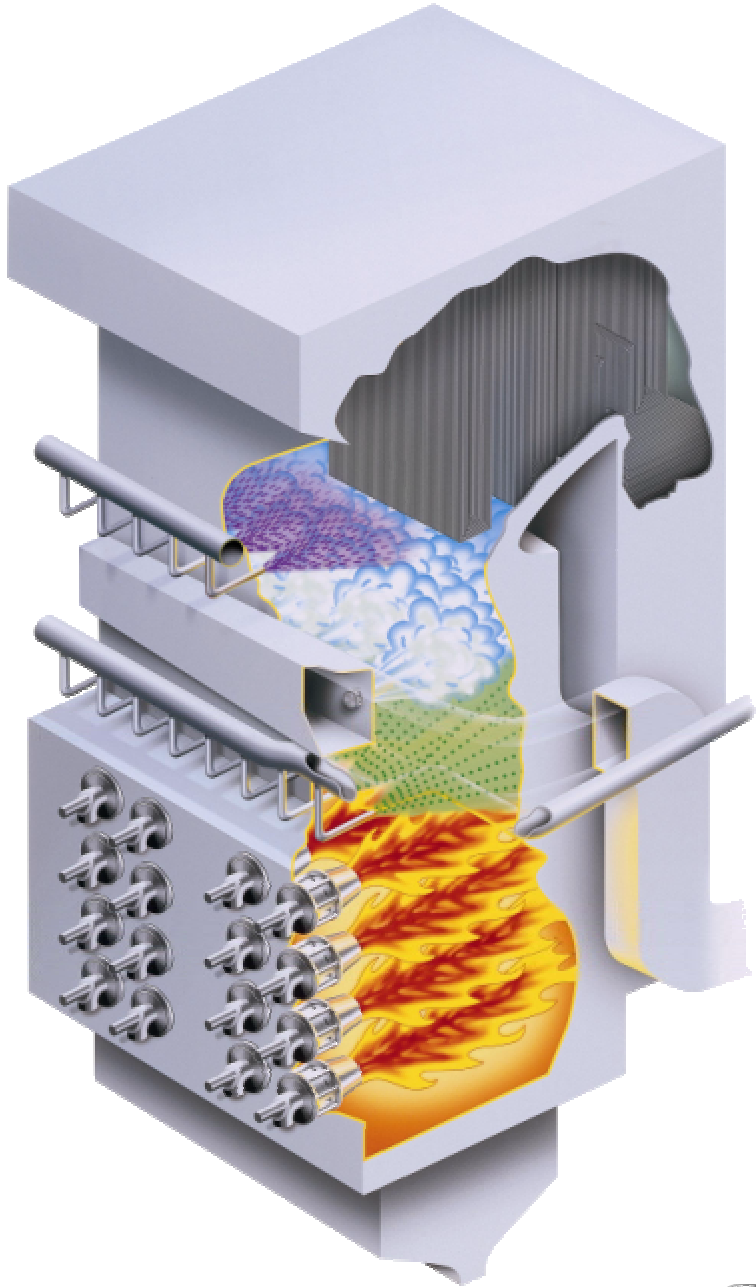
Reburn Technology Application Guidelines

David Moyeda

DOE NETL Conference on Reburning for NOx Control

Morgantown, West Virginia

18 May 2004



Overview

Reburning Process

Controlling Parameters

Application Considerations

Air Staging Verses Reburning

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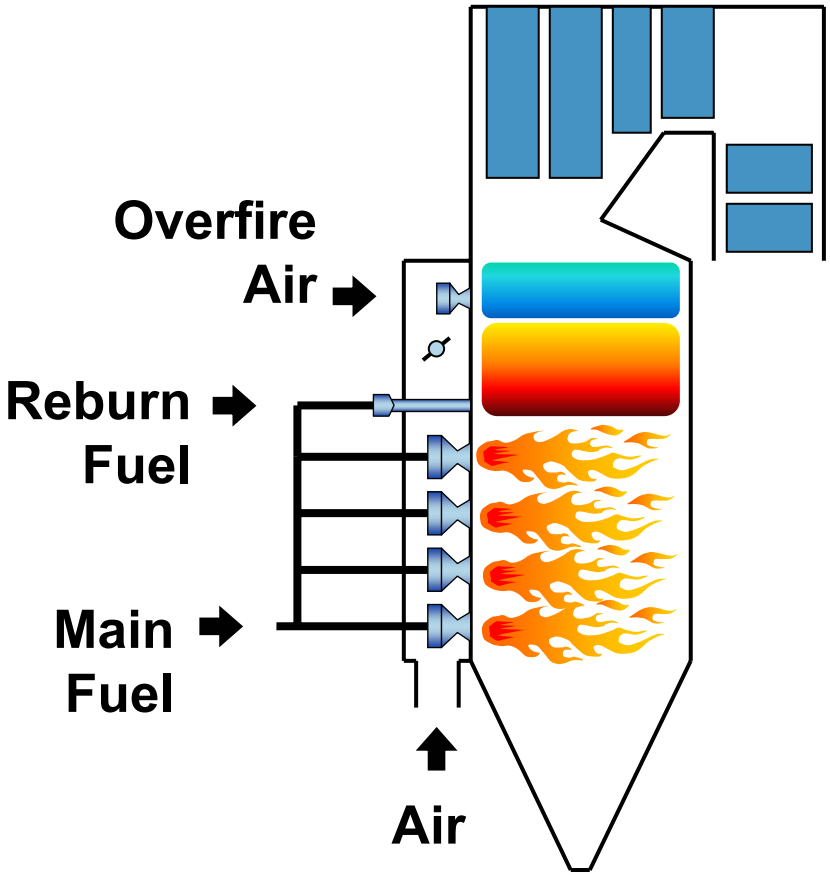
Reburning process includes fuel and air staging to reduce NOx emissions



NOx generated in the main combustion zone reacts with fuel fragments injected into the reburn zone reducing it to molecular nitrogen. Overfire air addition completes combustion in the burn-out zone.

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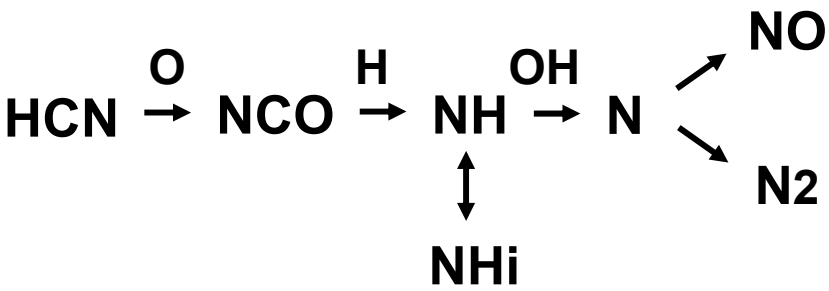
Reburning chemistry involves fuel radicals that reduce NO to N2

N2 Formation (Reburning Zone)

CH Availability:

$$CH_4 + OH \longrightarrow CH + H_2O$$
$$CH + NO \longrightarrow HCN + O$$
$$CH + O \longrightarrow CO + H$$

HCN Processing:



XN Conversion (Burnout Zone)

CO Oxidation:

$$CO + OH \longrightarrow CO_2 + H$$
$$H + O_2 \longrightarrow OH + O$$

NO Formation:

$$XN + OH \longrightarrow NO + \ldots$$

N2 Formation:

$$HCN \xrightarrow{O} NCO \xrightarrow{NO} N_2O \xrightarrow{H} N_2$$
$$NH_2 + NO \longrightarrow N_2 + H_2O$$

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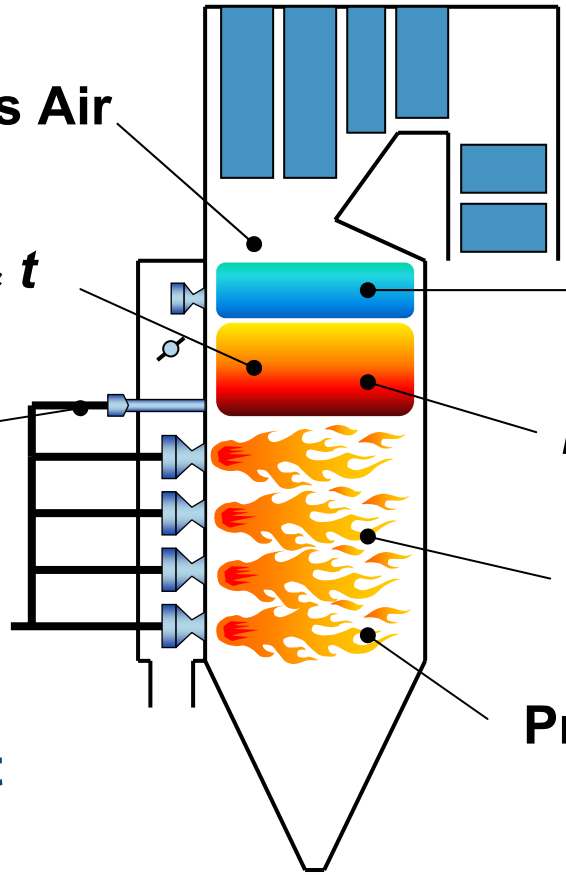
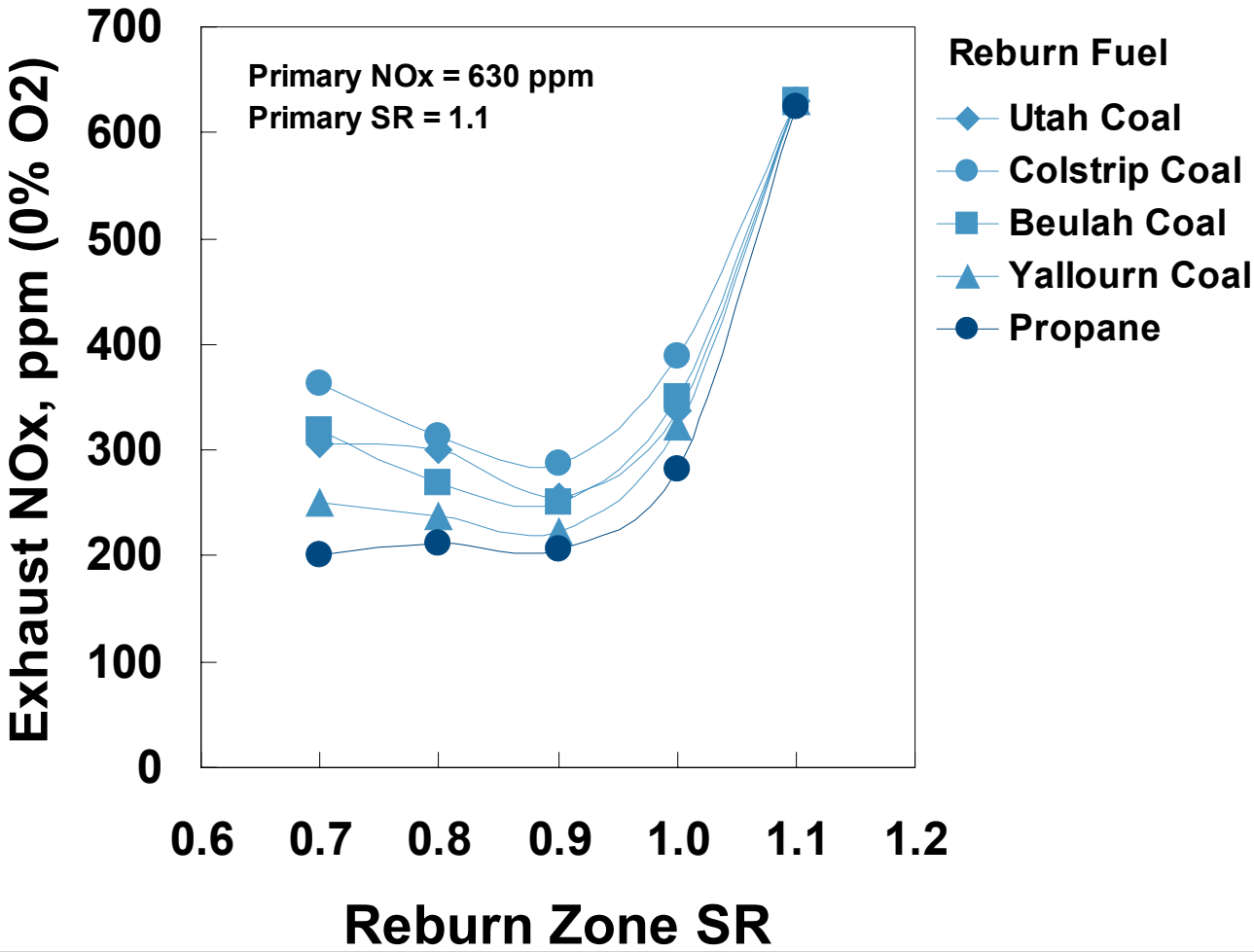
Various parameters impact reburn system design and performance



Parameters in italics have a first order impact on reburn performance

Reburn zone stoichiometric ratio is optimum around 0.9



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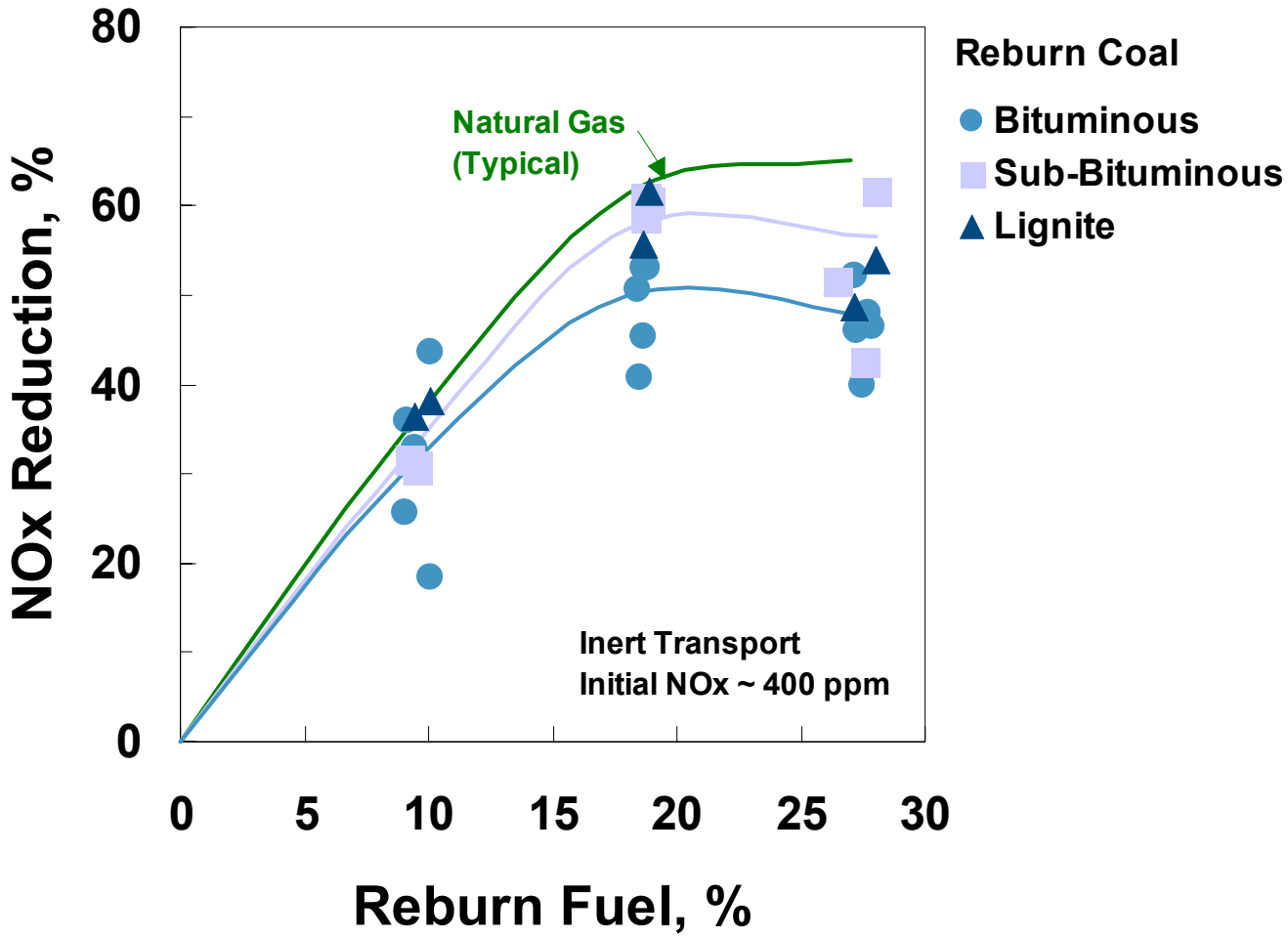
Performance of coal as a reburn fuel is impacted by coal type and reactivity



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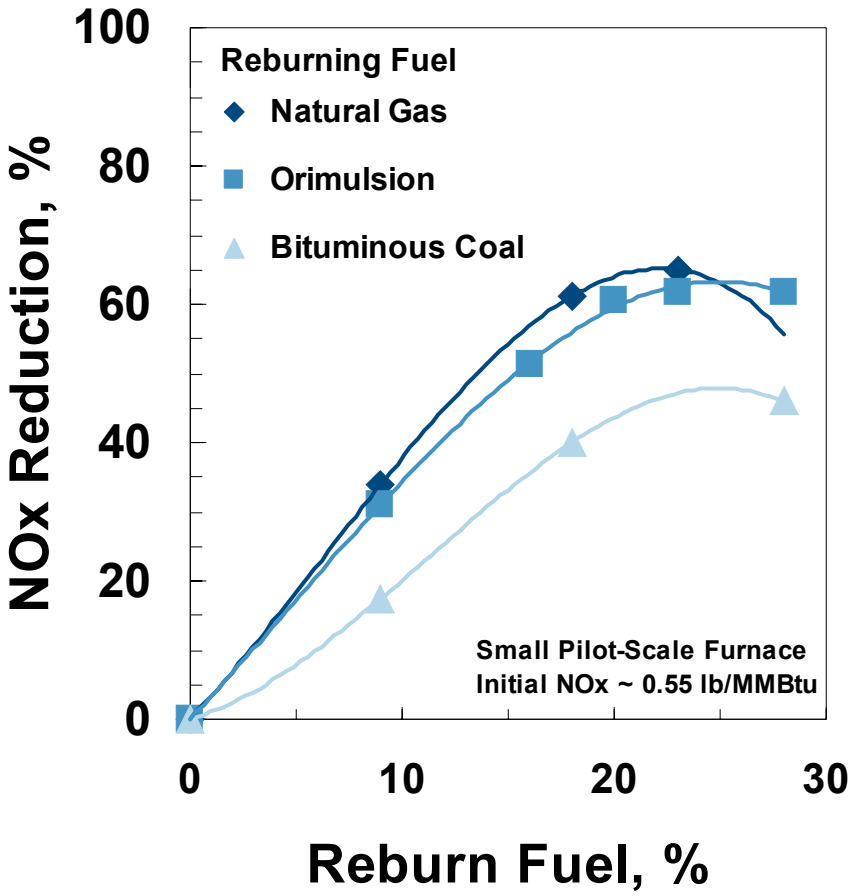
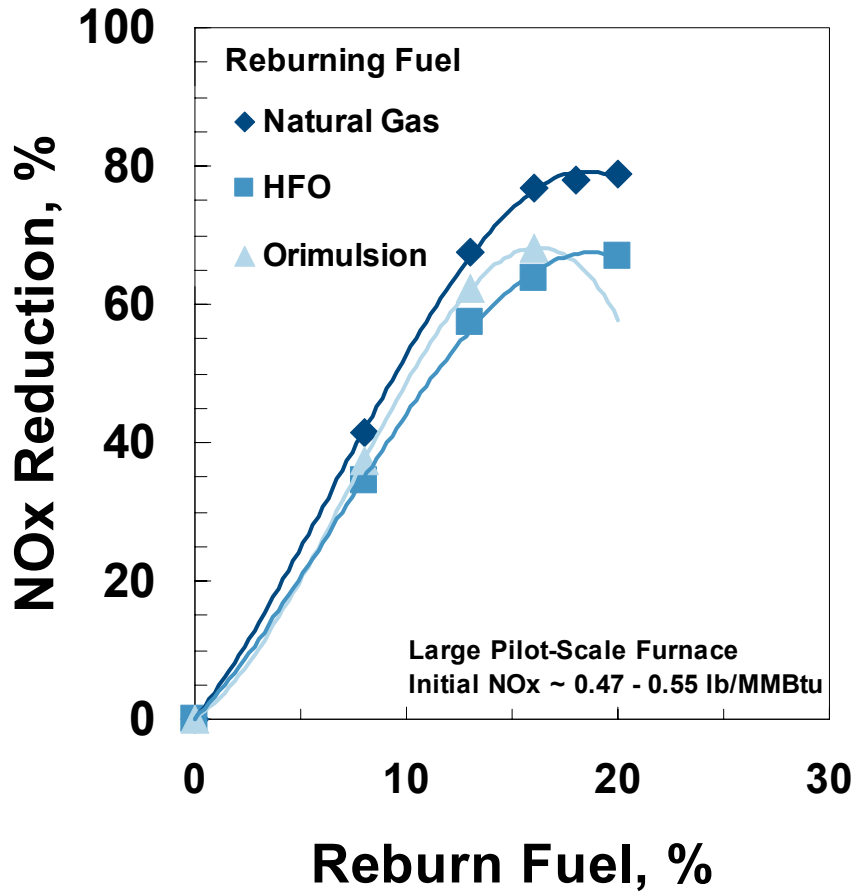
All hydrocarbon fuels can be used as a reburn fuel





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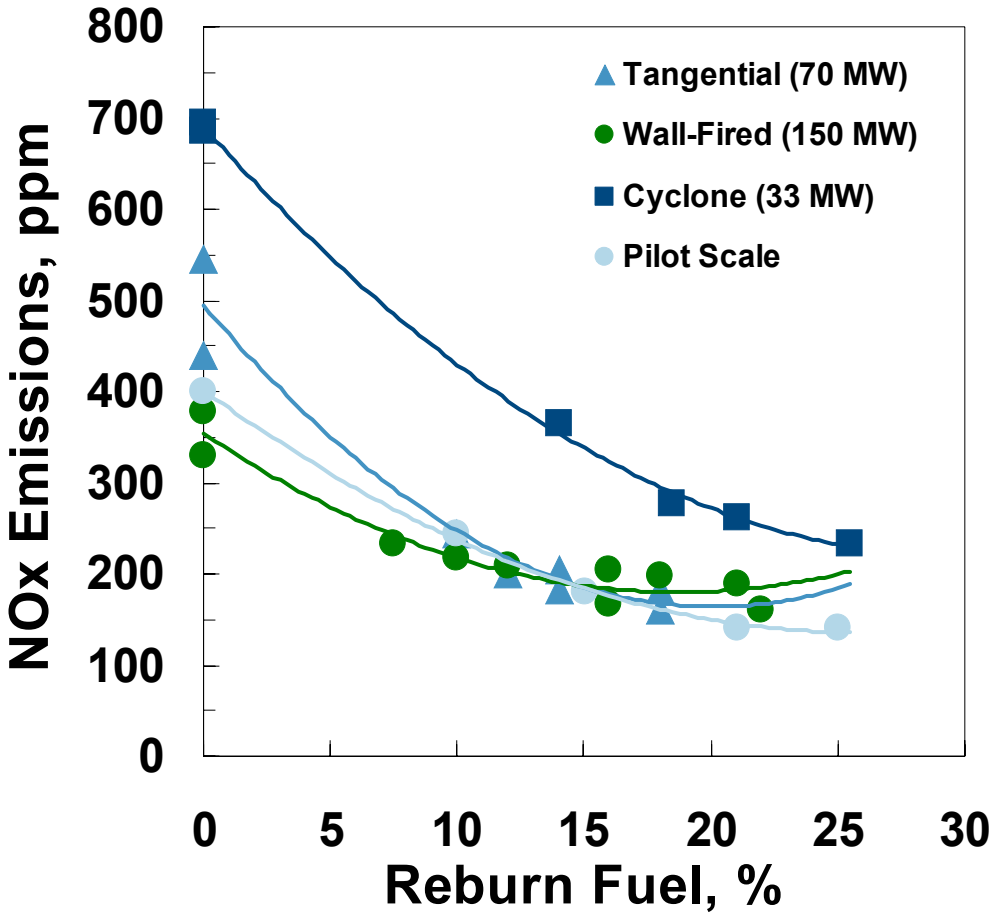
Full-scale results compare well to small-scale experimental results



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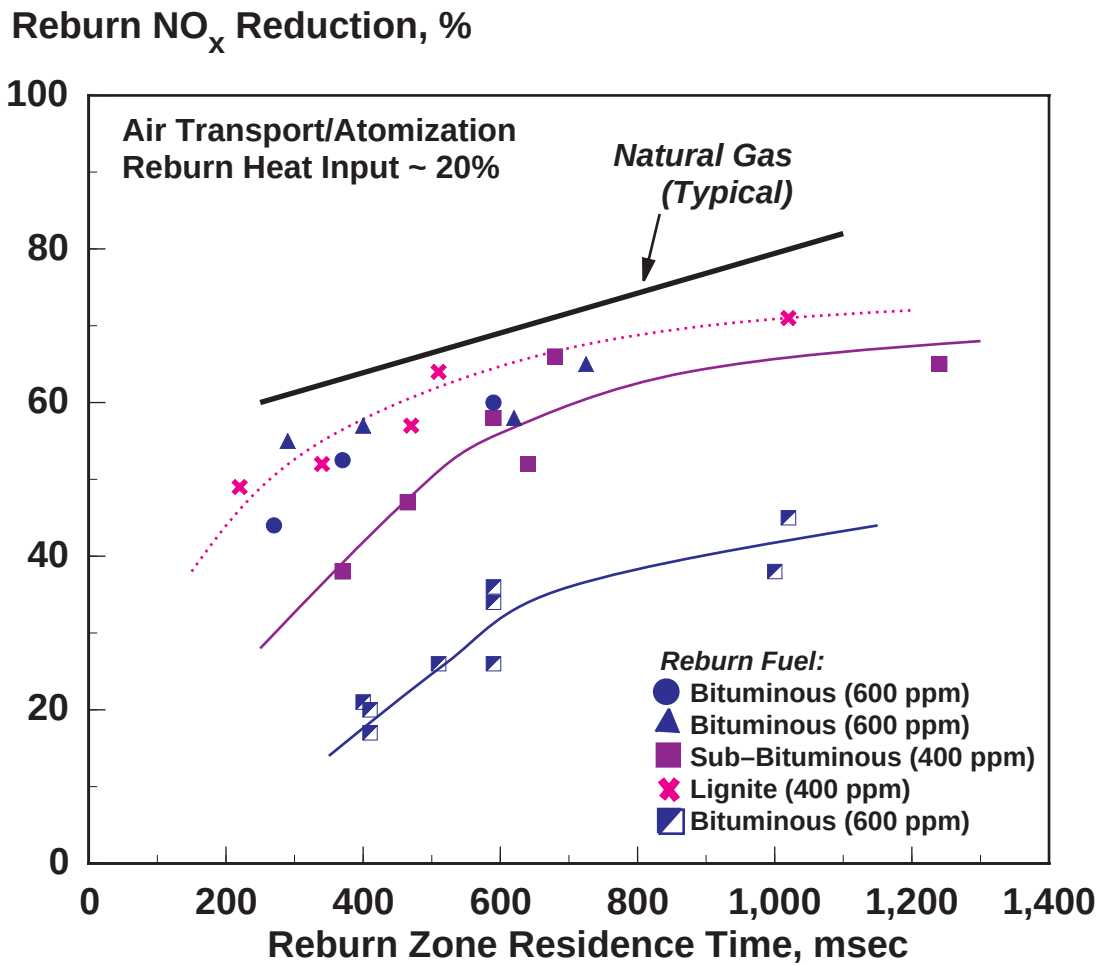
Reburn performance improves as reburn zone residence time increases



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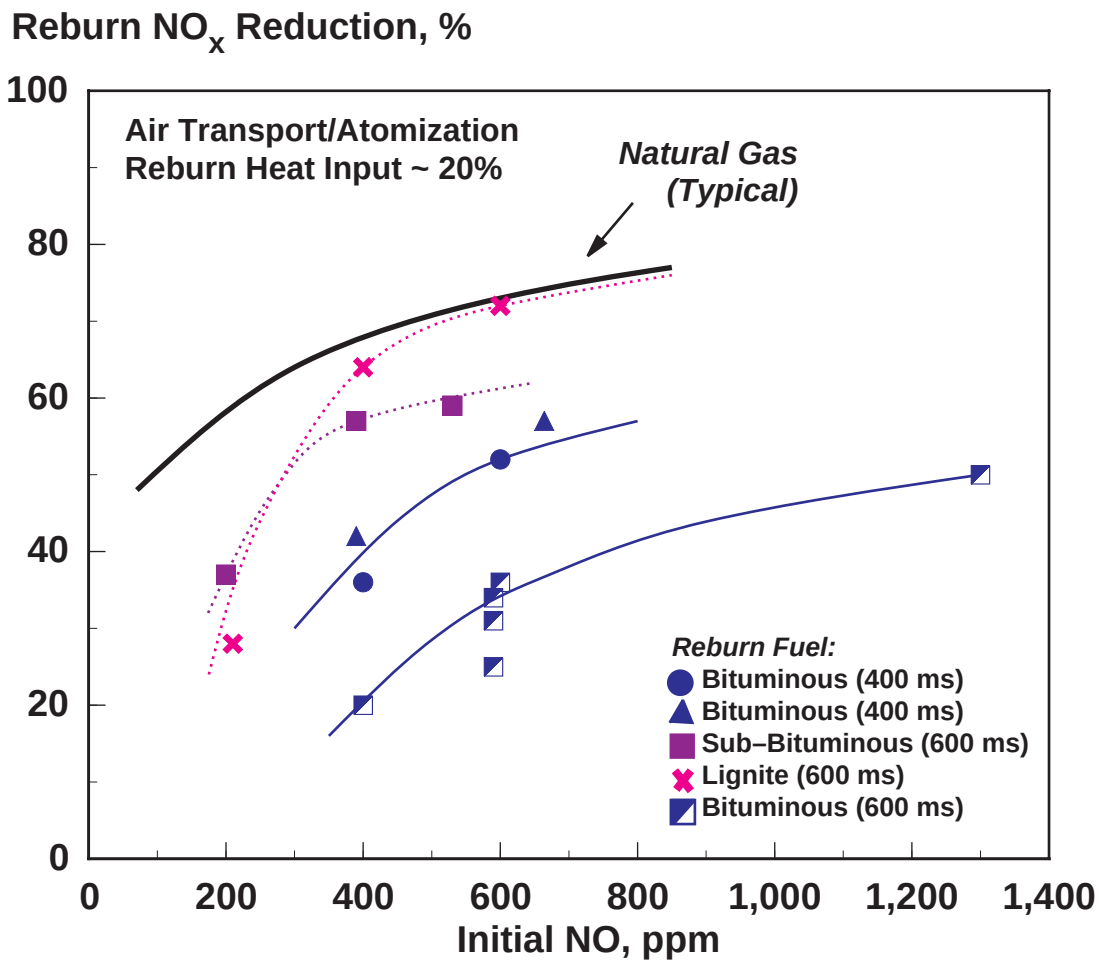
Reburn performance is reduces as initial NOx level decreases



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Reburn application considerations

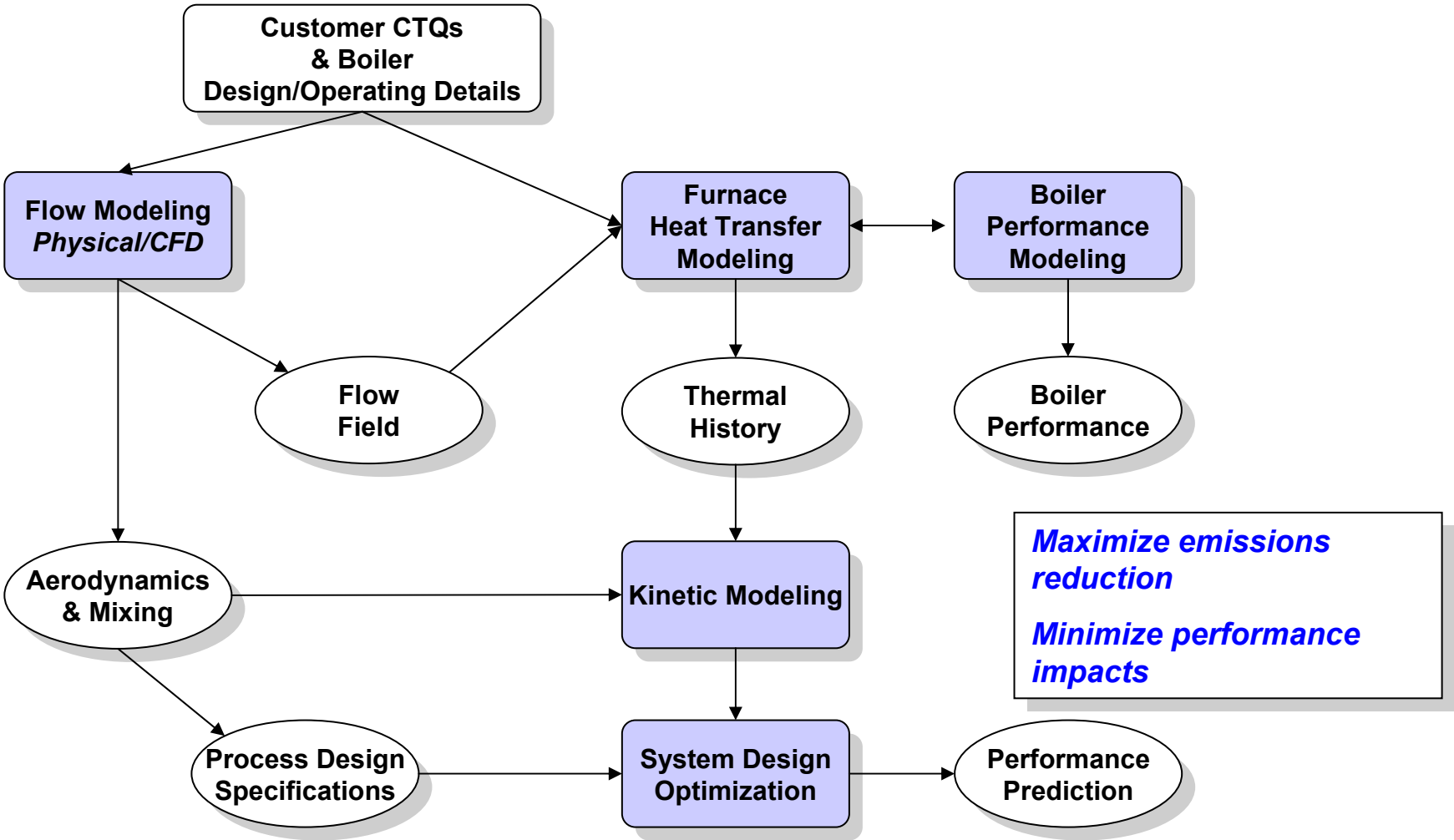
Boiler specific factors can influence reburn performance:

- Boiler design generally sets reburning zone residence time and temperature, and initial NO_x
- Firing configuration and fuel have a minor impact, except where they influence first order parameters
- Primary excess air does not influence reburn effectiveness, but does set amount of reburn fuel needed for optimum emissions control

Reburn system design parameters that dictate level of control which can be achieved for a particular boiler:

- Reburning zone stoichiometry
- Reburning fuel type
- Reburning fuel mixing

Optimizing GE's reburn system design



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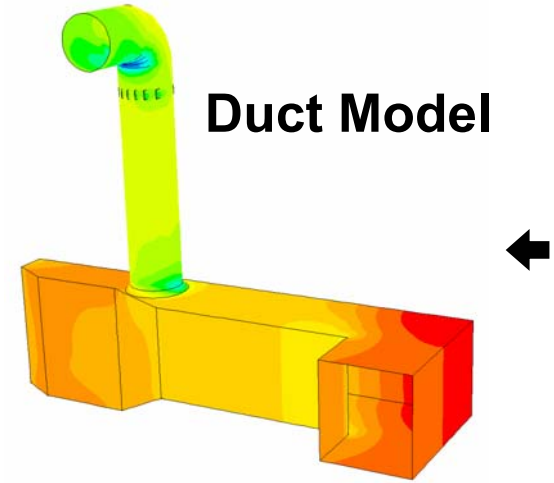
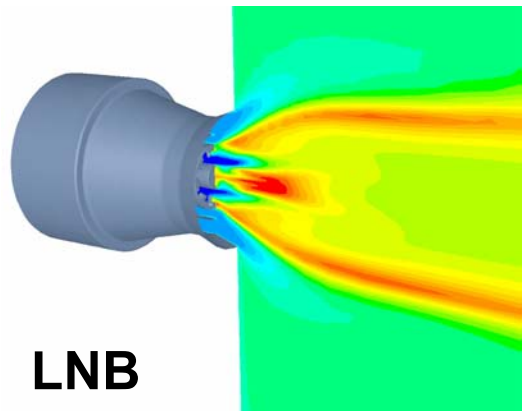
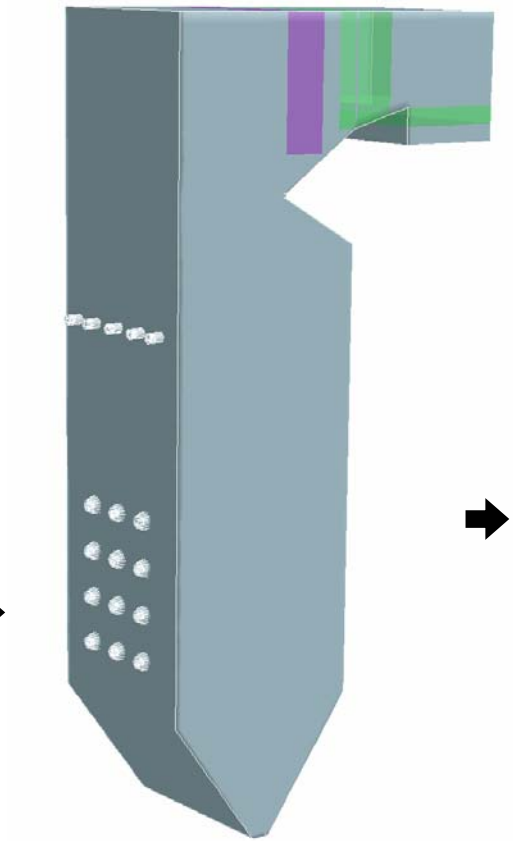
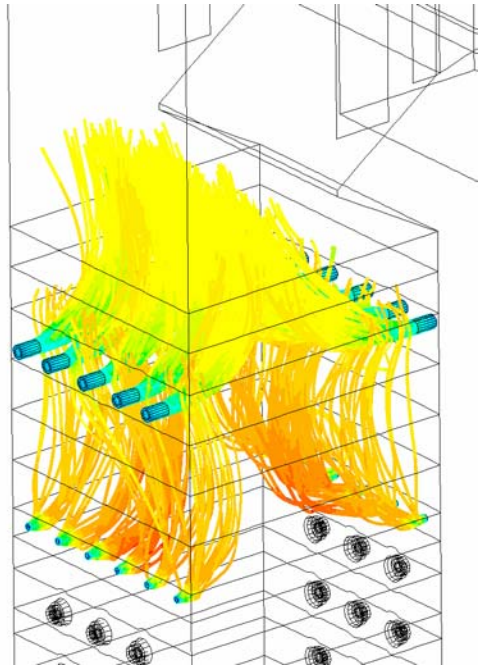
Advanced models ensure performance of retrofit technology









Reburn & OFA
Jet Pathlines

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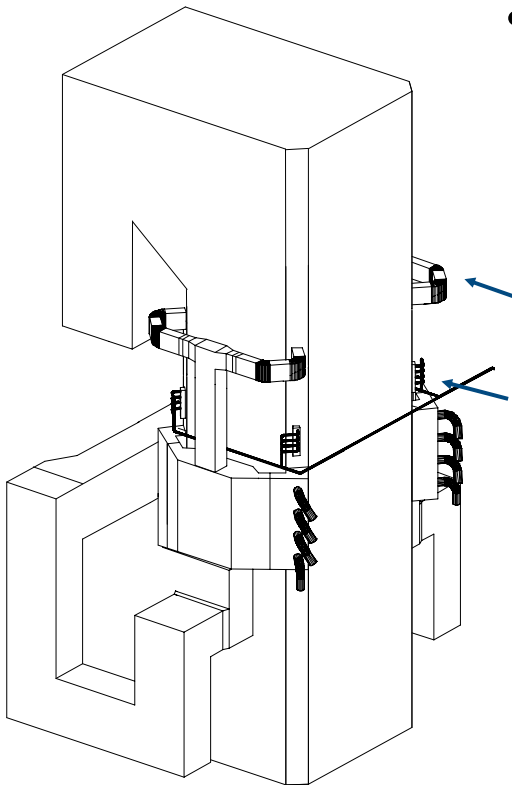
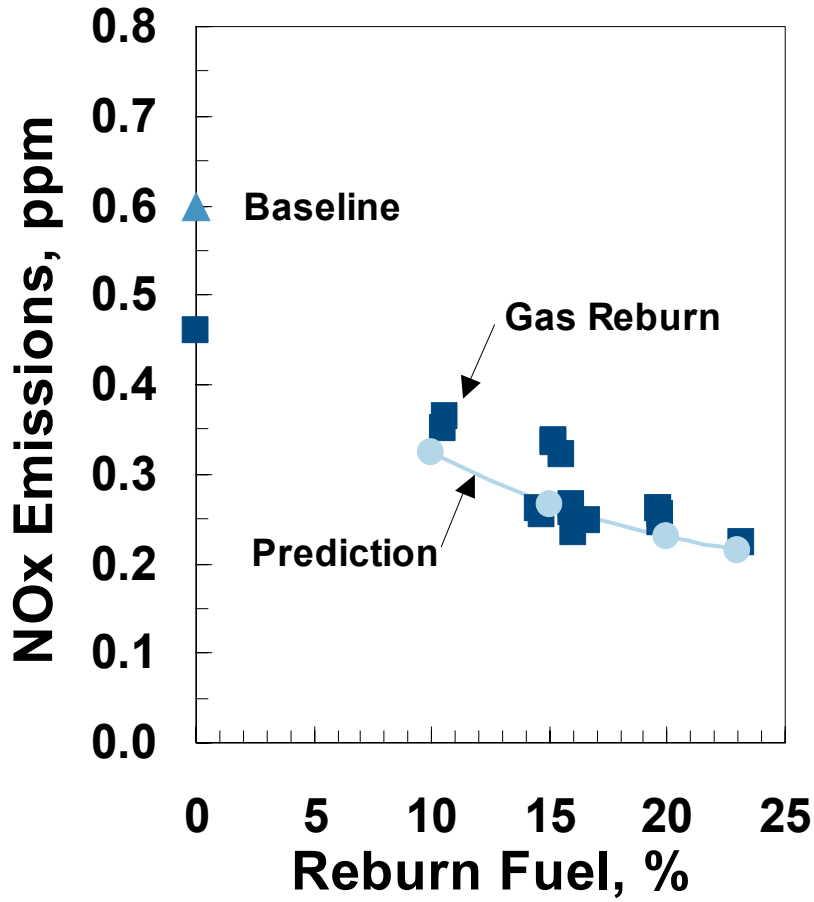
Gas reburn performance on tangentially fired boiler

- 100 MW
- Bit. Coal





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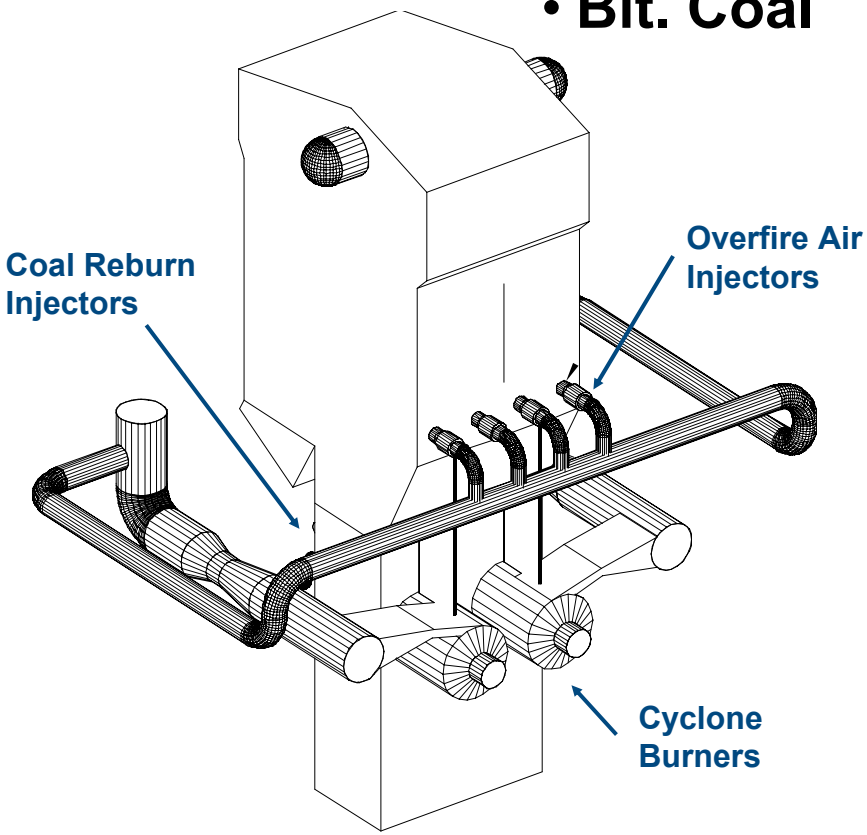
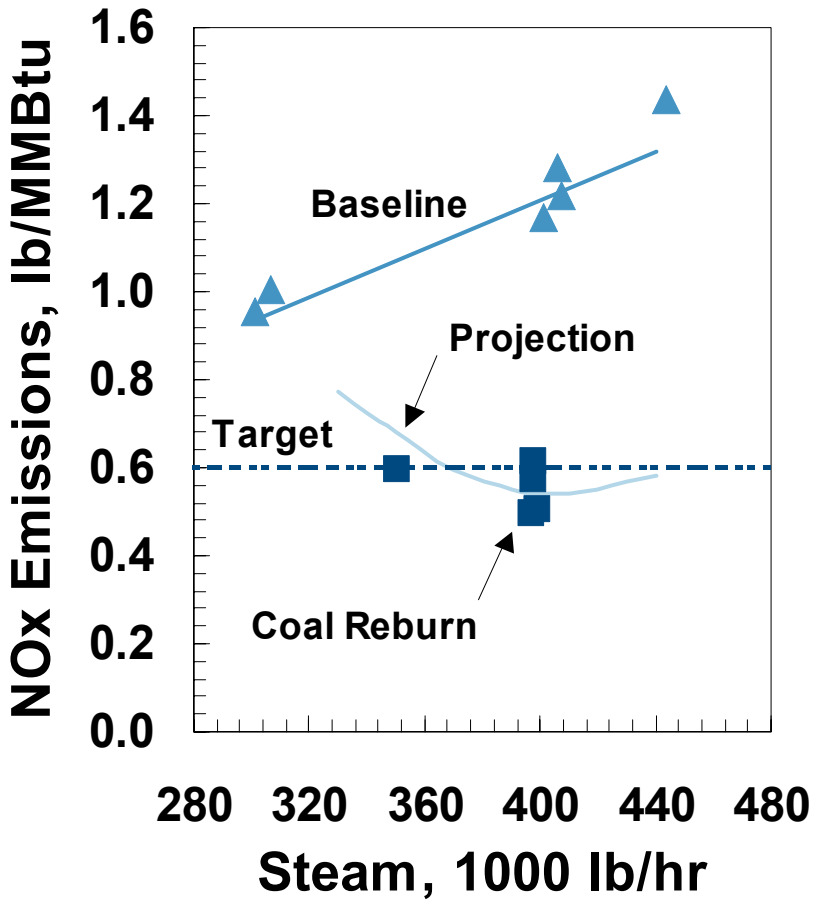
Coal reburn performance on cyclone fired boiler

- 50 MW
- Bit. Coal





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Air staging verses Reburn

Deep air staging can provide significant reductions in NO_X emissions

- Gas reburn generally results in lower NO_X emissions
- Coal reburn results in similar or lower NO_X emissions

Deep air staging can impact boiler performance and unburned carbon

- Reburn does not impact boiler performance
- Gas reburn has a small impact on unburned carbon; impact of coal reburn depends on coal and size distribution

Deep air staging can lead to lower furnace corrosion. Application of reburn technology can avoid this problem

Summary

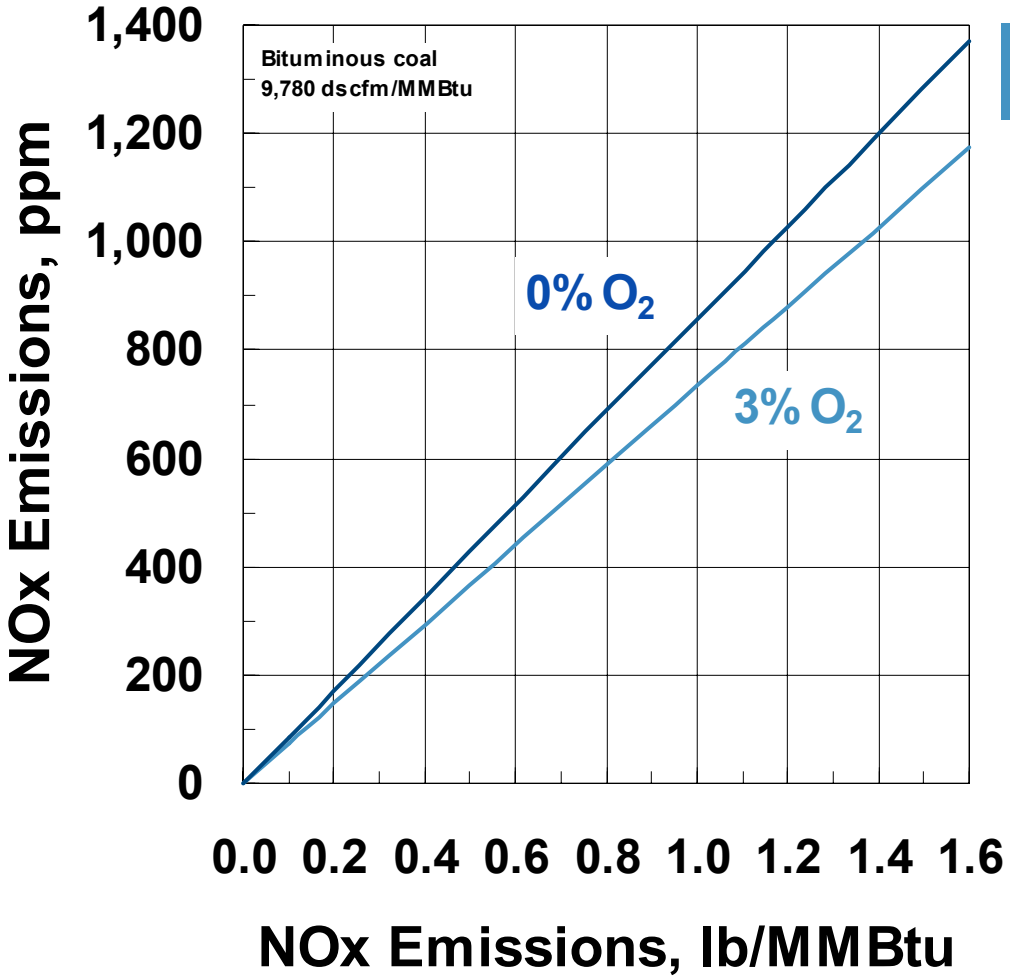
Reburn is effective with a wide range of utility fuels, including coal, natural gas, and fuel oil

Parameters controlling performance are well understood

Reburn performance is dictated by site specific characteristics and reburn fuel type

Design methodology can result in successful retrofit of reburn technology to utility and industrial boilers

Conversion from ppm to lb/MMBtu



1 lb/MMBtu ~ 733 ppm (3% O_2)
1 lb/MMBtu ~ 856 ppm (0% O_2)

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