SNCR Performance and Optimization: Wood Fired Boilers

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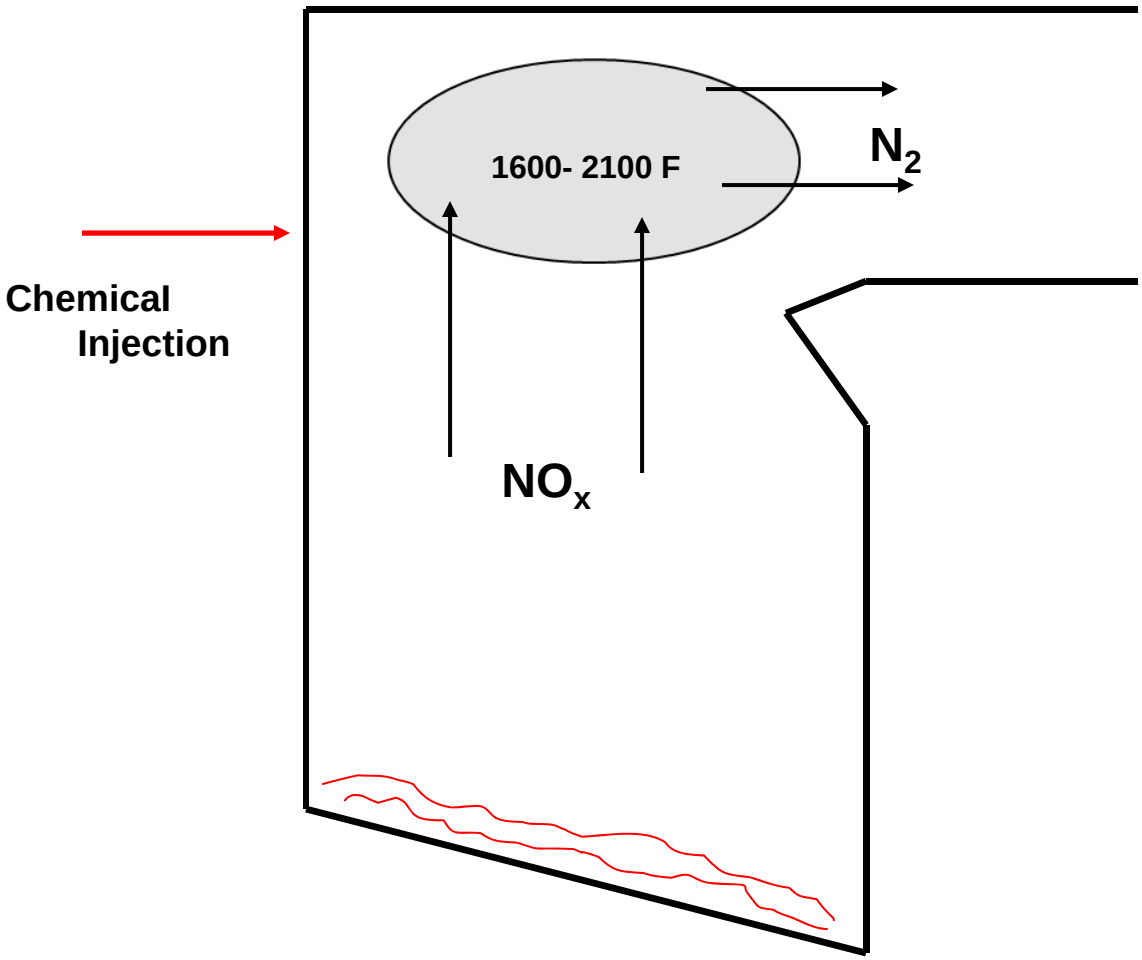
Objectives

- **Objectives**
  - Provide an overview of SNCR
  - Discuss the issues of SNCR applied to wood fired boilers
  - Discuss optimization of SPI's SNCR system at Lincoln,CA

- **Acknowledgement**
  - Ron Gaston (SPI)
  - Tim Sonnichsen (Sonnichsen Engineering)
  - John Pisano (U. C. Riverside)

SNCR Process

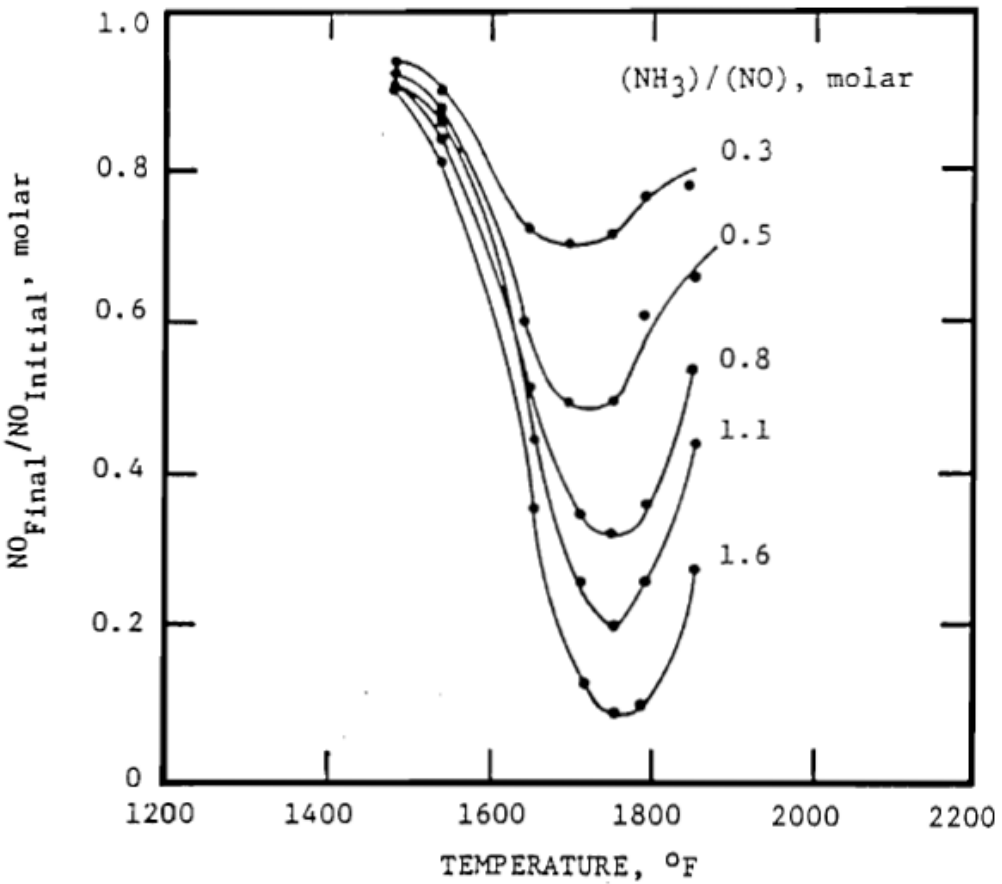


- Gas Phase Reaction Between the Injected Chemical and NOx
- Reactions Occur in the Temperature Region of 1600-2100 F
- Furnace is the Chemical Reactor

SNCR Process Parameters

- **SNCR Chemical**
  - Type (Ammonia, Urea)
  - Amount (NSR-N/NOx)
- **Temperature**
- **Residence Time**
- **Initial NO_x Level**
- **Background Gas Composition (i.e., CO, etc.)**

Temperature



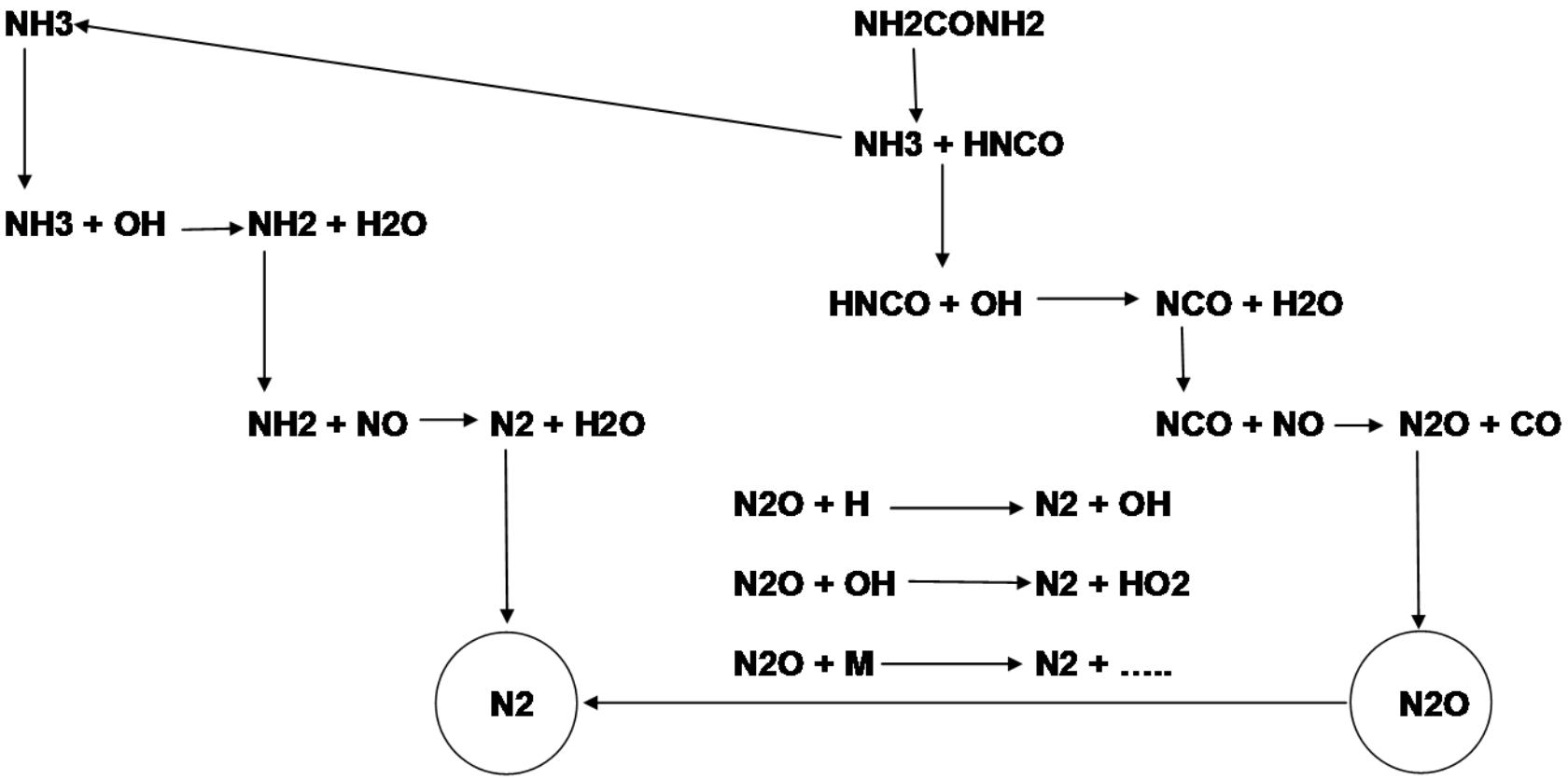
SNCR Chemistry

$NH_3 + NO + 1/2O_2 = N_2 + 3/2\ H_2O$

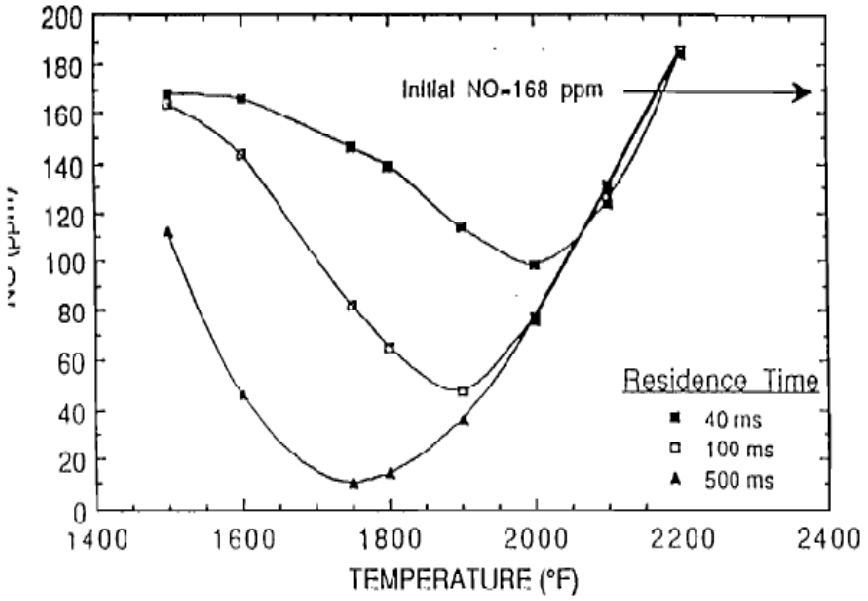
$NH_2CONH_2 + 2NO + 1/2O_2 = 2N_2 + 2\ H_2O + CO_2$

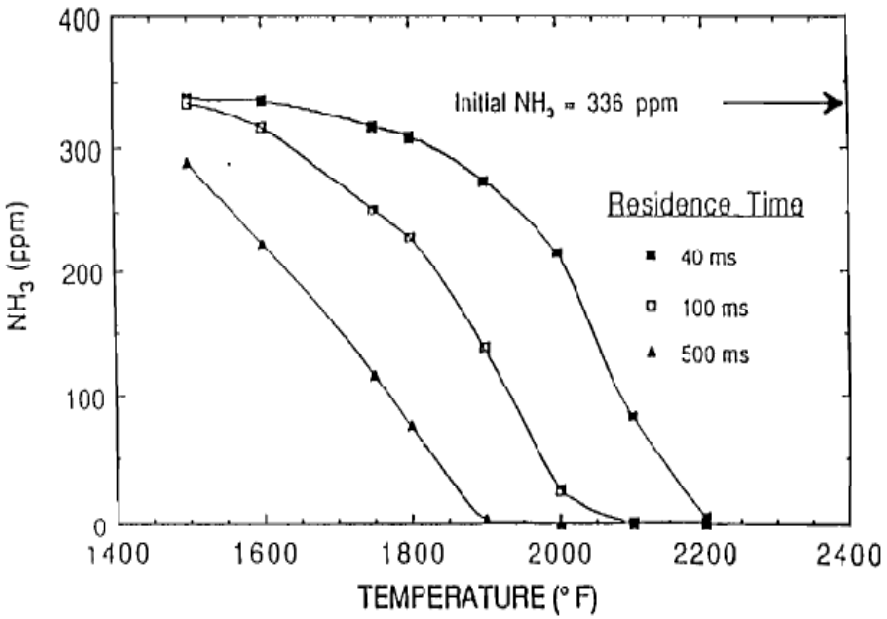
Ammonia (NH_3)

Urea (NH_2CONH_2)

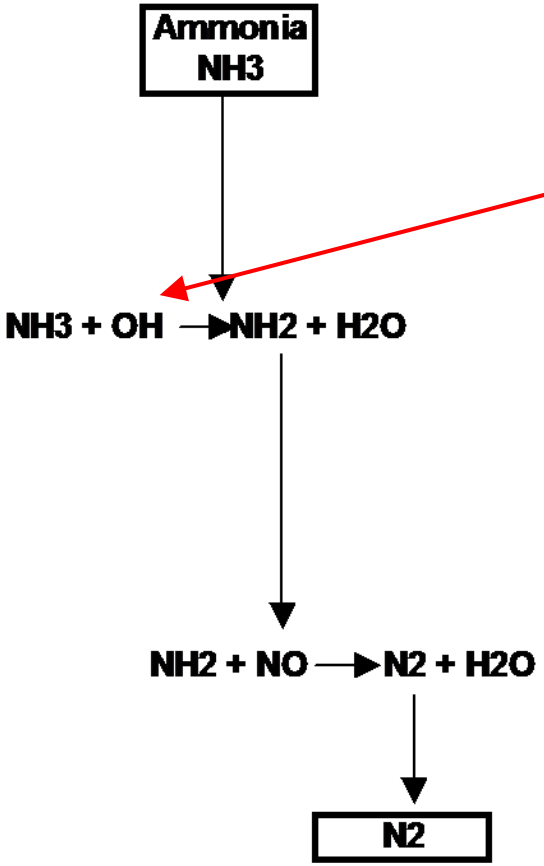


Effect of Residence Time





SNCR Chemistry (CO Effects)

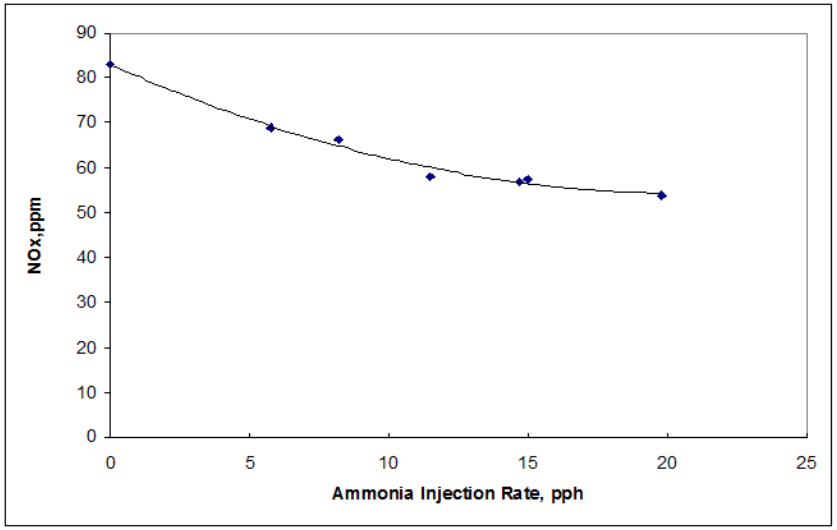


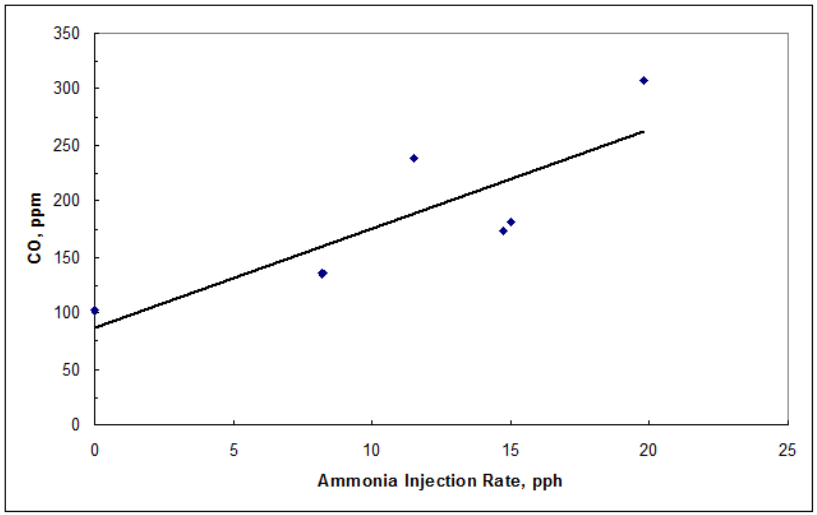
CO + OH → CO2 + H

H + O2 → OH + O
O + H2 → OH + H

- CO and NH3 compete for OH; Net result is SNCR can interfere with CO Oxidation
- CO can also generate more OH that can move the SNCR Temperature Window

CO Oxidation Impeded

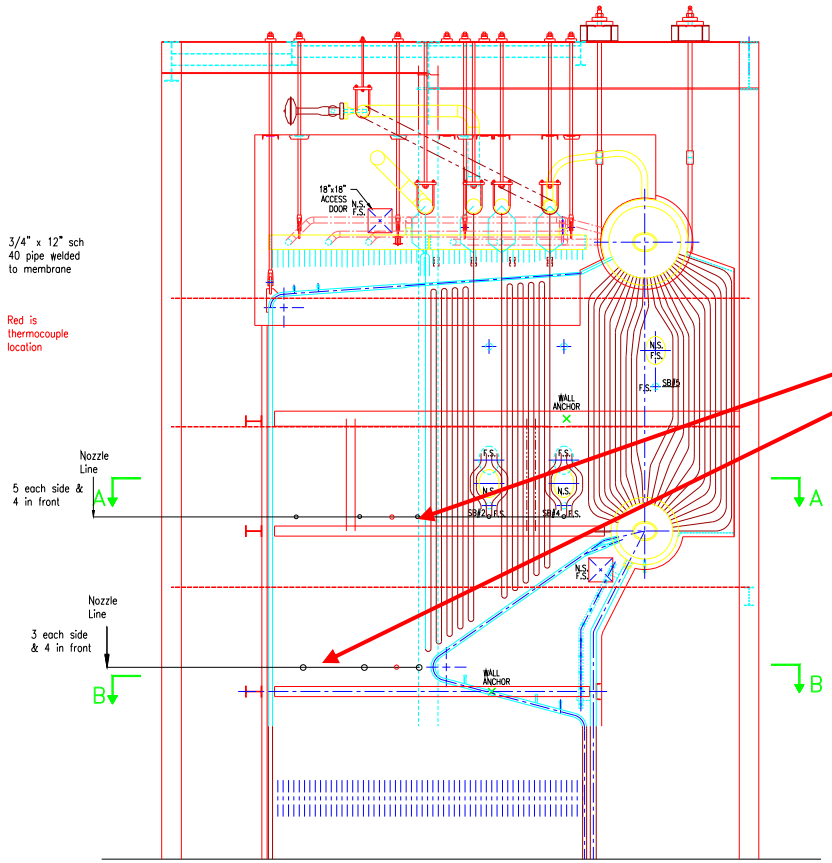




Wood Fired Challenges

- **Fuel Variability (Moisture, Composition)**
- **Fuel Feed Upsets affect the Combustion Process (Distribution, Temperature, CO)**
- **Initial NO_x Level (Can tend to be Low)**
- **Temperature Variations at the Injectors**

Case Study (SPI Lincoln McBurney Boiler)



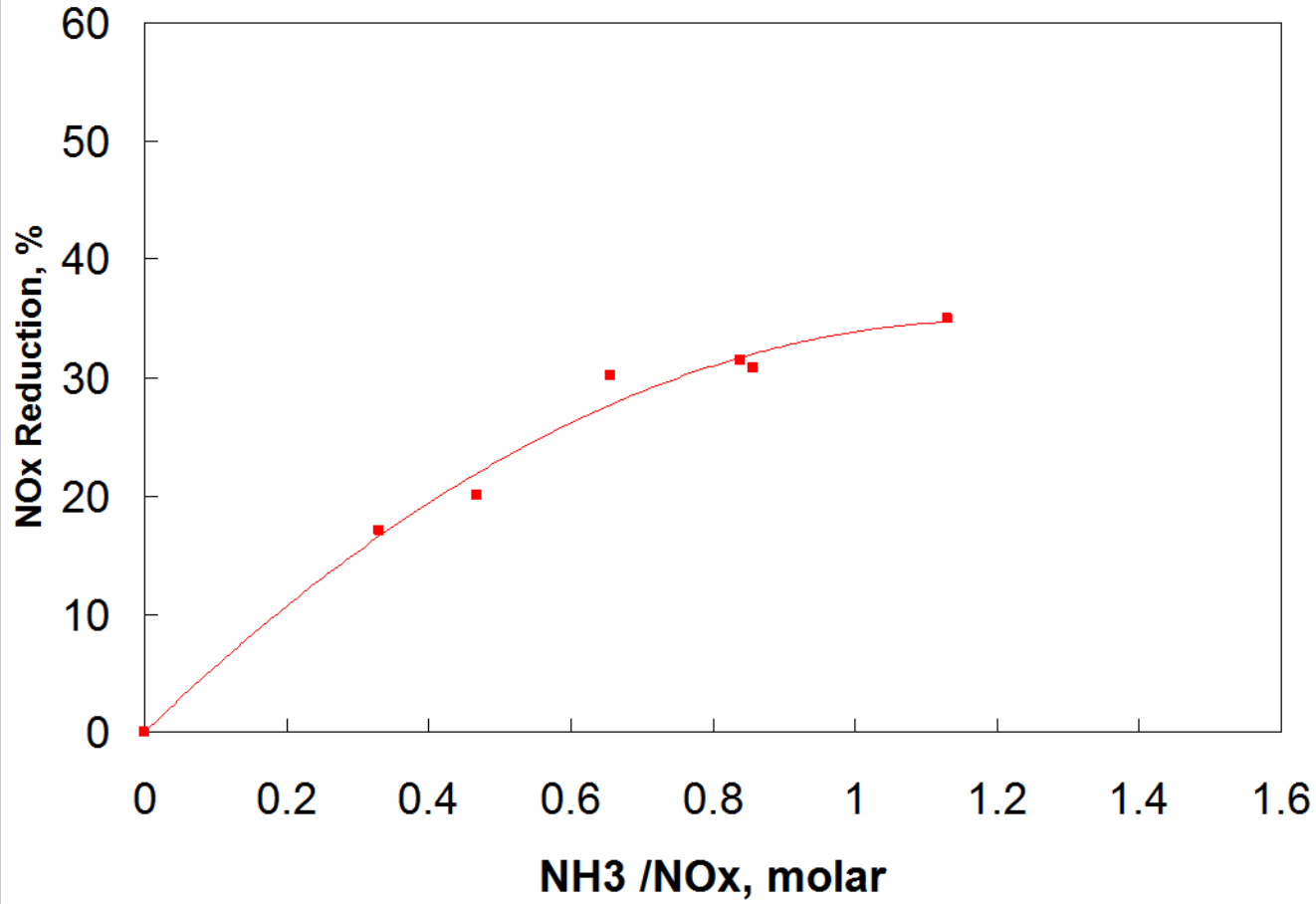
SECTION OF BOILER

- SNCR Reagent- Ammonia (NH3)
- Steam Carrier
- 2 levels of Injectors

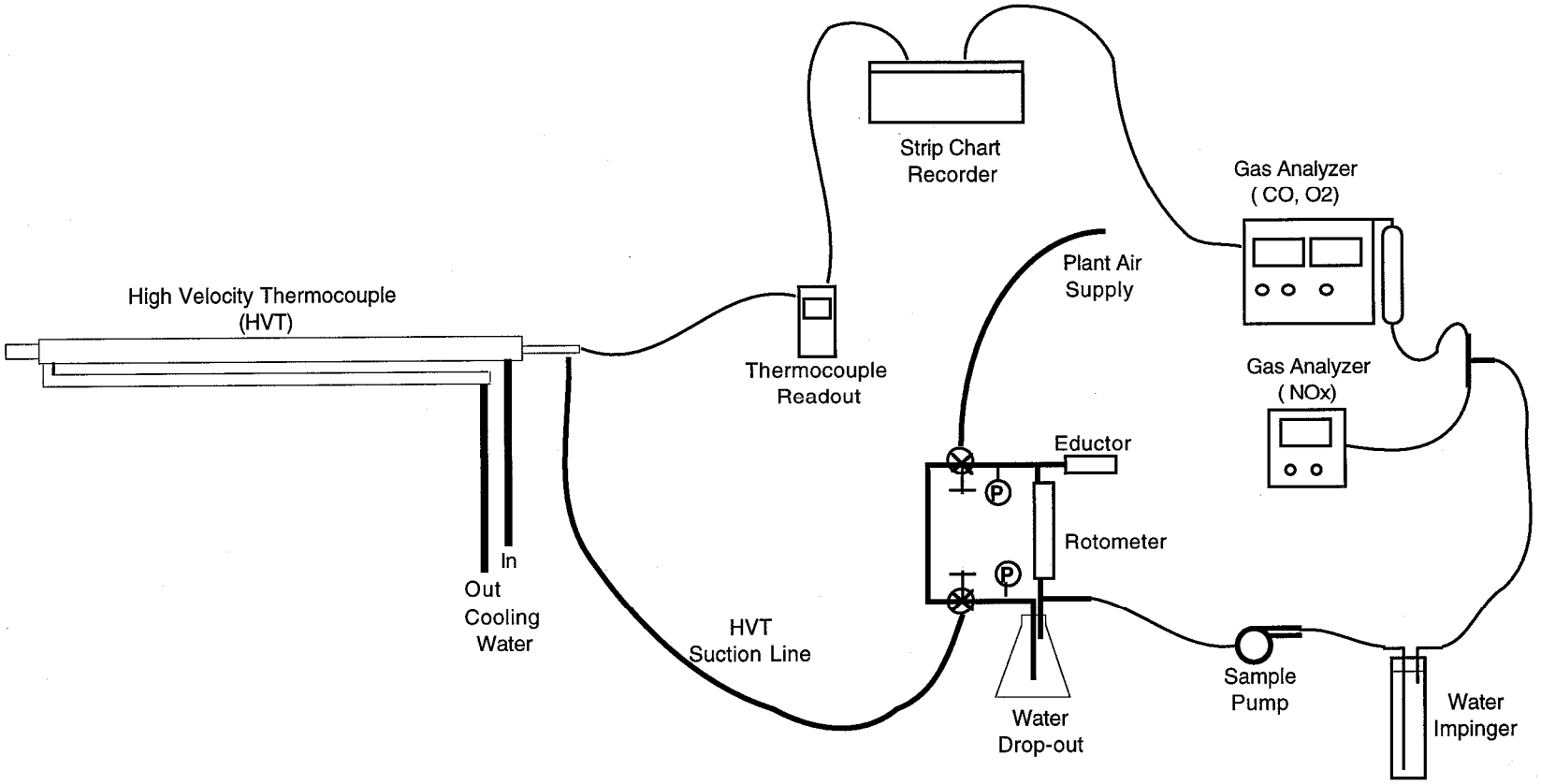
  (14-Upper, 10-Lower)

Photograph of the Injectors

Initial SNCR Performance (24 Injectors)

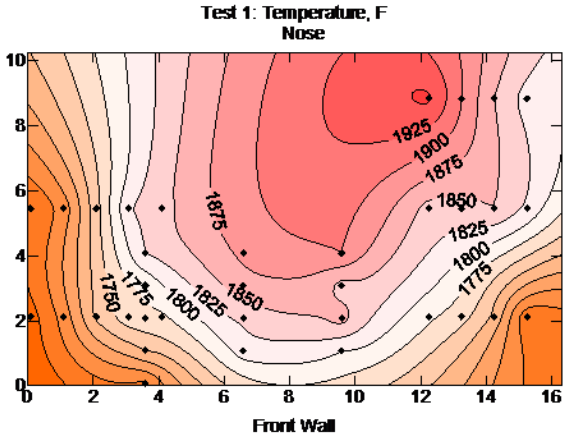


Water Cooled HVT Probe

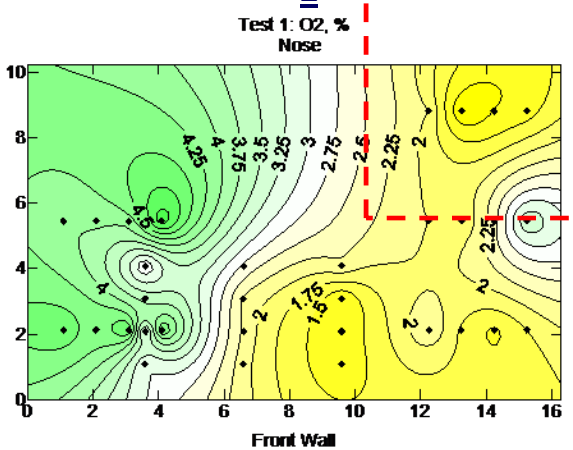


As Found

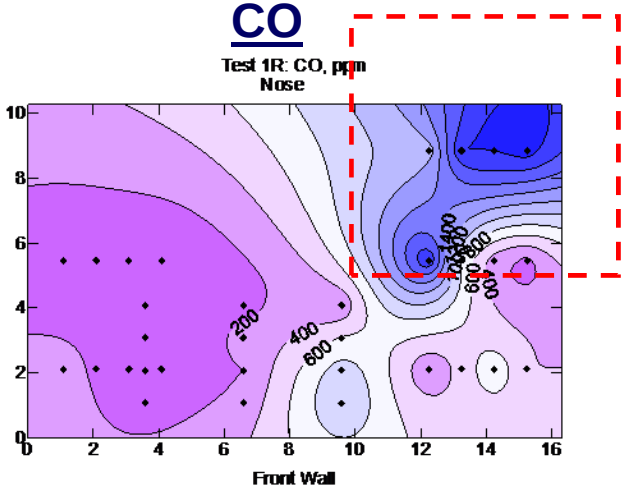
Temperature



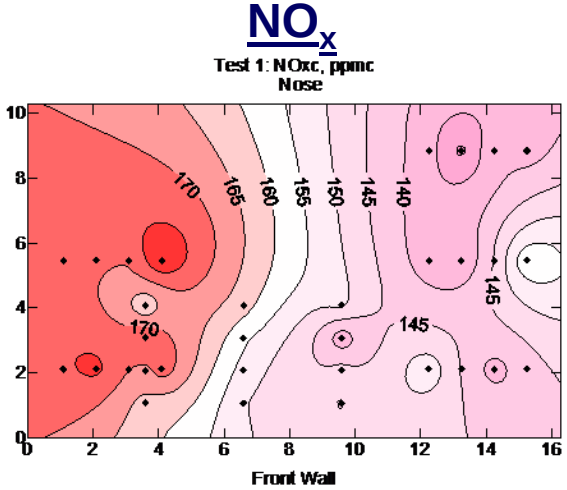
O_2



CO



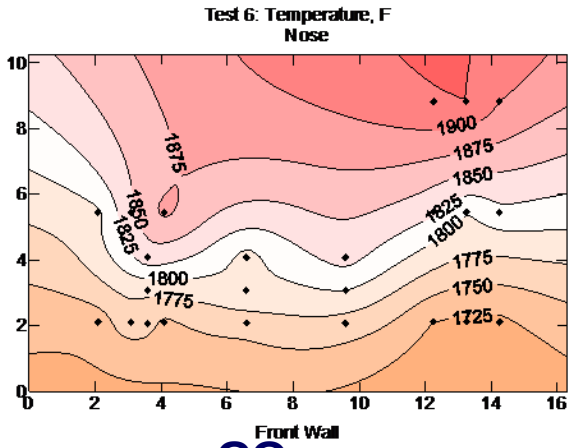
NO_x



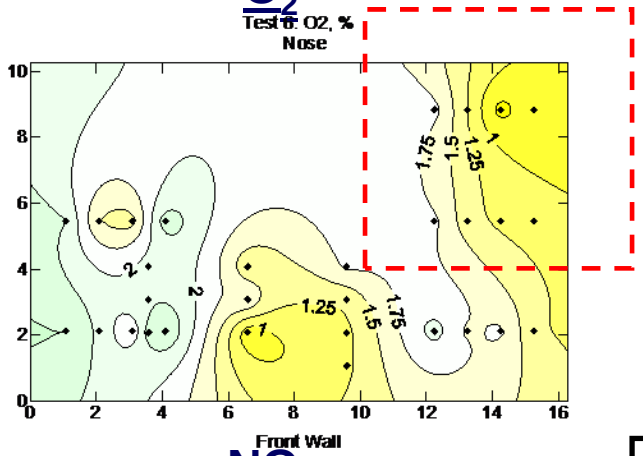
- T_{ave}= 1786°F at the lower injectors; ideal for SNCR
- Temperature profile is fairly symmetrical
- Gas Composition is stratified with low O_2 and high CO in the upper right corner

Optimized Combustion

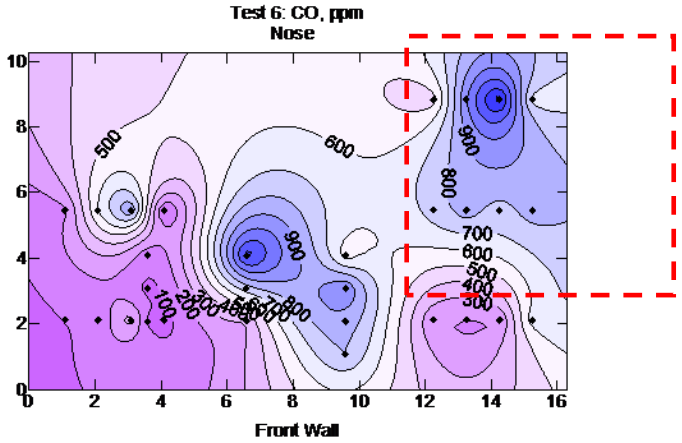
Temperature



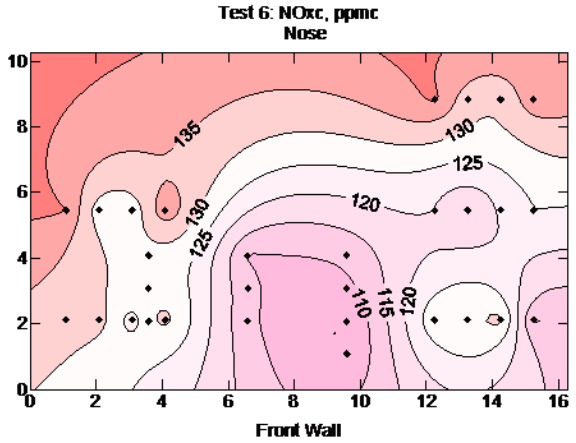
O_2



CO

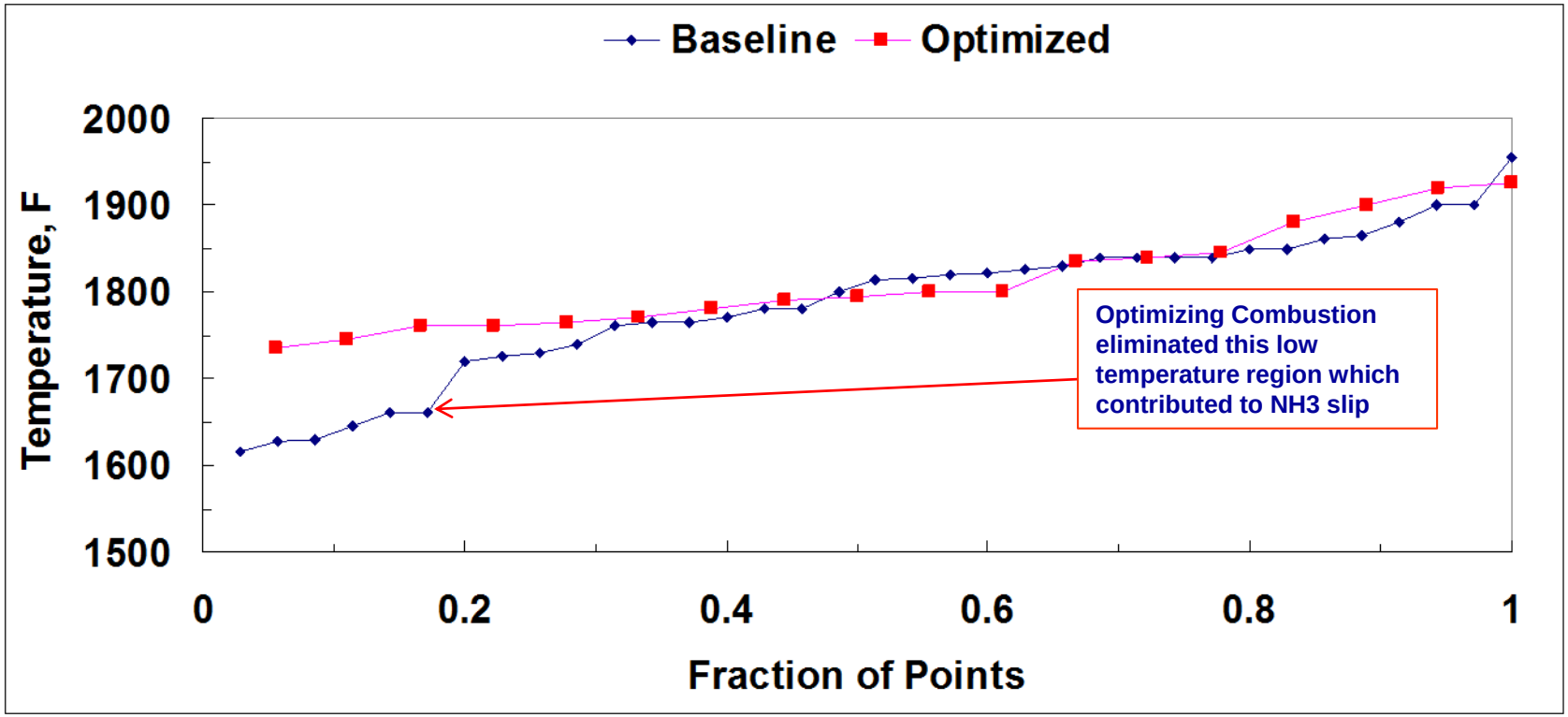


NOx

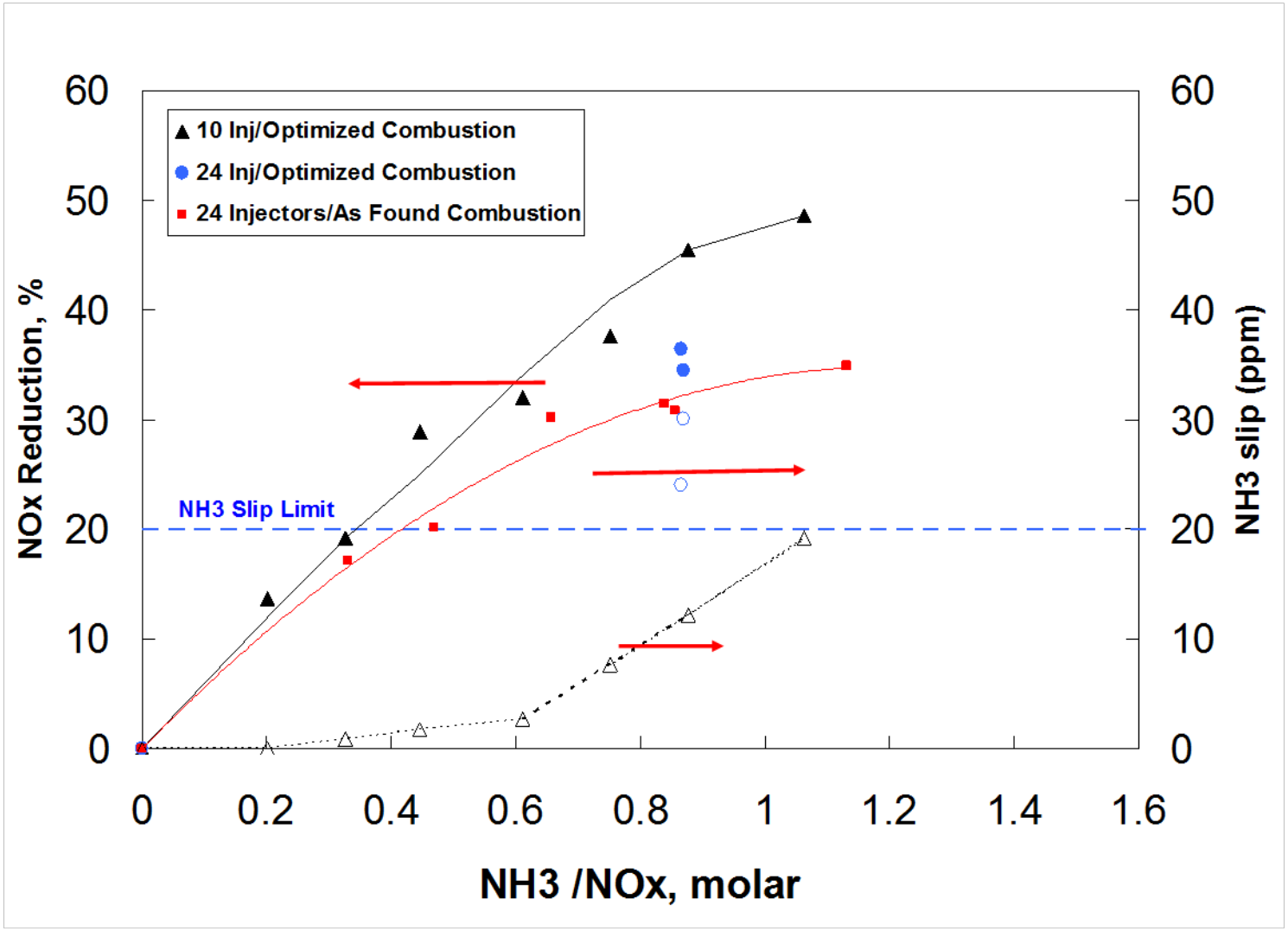


- Fuel Moved away from the upper right side, and more air added
- Temperature profile is somehat more uniform
- CO is more uniformly distributed
- NO_x is more uniform

Baseline vs Optimized Combustion



SNCR Performance Improvement



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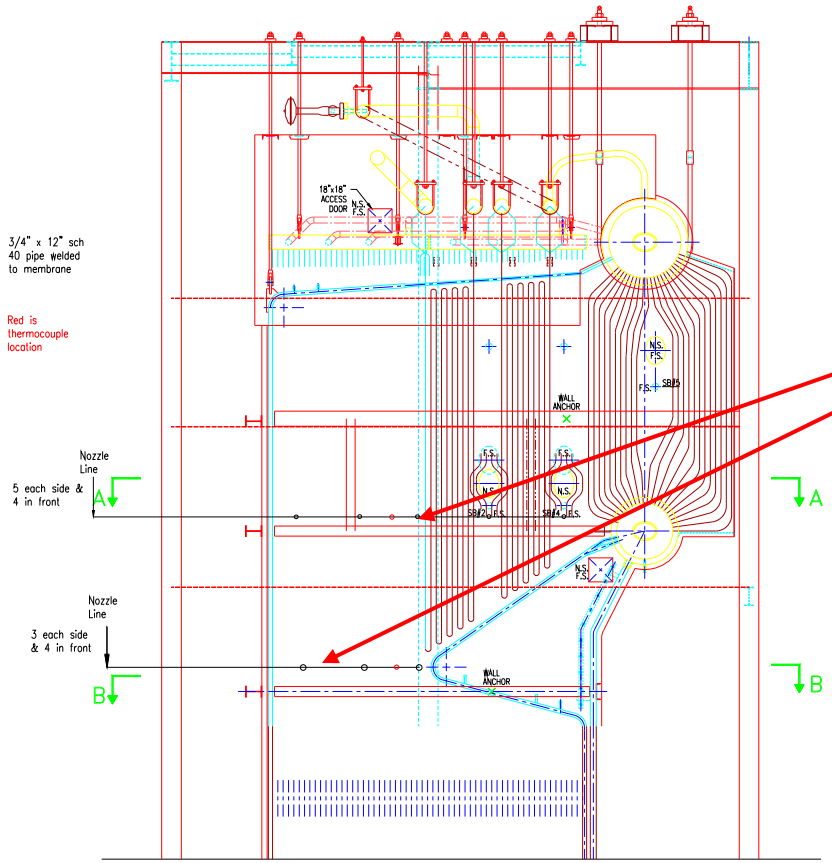

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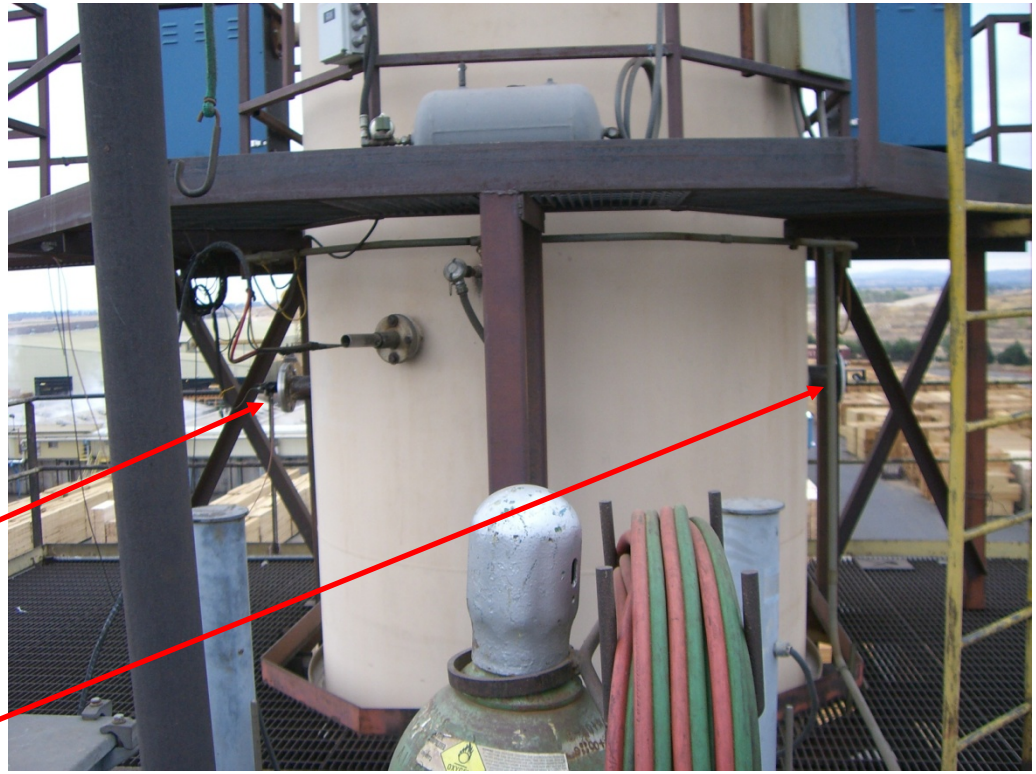
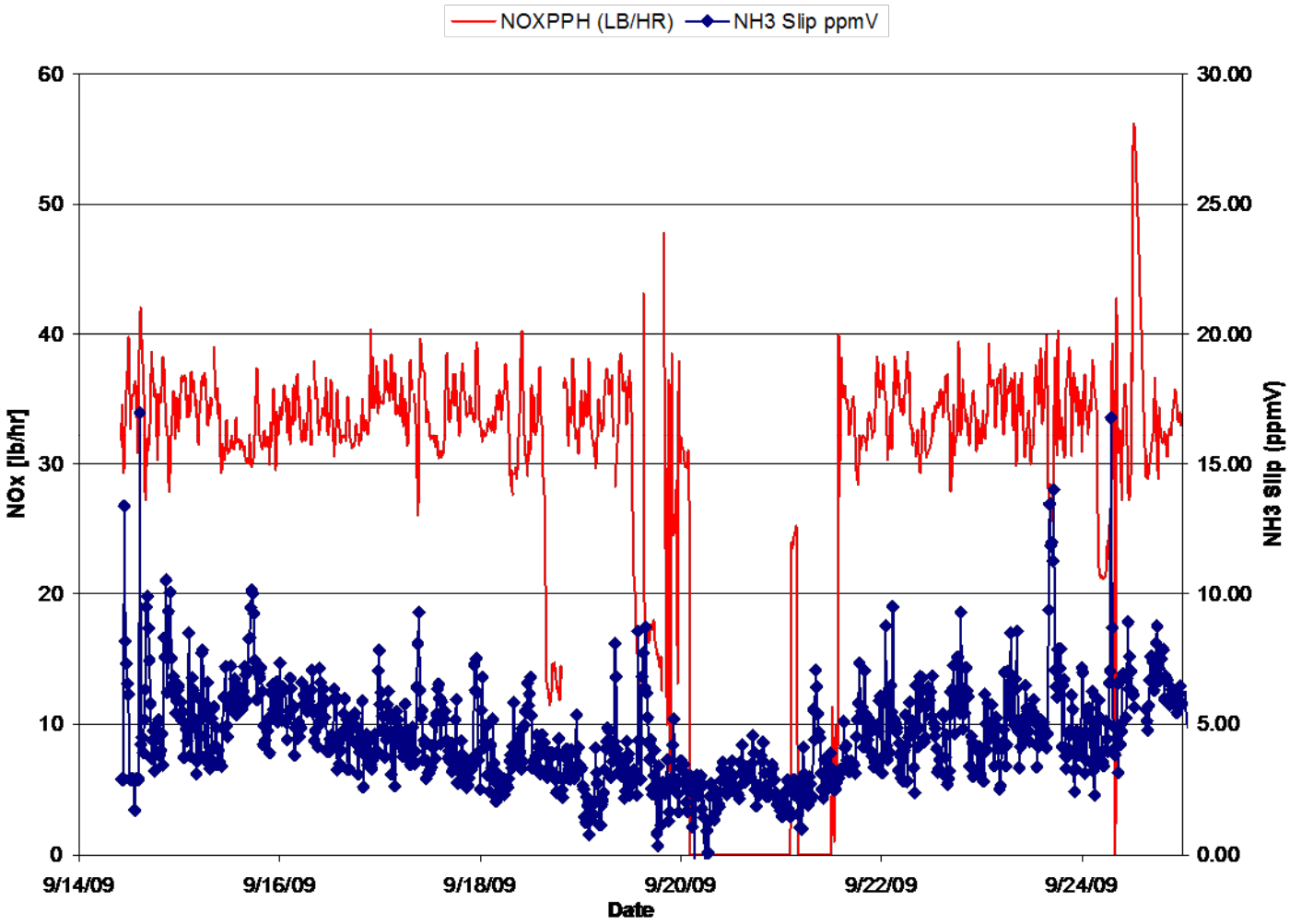
Continuous NH3 Analyzer



Laser/Detector

Retro Reflector

Typical Performance



SPI Boiler SNCR Summary

- Key was redistributing the fuel on the grate to minimize pockets of very high CO in the upper furnace and equalize the temperature
- This also reduced stack CO levels to ~ 100 ppm
- Using just the lower level of 10 injectors also improved performance
- NO_x reduction and NH_3 slip from this unit is quite good:
  - **NH_3/NO_x =0.8**
  - **dNO_x= 40%**
  - **NH_3 slip= 10 ppm**
- Key for good SNCR performance is to maintain low CO