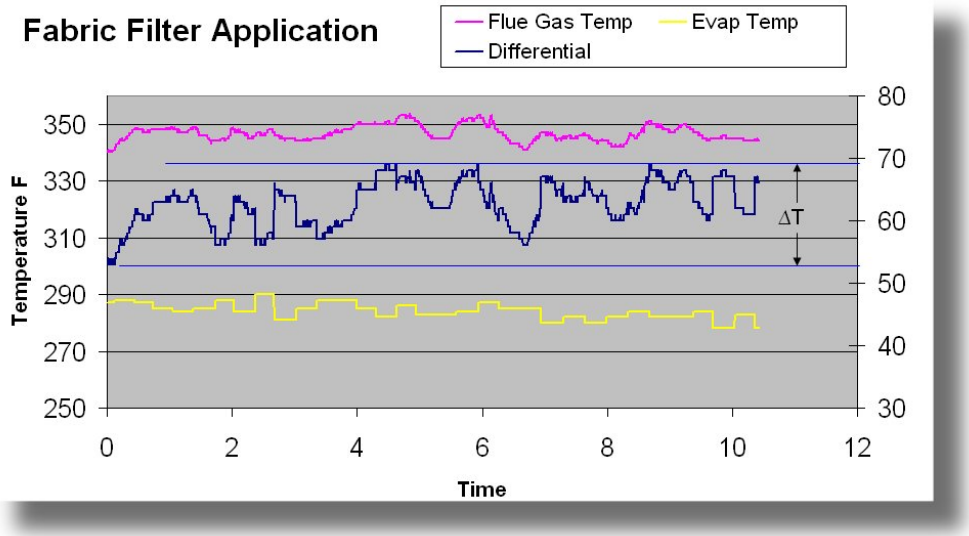
Sulfuric Acid Concentration Variations

- **SO3 levels often change during the course of a day from load changes, fuel changes, and ambient moisture conditions**
- **Because of this, the level of mitigation required will also change during the course of any given day!**



Baghouse Application

- **The plant holds the outlet temp at 350°F to avoid previous bag fouling**
- **There is a typical 50° F Differential between the Dew Point and the gas temperature.**
- **A drop to a 320°F set point would gain almost 1% in Heat Rate**

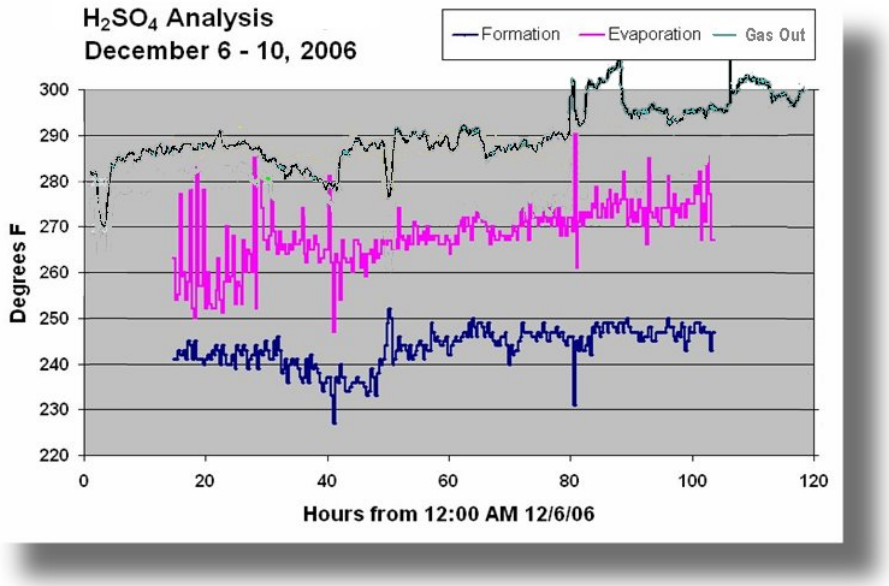


Cold Side ESP w/SNCR

- **This plant is currently adding approximately 20°F to the outlet temp to stay at an ACET of 190.**

- **The Air Heater Metal Matrix model is being generated but it is expected that the max metal temperature will be about 60°F higher than the outlet gas.**

- **This would allow the plant to remove the heating coils without worry of fouling.**



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Conclusion

- **A simple *in-situ, continuous condensables device* to measure Ammonium Bisulfate and Sulphuric Acid (SO_3)**
- **Helps minimize Air Heater fouling while maximizing NO_x reduction**
- **Helps minimize Sulphuric Acid related:**
  - **Back-end Corrosion**
  - **Blue Plume**
  - **Hg capture interference**

Acknowledgements

- **Special thanks to:**
  - **EPRI, and specifically Rick Himes and Jeff Stallings for their demonstration support and providing access to the APFG software**
  - **Rui Afonso for his guidance in utilization of the software**
  - **the multiple plants who have participated in commercial installations and field demonstrations,**

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Q?

- **Thank you for your attention!**
  - **Application Notes are available for:**
    - **Ammonium Bisulfate for SCR/SNCR control**
    - **SO_3 Measurement for Enhanced Mercury Capture**
    - **SO_3 Measurement for Blue Plume Control**
    - **SO_3 Measurement for Heat Rate Control**
  - **What additional Questions do you have?**

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Thank You

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