Improving Power Plant Efficiency and Power Generation

August 8th, 2013
Coal Creek Units #1 and #2…

- 2 X 600 MW Natural Circulation
- Tangentially Fired, Dual Furnace
- 8 X 8 burners, plus SOFA
- Eight Pulverizers per Unit
- Mine Mouth, ND Lignite
  - 6,200 BTU/lb (14.4 MJ/kg)
  - 38% moisture
- Commissioned 1979, 1981
- Base Loaded
- Wet FGD’s, No SCR’s
- Closed Loop Cooling
Efficiency Improvements: GRE

- Turbine blades
- Cooling Towers
- Simulator
- Ventilation
- Variable packing

- Coal Drying/beneficiation

- Fans
- Controls
- Leak detection
- Compressed air

- 605,771 tons
- 4%, 400,000 tons
Problem Statement:

- Plant performance is based on 6,800 BTU/lb (15.8 MJ/kg) fuel (with normal margins), but delivered fuel HHV has rarely exceeded 6,200 BTU/lb (14.4 MJ/kg)

- As a result:
  - Lost Boiler And Cycle Efficiency
    - 9% Higher Coal Flow Rate Than Design
    - 20 MW Of Station Service Power
    - 20% Higher Flue Gas Flow Rate Than Design
    - High Exit Gas Temperature
  - Lost Spare Mill Capability
  - Increased Operating And Maintenance Costs
  - **Flue Gas Flow Limited Scrubbers!**
DryFining™ Process

DryFining Technology

Less Moisture Lowers:
- Exit Gas Temperature
- Exit Gas Volume
- Exit Gas Velocity
- Power for Mills
- Power for FD & ID Fans
- Duct Erosion & Maintenance

Increased Efficiency Throughout

Lower Moisture Fuel

Less SO₂
Mercury
Ash
CO₂

Electrostatic Precipitator or Baghouse

Stack

Sulfur Dioxide Scrubber

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GREAT RIVER ENERGY®
A Touchstone Energy Cooperative
Solution

- **Objective.…**
  - Restore lost performance by removing moisture in the incoming fuel stream just prior to bunkering

- **How….**
  - Employ waste heat to reduce moisture content of the lignite conveyed to the bunkers

- **Approach….**
  - Demonstrate and Select Basic Drying Process Concept
  - Develop “Proof Of Concept” Pilot Plant
  - Develop Dryer Design And Predictive Performance Modeling
  - Prototype Full Scale Dryer Design
  - Integrate Full Scale Commercial Demonstration Into Existing Plant Project

2 Ton/Hr Pilot Coal Drying
Prototype Dryer: Unit 2 East
Prototype Coal Dryer

• Maximum capacity - 112.5 tons/hr

• Removed approx. ¼ of coal moisture.
  – Dried lignite from 38.5% to 29.5% moisture
  – Improved HHV from 6,200 BTU/lb (14.4 MJ/kg) to 7,045 BTU/lb (16.4 MJ/kg)

• Fully automated operation, integrated into the plant control system.

• Nine patent applications on dryer design and control filed by GRE (six awarded).
Coal Drying Testing

Prototype Coal Dryer Performance: March to April, 2006

- Coal HHV [%]
  - Wet Feed
  - Dried Product

- Total Coal Moisture Content [%]
  - Wet Feed
  - Dried Product
Unit #2 “Complete” April ‘08
DryFining Results

- 25% less $\text{H}_2\text{O}$ - dry lignite from 38 to 29% moisture, improving HHV from 6,100 to 6,800 BTU/lb
- 54% less $\text{SO}_2$ - Segregation of ash minerals, plus improved collection efficiency
- 40% less $\text{Hg}$ - Segregation of ash minerals, plus improved collection efficiency
- 32% less $\text{NO}_x$ - Reduced volumetric release rate, improved fineness and air & fuel distribution to furnace
- 4% less $\text{CO}_2$ - 4% improved cycle efficiency
2009 to July 2013

# coal/Gkw

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System Performance Impacts:

- **Observed:**
  - Each unit now operates with N-1 pulverizers in service
  - Total station service reduced
  - Boiler thermal efficiency increased by 3.7% (on HHV basis)

- **Expected:**
  - Further reductions in NO\(_x\) as the furnace is retuned to benefit from increased SOFA capacity and improved fuel distribution
  - **Substantially** reduced routine pulverizer, boiler, & AQCS maintenance costs
• **Coal Drying as needed**
  – On demand drying, no protracted storage limits nor risk of spontaneous combustion

• **Moisture reduction**
  – Lower fuel throughput
  – Boiler efficiency & net heat rate improvement
  – Station service reduction
  – Flue gas volume reduction

• **Emissions effects**
  – Pre-combustion segregation of Sulfur, Mercury, Iron
  – NO\textsubscript{x} reduction from fuel distribution improvement and volumetric release reduction
  – CO\textsubscript{2} reduction equivalent to net heat rate improvement
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