Combustion Optimization for Coal-Fired Boilers

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The problem ...
Poor combustion result in many performance issues.

- Increased Steam Spray
- Economizer O₂ Imbalance
- Increased FEGT (Furnace Exit Gas Temperature)
- Local Slagging
- Local Hot Spots
- Local Corrosion
- Local Fouling
- Increased Excess O₂
- Reduced Efficiency
- High NOx
- High Carbon in Ash, eg. LOI (Loss on Ignition)
- Reduced Throuput (Load)
- High CO

Combustion profile as monitored by Spatial Sensors
The major lost opportunities result from poor combustion.

Fleet-wide lost opportunity cost can be over $80 MM per year.
Improved burner operation drives performance gains.

- Fuel Savings
- Output (Throughput)
- Emissions Credits
- Availability & Peak Power

High CO Burners Limit Performance
Solutions ...
Components ...

Coal Flow Dampers

Burner Airflow Controls

Coal Flow Sensors

Combustion Sensors

Zonal™ Combustion Controls

Combustion Tuning Model
Zonal™ combustion control system ... how fuel & air controls work together.

Zonal Fuel Trim - coarse controls for combustion shaping:
- Optimize wall-burner firing
  - Reduce impingement
- Reshape tangential fireball
  - Centered and round
- Tune furnace fuel distribution
  - Balance economizer O₂
  - Divert heat loading from peak FEGT & slag regions

Zonal CO Trim - fine controls for combustion balancing:
- Trim furnace zonal air/fuel ratios based on sensor grid
  - Balance CO
  - Reduce hot spots
  - Reduce delayed combustion
  - Maintain burner flame
  - Reduce LOI
  - Reduce excess O₂
Fuel control can reduce temperature and CO zones ... the precursors to slag.
Automatic Fuel Trim controls are successful at tightening distribution.

First Demonstration August 2003

Burner Coal Flow Bias

As-Found Manual Automatic

Coal Distribution

Burner C1
Burner C2
Burner C3
Burner C4
Burner C5
Balanced and optimized coal flow distribution reduced peak FEGT 60°F.
20°F Peak FEGT limited boiler capacity approximately 10MW.
Zonal™ combustion monitoring system

- Modeling (upgrade)
- Sensor Array
- Flow and Control Panel
- Interface Display
Zonal™ combustion model-based control system.

Monitoring & Control Interface

Combustion Trim Model
Zonal™ combustion tuning system demonstration.
Systematic tuning balanced CO and fly-ash LOI ... synergistic with Hg control.
Zonal™ combustion control system features:

- Faster tuning experience
- One system for managing Zonal™ combustion
- Improves quality through systematic methods
- Advises burner adjustments
- Stores preferred burner setting by operating mode
- Diagnoses combustion performance
Benefits ...
Combustion Optimization – Case Study

Sunflower Electric 380 MW Boiler

Scope:
> GE coal flow monitors & control
> GE combustion sensors
> GE boiler tuning services
> GE control software

System Benefits:
> Reduced peak FEGT 60°F
  - Eliminated barrier to increasing output 10 MW worth $1M/yr
> Reduced high CO and temperature zones
  - Avoid future slag outage 1 weeks worth ~ $2.5M/yr
> Reduced NOx and Heat Rate
Zonal™ combustion controls benefits:

- Reduce average and peak FEGT
- Reduce fuel rich (CO) zones
- Reduce corrosion
- Reduce slagging
- Reduce LOI
- Reduced NOx
Good combustion provides significant benefits.

Improvements:

- Excess O\(_2\): 0.5% reduction
- Emissions (NO\(_x\)): 15% reduction
- Heat Rate: 0.4% improvement
- Peak Power: 2.3% increase
- Availability: 1 week avoided outage

Economic benefits are site-specific. Your plants benefits may vary.

Economic assumptions provided in notes.