Pilot Scale Study of ABS Formation Temperature: Application of a Dewpoint Technique*

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EPRI 2007 SCR Workshop

Pensacola, Fl

November 12-14, 2007

* **Work sponsored by EPRI and UCI**

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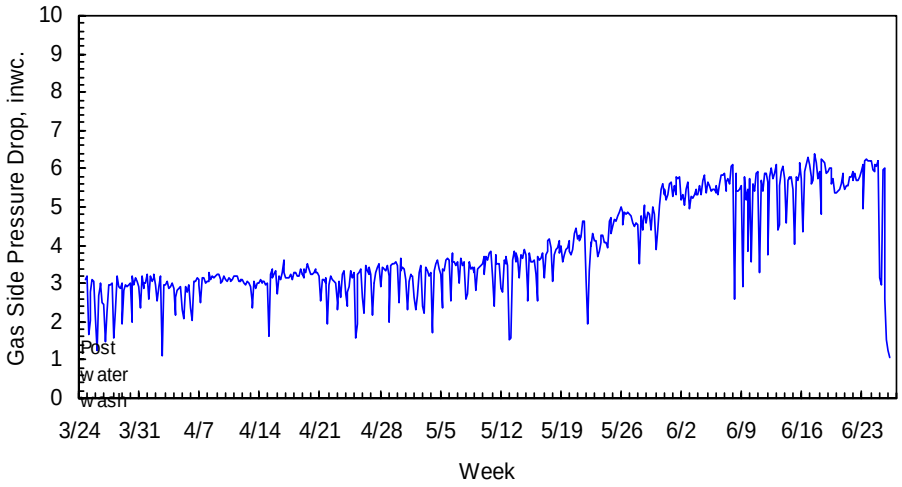
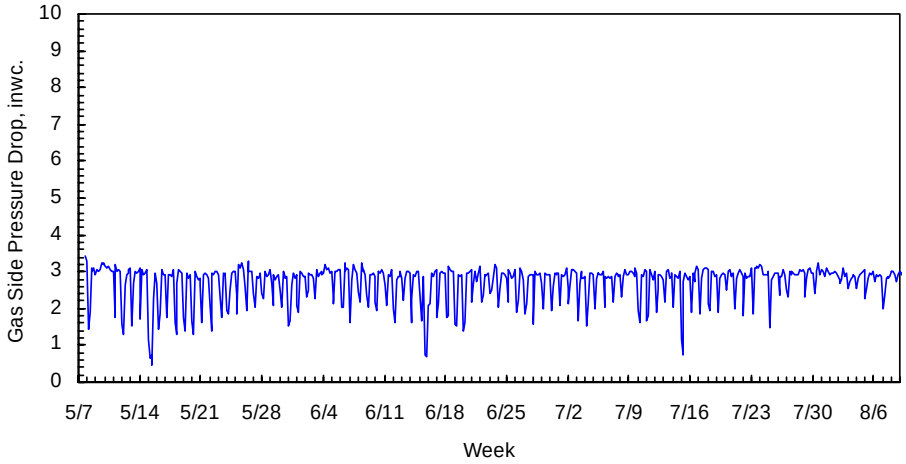
Ammonium Bisulfate (ABS)

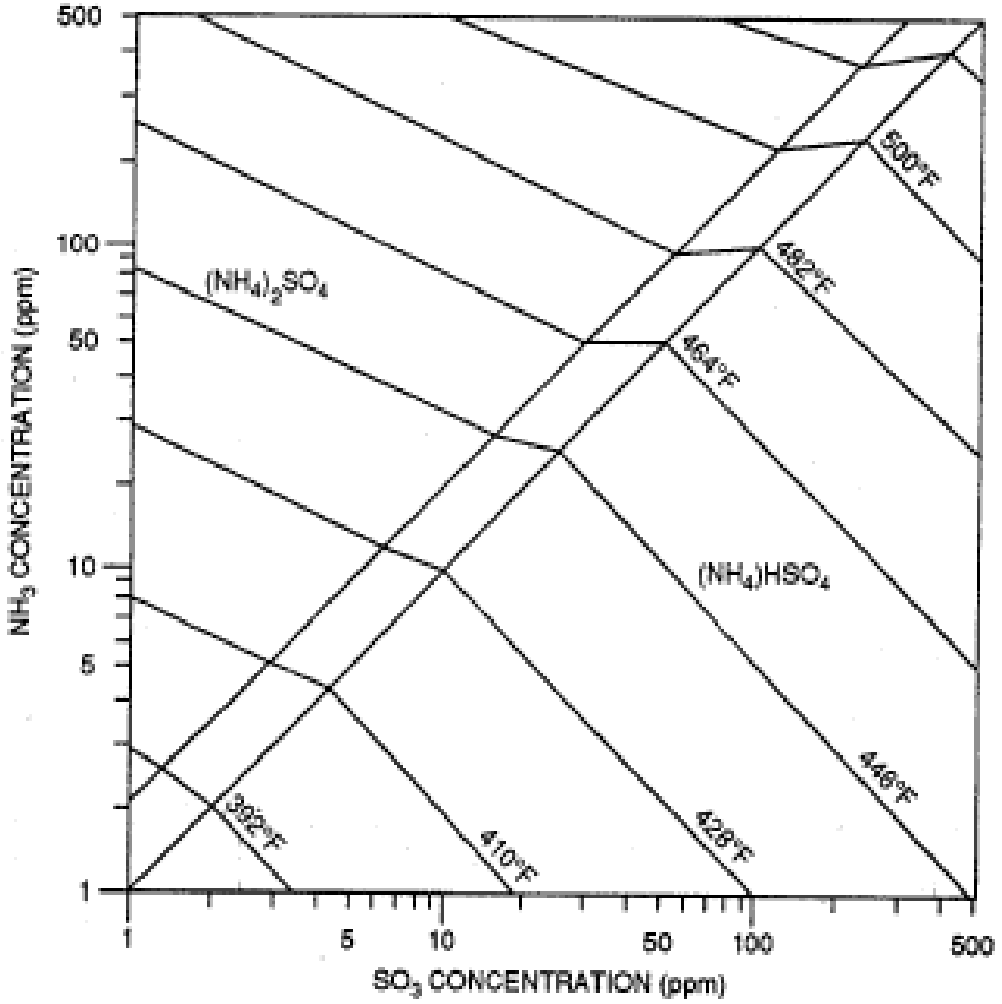
- **ABS: sticky liquid,**
  - deposits in APH,
  - deposits on the catalyst while operating below the “Minimum Operating Temperature” reducing Reactor Potential
- **Governing chemical reactions**
  - $NH_3 + SO_3 + H_2O \leftrightarrow NH_4HSO_4$
  - $NH_3 + H_2SO_4 \leftrightarrow NH_4HSO_4$
  - $H_2O + SO_3 \leftrightarrow H_2SO_4$

Impact of ABS Deposition on APH Performance

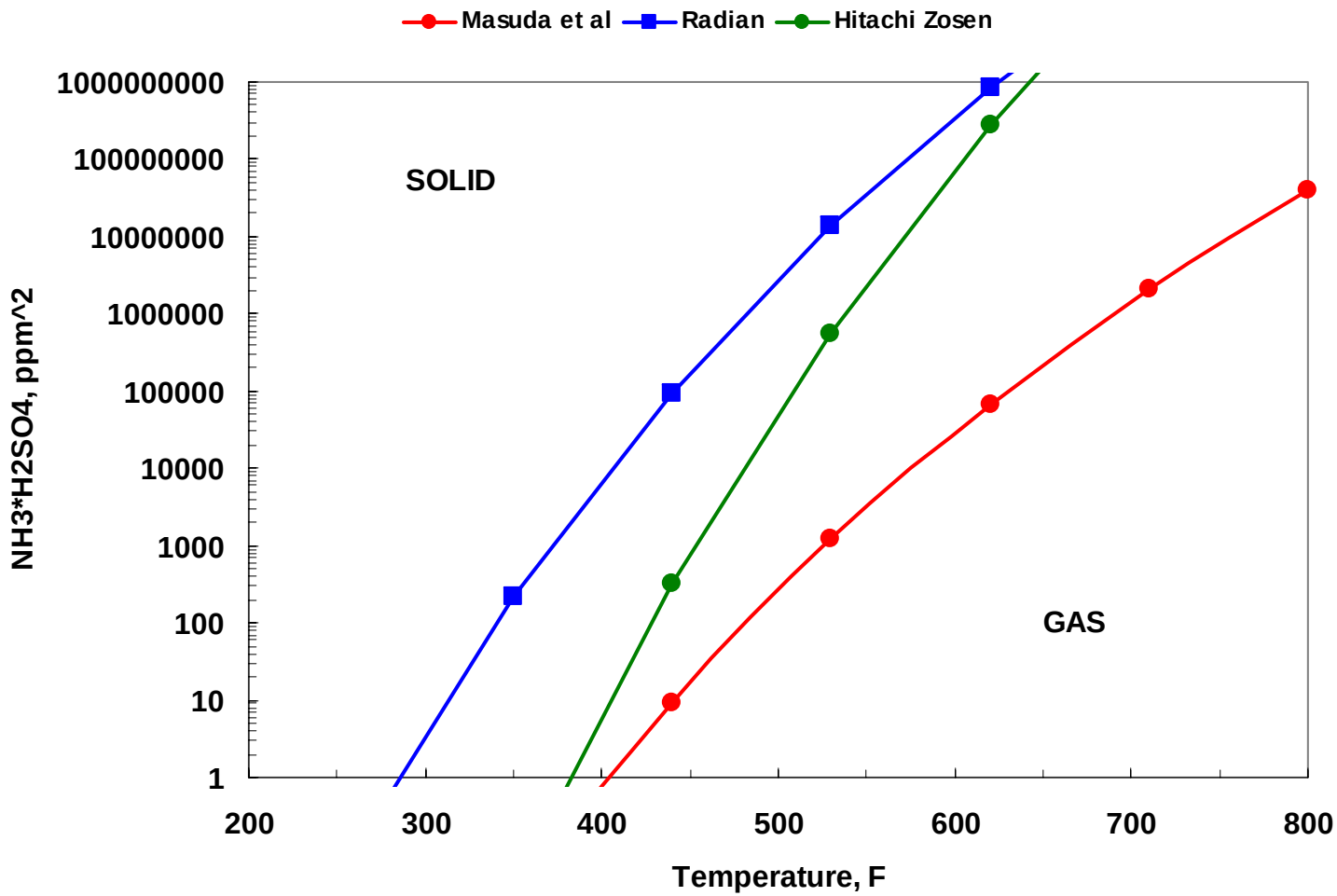




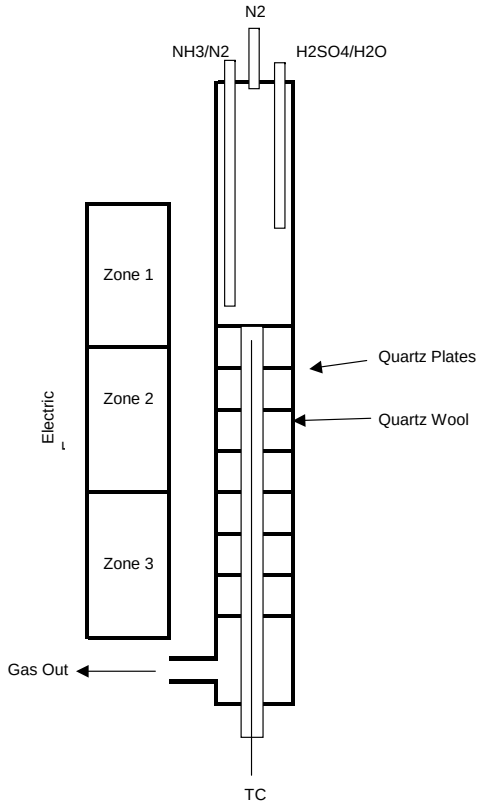
Hitachi Zosen Ammonium Sulfate and Bisulfate Formation



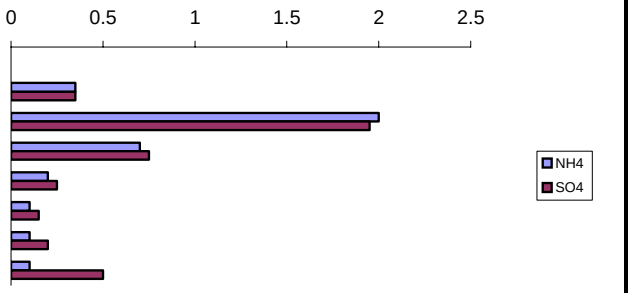
ABS Formation Temperature Data Varies



Matsuda et al



Region	Temperature C	NH4+/SO42
1	356-323	-
2	323-291	0.91
3	291-265	1
4	265-241	0.95
5	241-222	0.77
6	222-203	0.26
7	203-183	0.14
8	183-158	0.11



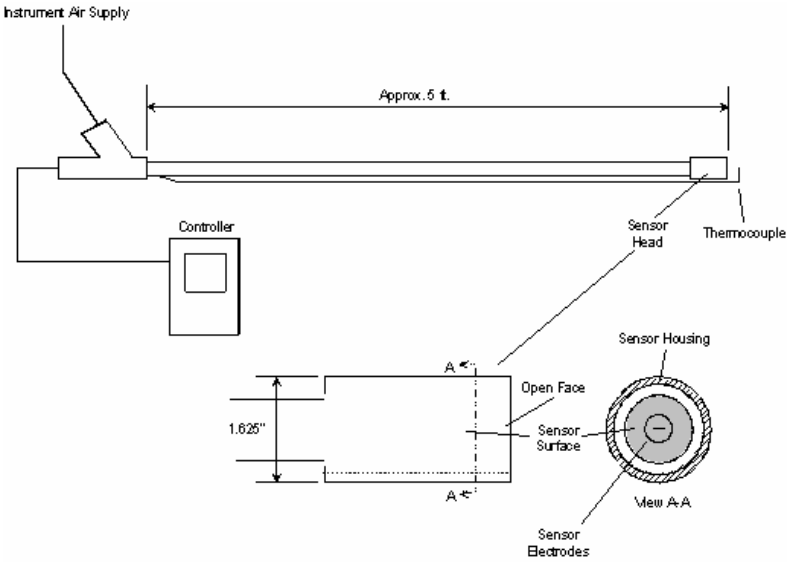
- **For this experiment T_{ABS} taken to be 300 C**
- **Why not 323 C, or 291 C, or <291 C?**
- **What is the wall temperature compared to the measured temperature?**

Project Objectives

- **Conduct a pilot scale study to determine ABS formation temperatures**
- **Specifically are the Radian or Matsuda et. al values more correct**
- **These wide variations in ABS formation temperatures can have significant impacts in dealing with APH and SCR issues**

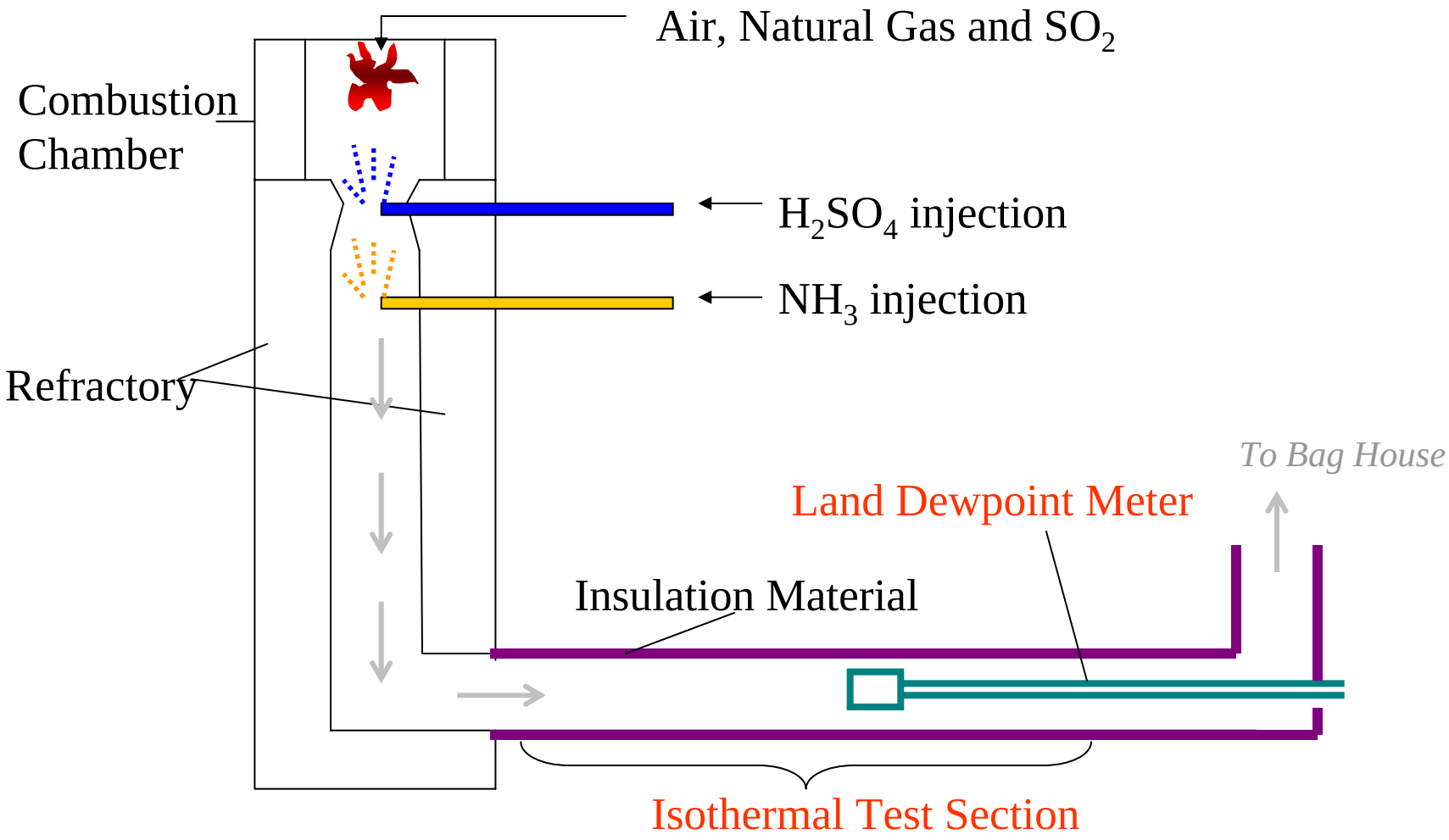
Land Dewpoint Meter*

- **5‘ probe with sensor tip for condensation detection**
  - Glass tip with a ring and an inner electrode
    - A current is detected when condensate film forms and completes the circuit
  - Ambient air is drawn to cool the tip



  - Two Temperature Sensors
    - One on the glass tip for surface temperature
    - The other protruding out of the probe for flue gas temperature

*** Note: A commercial version of this ABS probe is available from Breen Energy Solutions**

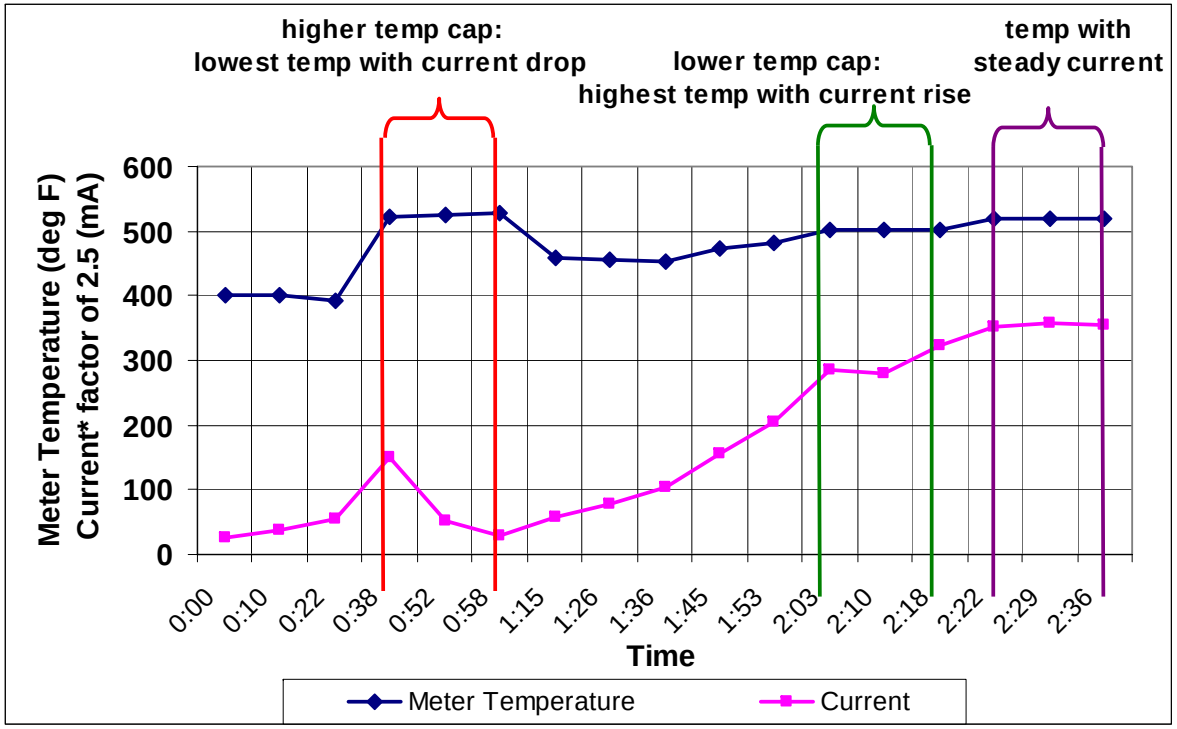

Air, Natural Gas and SO_2
Combustion Chamber
H_2SO_4 injection
NH_3 injection
Refractory
To Bag House
Land Dewpoint Meter
Insulation Material
Isothermal Test Section

Experimental Setup

- **High temperature**
  - Natural gas-burning combustor with an isothermal region for probe insertion
  - Adjustable temp and airflow
- **Gas composition**
  - Combustion products:

    CO_2, H_2O, N_2 and O_2
  - Injection of NH_3 and SO_2 gas and H_2SO_4 solution

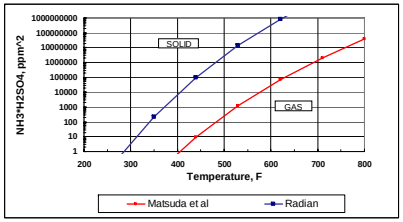
Test Approach



Temp selection rule:

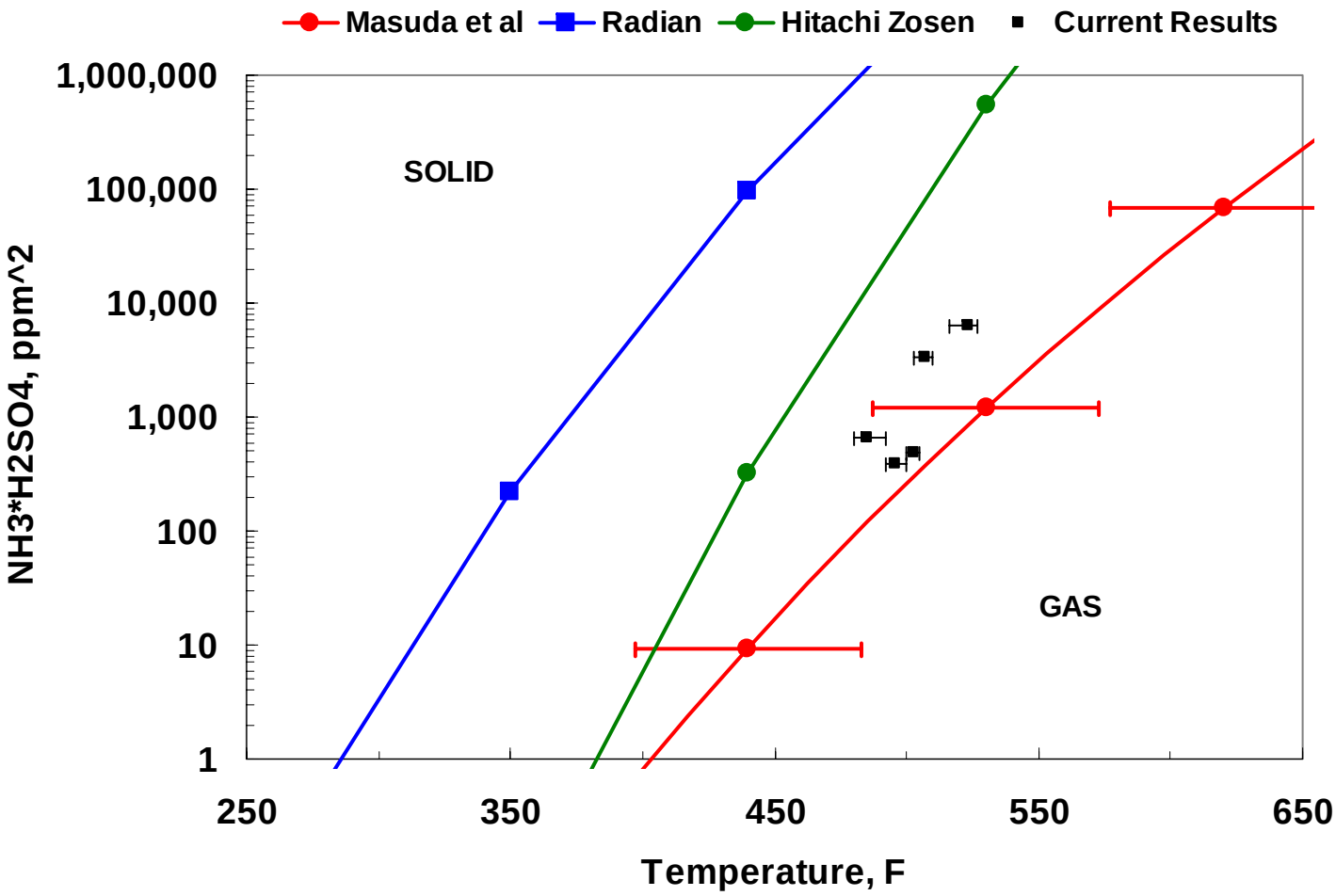
At each temp

- Increase in current
  → condensation
- Decrease in current
  → evaporation
- Steady current
  → dewpint temp



- **Determine preliminary temperature range from curves**
- **Maintain probe at each temp within the range for 20 ~ 30 min and select the next test temp accordingly**

Results


Masuda et al
Radian
Hitachi Zosen
Current Results
SOLID
GAS
NH3*H2SO4, ppm^2
1,000,000
100,000
10,000
1,000
100
10
1
250
350
450
550
650
Temperature, F

Conclusions

- **The current dew point determination of ABS formation temperatures are markedly higher than the prior work of Radian which has been use in APH models**
- **The current results fall between the Hitachi Zosen and the Matsuda et al curves**
- **The current experiment is not without issues. For instance does the ABS form on the sensor tip, or at a higher temperature in the boundary layer**
- **The current approach will be duplicated at a full scale coal fired power plant**

Thank you for your attention

Questions/Comments?