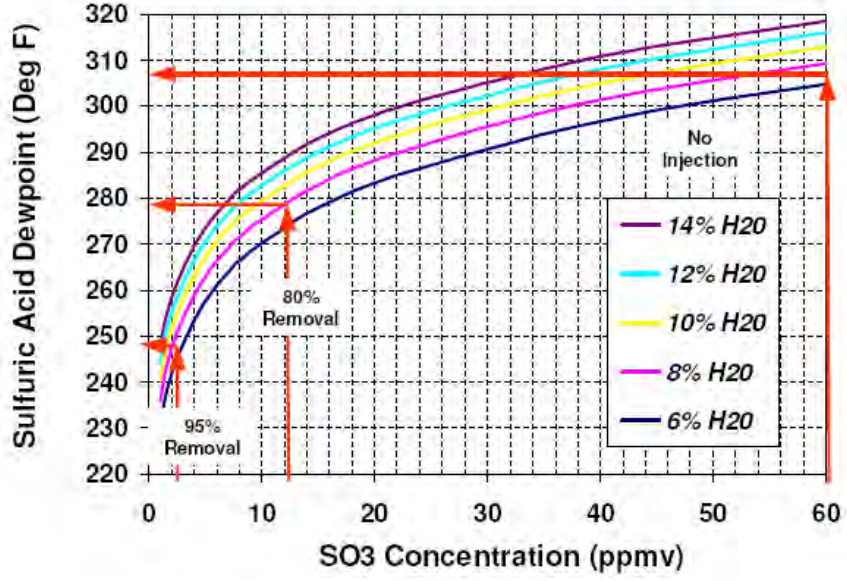
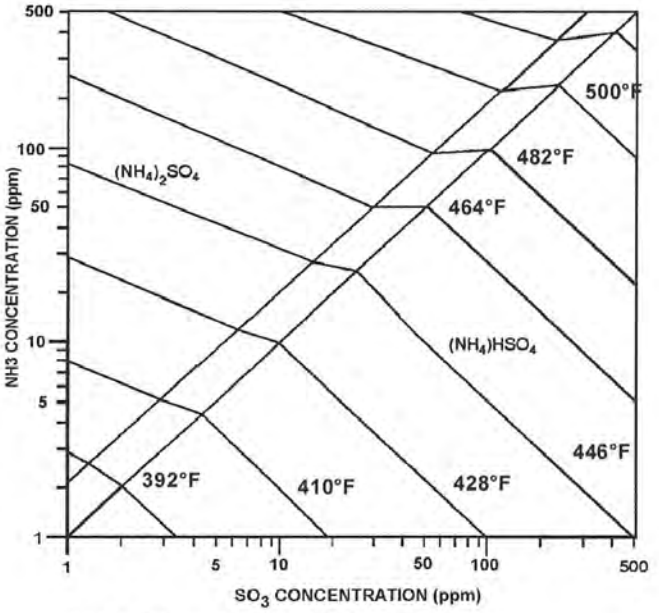
REINHOLD ENVIRONMENTAL Ltd.

2016 NOx-Combustion-CCR Round Table Presentation

February 1 & 2, 2016, in Orlando, FL / Hosted by OUC

Air Heater Fouling

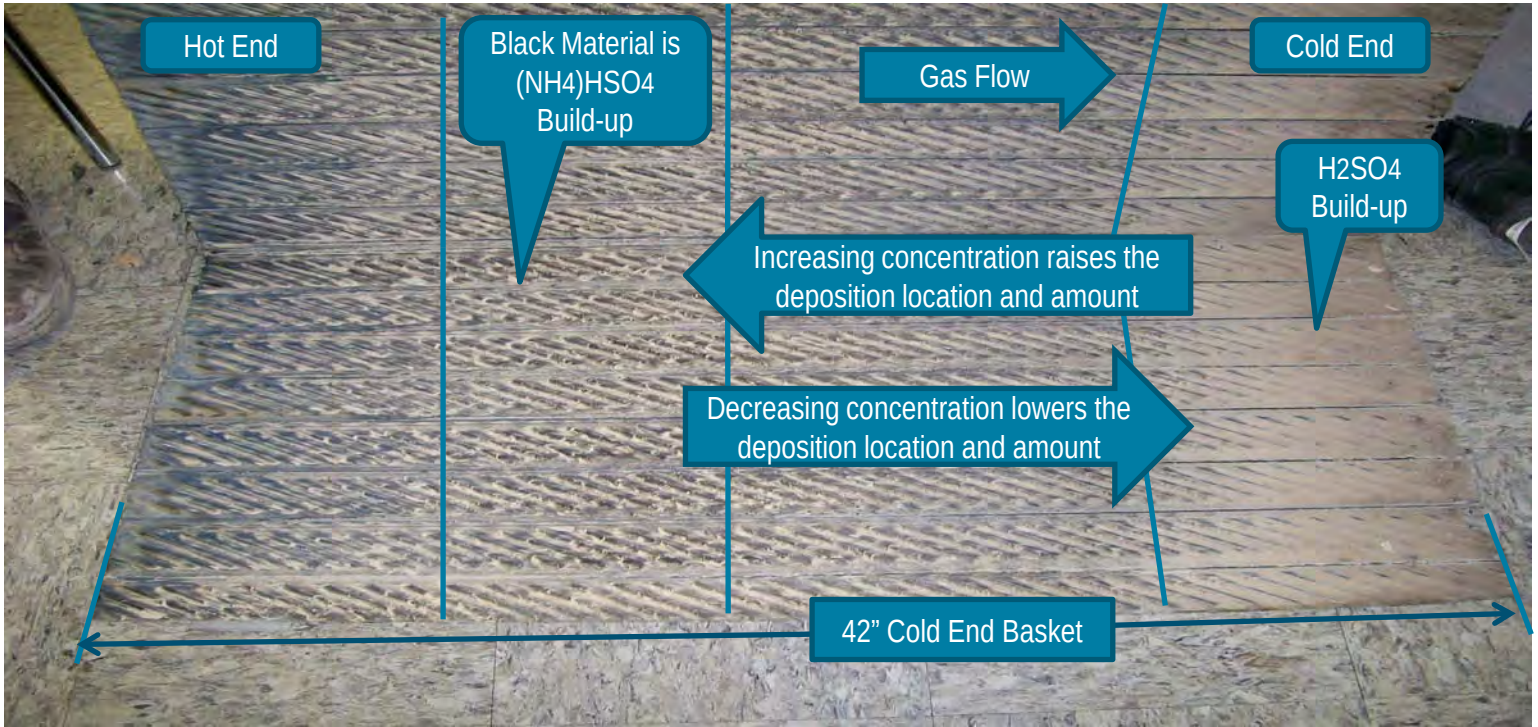




$(NH_4)_2SO_4$ = Ammonium Sulfate
$(NH_4)HSO_4$ = Ammonium Bisulfate

- Two different fouling mechanisms as a function of SO_3
  - Ammonia & Sulfuric Acid
- Sorbent Injection works to reduce or eliminate air heater fouling by reducing the SO_3 in the flue gas
  - Assuming SO_3 is neutralized prior to the air heater
- Testing at Zimmer has shown Sulfuric Acid dewpoints down to 220-230F measured on Breen Probe with high injection rates

- East Bend air heater basket plate dissected showing $(NH_4)HSO_4$ and H_2SO_4 build-up
- HSESP air heaters are more prone to pluggage as there is little ash for condensables to condense on which results in more condensation on the plates

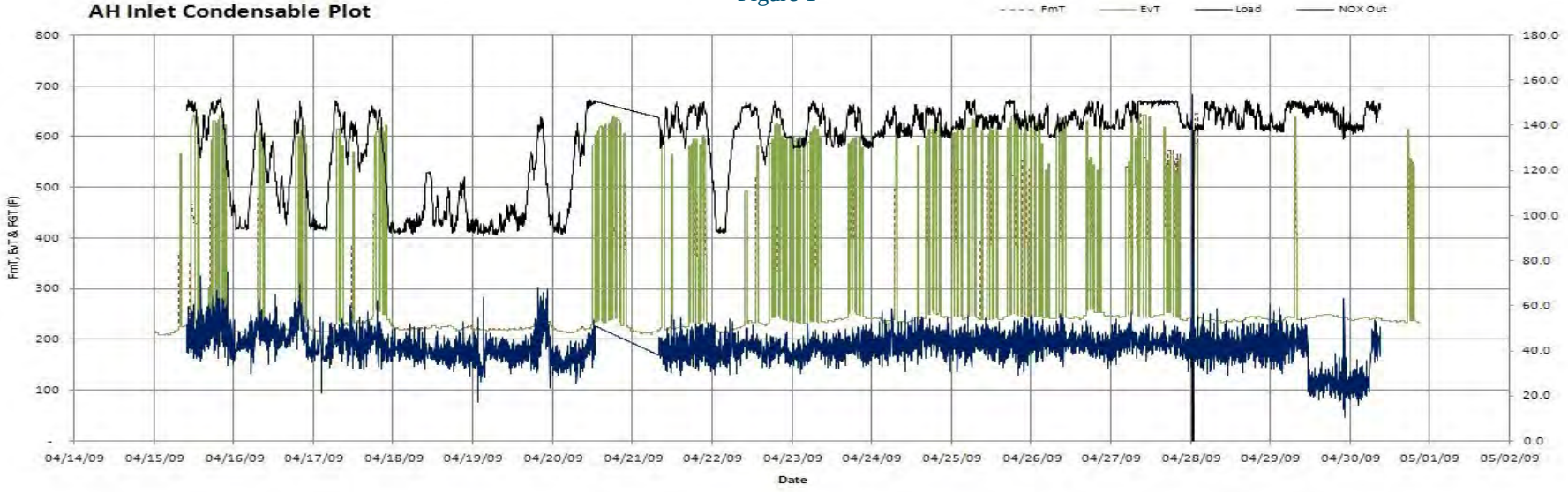



SO_3
H_2O
H_2SO_4


NH_3
SO_3
H_2O
$(NH_2)HSO_4$

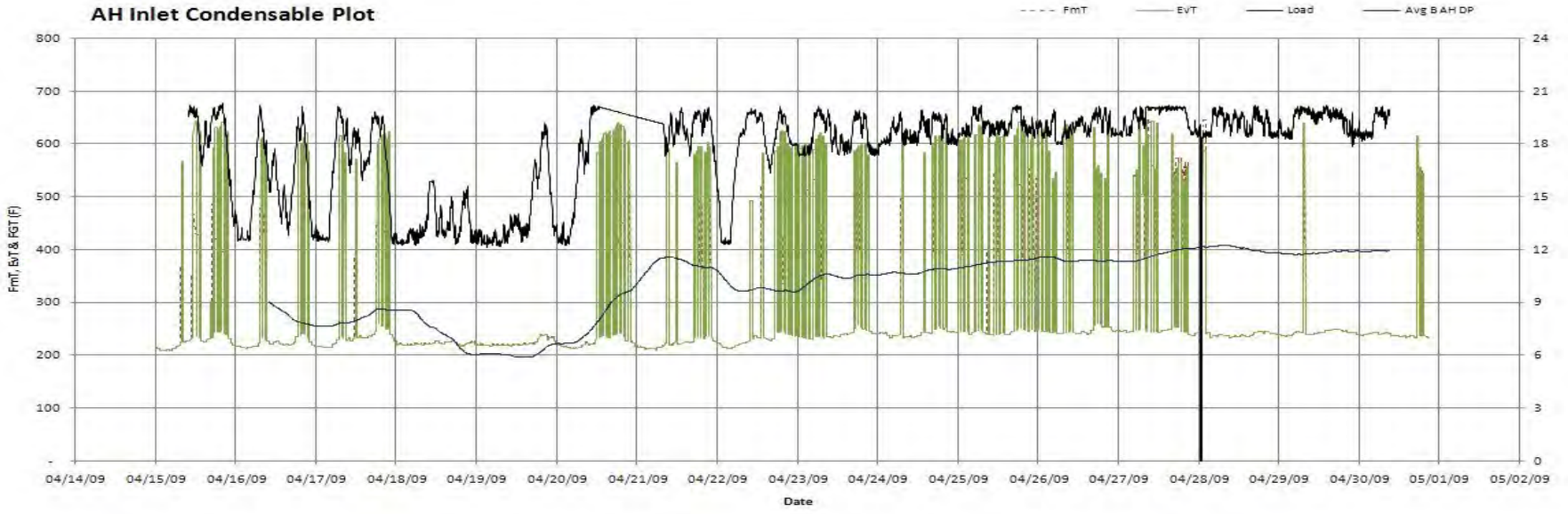
- Gibson 5 SBS injection and condensables trends while being manually controlled from April 28th-30th
- Continuously adjusted the SBS injection molar ratio so no current was observed on the Breen probe (Green line) which indicates potential fouling
- Tested enhanced Nox removal by increasing the ammonia injection rate and increasing the removal from 85% to 93% for a period of 24 hrs

Figure 1



Air Heater Fouling

- Gibson has always struggled with Nox removal and air heater pluggage
- Trend shows air heater DP levels off when the SO_3 mitigation system was increased to make the condensable formation stop



Air Heater Fouling

- Installed 4th layer in Fall '11, removed 3rd layer in Spring '12
  - Later discovered the 4th layer that was installed had double the SO_2 oxidation rate, increasing SO_3 to the AH
- Air heater rebuild with new seals and partial basket replacement
  - Tightened AH's and dropped outlet temp
  - Started having significant sulfuric acid pluggage
- Fuel flexibility drove decision to reverse direction of rotation on tri-sector air heater for more PA temp
- Installation of an intermediate reheater reduce economizer outlet temps
  - Further reduced AH outlet temps
- Made the decision to move the current Sorbent Injection upstream of the SCR/AH to mitigate air heater pluggage

Air Heater Averages	Pre 2012 Outage	Post 2012 Outage	Δ
Primary Air Temp.	504	574	+70
Secondary Air Temp.	553	546	+7
Gas Inlet Temp.	653	644	-9
Gas Outlet Temp.	335	313	-22

Air Heater Fouling

Heat Rate Improvement

- A reduction of 30 degrees F on air heater exit gas temp is approximately a 1% savings in unit heat rate
- Improved heat rate has benefits beyond coal cost
  - Decreased fuel handling
  - Decreased ash & waste handling and stabilization
  - Decreased CO_2 emissions
  - Better native Hg capture
  - Better precip performance
  - Decreased emissions overall
- Sustainability
  - People, Planet, and Profits

	Baseline	Less 1% HR	Savings
Heat Rate (BTU/KWh)	10,000	9,900	100
Yearly Fuel (TN's)	1,368,750	1,355,063	13,688
Yearly Ash (TN's)	109,500	108,405	1,095
Coal & Ash Cost ($'000)	87,600	86,724	876
CO_2 Emissions (TN's)	3,367,125	3,333,454	33,671

Assumptions:

500 MW Unit
12,000 BTU/lb fuel heating value
75% Capacity Factor
$60/ton coal cost
10% ash content
$50/ton ash processing cost
205 lb/Mmbtu CO_2 Emissions per EIA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