

Reinhold Environmental Ltd.



2010 NO_x-Combustion Round Table & Expo Presentation

February 8 & 9, 2010

Chattanooga, TN

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Boilers Burning High Iron/ High Sulfur Coals: Fuels Risk Mitigation

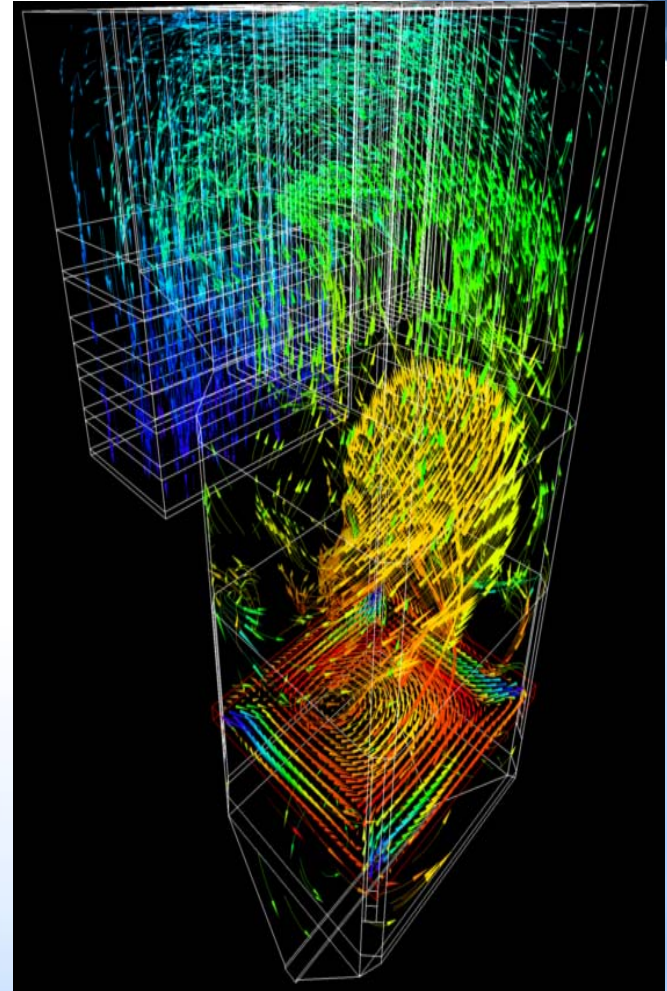
Chris R. Smyrniotis
Fuel Tech, Inc, Warrenville, Illinois USA

Areas Covered

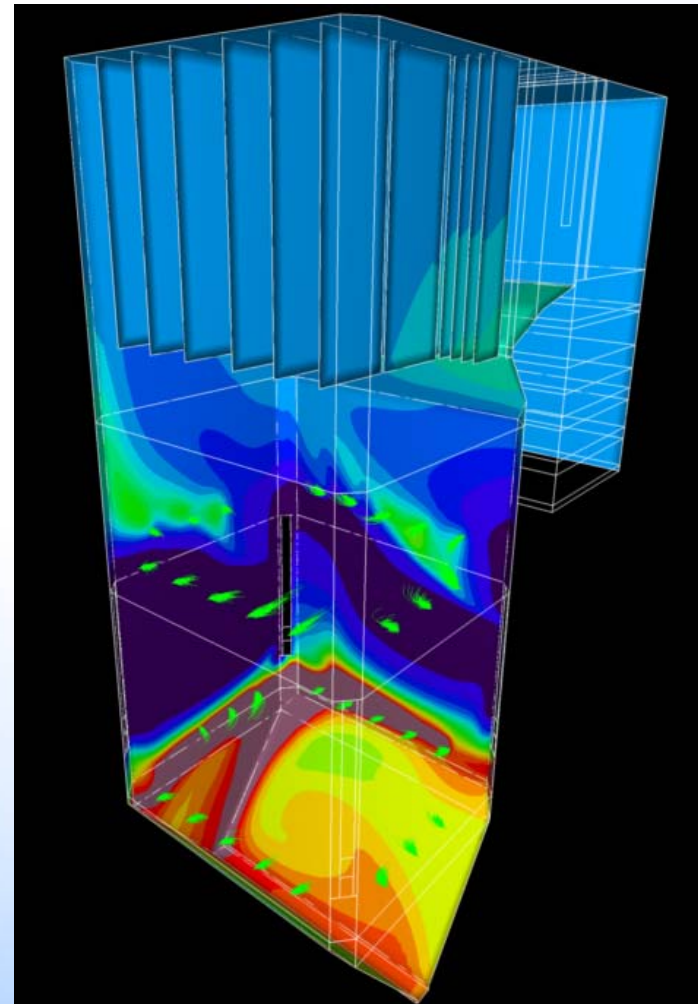
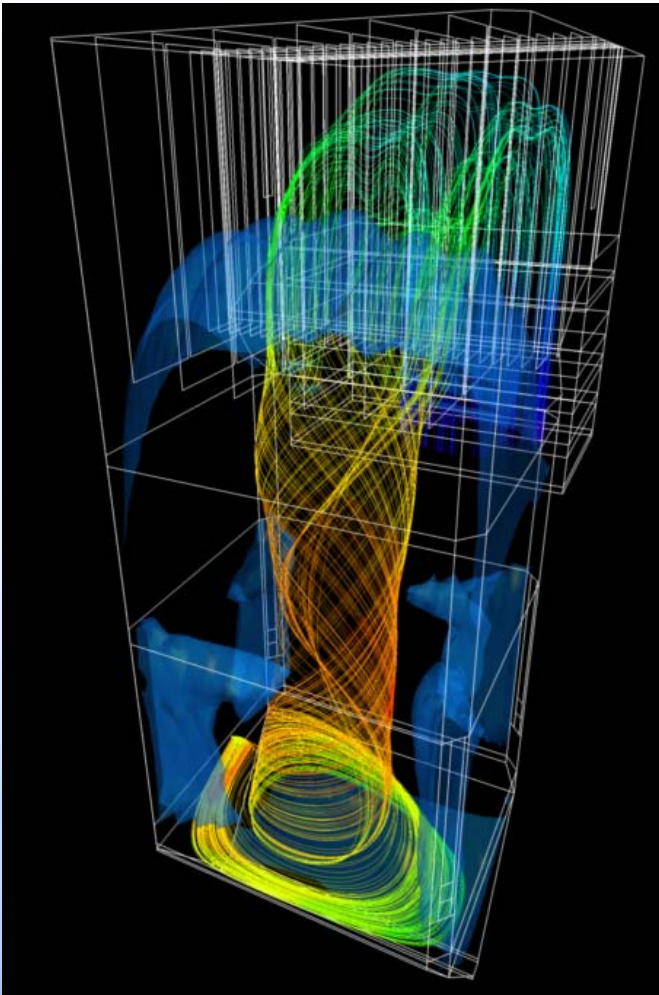
- **Key Technologies**
- **Background**
- **Industrial Boiler Case Study**
- **Utility Boiler Case Studies**

Key Technologies

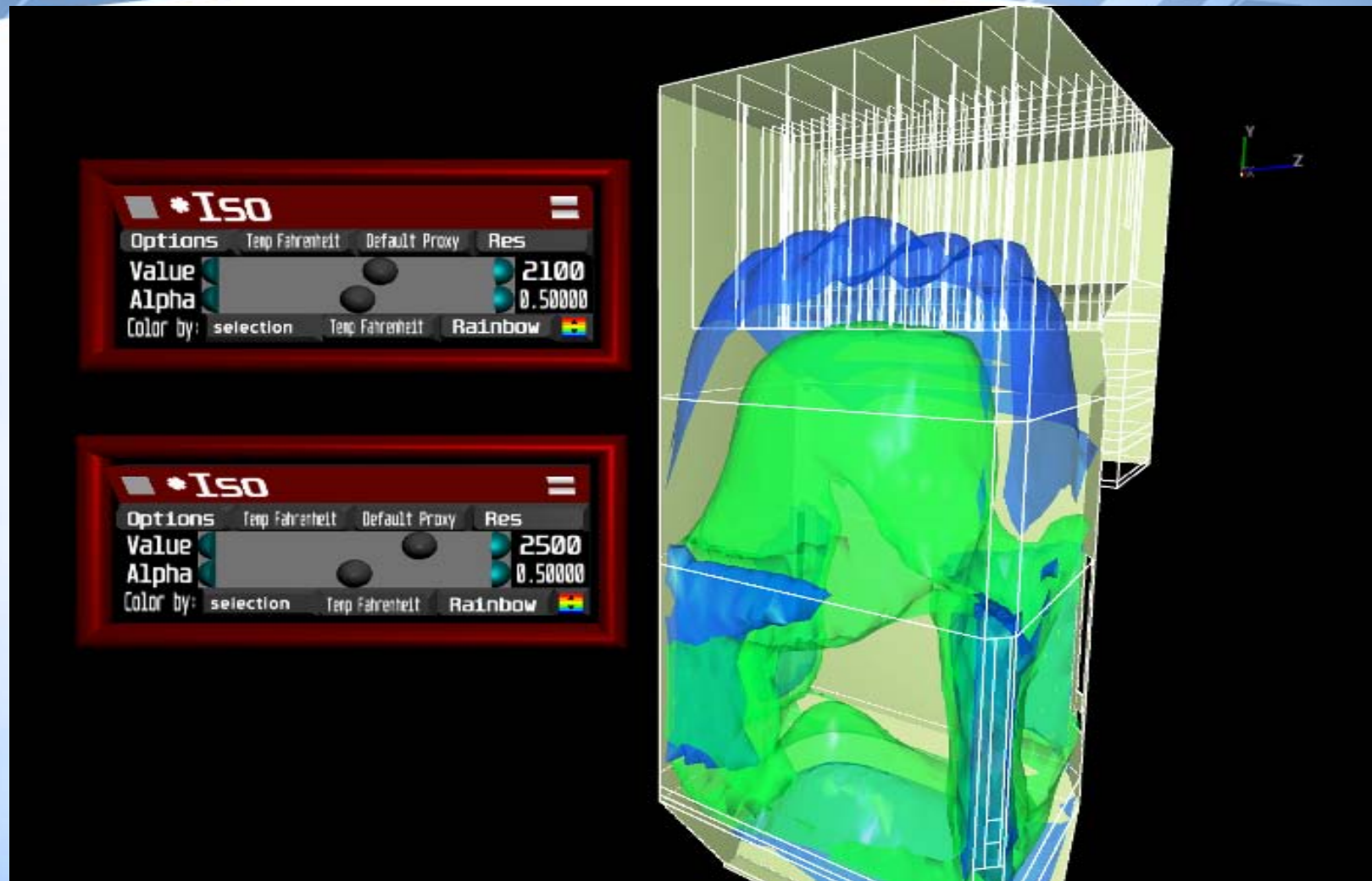
- **Computational Fluid Dynamics (CFD)**
- **Injection Technology**
- **Chemical Technology**
- **Combustion Expertise**



Prediciting what will form, where it will form and how to get the proper chemical to the correct place.
Result: Lower Fuel Risk + Lower Fuel Cost



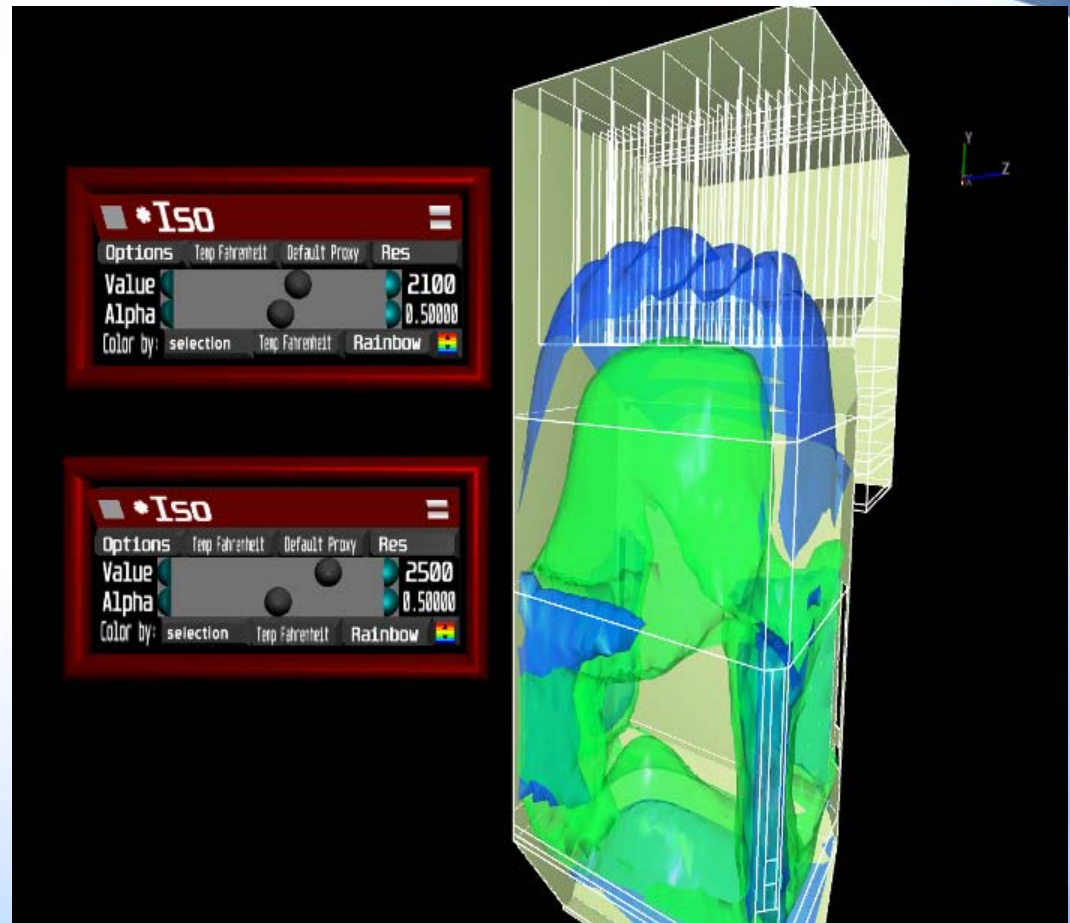
Virtual Reality CFD Inside Furnace View



Virtual Reality CFD - Inside Furnace View

- Boiler Designed to Burn Coal with Ash Fusion Temp = 2500°F (Green)

Coal With Ash
Fusion Temp =
2100°F Less
Costly (Blue)



Untreated ILB Coal Slag



17 12:55PM

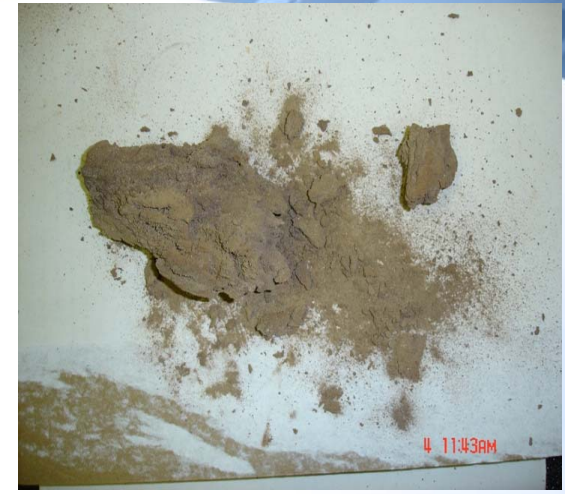
Slag Transformation Using TIFI Technologies



Untreated



Transition



Treated

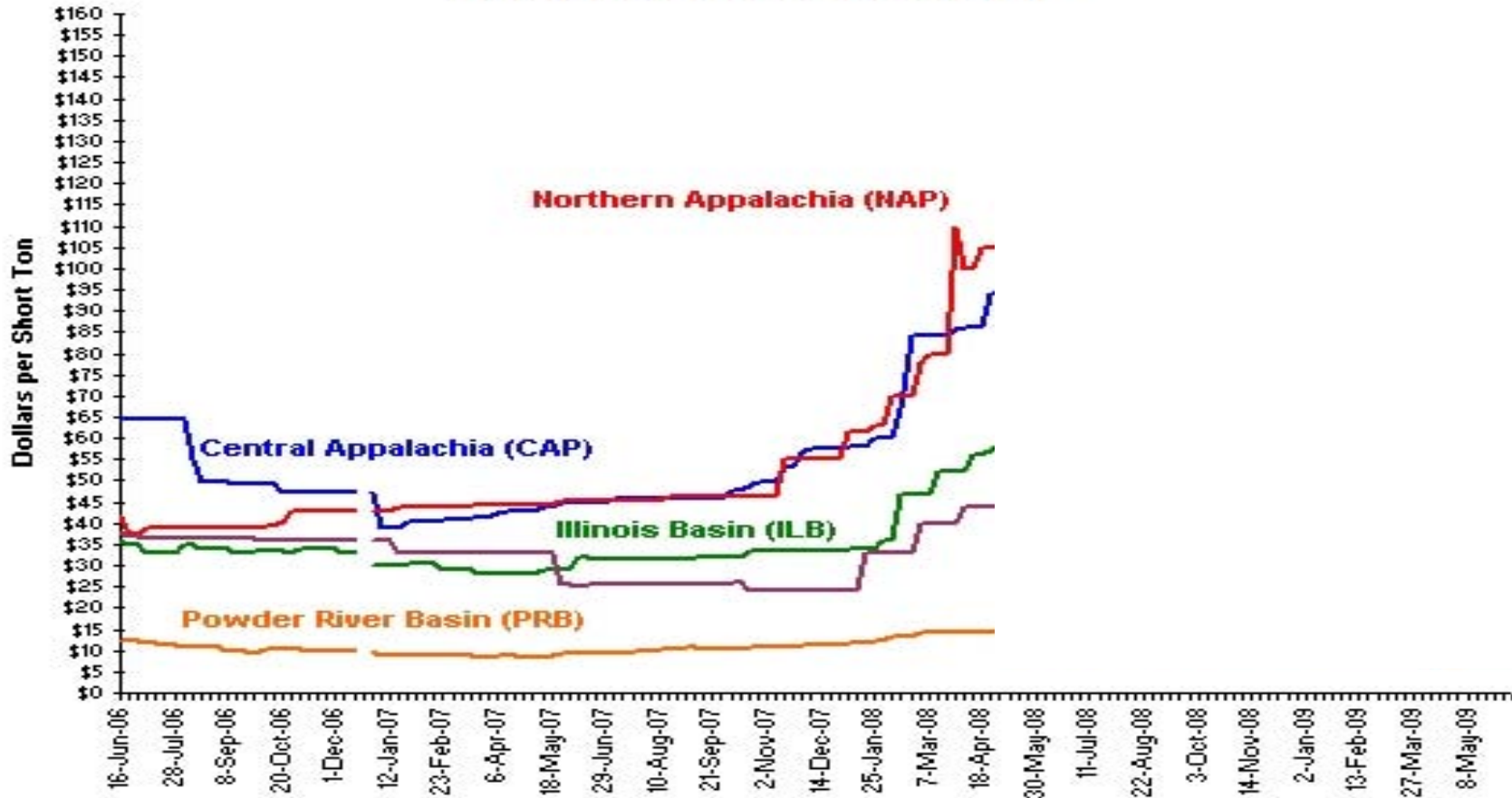
- Nano Technology & Eutectics Are Key
- New Technology is Highly Responsive
- Slag Changes Begin in Less Than 12 Hours

True Cost of Coal Switching

- Δ Contract Terms
 - Δ BTU Content
 - Δ Grindability
 - Δ Volatility (Housekeeping)
 - Δ Scrubbing
 - Δ SO₃ mitigation
 - Δ Ash Handling/Revenues
 - Δ Coal Handling Costs
 - Δ Higher Chlorides and/or Sulfates
 - Δ Freight
-
- Total Cost

Coal Prices

Historical Average Weekly Coal Commodity Spot Prices
(Dollars per Short Ton)
Business Week Ended June 12, 2009



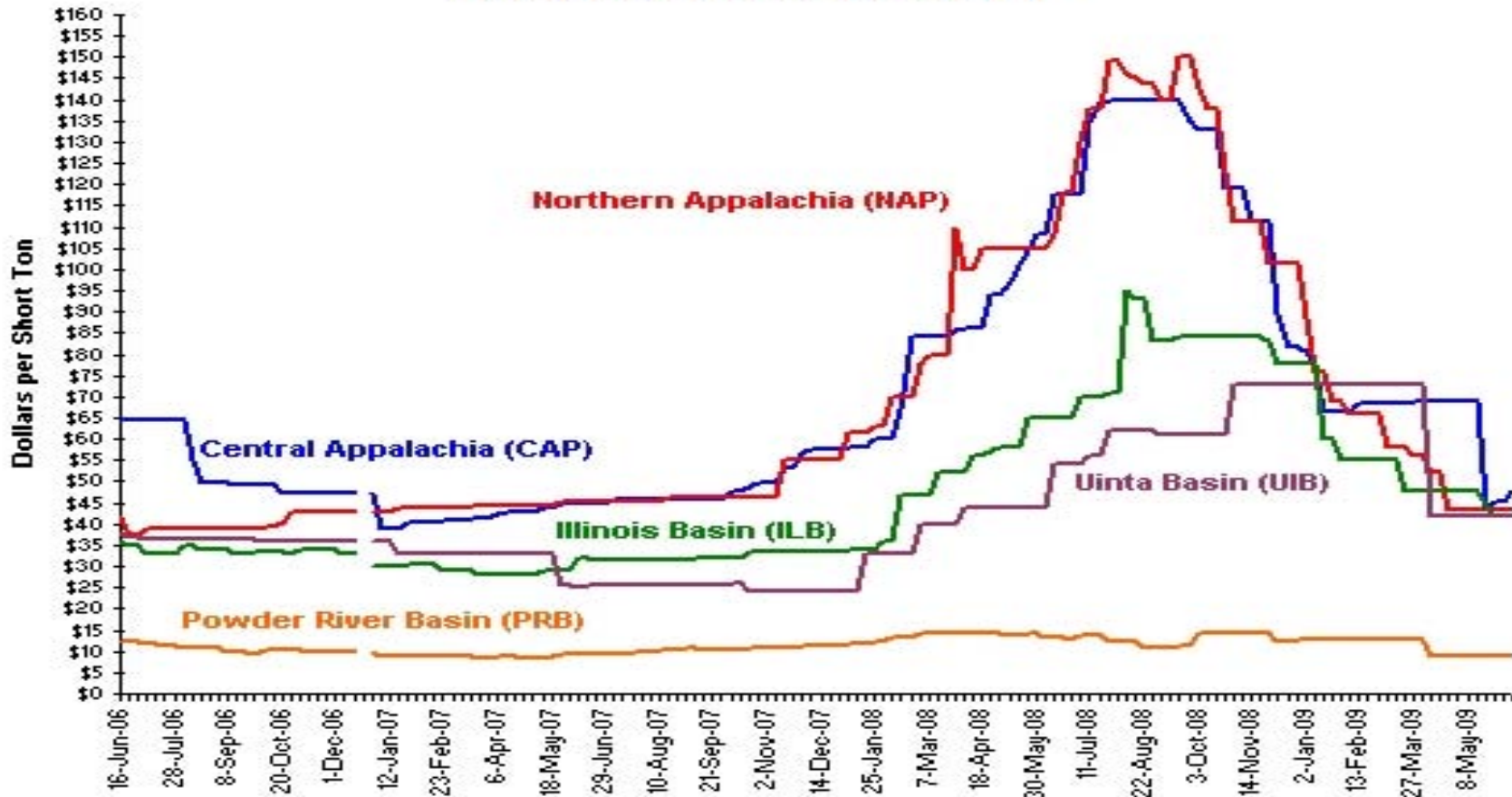
Key to Coal Commodities by Region¹

Central Appalachia: Big Sandy/Kanawha 12,500 Btu, 1.2 lb SO₂/mmBtu
Northern Appalachia: Pittsburgh Seam 13,000 Btu, <3.0 lb SO₂/mmBtu
Illinois Basin: 11,600 Btu, 5.0 lb SO₂/mmBtu

Powder River Basin: 8,600 Btu, 0.8 lb SO₂/mmBtu
Utah Basin in Colo.: 11,700 Btu, 0.6 lb SO₂/mmBtu

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Uinta Basin in Colo.: 11,700 Btu, 0.6 lb SO₂/mmBtu

Changing Conditions

- **Pacific (China) Imports of U.S. Coal Move Up/Down**
- **Spot Market Prices CAPP Close to ILB**
- **Contract Prices of CAPP Up \$20 vs. ILB**
- **Dozens of CAPP Permits Denied (97 in Limbo)**
- **Price Spread Expected to Widen**
- **Economy Up, But Unsettled**

The ACALAT Concept



Any Coal

Any Load

Any Time

Manage the SLAG RISK box

Results of Using TIFI Technologies

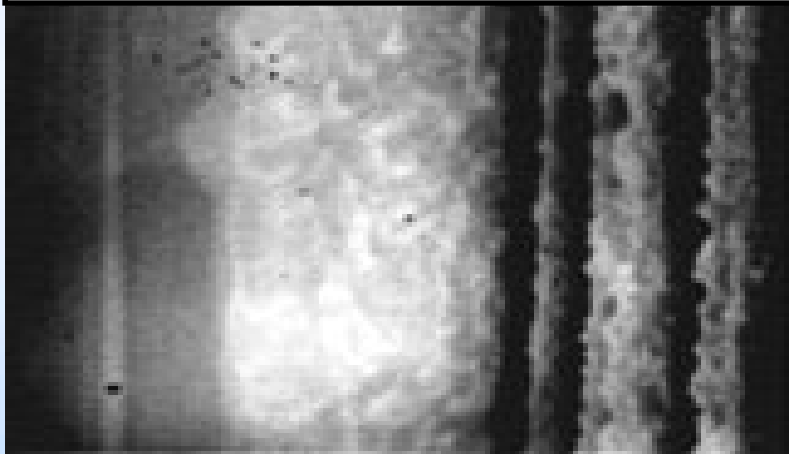
- Ability to Burn Less Expensive (More Problematic) Fuels
- Avoid Derates due to Slag/Fouling
- Better Heat Absorption
- Overall Increased Efficiency (2%)

TIFI Targeted In-Furnace Injection Case History I

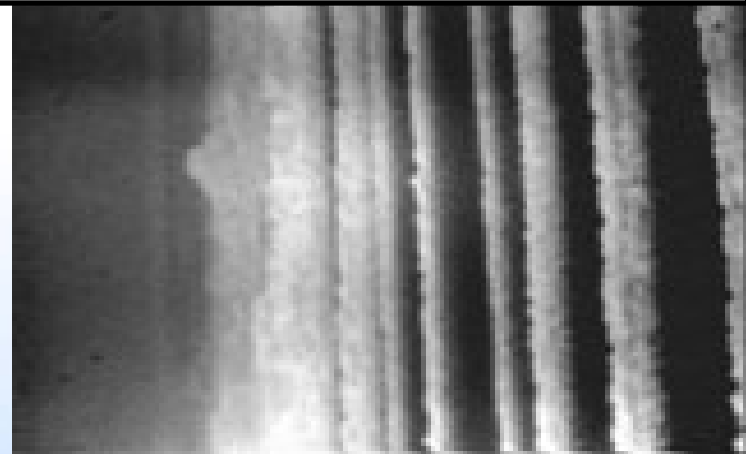
- **Beta Site Selected in 2008**
- **Client Highly Motivated to Reduce Fuel Cost**
- **Δ Price Between CAP & ILB \$25 - \$80/ton (at the time)**

Typical Coal: Case History I

- Fe_2O_3 = 26.7%
- Al_2O_3 = 21.59%
- SiO_2 = 43.43%
- CaO = 2.04%
- Na_2O = 0.3%
- K_2O = 2.17%
- S (dry) = 4.4%

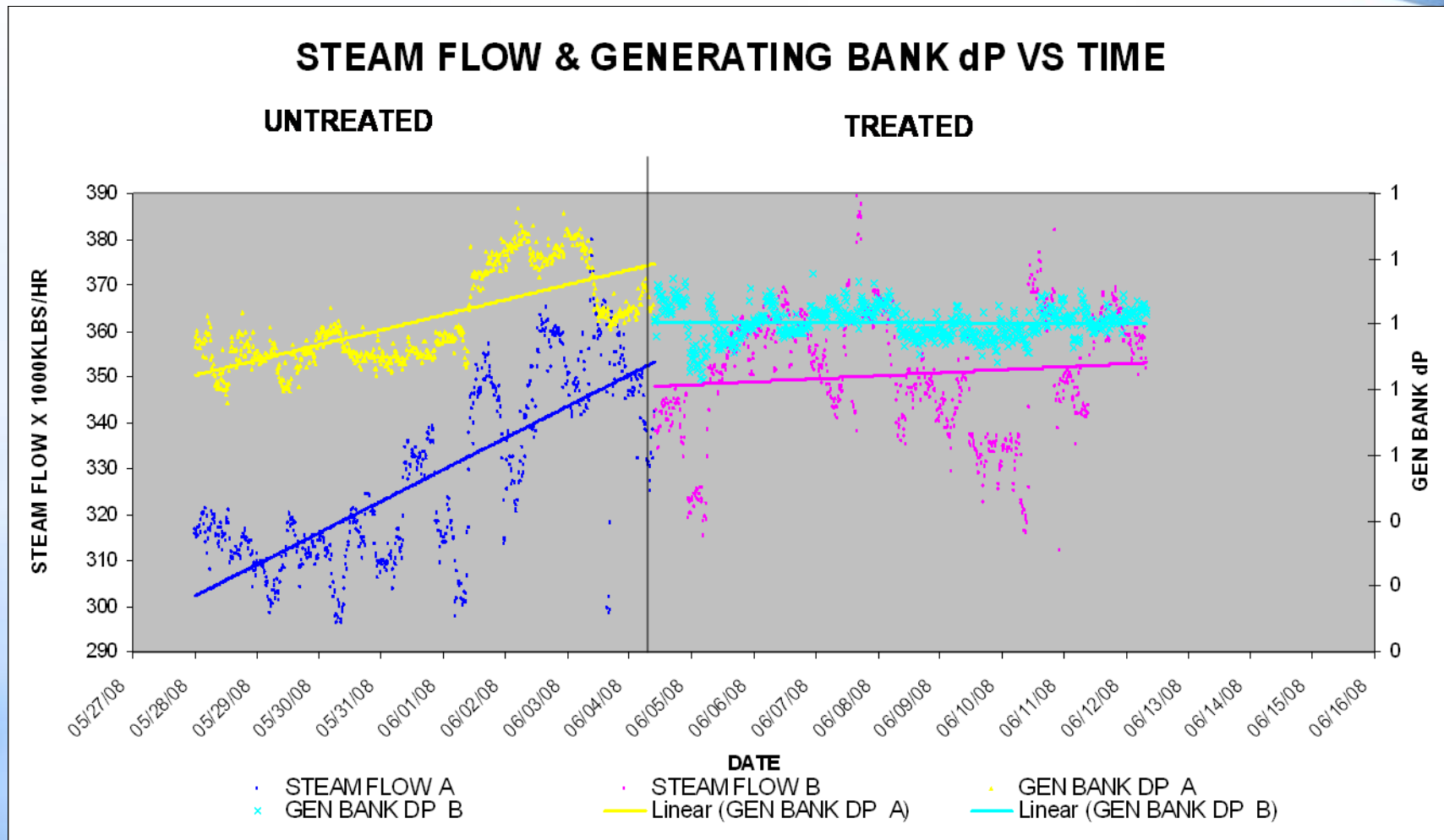


Before Treatment

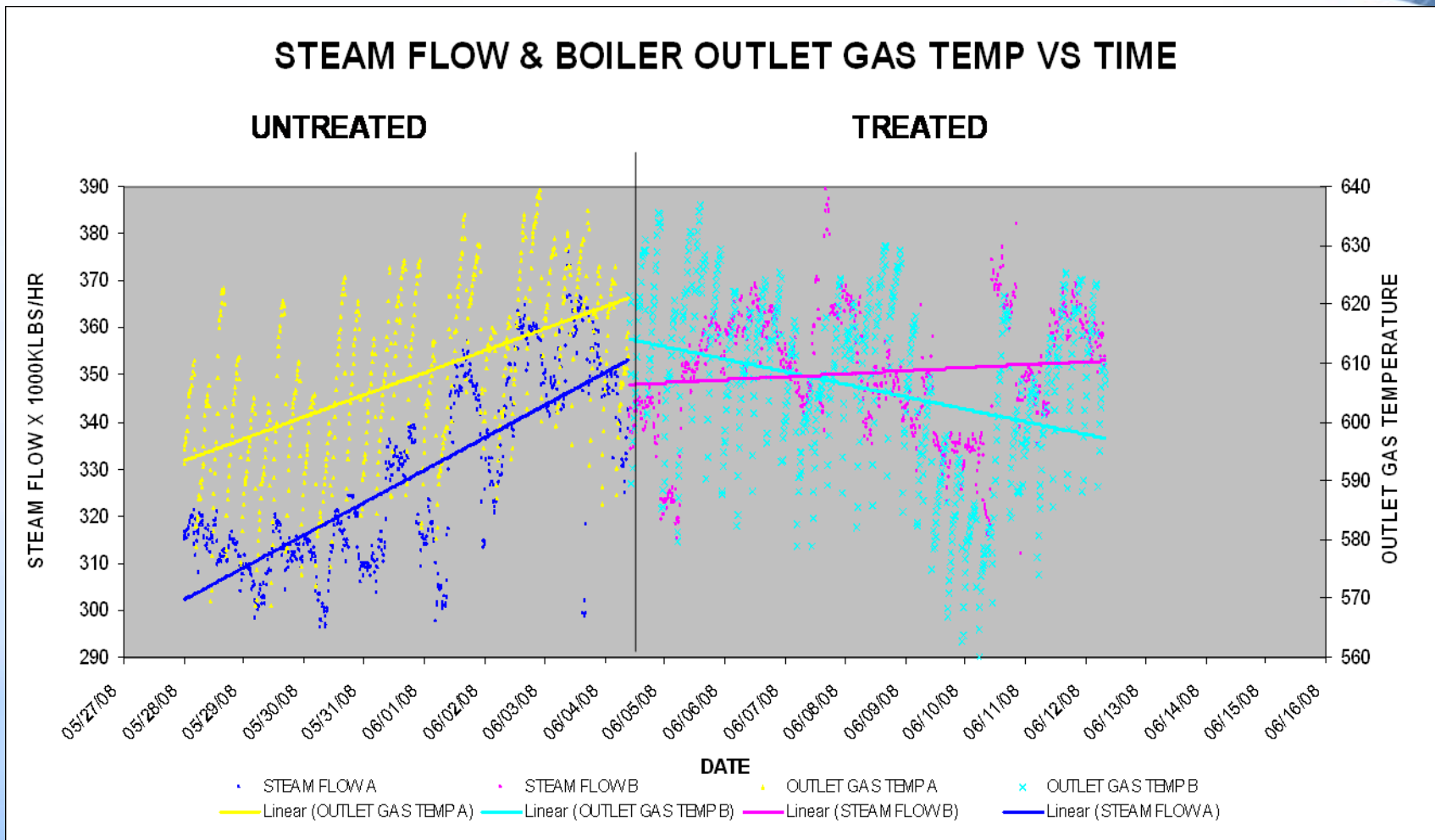


After Treatment

TIFI Technology in High Fe/S Coal Environment Case History I

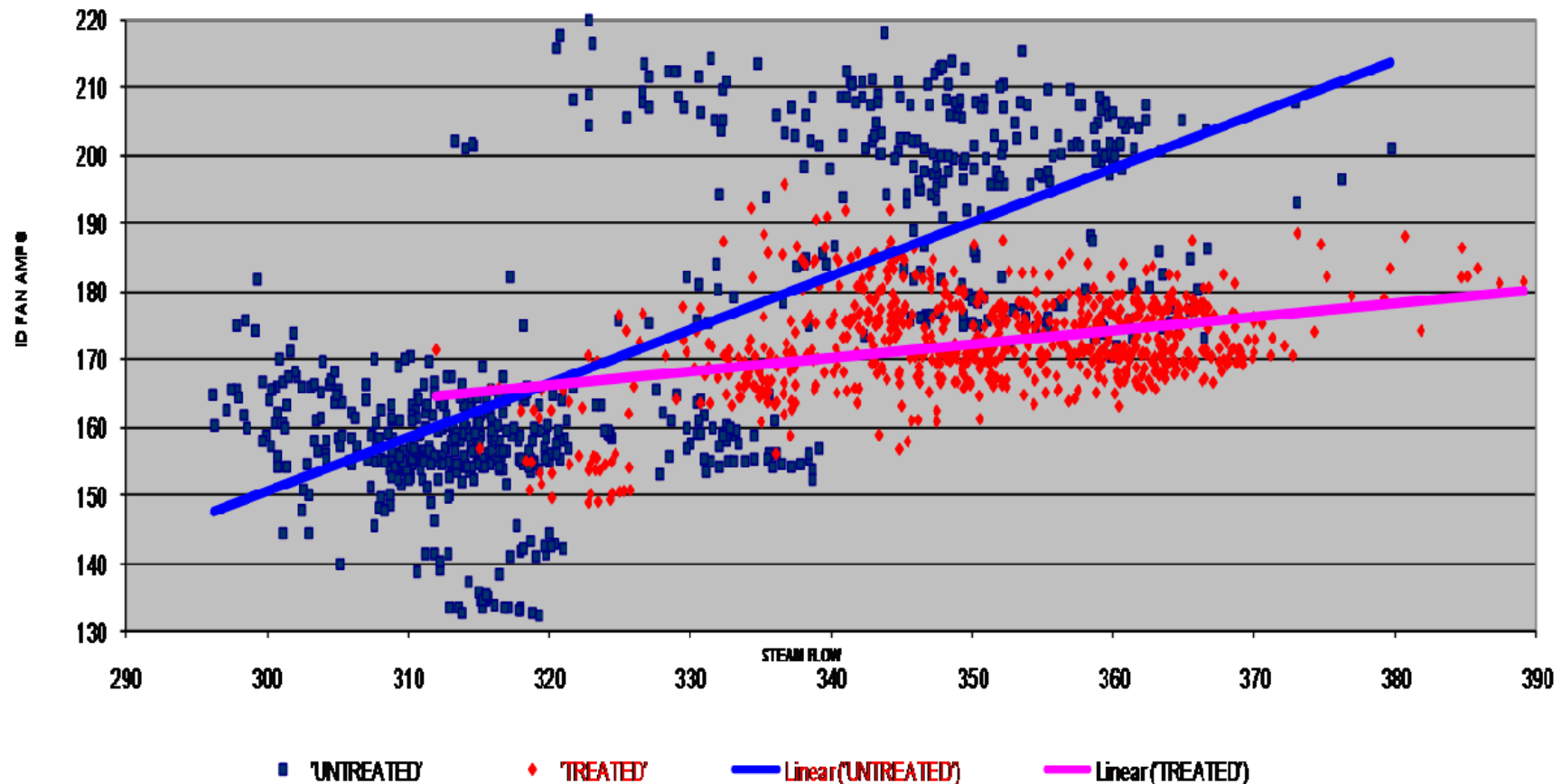


TIFI Technology in High Fe/S Coal Environment Case History I



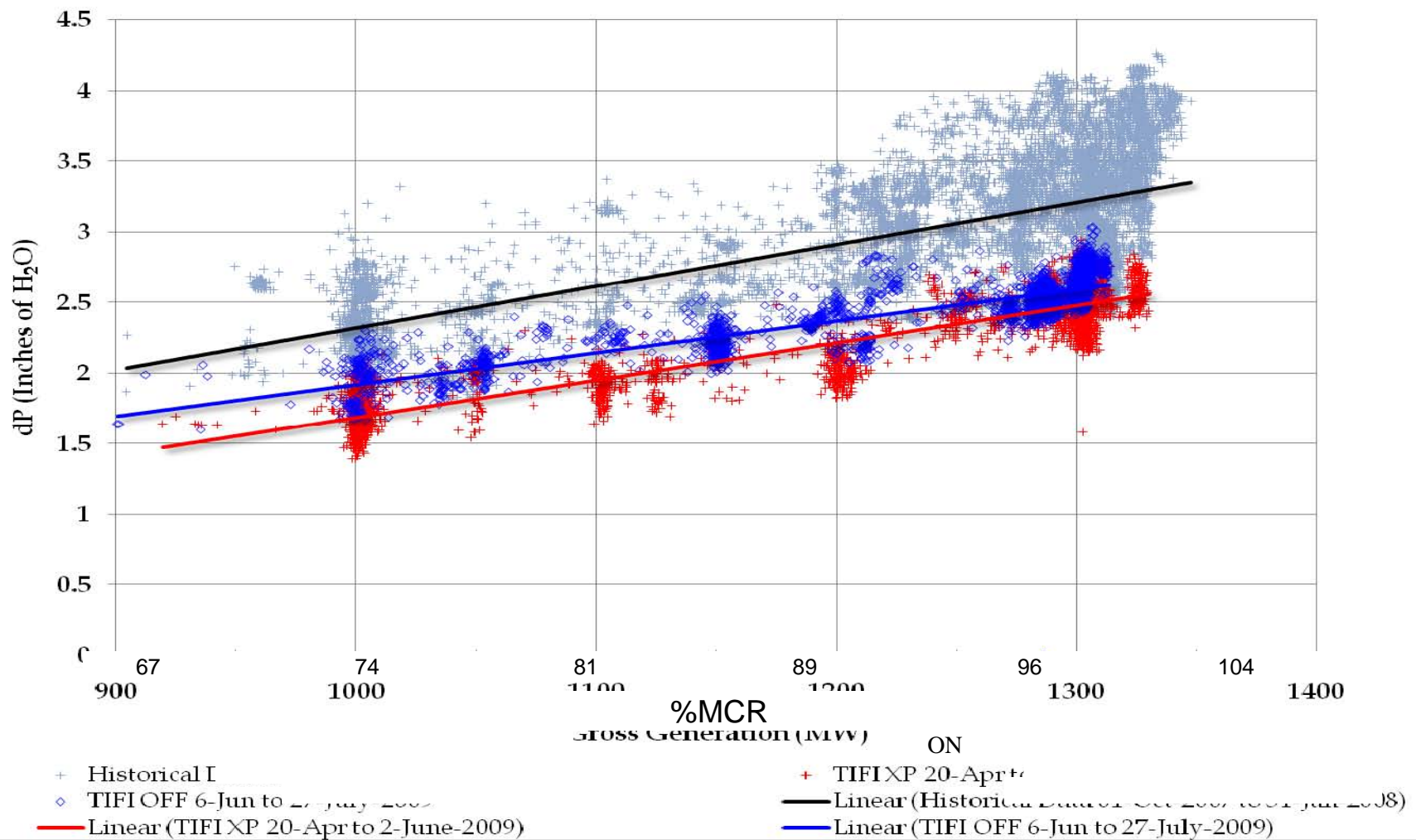
TIFI XP in High Fe/S Coal Environment Case History I

ID FAN AMPS VS STEAM FLOW

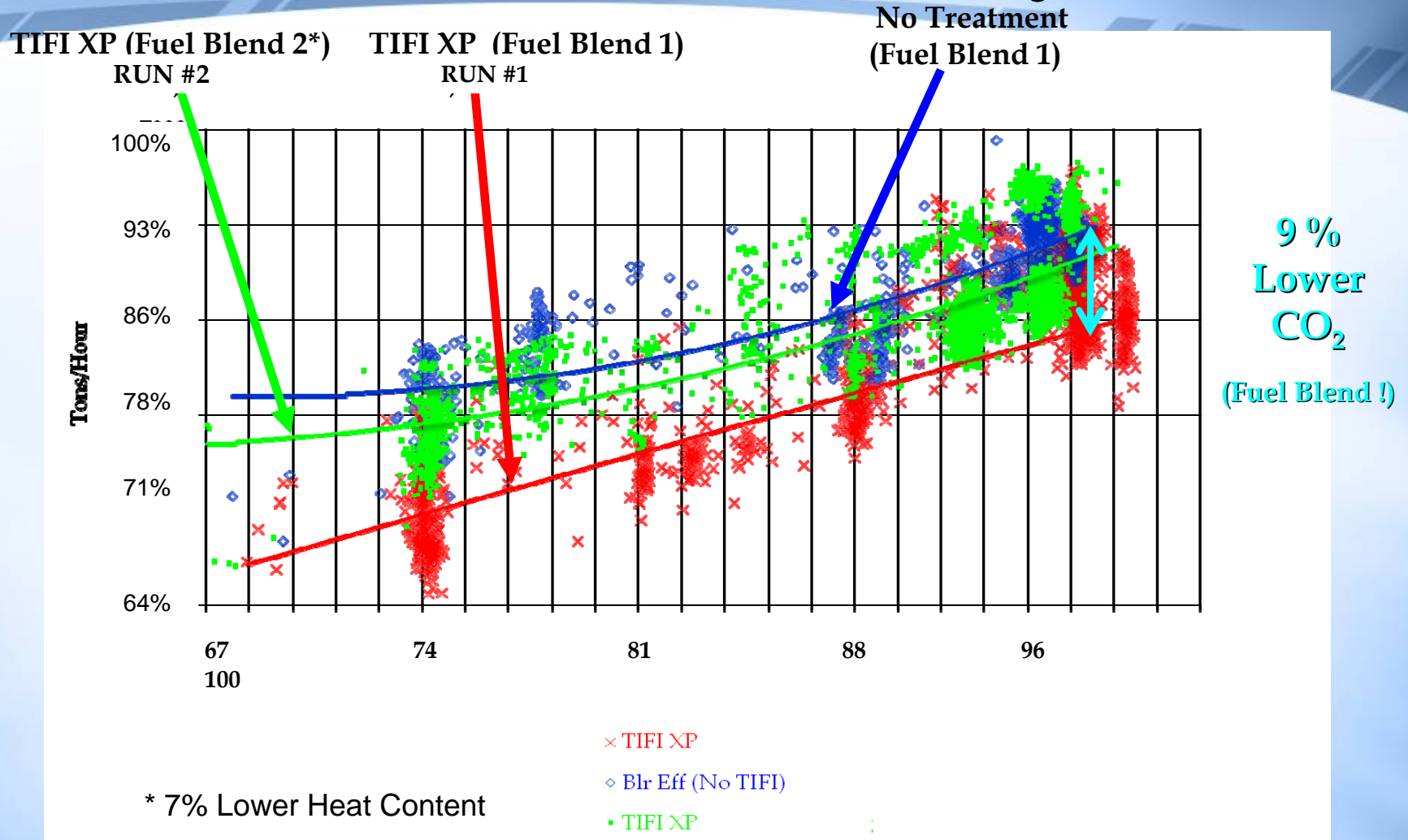


PSH & RH dP Vs % MCR

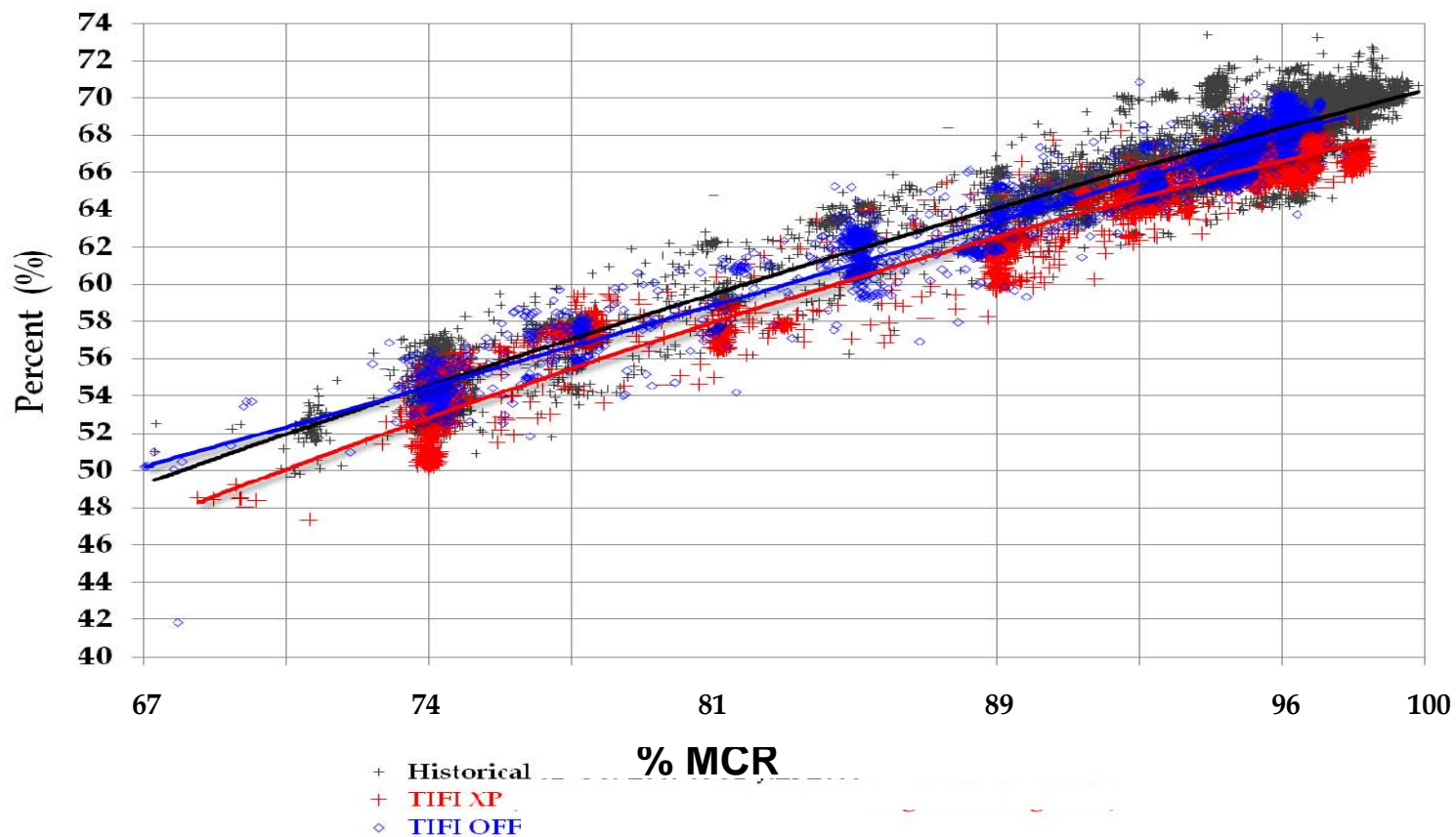
Case History II



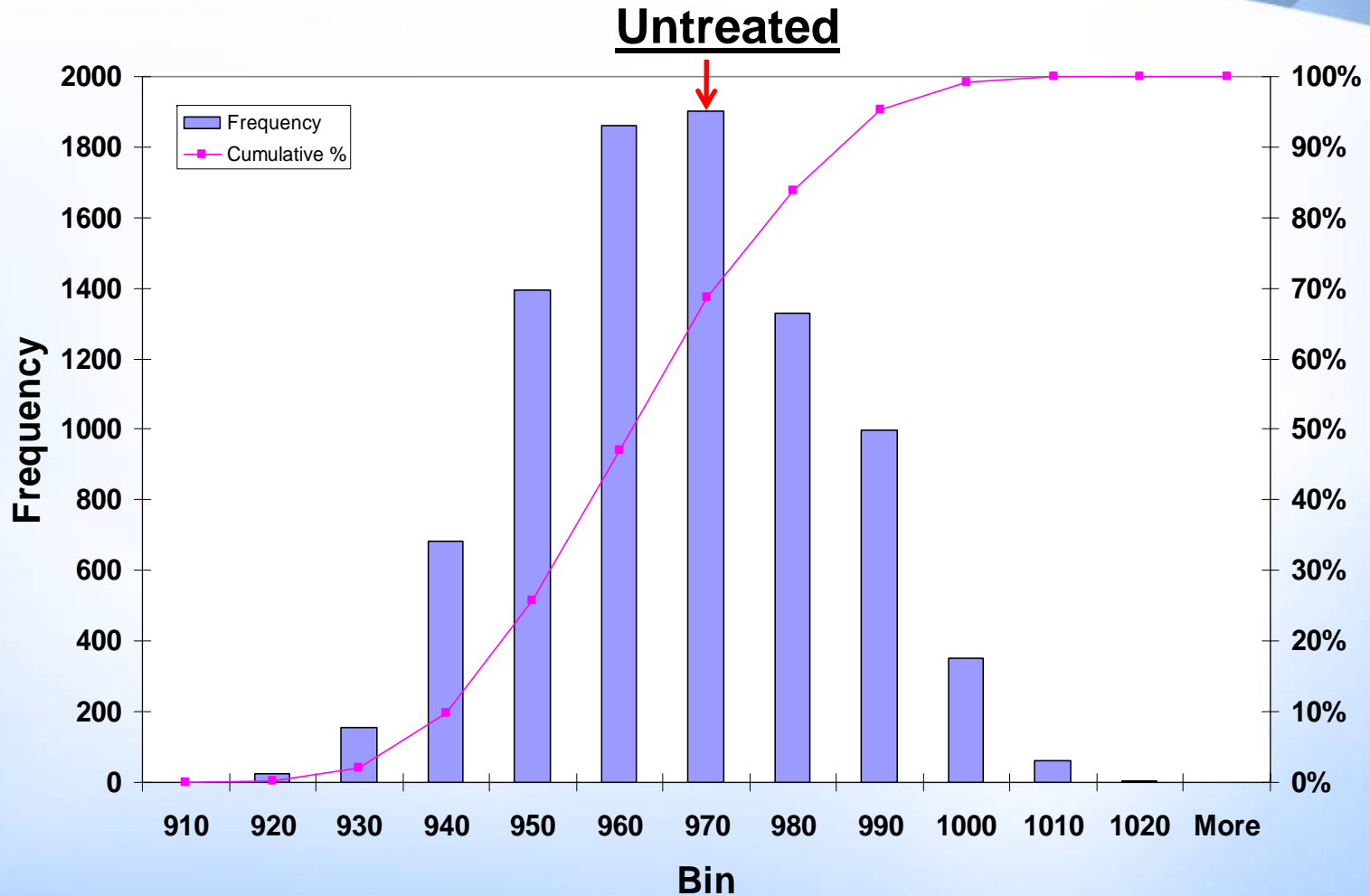
Calculated % Flue Gas Flow Vs % MCR (Case History II)



Total Fuel Flow (%) Case History II

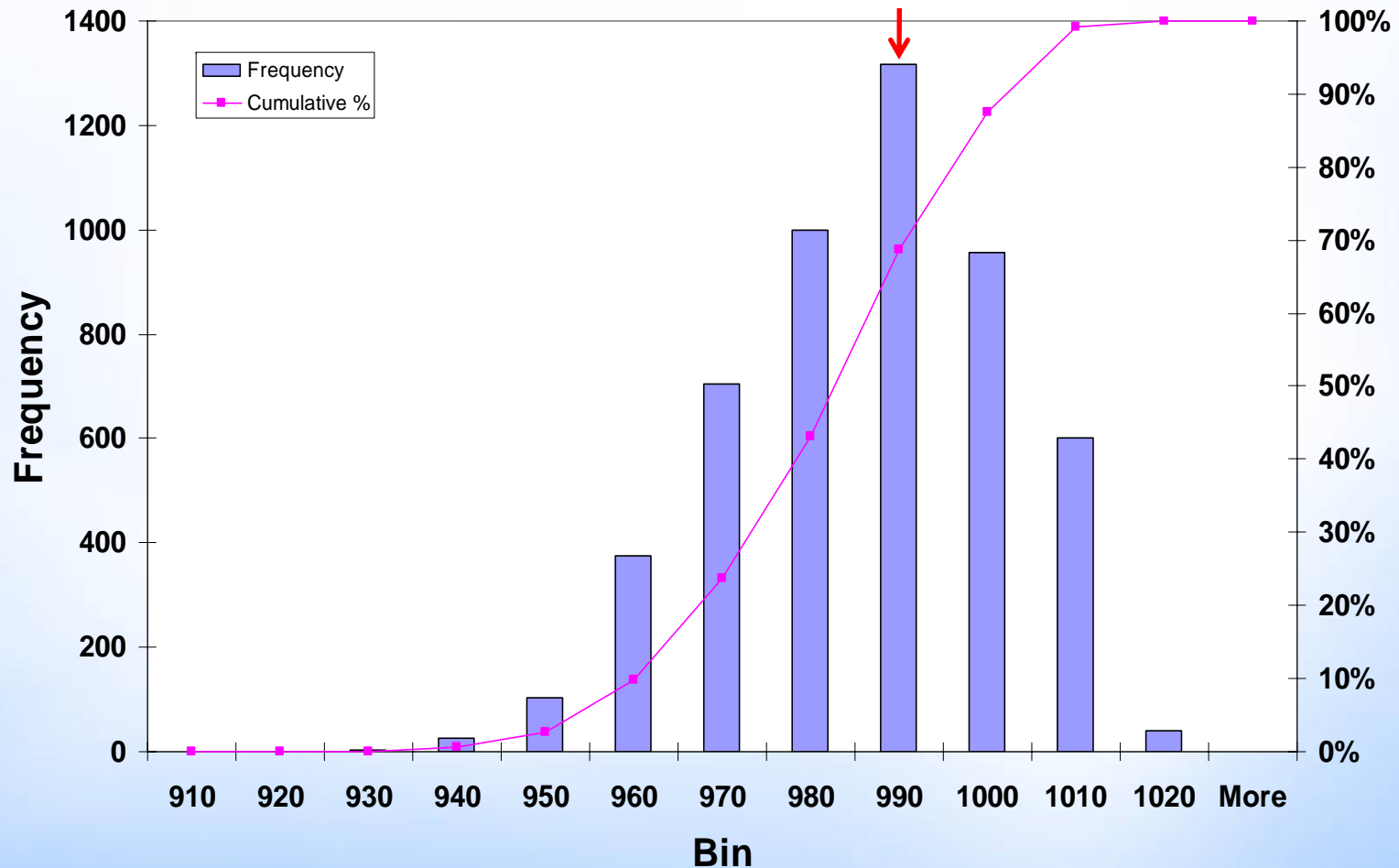


Steam Temperature Recovery Case History III



Steam Temperature Recovery Case History III

Treated (+ 20°F)



Comparison of Technologies

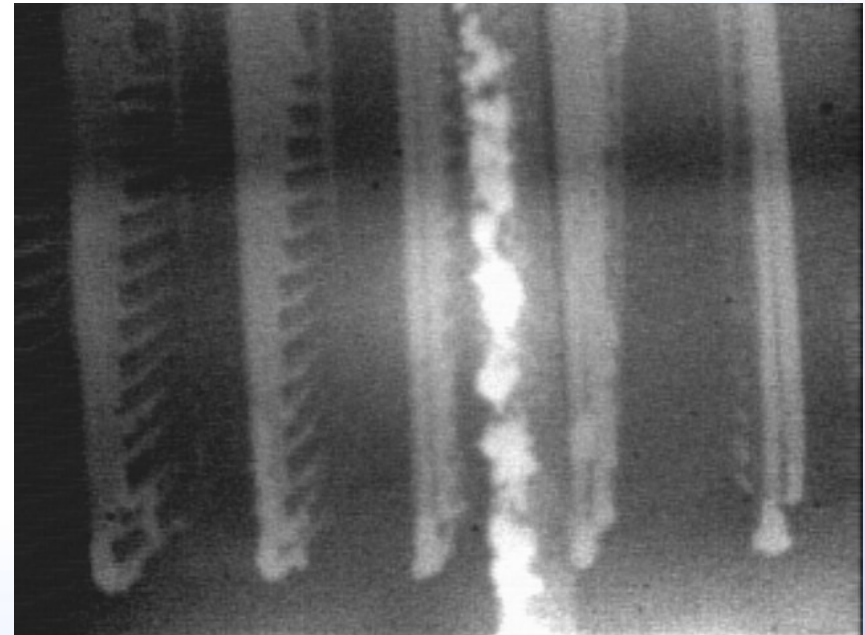
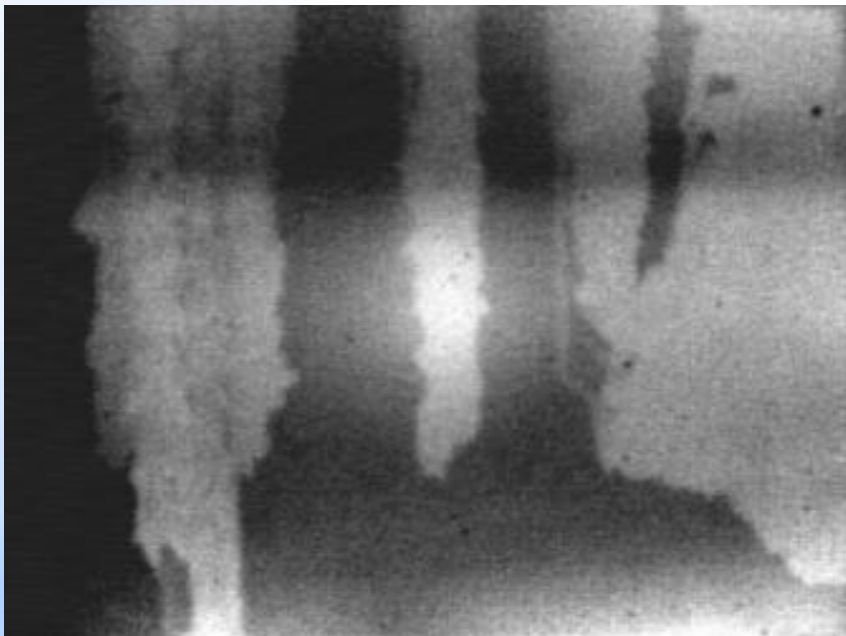
Technology	Feature	Results
Conventional Feed to Fuel Belt	Applied to Fuel Belt	Simple to Use Not Precise
Conventional Feed to Fuel Belt	Kerosene Carrier	Adds BTU Content to Fuel
Conventional Feed to Fuel Belt	Economical Application	Not Successful at Economical Doses
Conventional Feed to Fuel Belt	Kerosene Carrier	Flammable Toxic Fumes
TIFI-XP (Targeted In Furnace Injection)	CFD Modeling & Multi-Injector Feed Required	Near 100% Coverage & High Performance at Low Doses
TIFI-XP	Modifies Crystal Structure of Ash	Reduces Deposit Hardness
TIFI-XP	Cleans 90%+ Heat Transfer Surfaces	2% Efficiency Increase & More MW w/Lower Cost Fuels

Conclusions

- **Supply/Demand Economics
Complements TIFI Technologies**
- **TIFI Technologies Outperformed
Conventional Chemical Programs**
- **Clean SHs Mean Downstream Heat
Transfer Surfaces Remain Clean**
- **Additional Benefits of the New
Technology = 1.5 - 2.0% Efficiency
Increase**

Photos Confirm Numbers

UNTREATED



TIFI-XP TREATED

- 3% MORE MW
- 2% MORE EFF.
- 9% LESS CO₂