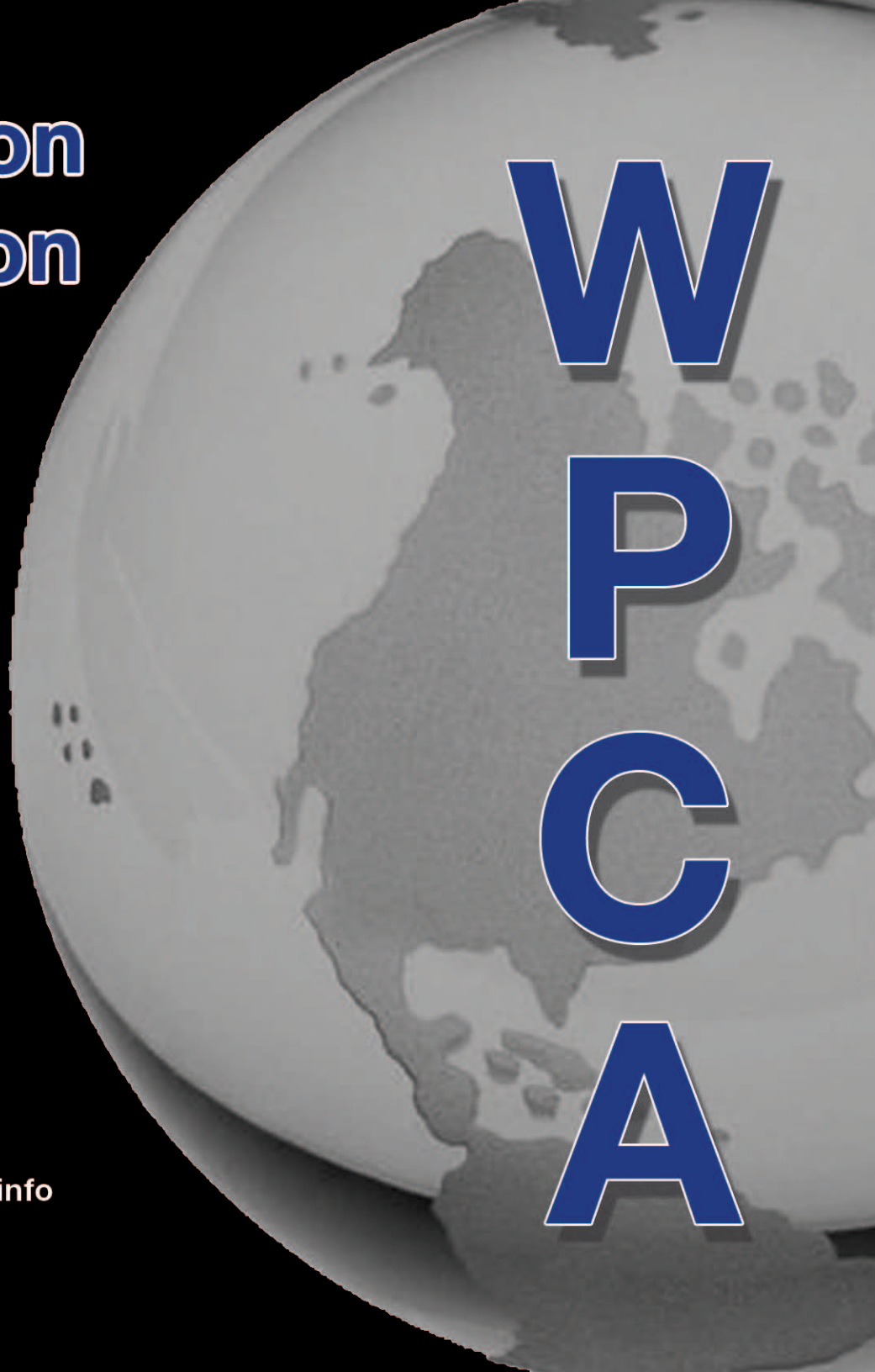
Worldwide Pollution Control Association



Duke Energy Seminar

September 3 – 5, 2008

Concord, NC

WPCA

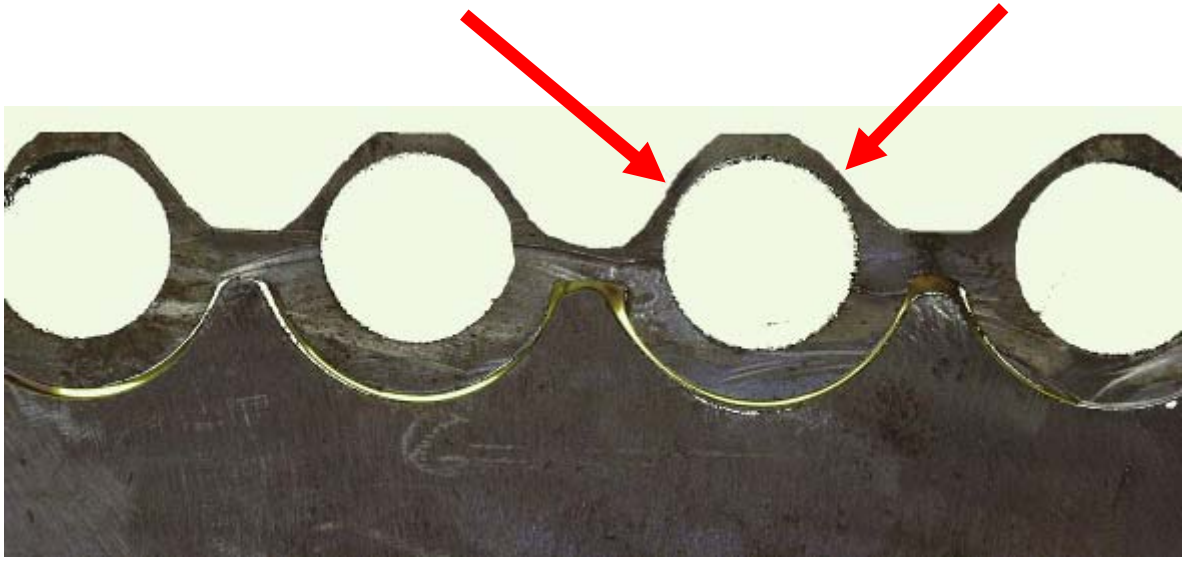
Vist our website at www.wpca.info

Water Wall Corrosion from Low NO_x Burners

George Harth
Sr. Technical Advisor

Effect of Low NO_x Burners on Boiler Components

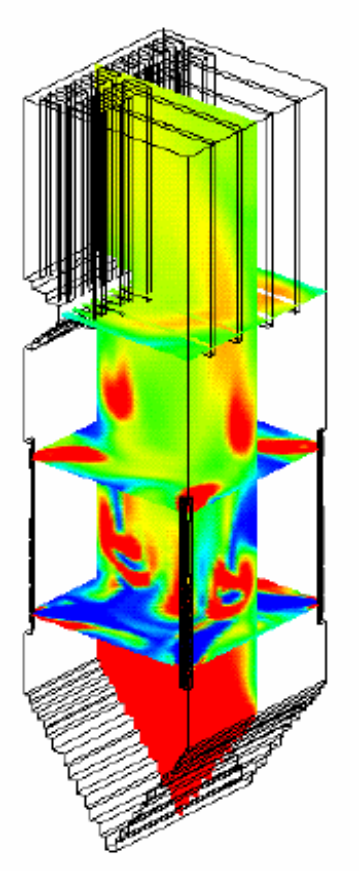
Factors Affecting Furnace Wall Corrosion



Effect of Low NO_x Burners on Boiler Components

Factors Affecting Furnace Wall Corrosion

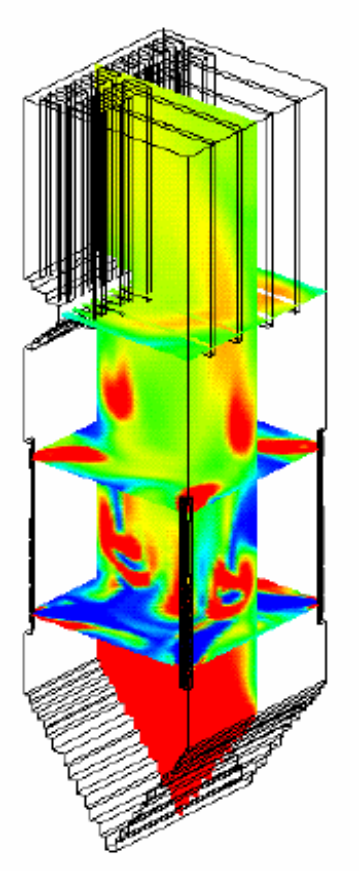
- Sulfur and Chlorine in Coal



Effect of Low NO_x Burners on Boiler Components

Factors Affecting Furnace Wall Corrosion

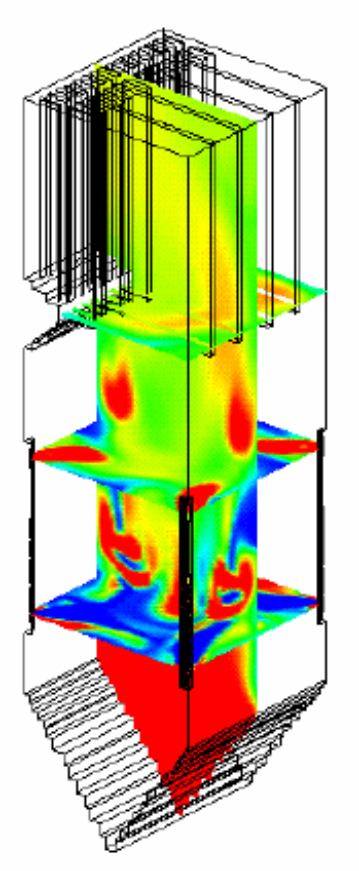
- Sulfur and Chlorine in Coal
- Tube Metal Temperatures



Effect of Low NO_x Burners on Boiler Components

Factors Affecting Furnace Wall Corrosion

- Sulfur and Chlorine in Coal
- Tube Metal Temperatures
- Reducing/Oxidizing Conditions



Effect of Low NO_x Burners on Boiler Components

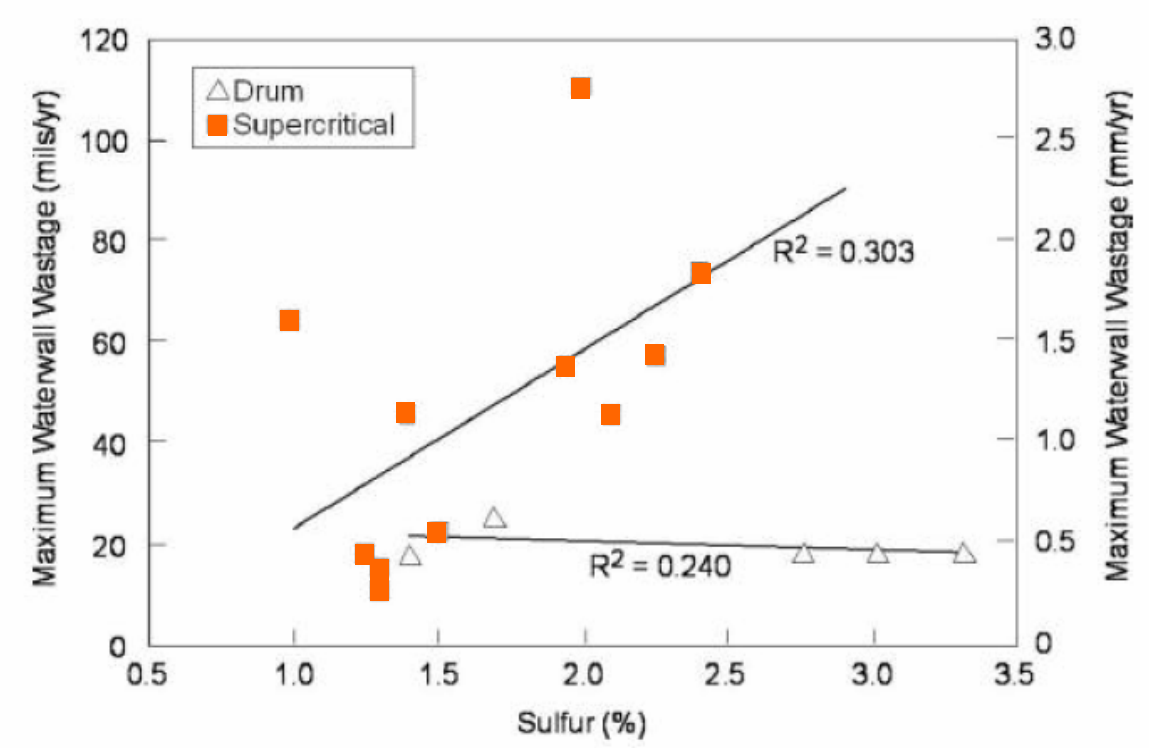
Factors Affecting Furnace Wall Corrosion

- Sulfur and Chlorine in Coal

Effect of Low NO_x Burners on Boiler Components

Factors Affecting Furnace Wall Corrosion

- Sulfur and Chlorine in Coal



Effect of Low NO_x Burners on Boiler Components

Factors Affecting Furnace Wall Corrosion

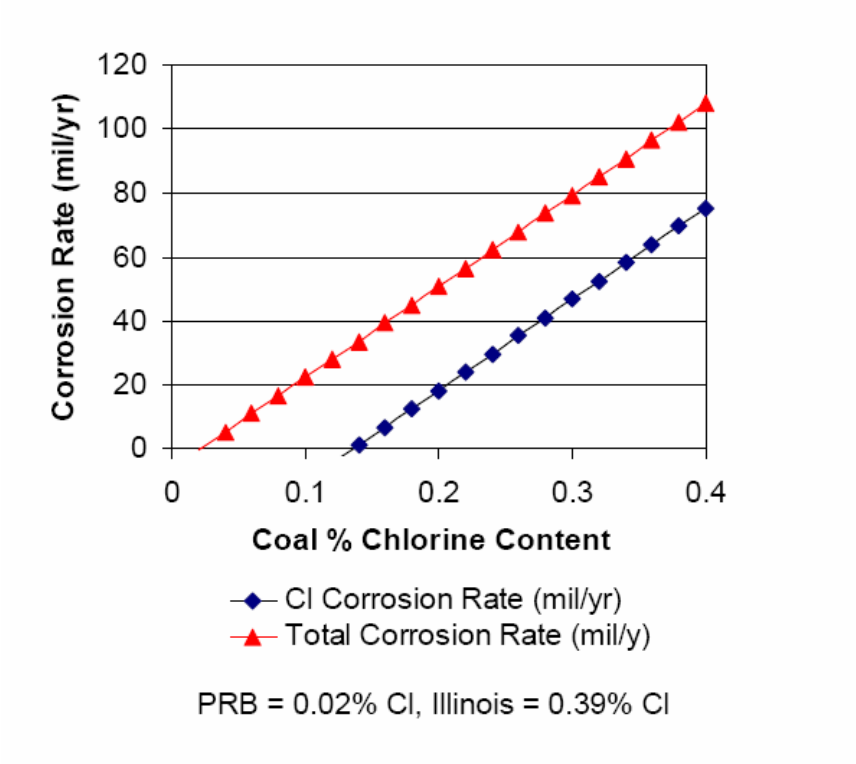
- Sulfur and Chlorine in Coal

	Illinois Coal	PRB Coal
C	68.32 %	48.89 %
H	4.39 %	3.29 %
O	6.74 %	12.30 %
N	1.59 %	0.99 %
S	0.96 %	0.33 %
ash	5.50 %	4.90 %
moisture	12.50 %	29.30 %
HHV	11,980 Btu/lb	8,500 Btu/lb
Cl	0.40 %	0.017 %

Effect of Low NO_x Burners on Boiler Components

Factors Affecting Furnace Wall Corrosion

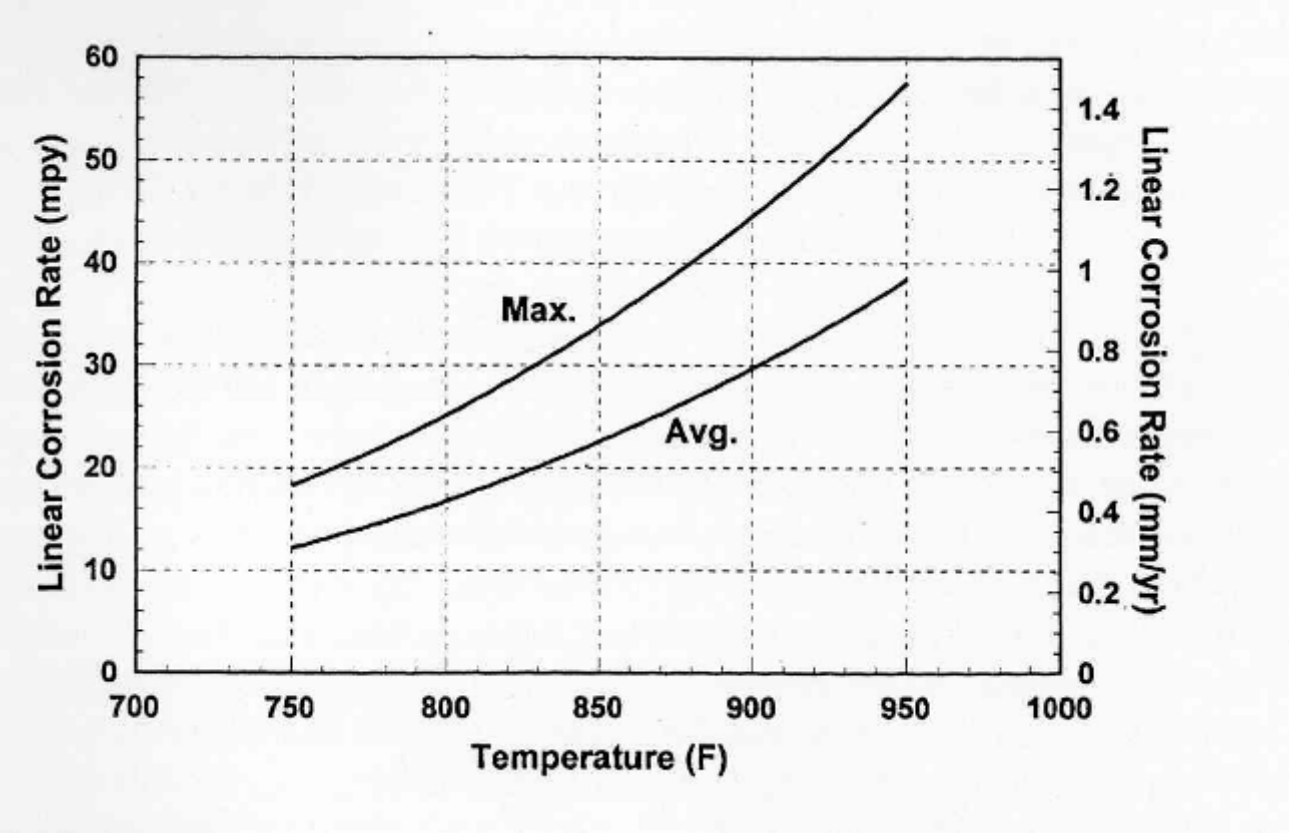
- Sulfur and Chlorine in Coal



Effect of Low NO_x Burners on Boiler Components

Factors Affecting Furnace Wall Corrosion

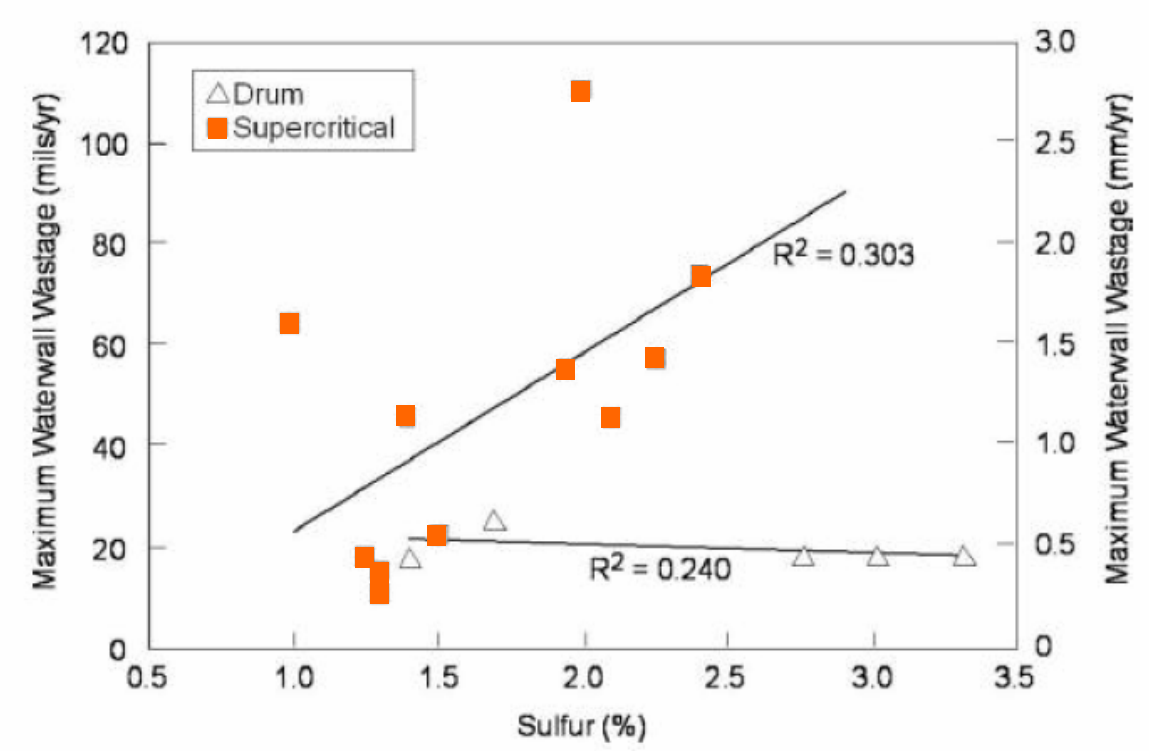
- Tube Metal Temperatures



Effect of Low NO_x Burners on Boiler Components

Factors Affecting Furnace Wall Corrosion

- Sulfur and Chlorine in Coal



Effect of Low NO_x Burners on Boiler Components

Factors Affecting Furnace Wall Corrosion

- Reducing/Oxidizing Conditions

Effect of Low NO_x Burners on Boiler Components

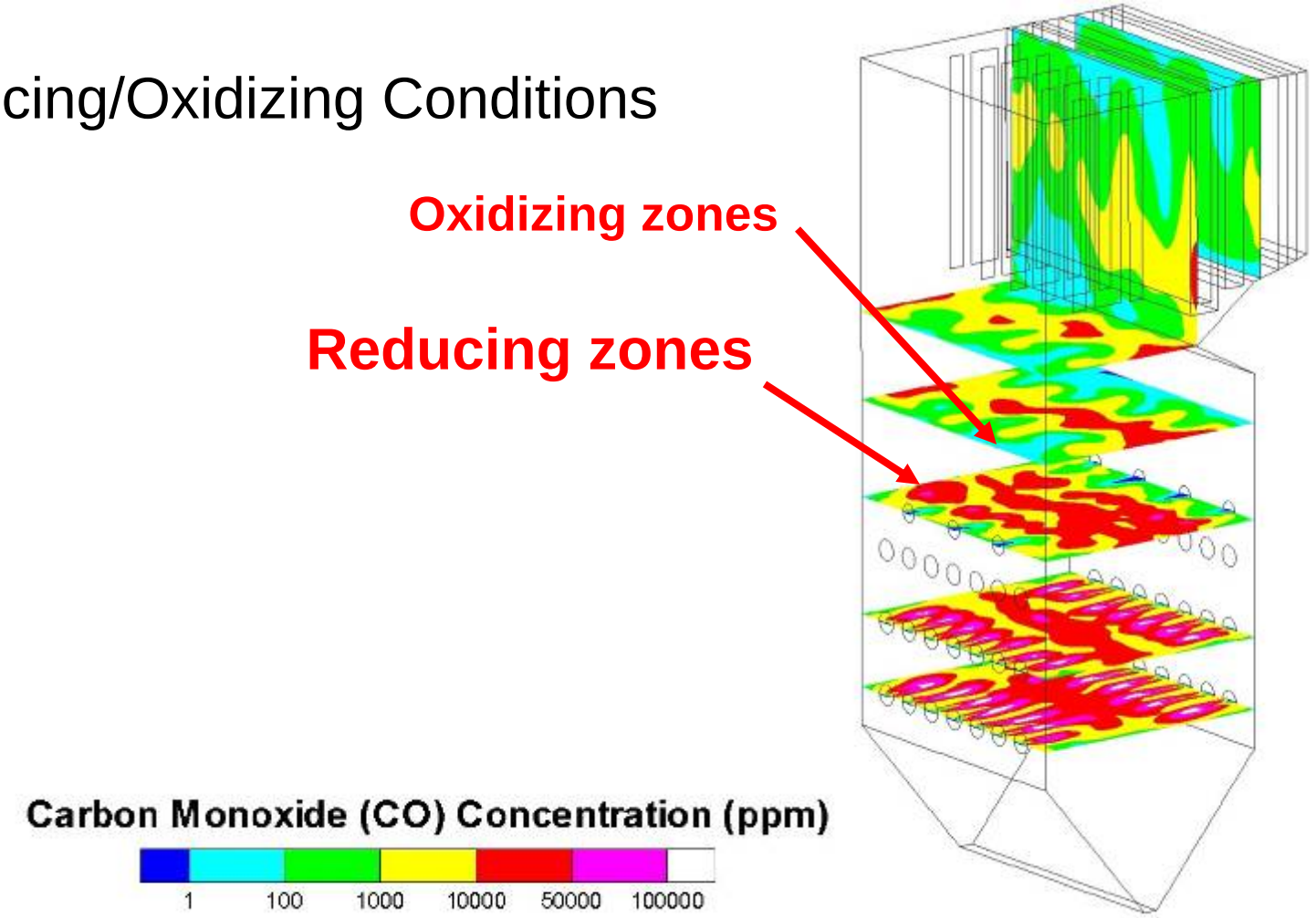
Factors Affecting Furnace Wall Corrosion

- Reducing/Oxidizing Conditions
  - **Reducing = High CO and Low O_2**
  - **Oxidizing = Low CO and High O_2**

Effect of Low NO_x Burners on Boiler Components

Factors Affecting Furnace Wall Corrosion

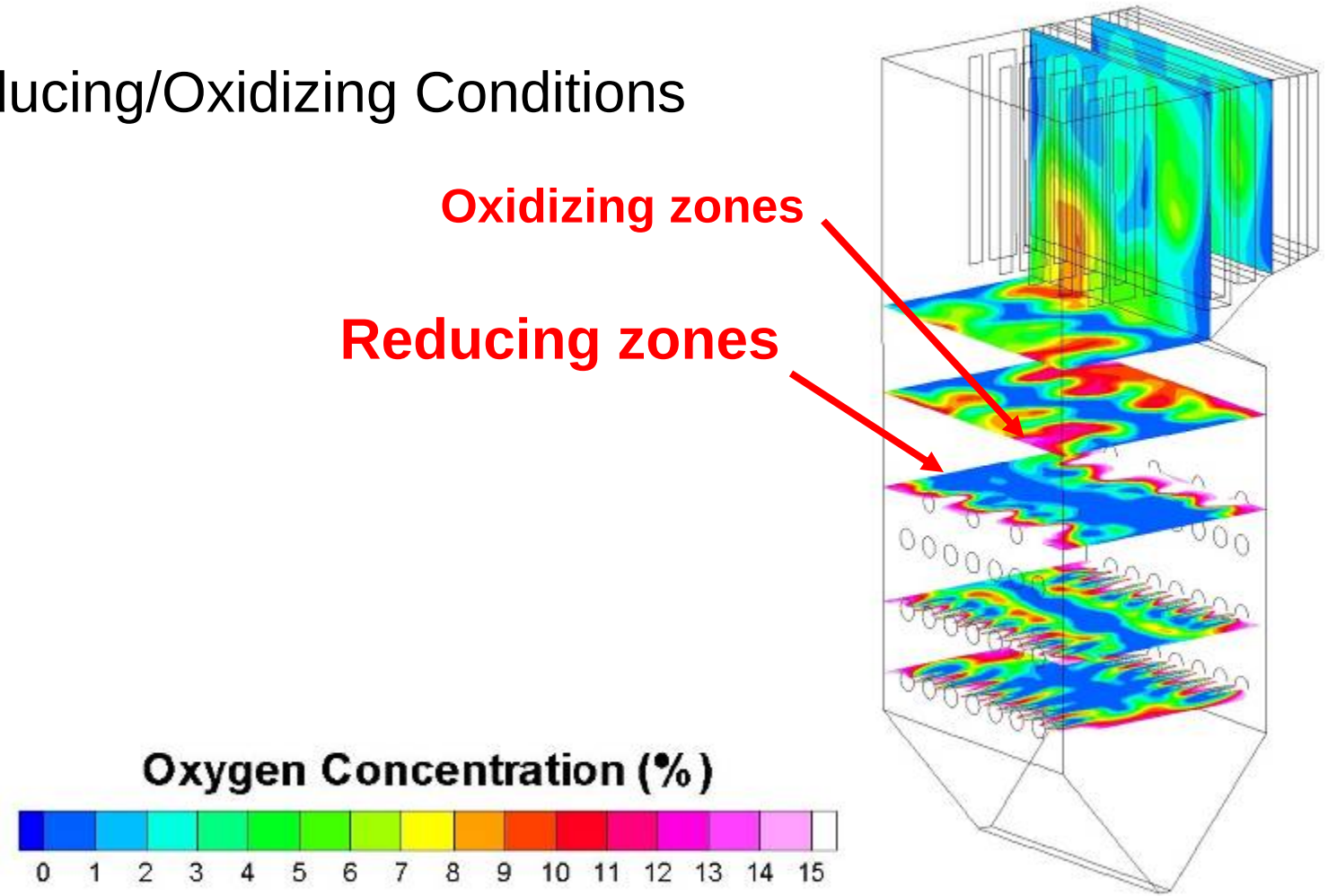
- Reducing/Oxidizing Conditions



Effect of Low NO_x Burners on Boiler Components

Factors Affecting Furnace Wall Corrosion

- Reducing/Oxidizing Conditions



Effect of Low NO_x Burners on Boiler Components

Factors Affecting Furnace Wall Corrosion

- Reducing/Oxidizing Conditions
  - Near-wall gas chemistry
  - Wall slag chemistry

Effect of Low NO_x Burners on Boiler Components

Factors Affecting Furnace Wall Corrosion

- Reducing/Oxidizing Conditions
  - Near-wall gas chemistry

    H_2S and **O_2**

Effect of Low NO_x Burners on Boiler Components

Factors Affecting Furnace Wall Corrosion

- Reducing/Oxidizing Conditions
  - Near-wall gas chemistry
  - Wall slag chemistry

Effect of Low NO_x Burners on Boiler Components

Factors Affecting Furnace Wall Corrosion

- Reducing/Oxidizing Conditions
  - Near-wall gas chemistry
  - Wall slag chemistry
    - **FeS and KCl**

Effect of Low NO_x Burners on Boiler Components

Factors Affecting Furnace Wall Corrosion

- Reducing/Oxidizing Conditions

  - **FeS forms in slag from pyrite (FeS_2)**

    Under reducing conditions

  - **KCl deposits in slag from chlorides in coal**

    Under reducing conditions

Effect of Low NO_x Burners on Boiler Components

Factors Affecting Furnace Wall Corrosion

- Reducing/Oxidizing Conditions

  - **FeS is oxidized to release Sulfur**

    Under oxidizing conditions

    Sulfur causes sulfidation of tubes.

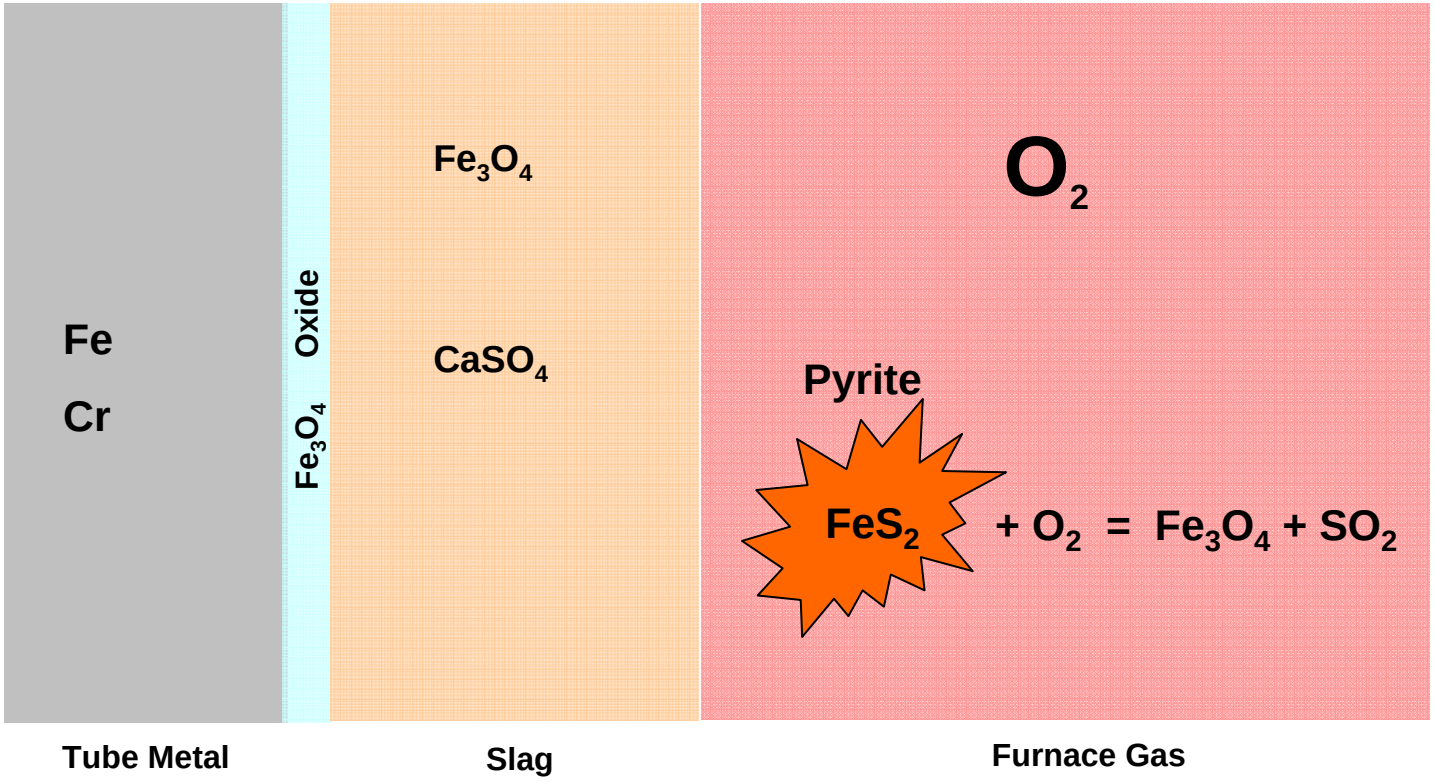
  - **KCl breaks down protective oxides on tubes.**

    Under oxidizing conditions

Effect of Low NOx Burners on Boiler Components

Factors Affecting Furnace Wall Corrosion

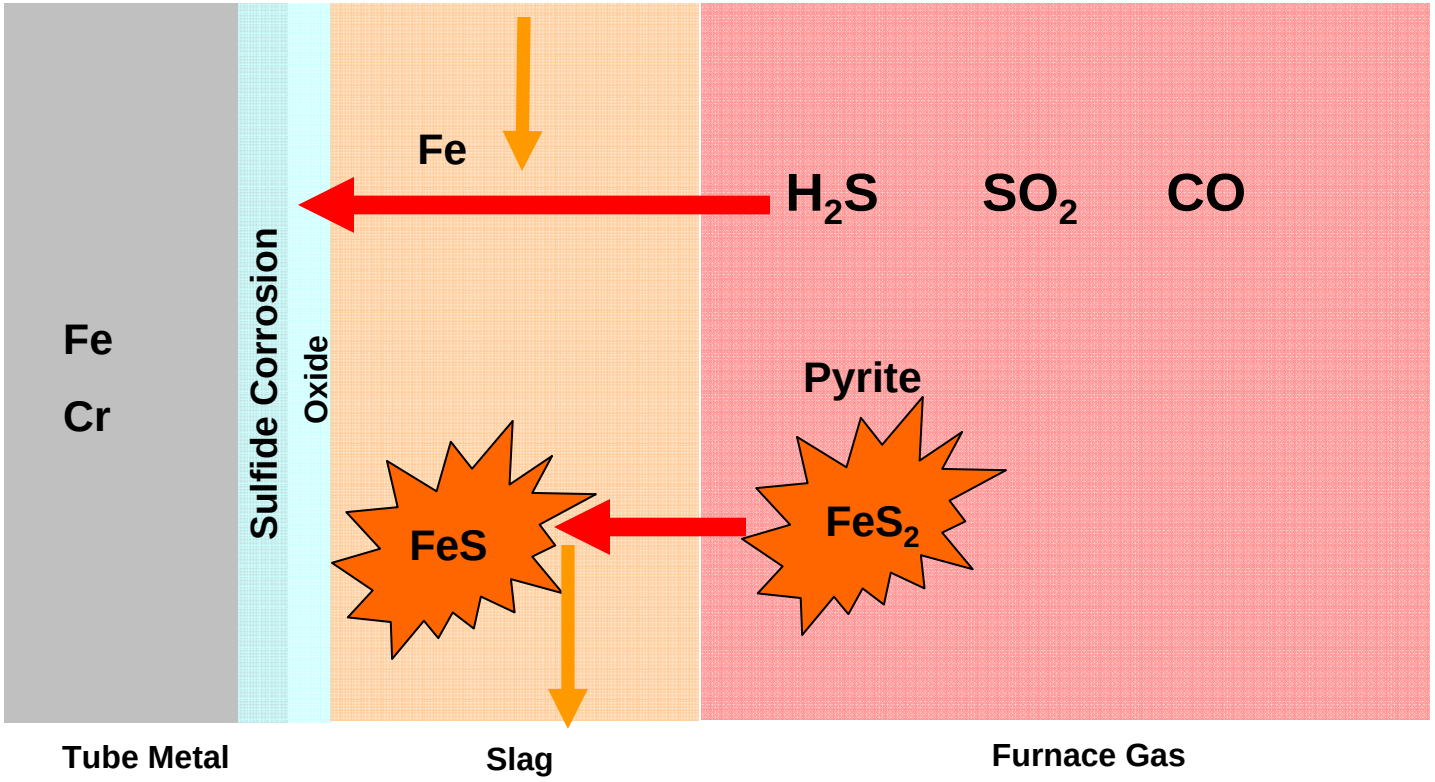
Oxidizing Low Sulfur Conditions



Effect of Low NOx Burners on Boiler Components

Factors Affecting Furnace Wall Corrosion

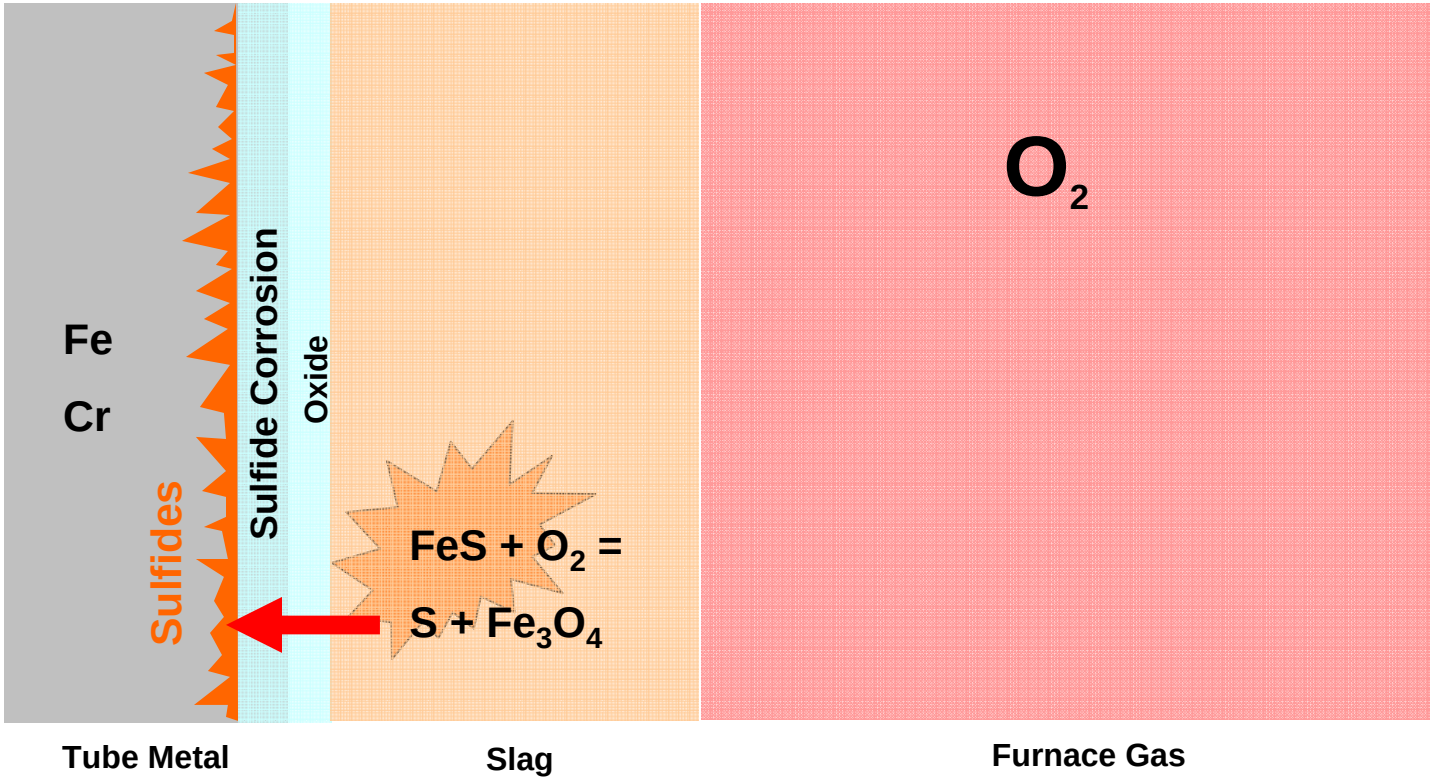
Reducing Conditions



Effect of Low NOx Burners on Boiler Components

Factors Affecting Furnace Wall Corrosion

Oxidizing High Sulfur Conditions



Effect of Low NO_x Burners on Boiler Components

Factors Affecting Furnace Wall Corrosion

Protective oxide layer is broken up by Chlorides and Sulfur

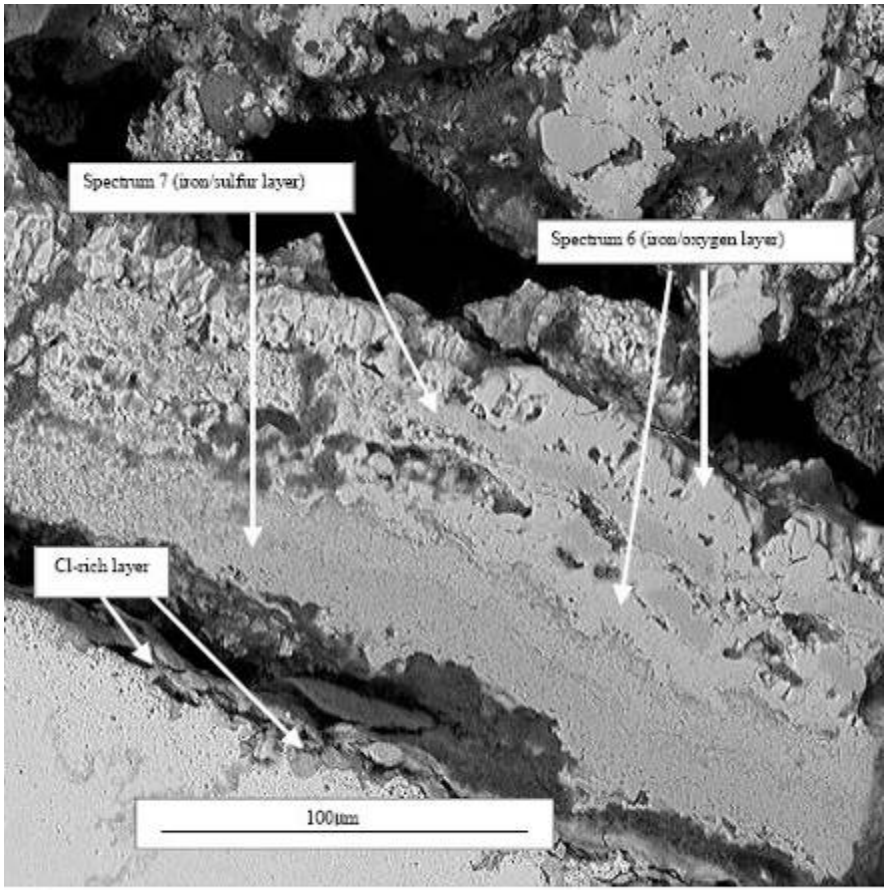


Figure 2-4
Chloride Corrosion under Deposits Containing 20% Cl

Effect of Low NO_x Burners on Boiler Components

Reducing/Oxidizing Conditions – Load Changes

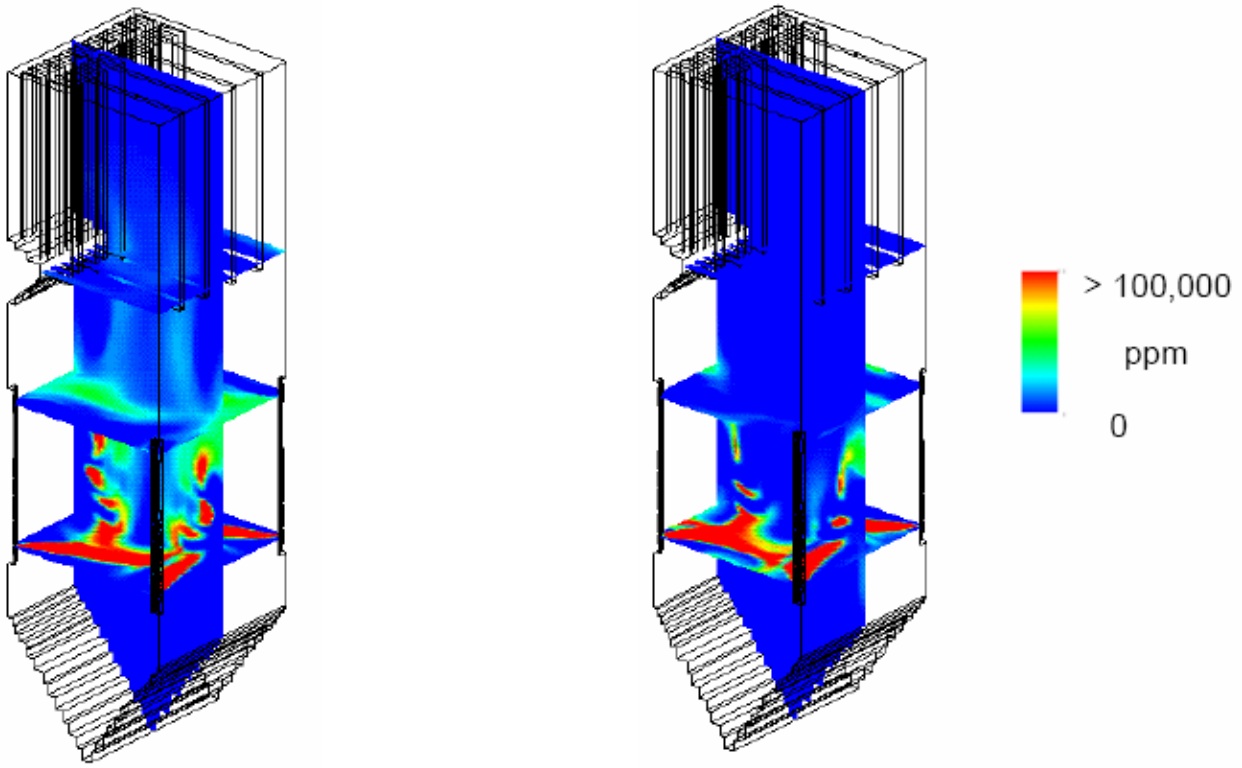


Figure B-4
Predicted CO concentration for each simulation

Effect of Low NO_x Burners on Boiler Components

Reducing/Oxidizing Conditions – Load Changes

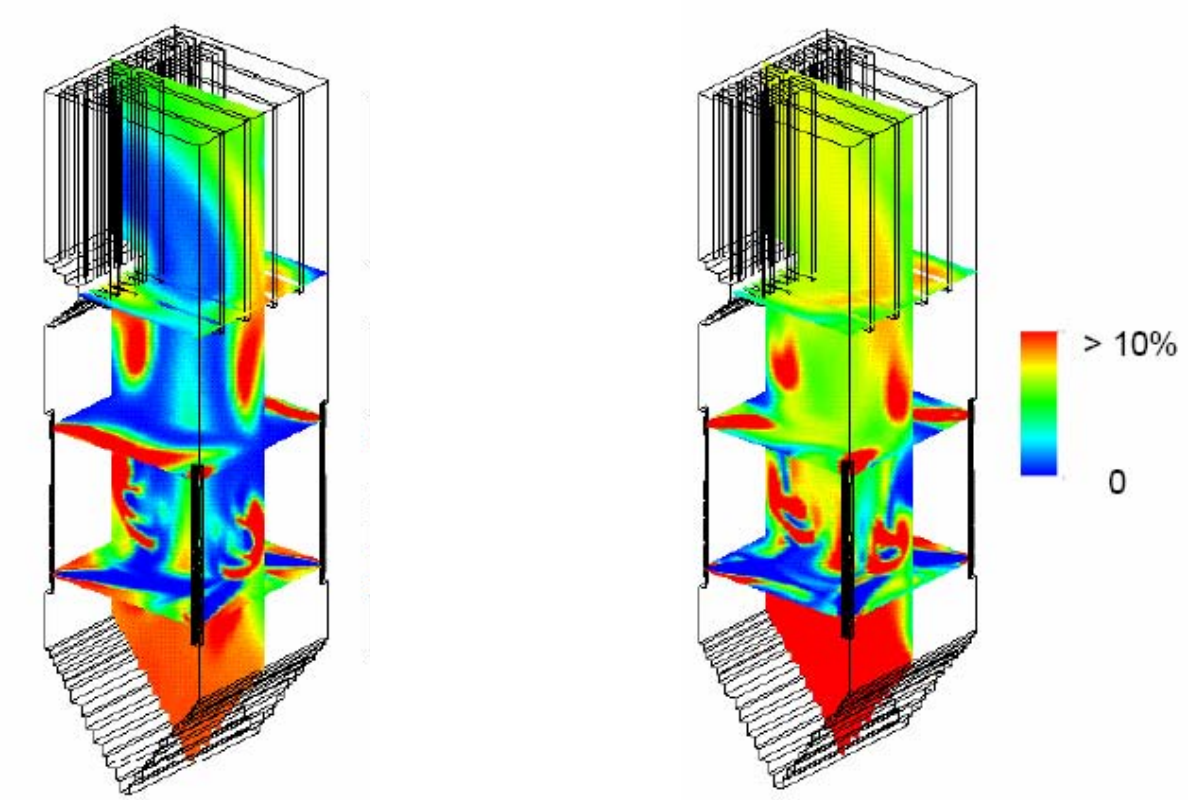
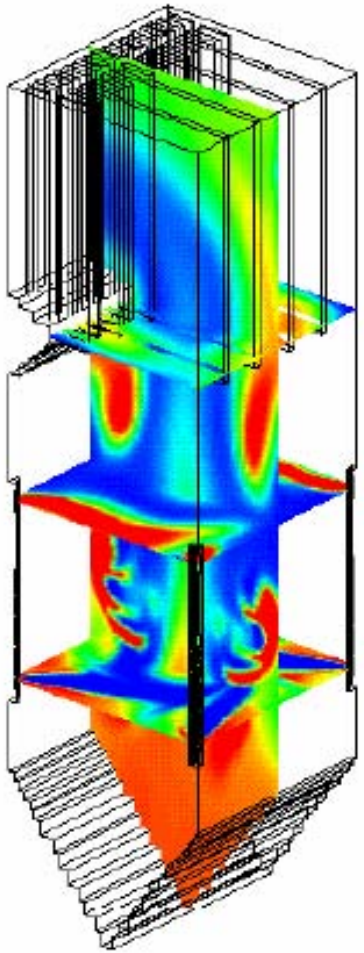


Figure B-3
Predicted O2 concentration for each simulation

Effect of Low NO_x Burners on Boiler Components

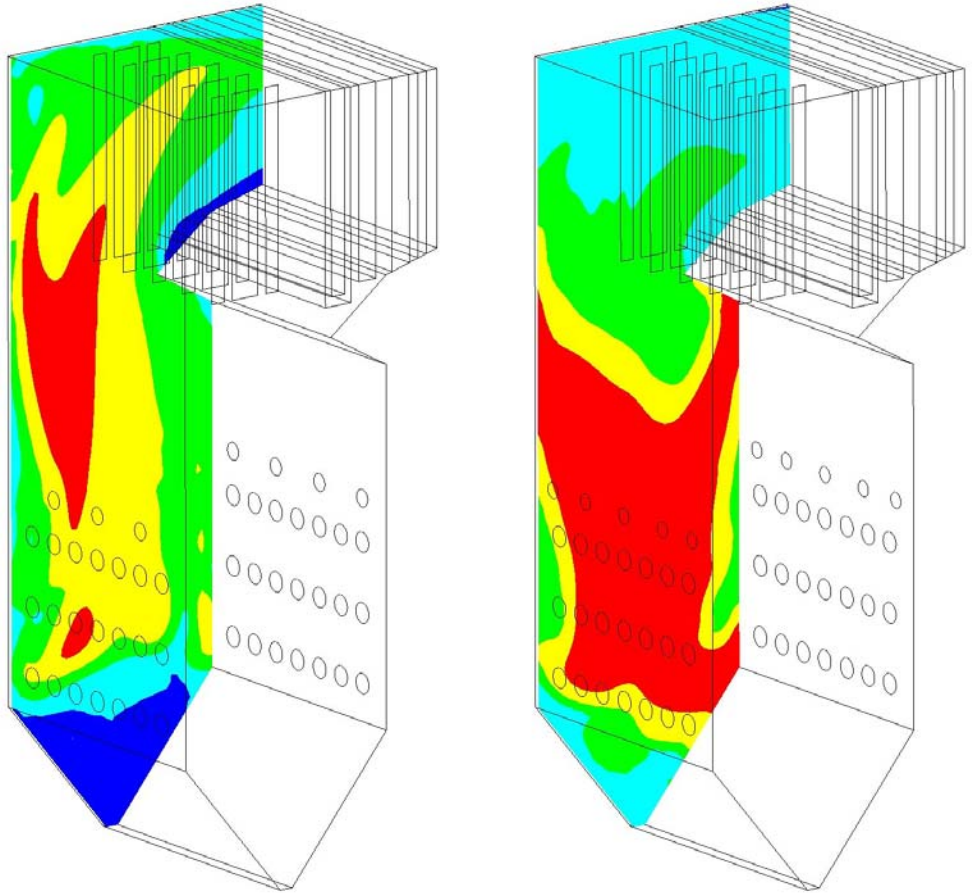
Reducing/Oxidizing Conditions – Load Changes

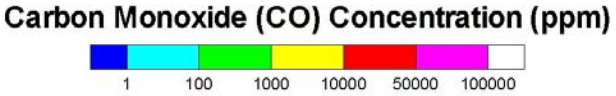
Cycling operation causes the highest corrosion rates as conditions fluctuate.



Effect of Low NO_x Burners on Boiler Components

Patterns of corrosion from unit to unit.

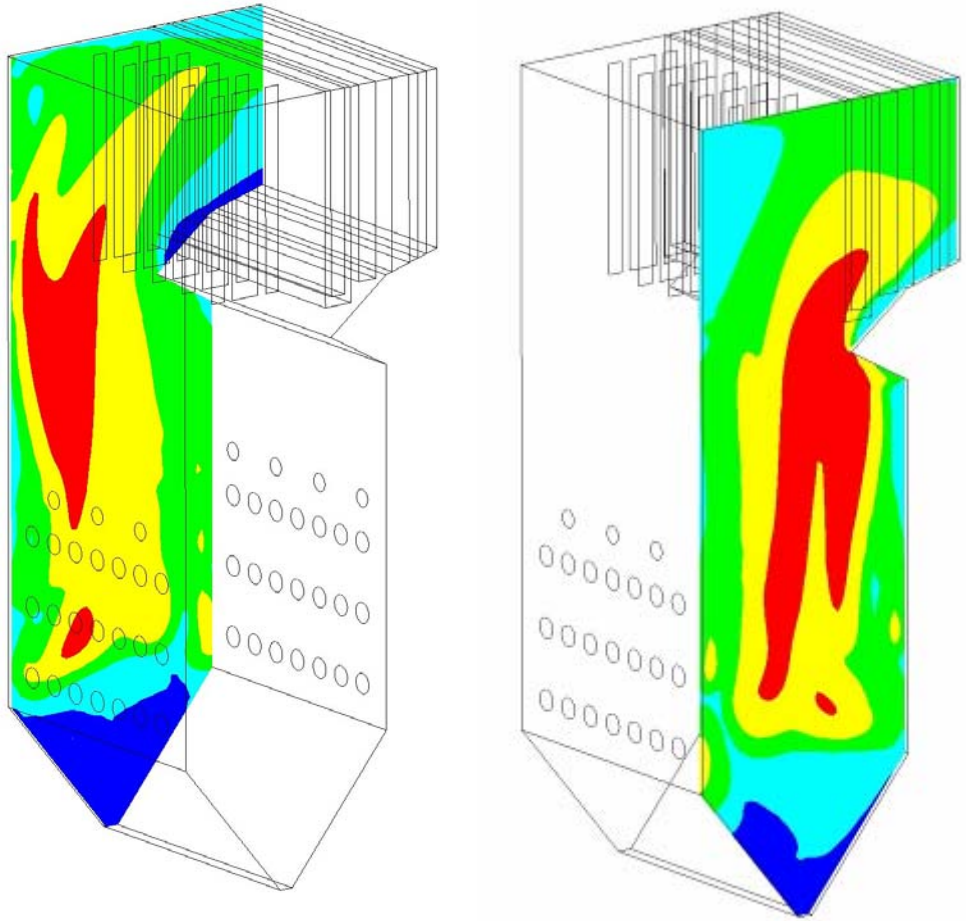




Effect of Low NO_x Burners on Boiler Components

Patterns of corrosion from unit to unit,

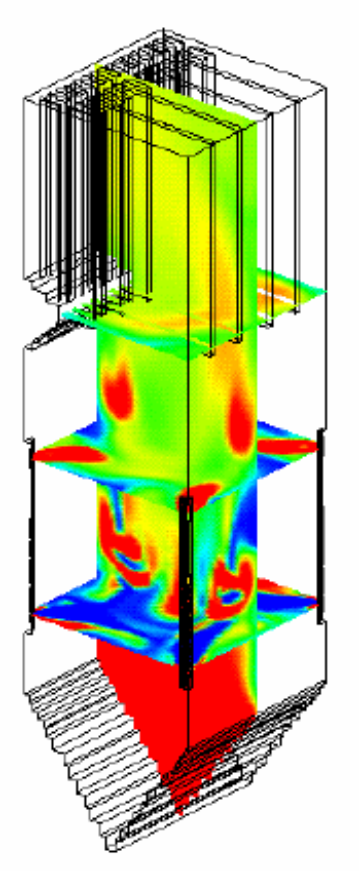
and wall to wall.



Effect of Low NO_x Burners on Boiler Components

Factors Affecting Furnace Wall Corrosion

- Sulfur and Chlorine in Coal
- Tube Metal Temperatures
- Reducing/Oxidizing Conditions

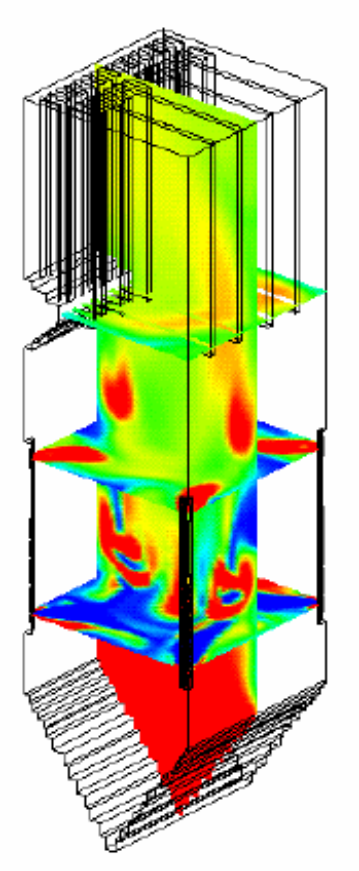


Effect of Low NO_x Burners on Boiler Components

Factors Affecting Furnace Wall Corrosion

- Sulfur and Chlorine in Coal
- Tube Metal Temperatures
- Reducing/Oxidizing Conditions

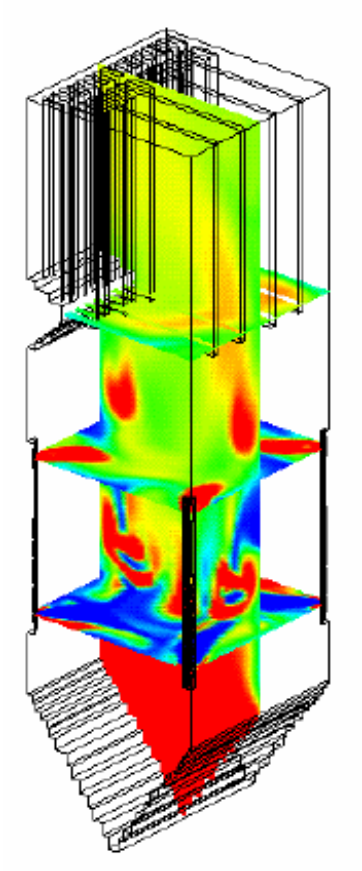
Solutions:



Effect of Low NO_x Burners on Boiler Components

Factors Affecting Furnace Wall Corrosion

- Sulfur and Chlorine in Coal
- Tube Metal Temperatures
- Reducing/Oxidizing Conditions



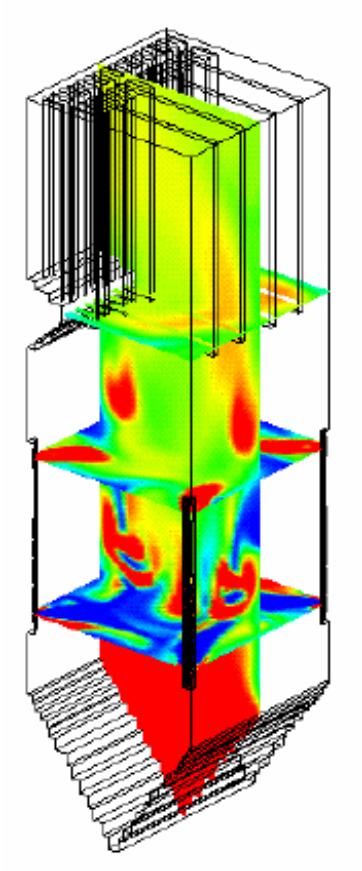
Solutions:

- **Weld clad with Alloy 622**

Effect of Low NO_x Burners on Boiler Components

Factors Affecting Furnace Wall Corrosion

- Sulfur and Chlorine in Coal
- Tube Metal Temperatures
- Reducing/Oxidizing Conditions



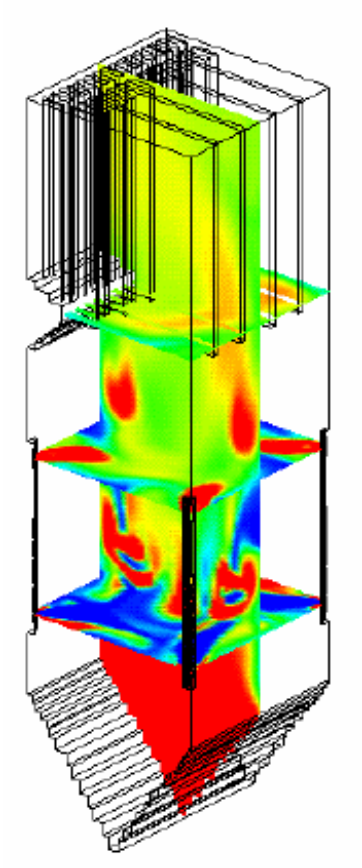
Solutions:

- **Weld clad with Alloy 622**
- **High density, Hi nickel spray coatings**

Effect of Low NO_x Burners on Boiler Components

Factors Affecting Furnace Wall Corrosion

- Sulfur and Chlorine in Coal
- Tube Metal Temperatures
- Reducing/Oxidizing Conditions



Solutions:

- **Weld clad with Alloy 622**
- **High density, Hi nickel spray coatings for lower corrosion rate areas.**

Effect of Low NO_x Burners on Boiler Components

Thank you