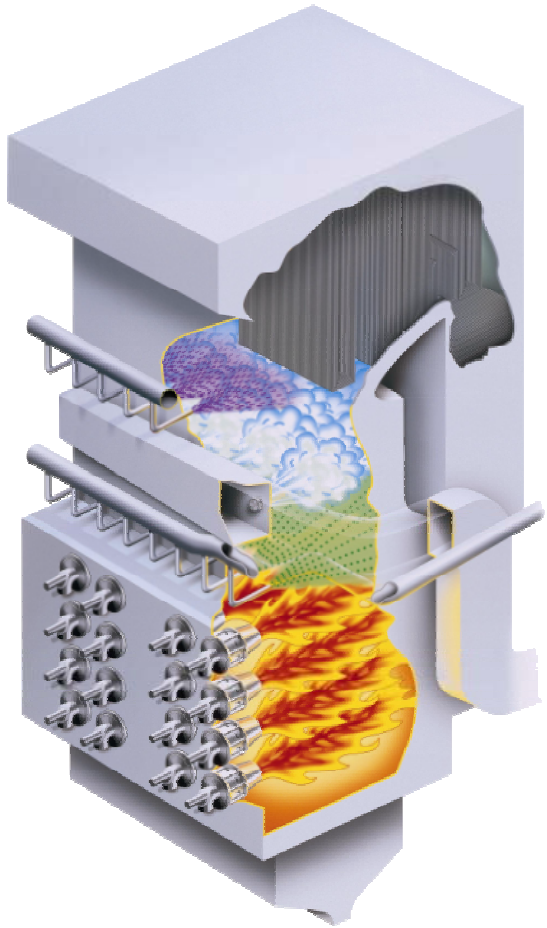
Enhancement of the "naturally occurring" mercury capture by fly ash



World of Ash Conference

Lexington, Kentucky

April 13, 2005

imagination at work

GE approach to mercury control

Mercury control in existing pollution control devices (ICR data)

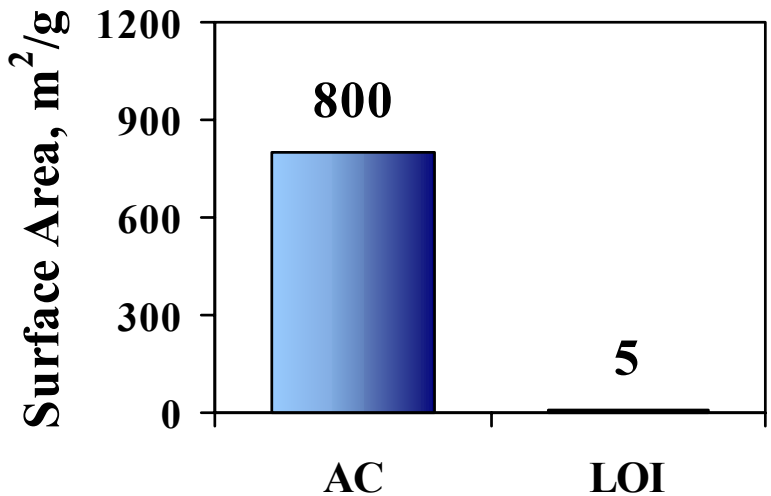
Existing Control Technology	% of Mercury Captured	
	Bitum	Subbitum
Particulate equipment		
Cold-side ESP	46%	16%
Hot-side ESP	12%	13%
Fabric Filter	83%	72%

"Natural" mercury capture on fly ash can be significant

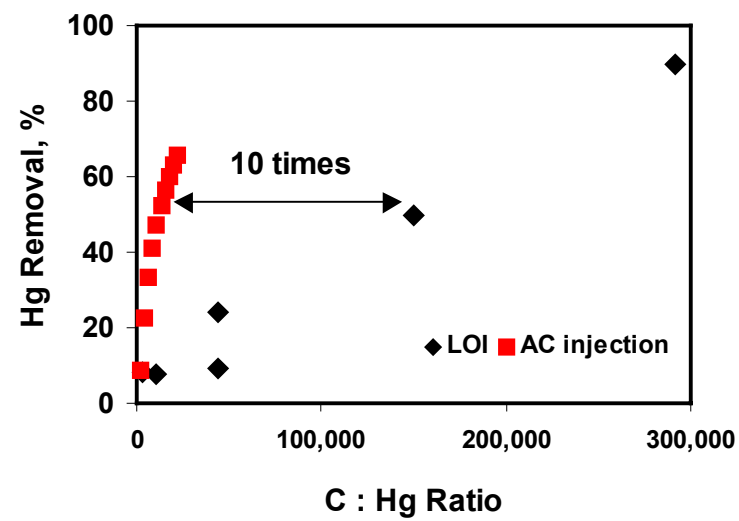
- **Enhancement of naturally occurring mercury removal and oxidation on fly ash to provide consistent Hg removal efficiency**
  - carbon in fly ash is an effective mercury sorbent
    - ✓ LNB, SOFA, Coal Reburning
  - mercury removal is more effective at T < 300 ^{o}F
- **Combustion optimization for optimum conditions for mercury removal**

Effect of carbon on Hg reduction

Comparison of AC and LOI Surface Areas



Comparison of AC and LOI Reactivities Toward Mercury



Although AC has two order of magnitude higher capacity for mercury removal than LOI, it's reactivity upon injection is only 10 times higher

Mercury control for Bituminous coals

LOI 6-12%
Mercury removal potential 60-80%

CO/O_2 sensors

Combustion sensors

Stack

Duct Humidification

- Lowering flue gas temp
- Improved absorption on fly ash

APH

ESP

Fuel

Air

Combustion Modifications

- LNB
- SOFA
- Reburning

Bed of Activated Carbon

Fluidized Bed Decoker

Flue Gas Free of Hg

Carbon and Hg Free Ash

Global Hg Management (GE patented technology)

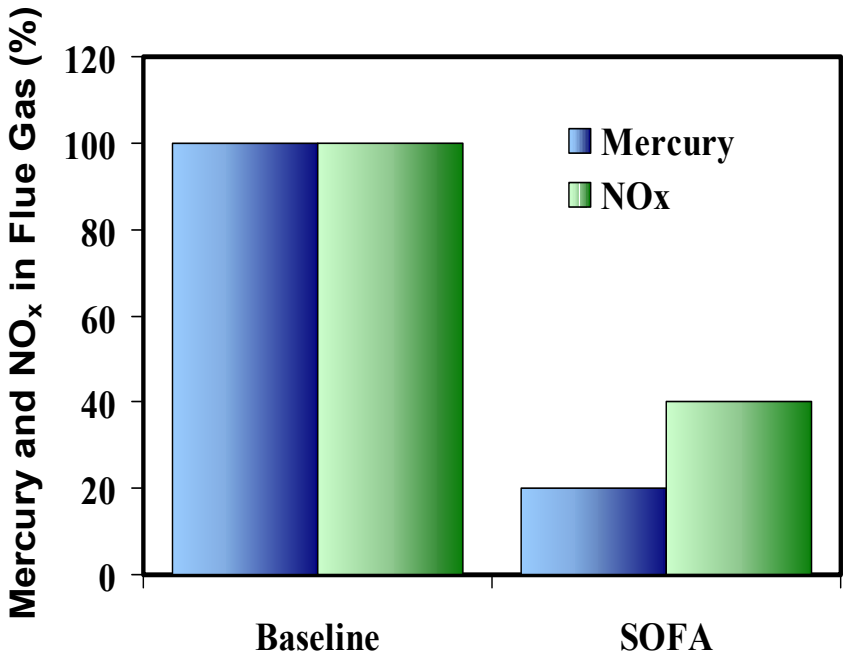
GE pilot-scale combustor

- Boiler Simulator Facility ($1x10^6$ Btu/hr, 300kW)
- Simulation of combustion conditions and time-temperature profile in full-scale utility boiler
- Test variables include combustion conditions, coal type, and coal blending
- Continuous mercury measurements

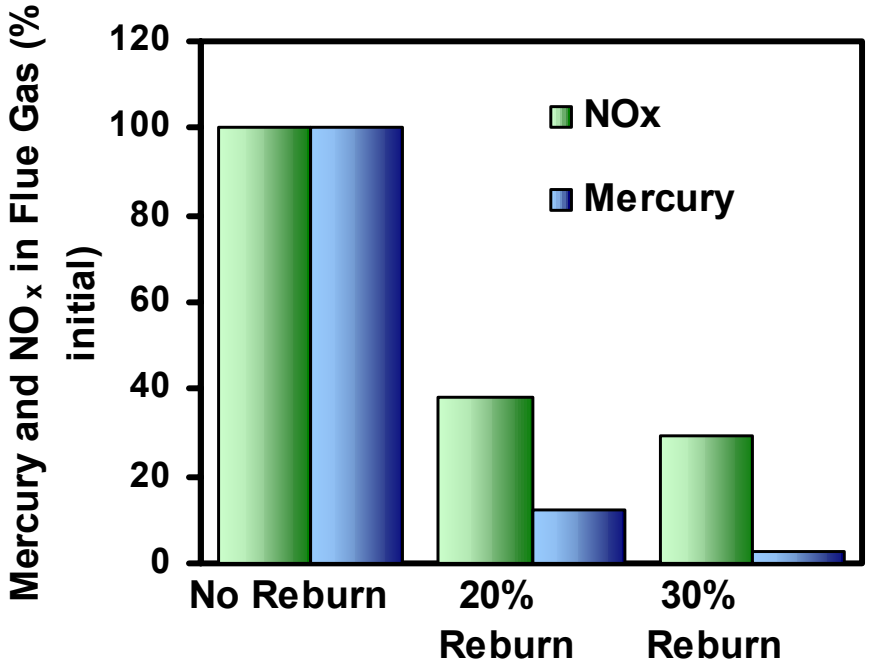
Effect of staging on mercury control

Bituminous Coal

Mercury removal in SOFA



Coal reburn impacts

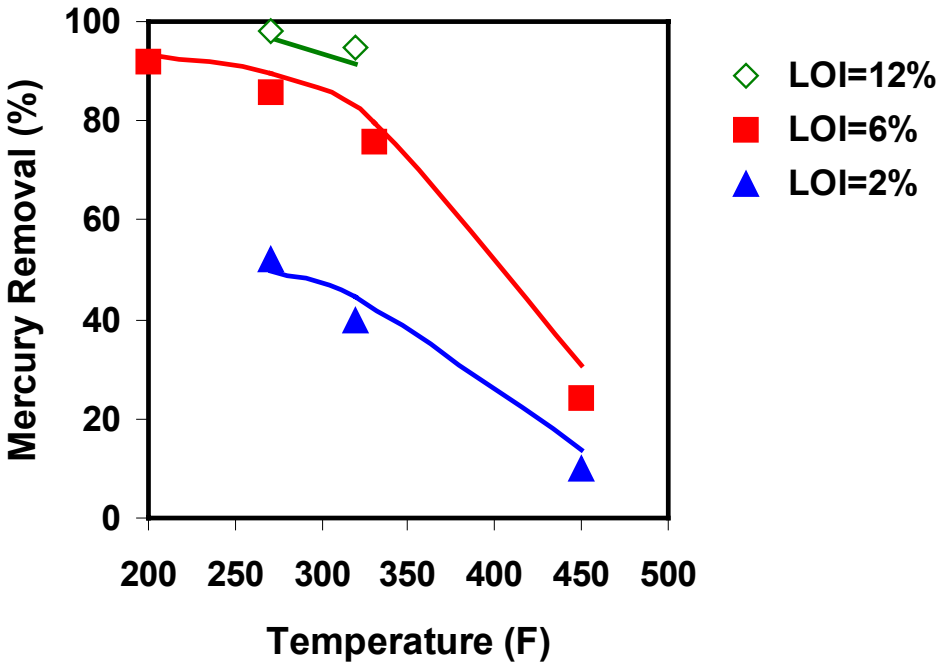


Pilot-scale data

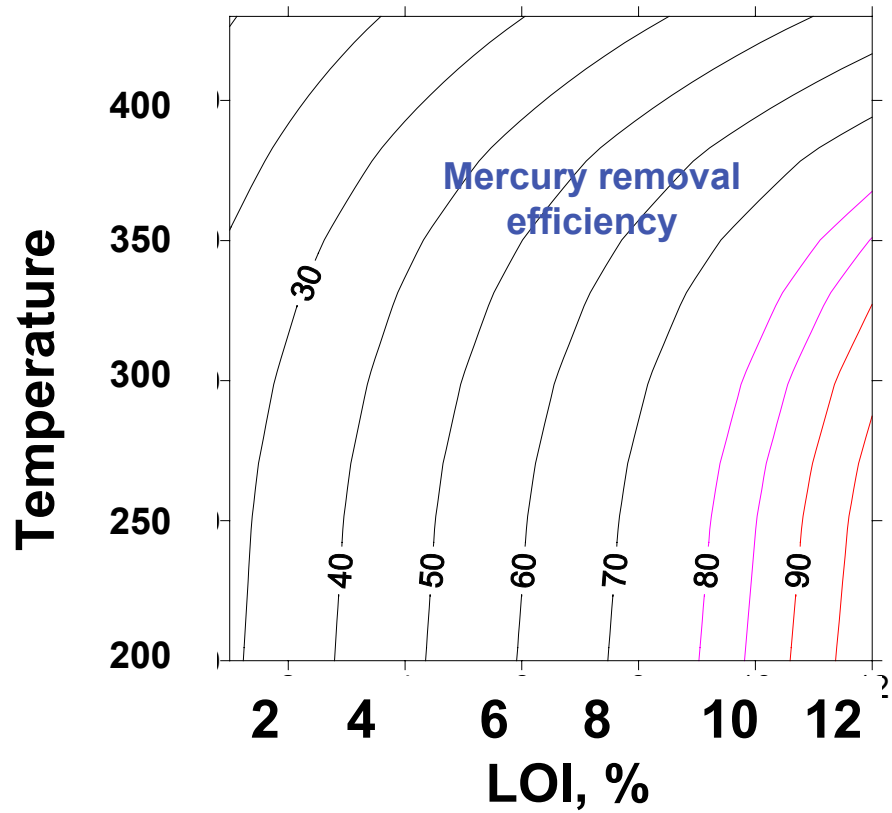
Enhancing mercury control via combustion modification for bituminous coals

Effects of LOI and temperature: pilot-scale data

Effects of LOI and ESP temperature



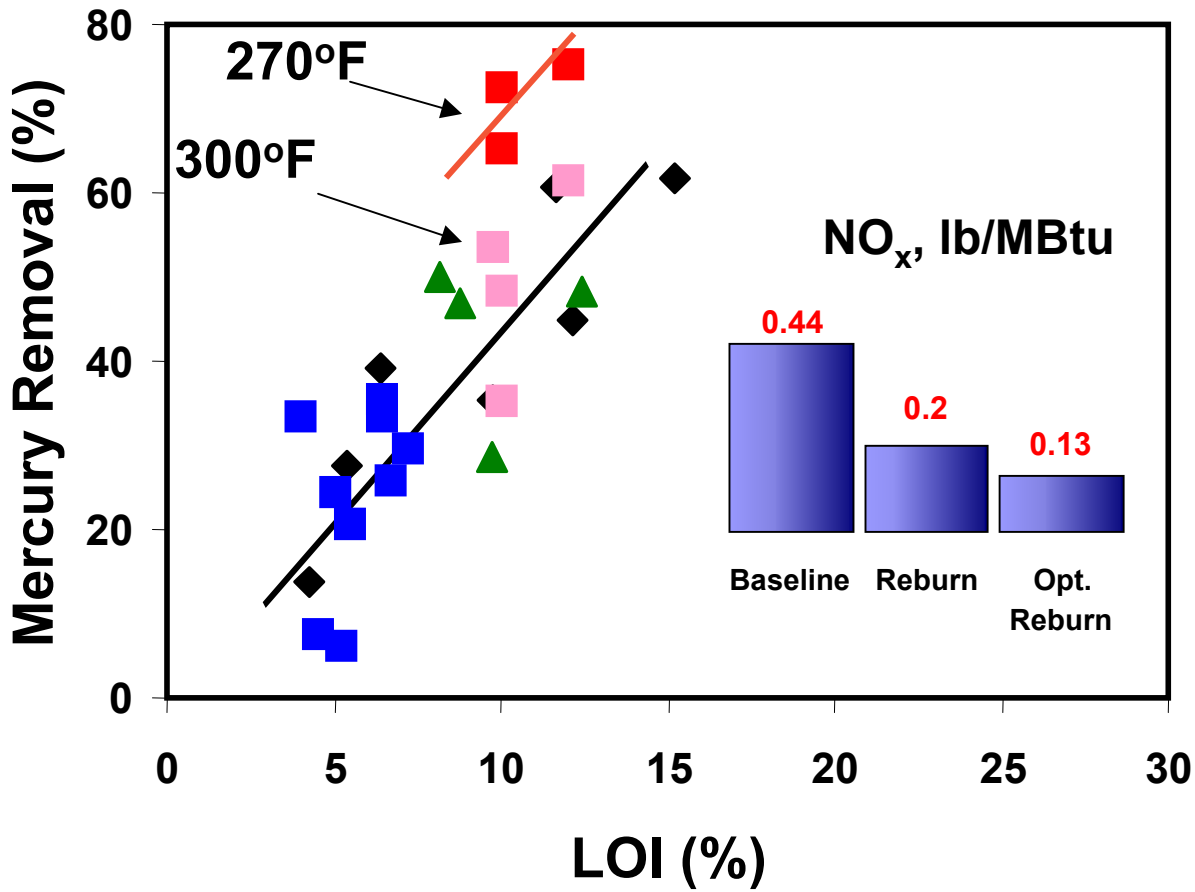
Mapping of process conditions



LOI and temperature affect mercury removal

Summary of pilot- and field data

- DOE/GE funded program
- 2003-2004
- 250 MW Unit 2 at Green Station
- Coal Reburning
- High sulfur Bituminous coals

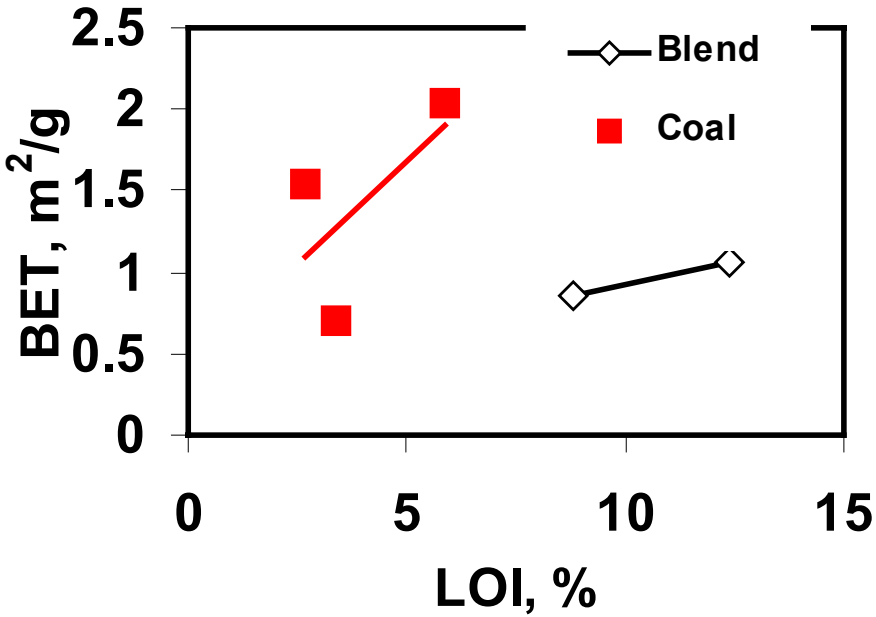


- ◆ Pilot-scale data
- ■ Baseline data
- ▲ Reburning non-optimized
- ■ Optimized Reburning

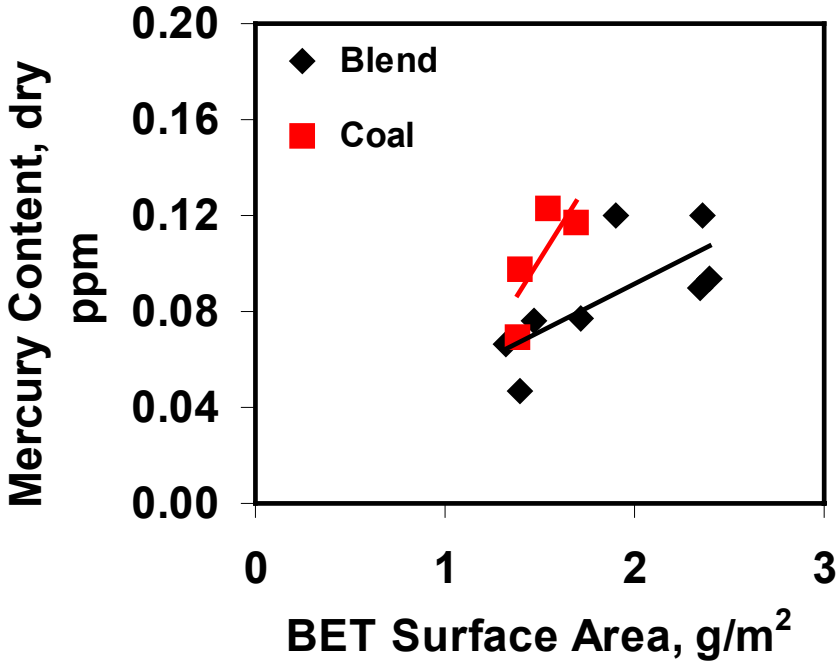
Up to 80% Hg removal at optimized conditions

Mercury absorption on fly ash

Fly ash surface area vs. LOI



Mercury in ash



Effect of temperature on mercury removal

- DOE/GE funded program
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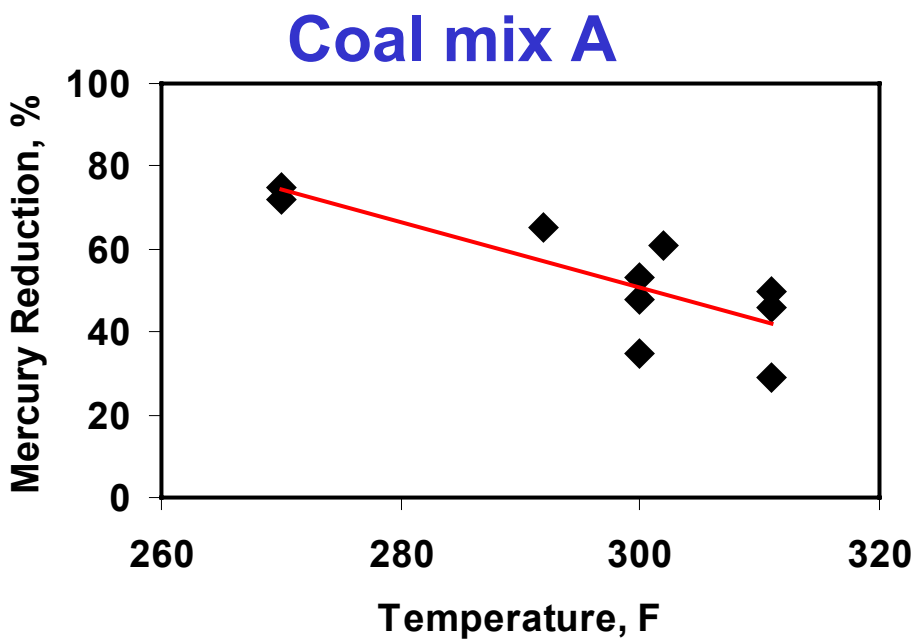
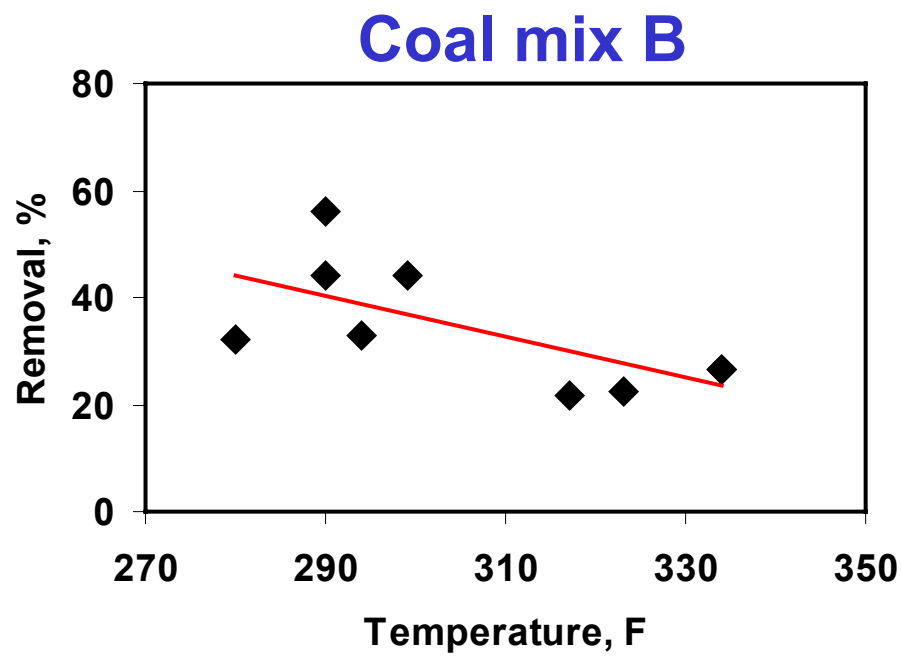
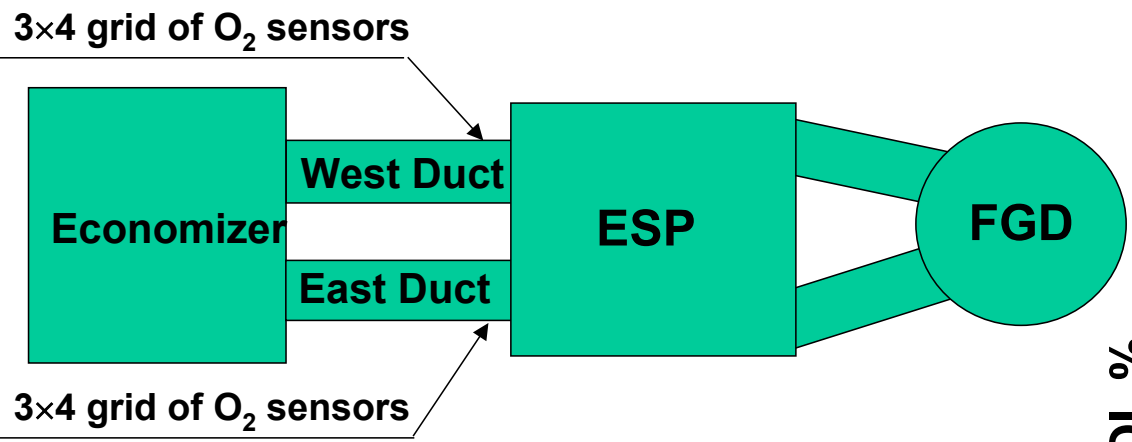


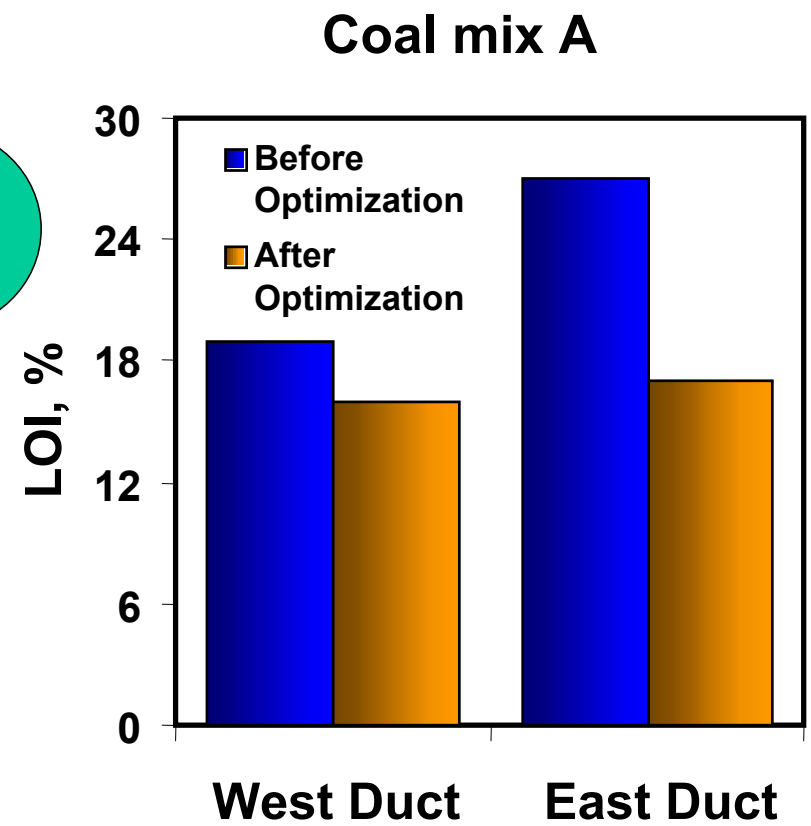


Decreasing ESP temperature improves mercury removal

Enhancement of naturally occurring Hg removal while minimizing LOI

Green Unit 2



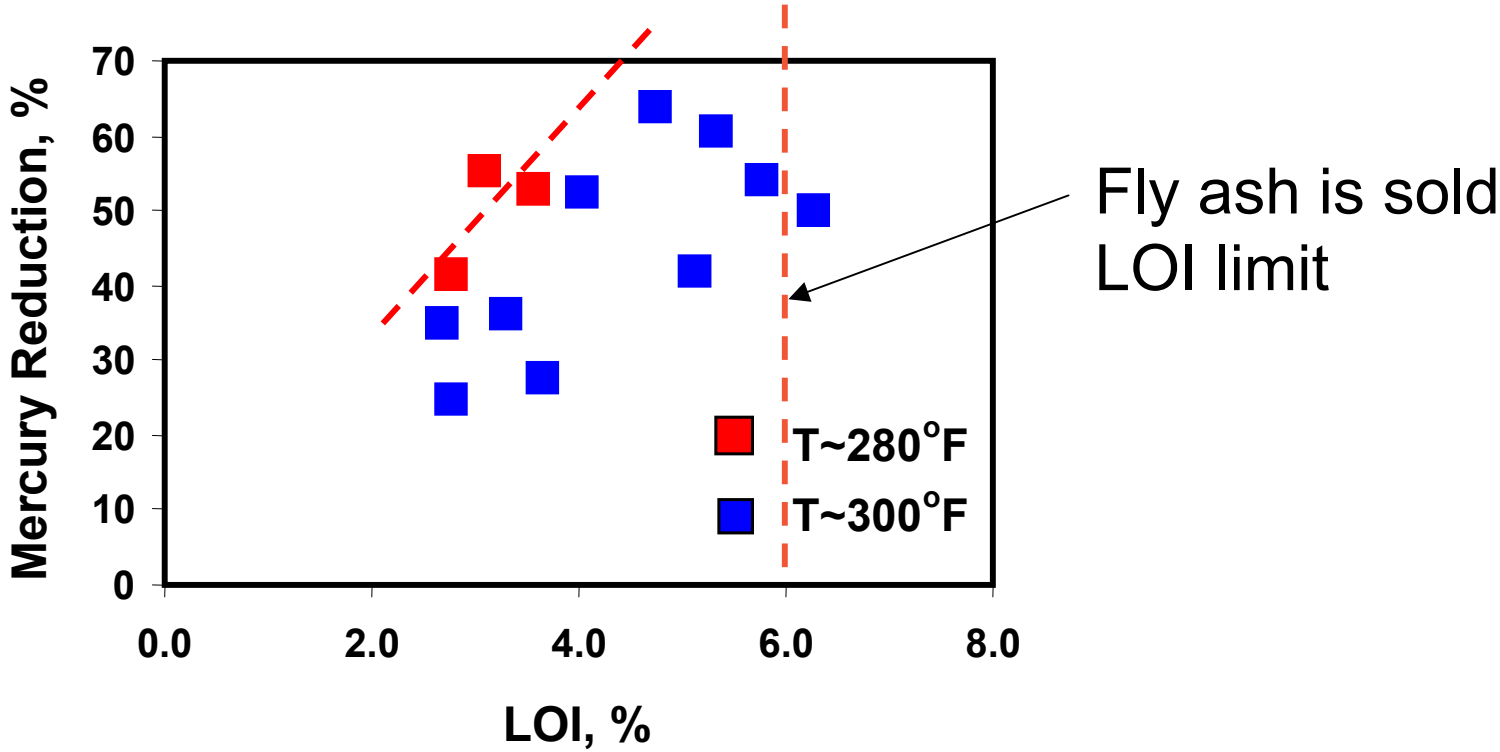


- Coal line balancing
  - Manually operated coal line balancing dampers
- Burner tuning
  - Oxygen balance at the economizer exit grid

Mercury reduction in air staging

- Dual furnace 200 MW t-fired unit equipped with SOFA
- Low sulfur bituminous coal
- c-s ESP

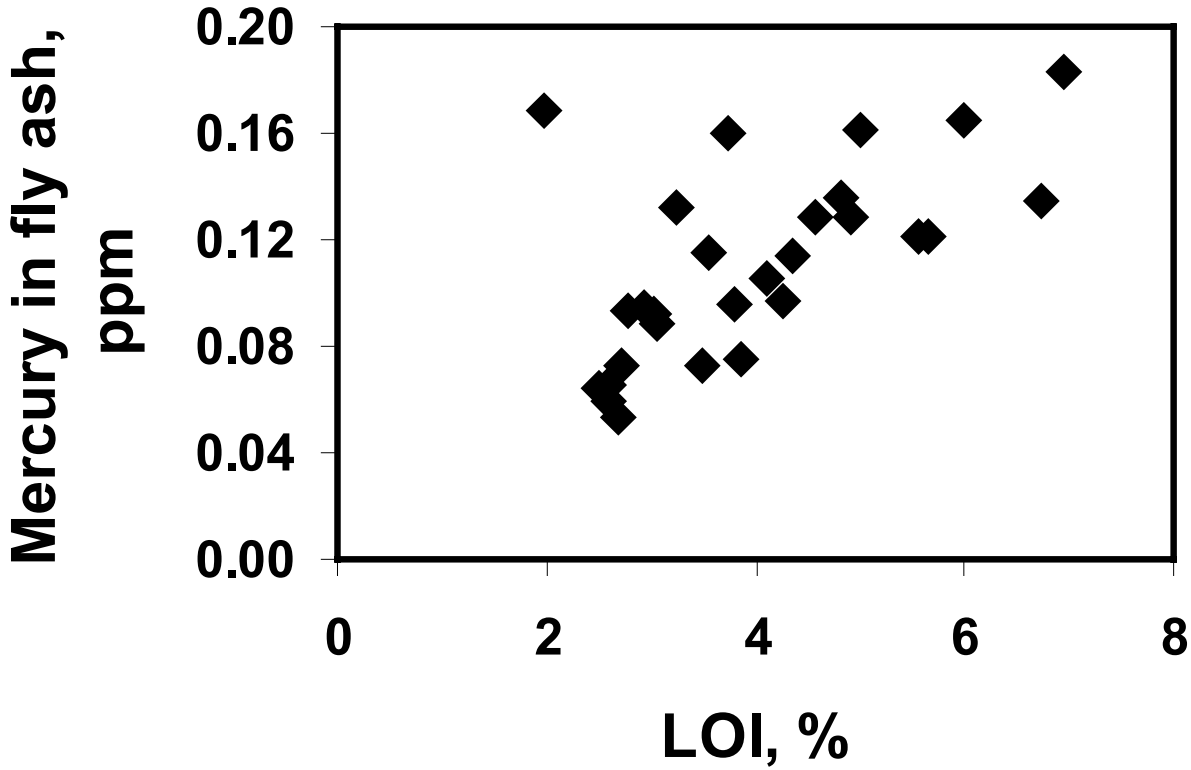
- Carbon tubes (EPA method 324)
- ESP inlet and outlet



Mercury removal increases with LOI increase

Decreasing temperature improves mercury removal

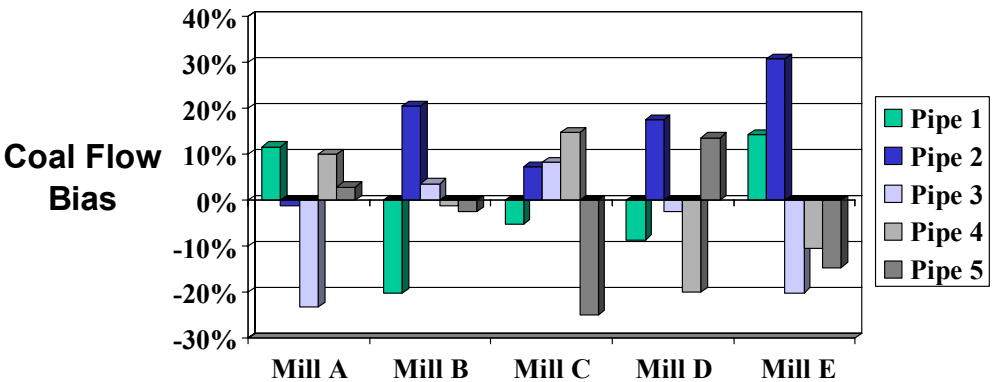
Mercury absorption on fly ash



Mercury absorption on fly ash increases with LOI increase

Combustion Optimization

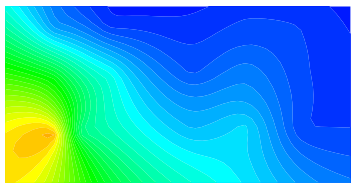
Boilers typically have poor coal flow distribution to burners



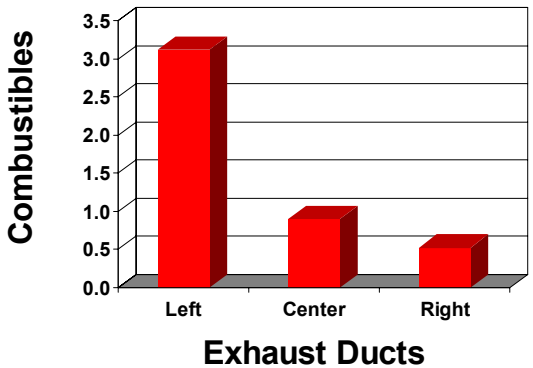
Coal Damper

Coal Flow Sensor

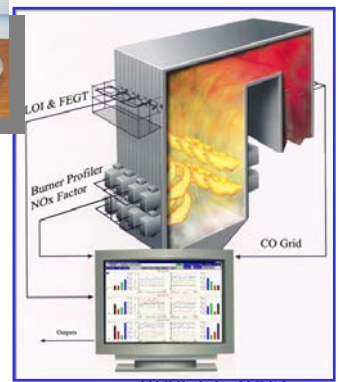
CO distribution in backpass



LOI distribution



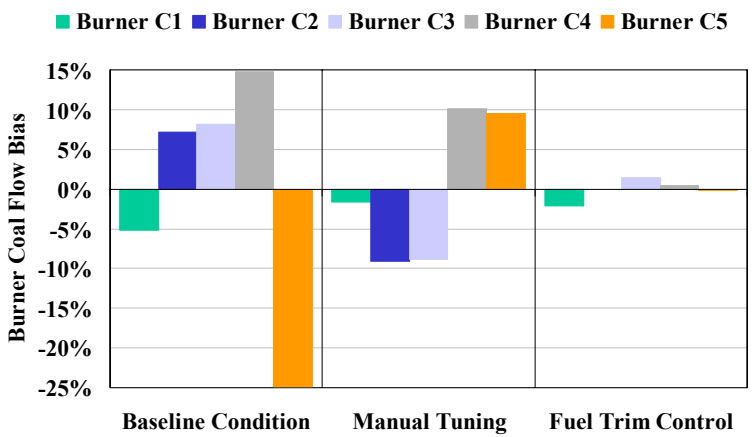
CO/O2 Sensor



Manual/Automatic control

Combustion Optimization

Fuel trim successfully tightens fuel distribution



Coal Damper

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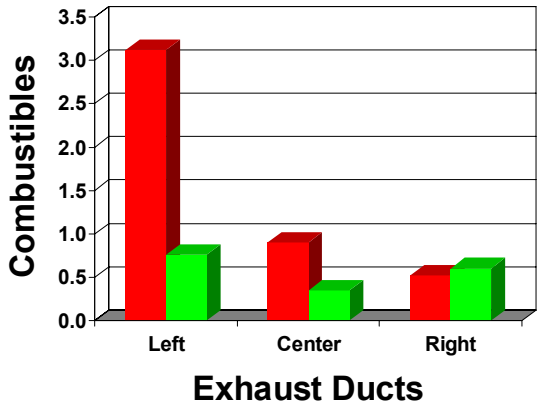
CO distribution in backpass

LOI distribution



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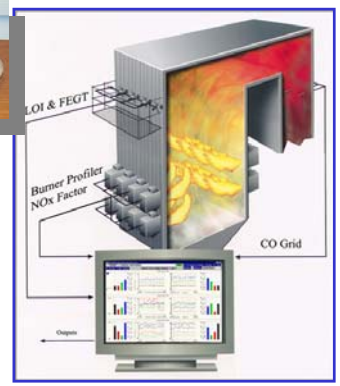
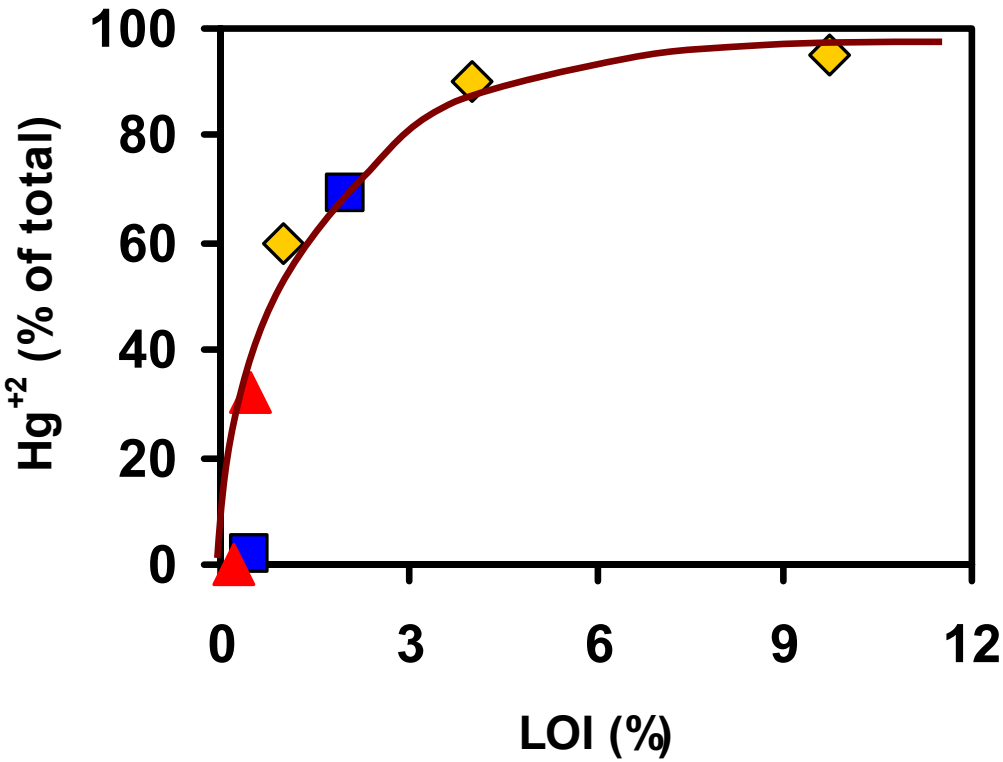


Manual/Automatic control

Mercury control for low rank coals

Data on mercury speciation



◆ Cl = 1,500 ppm
■ Cl = 200 ppm
▲ Cl = 40 ppm

Coal Reactivity

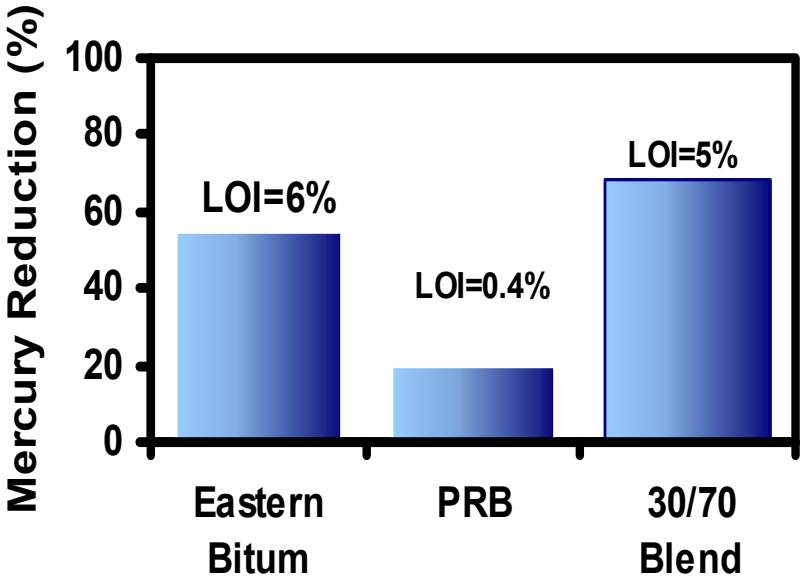
Low
Medium
High

Data at ESP Inlet

Mercury oxidation is catalyzed by carbon in fly ash
Coal blending may improve "natural" Hg removal for low rank coals

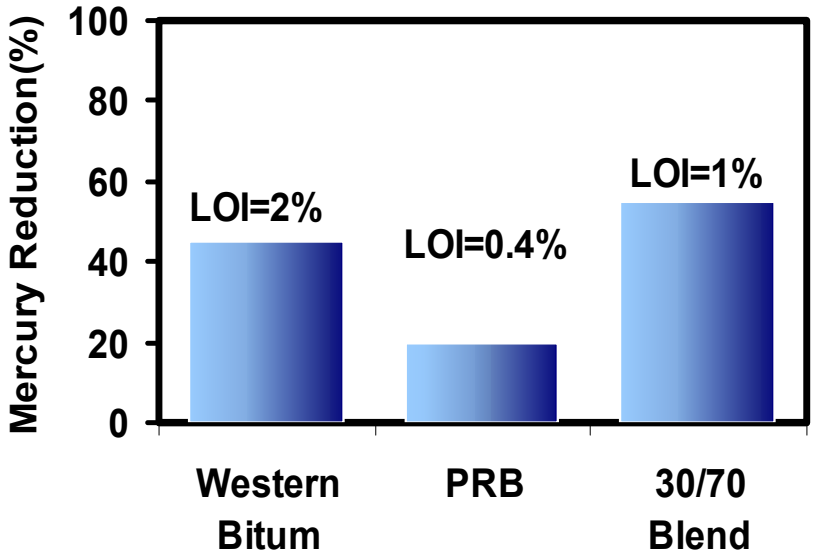
Blending PRB with Bituminous Coals

70PRB / 30 Eastern Bituminous



Eastern Bituminous coal – low reactivity coal with high Cl content

70PRB / 30 Western Bituminous



Blending improves Hg removal and catalyzes Hg oxidation

Coal properties affect behavior of coal blends

Summary

- **Combustion Modifications and Combustion Optimization - available, proven products**
- **Mercury solution is tailored to plant configuration**
- **Up to 80% mercury reduction**
- **CM/CO approach reduces mercury, NO_x, and CO, and improves combustion**
- **CM/CO approach can be applied in Phase I of mercury regulations to achieve early mercury reduction**