REINHOLD ENVIRONMENTAL Ltd.

2011 NOx-Combustion Round Table & Expo Presentation

February 7-8, 2011, in Birmingham, AL / Hosted by Southern Company

Babcock Power Inc.




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Combustion Optimization for Maintaining Reduced Emissions on Wall Fired Boilers

Reinhold Conference

February 7, 2011

Training Program Overview

- Key Parameters Effecting Low NO_X Combustion
  - What are NOx Emissions
  - Types of NOx Production
  - Combustion Fundamentals
  - NOx Control Strategies
- Effects of the Mill System on Low NO_X Combustion
  - Primary Air and Coal Flow Balance
  - Coal Fineness
  - Coal Feed Control
  - Maintaining the Mill System
- Effects of Low NO_X Burners on Low NO_X Combustion
  - Secondary Air Distribution
  - Critical Burner Component Geometry
  - Reliability and Functionality of the Air Register System
  - Burner Maintenance

Training Program Overview (Cont'd.)

- Effects of the Boiler System on Low NO_X Combustion
  - Heat Absorption & Soot Blower Operation
  - Effects of Boiler Operating Parameters
- Re – Tuning of Low NOx Burners
  - Detailed Test Plans
  - Equipment Settings
  - Optimization Strategies
  - Test Support & Personnel
- Summary

What are NO_X Emissions

- NO_X represents various "oxides of nitrogen" compounds
  - Any Combination of Nitrogen and Oxygen
  - Nitric Oxide, NO
  - Nitrogen Dioxide, NO_2
  - Stack Emissions Typically Over 95% NO
- Nitrogen can come from the Air or Fuel
- Oxygen can be found in the Air and Fuel Supplied

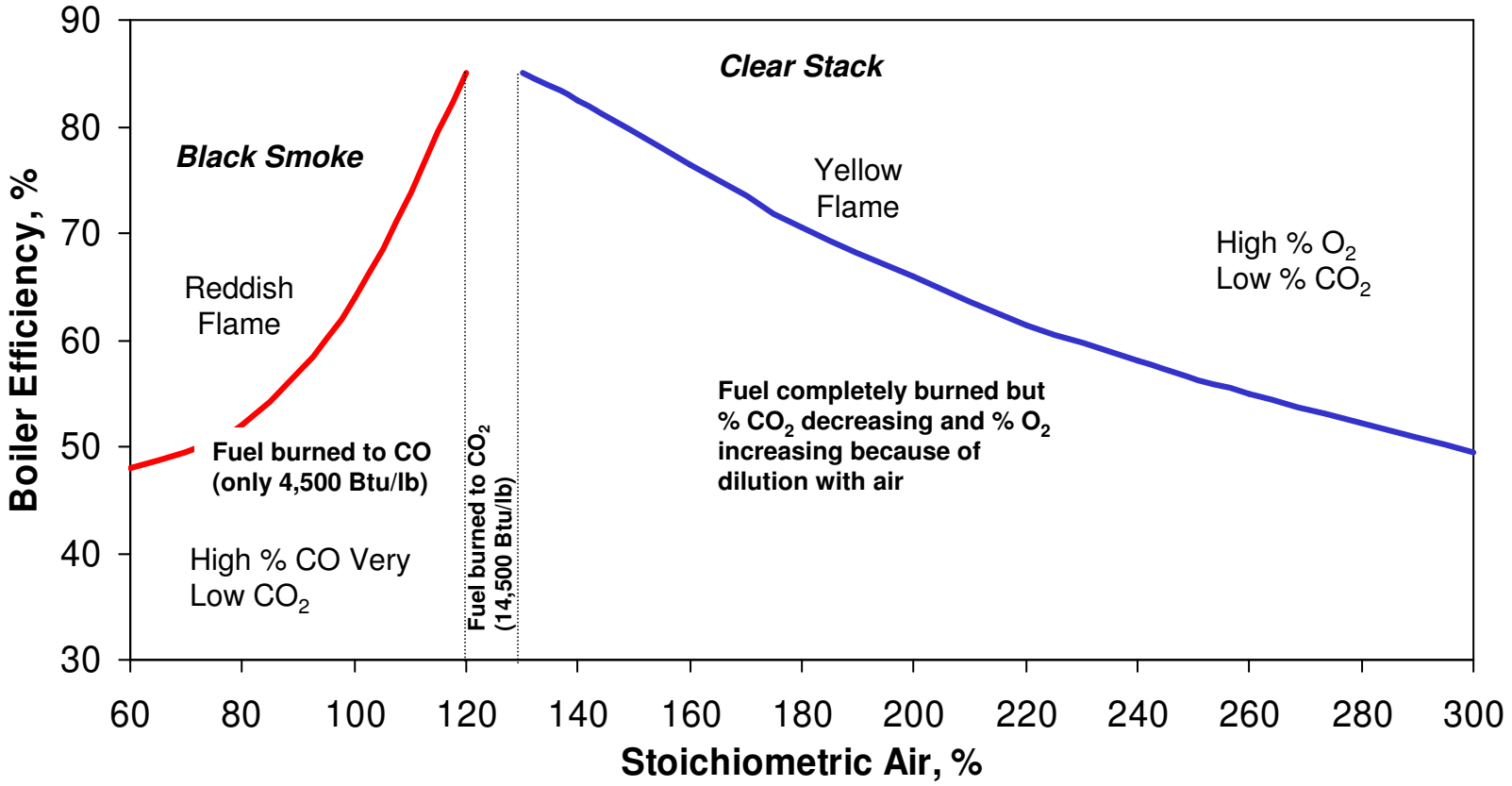
Types of NO_X Production

- Thermal NO_X (~10% for coal)
  - Oxidation of the nitrogen in combustion air
  - Extremely sensitive to temperature
    - $N_2 + O \Leftrightarrow NO + N$
    - $N + O_2 \Leftrightarrow NO + O$
    - $N + OH \Leftrightarrow NO + H$
- Fuel NO_X (~90% for coal)
  - Produced from nitrogen in the fuel
  - N volatizes off the surface of the coal particle as the particle heats
  - The N combines with available Oxygen in the same fashion as shown above

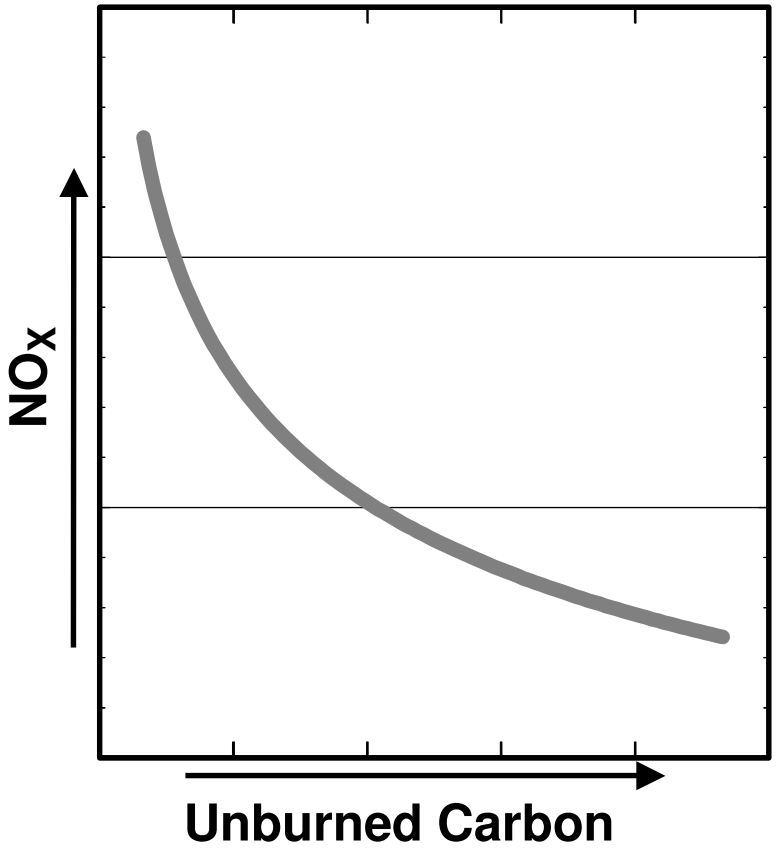
Combustion Fundamentals Effecting NO_X Formation

- 3 "T's" of combustion
  - Time (furnace geometry dependant)
    - Fuel type
    - Size of particles
  - Temperature *(LNB's reduce peak flame temperature)*
  - Turbulence *(LNB's reduce turbulence)*

Effects of Excess Air on Combustion

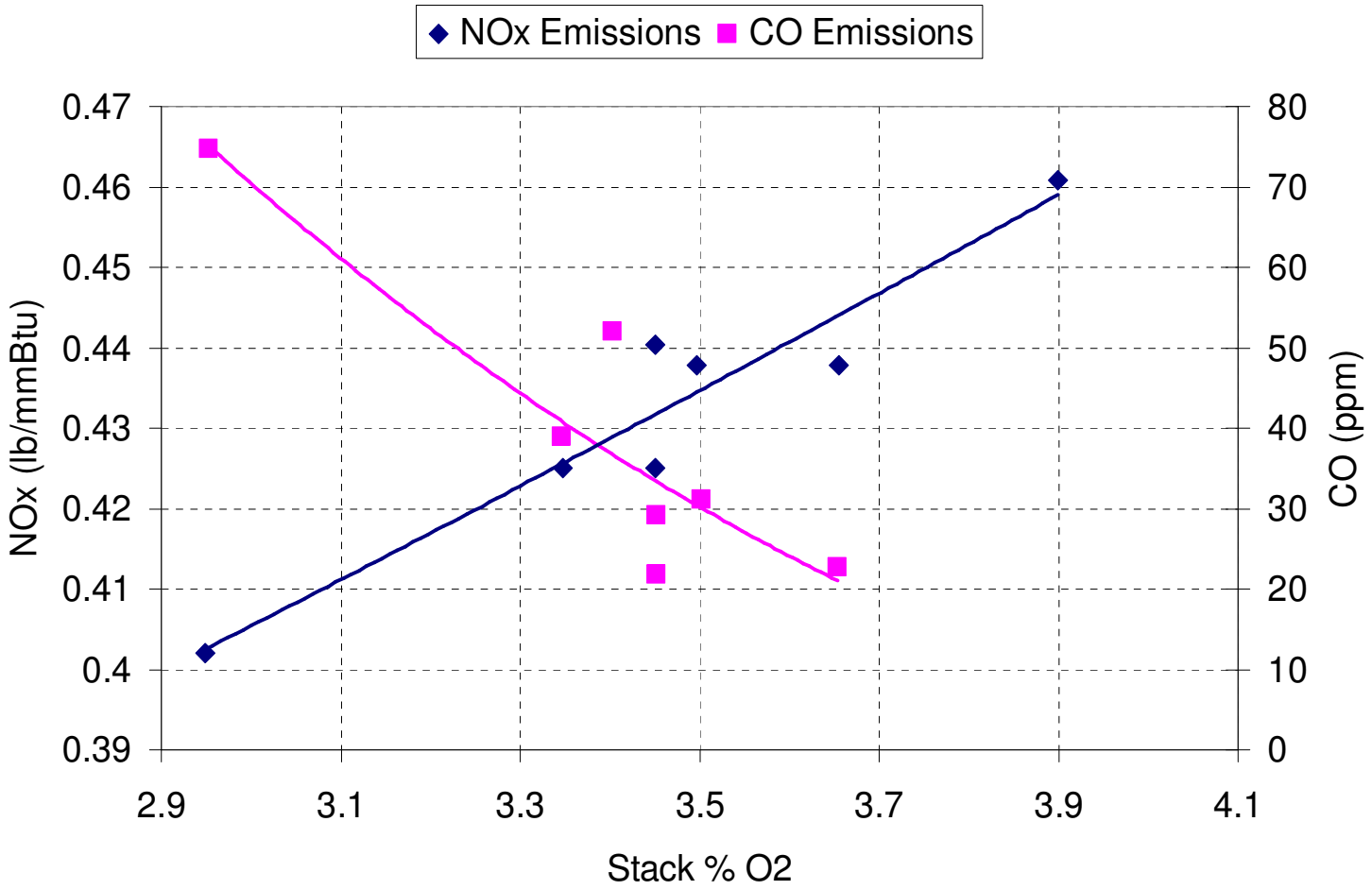


NO_x Emissions and UBC



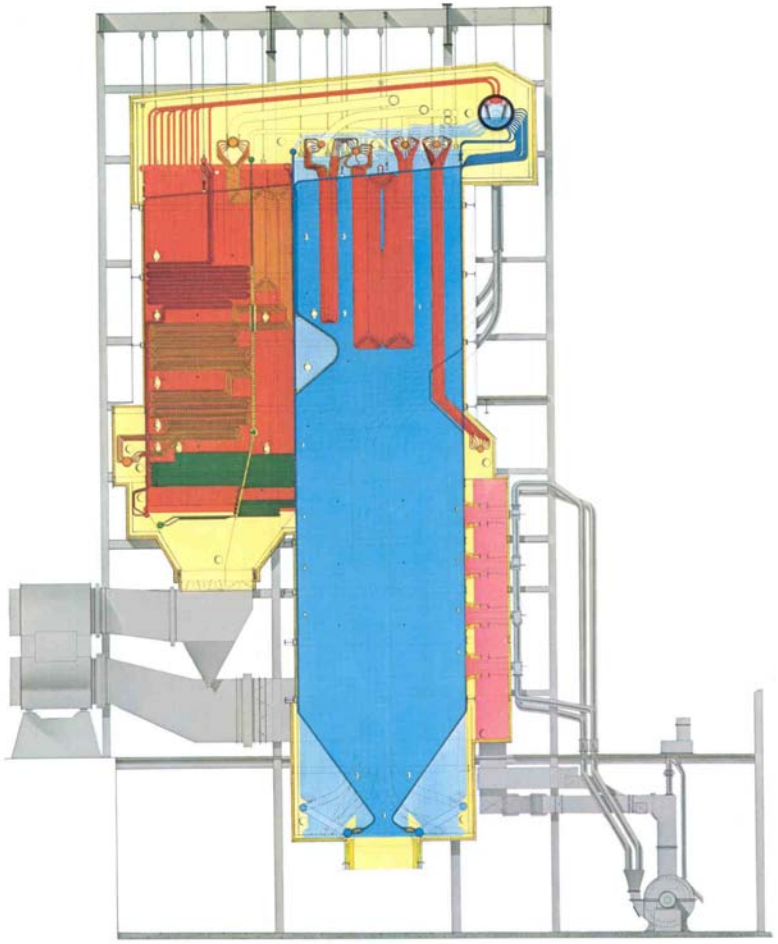
- Coal properties
  - Coal Rank
  - FC/VM Ratio
- Coal fineness
- Operating conditions
  - Excess O_2
  - Boiler load

NOx Emissions, CO, and Excess Air 235 MW boiler – bit. coal



Wall Fired Boilers

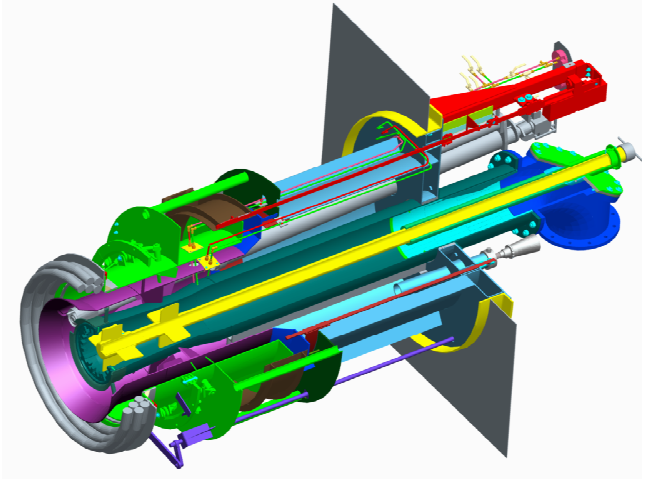
- **Front Wall, Rear Wall or Opposed Fired**
- **Multi-level**
- **Vertical Columns of burners**
- **Key Design Factors**
  - Furnace depth
  - Furnace height
  - Fuel Composition
  - Air & Coal Distribution



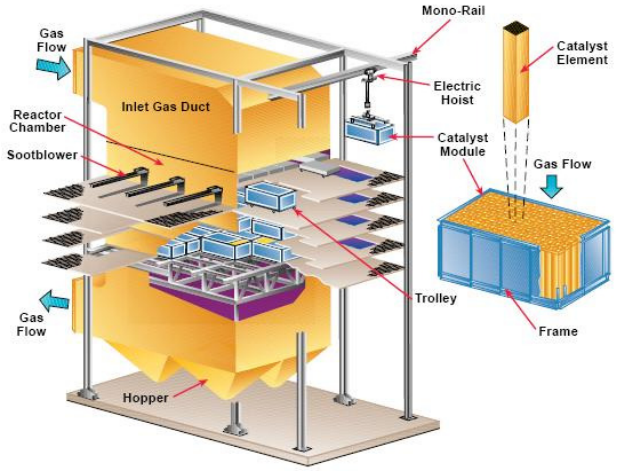
JEFFRIES STEAM PLANT
UNITS NO. 3 & 4

NO_X Control Strategies

- In Furnace:
  - Modifications to the fuel and air delivery systems which reduce or eliminate the conditions that lead to the formation of NO_X during the combustion process



- Post Combustion:
  - Additional equipment downstream of the combustion process which chemically reduces NO_X to harmless Nitrogen (SCR).



In Furnace NO_X Control Strategies Coal Firing

- Low NO_X Burners
- Combustion Air staging (Overfire Air)
- LNB & OFA