Smart Firing Control System

Corey Houn & Bernard Begley, Wisconsin Public Service

Don Labbe, Tom Kinney, Alan Morrow & Andy Speziale, Invensys Operations Management

55th Annual ISA Power Industry Division Symposium
4-6 June 2012, Austin, Texas

Outline

- The challenges of firing optimization for a large coal fired boiler
- A novel approach
- Optimization results
- Conclusions

ISA POWID – Source of Technical Automation Information for the Power Industry

ISA Technical Papers-Search Results: 8 products found

- Implementation and Benefits of Model Reference Feedforward (MRFF) Control **- POWID 1989**, **Author:** D. E. Labbe
- Automated Soot Blow and Model Based Control at MT. Storm **- POWID 1993**, **Authors:** Donald Labbe, Larry Line
- Optimizing Heat Rate With Model Predictive Control On Riley Turbo-Furnace Units **- POWID 2002**, **Authors:** Donald Labbe; Darryl Roberts; Lewis Gordon
- Field Test Results Of On-Line Coal Flow Control Technology Y - POWID 2005, **Author(s):** Harun Bilirgen, Edward K. Levy, Aly Elshabasy
- Optimizing Turbine Life Cycle Usage And Maximizing Ramp Rate **- POWID 2006**, **Authors:** David Runkle, Don Labbe, John Lax, Robert Chapa
- Soot Blow And Nox Optimization Enhance Once-Thru Unit Performance **- POWID 2007**, **Authors:** Don Labbe, Don Andrasik, Andy Speziale
- LOWERING NOX EMMISIONS AND CO2 AT OPG-THUNDER BAY **- POWID 2010**, **Authors:** Don Labbe, Steve Carlson, Tony Gibbons, Bob Simpkins, Andy Speziale
- SMART FIRING CONTROL SYSTEM **- POWID 2012**, **Authors:** Corey Houn, Don Labbe, Bernie Begley, Tom Kinney, Alan Morrow and Andy Speziale

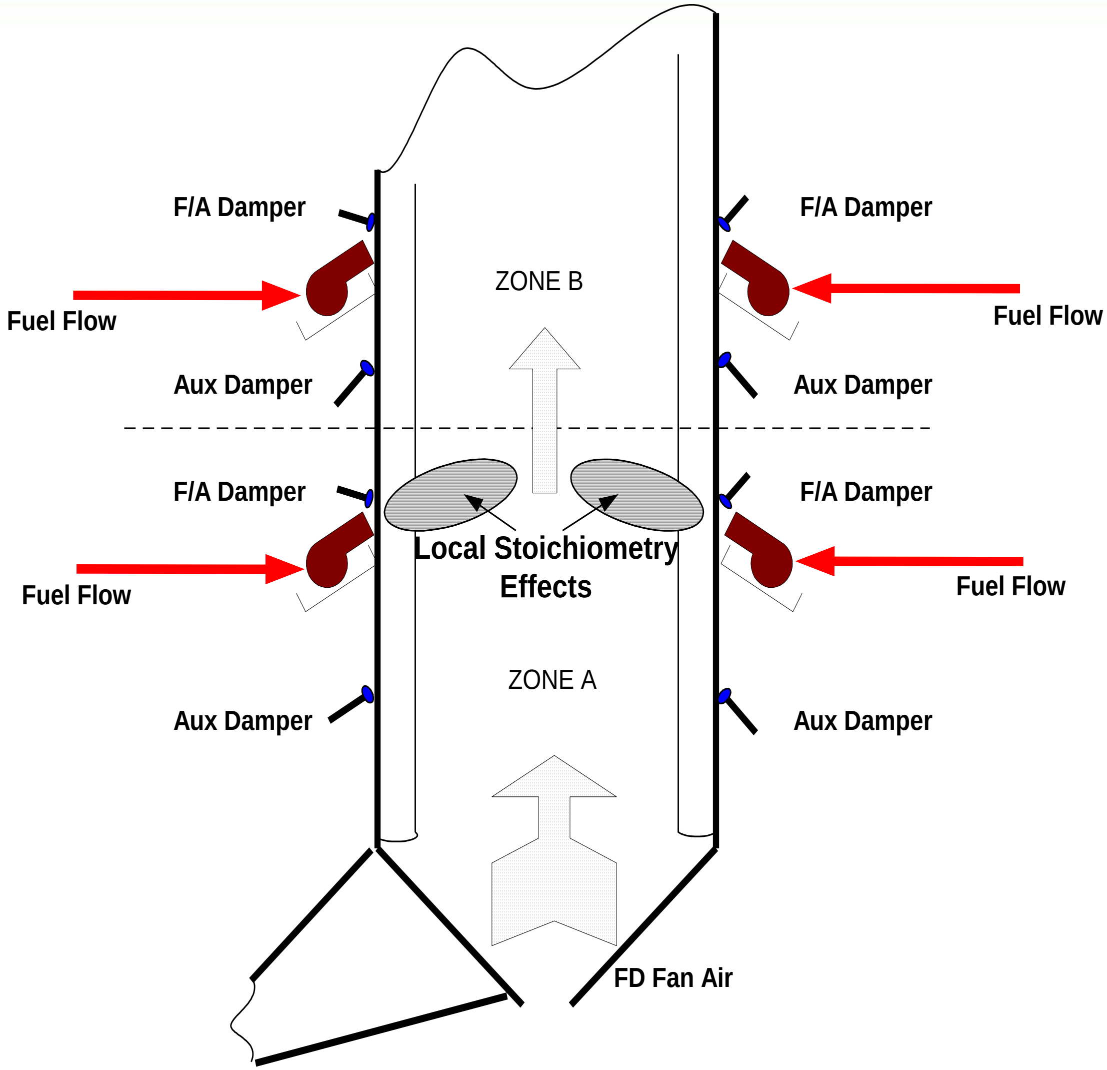
Challenges Of Large Coal Fired Boiler Burner Optimization

- When pulverized coal is fed to a utility boiler a phenomenon sometimes referred to as “roping” occurs
  - Impacts the distribution of coal flow to the coal pipes supplying the burners
  - Roping characteristics are unique mill to mill and dependent on primary air flow
- Coal maldistribution in turn causes some regions of the furnace to have more fuel and some to have less fuel
  - O_2 imbalances
  - Regions of high CO and unburned carbon in oxygen depleted areas
  - High NO_x in regions of higher O_2.

Typical APC Burner Optimization

- Advanced Process Control (APC) applications such as multivariable model predictive control and neural networks are frequently applied to bias furnace air flow distribution and address O_2 imbalances and regions of high CO
- However coal pipe roping and other phenomena create a need for a recalibration of the APC models of the air register positions related to excess O_2, CO, and NO_x

Furnace Air Distribution



Adapting APC burner optimization automatically

- The adapting system periodically tests the APC system on line without operator intervention and adapts the models to capture the characteristics of shifting relationships
- This solution has contributed to significant additional boiler efficiency improvements above and beyond the original APC application

System Deployed on Wisconsin Public Service Weston Unit 4

- Located in central Wisconsin
- 590 MW Gross coal fired once thru B&W supercritical unit commissioned in 2008
- Latest generation of high efficiency supercritical boiler and turbine
- Full complement of emissions reduction equipment
- Modern DCS with an integrated APC combustion optimization system (COS)

Wisconsin Public Service Unit 4 Emissions Control

- Features a full complement of emissions reduction equipment:
  - Dry scrubber for SO2 reduction
  - Selective catalytic reduction (SCR) using ammonia for NO_x reduction
  - Bag house for particulate removal
  - Mercury removal controls
  - Modern DCS with an integrated APC combustion optimization system (COS)
  - Many auxiliary systems to address both production and emissions requirements
- DCS – over 80,000 tags and coordinates all unit controls

Original APC Combustion Optimization System

- Objective – further improve unit efficiency following extensive tuning process of this new unit by the boiler vendor, A&E and control vendor
- Results
  - delta Heat Rate Methodology indicates an average heat rate performance improvement in excess of 0.5% at all loads above minimum load
  - Weston 4 performance program indicates a full load heat rate improvement in excess of 1%
  - Additionally, a reduction in ammonia flow of ~8%
  - COS sustained these performance results, but did not reap further improvement

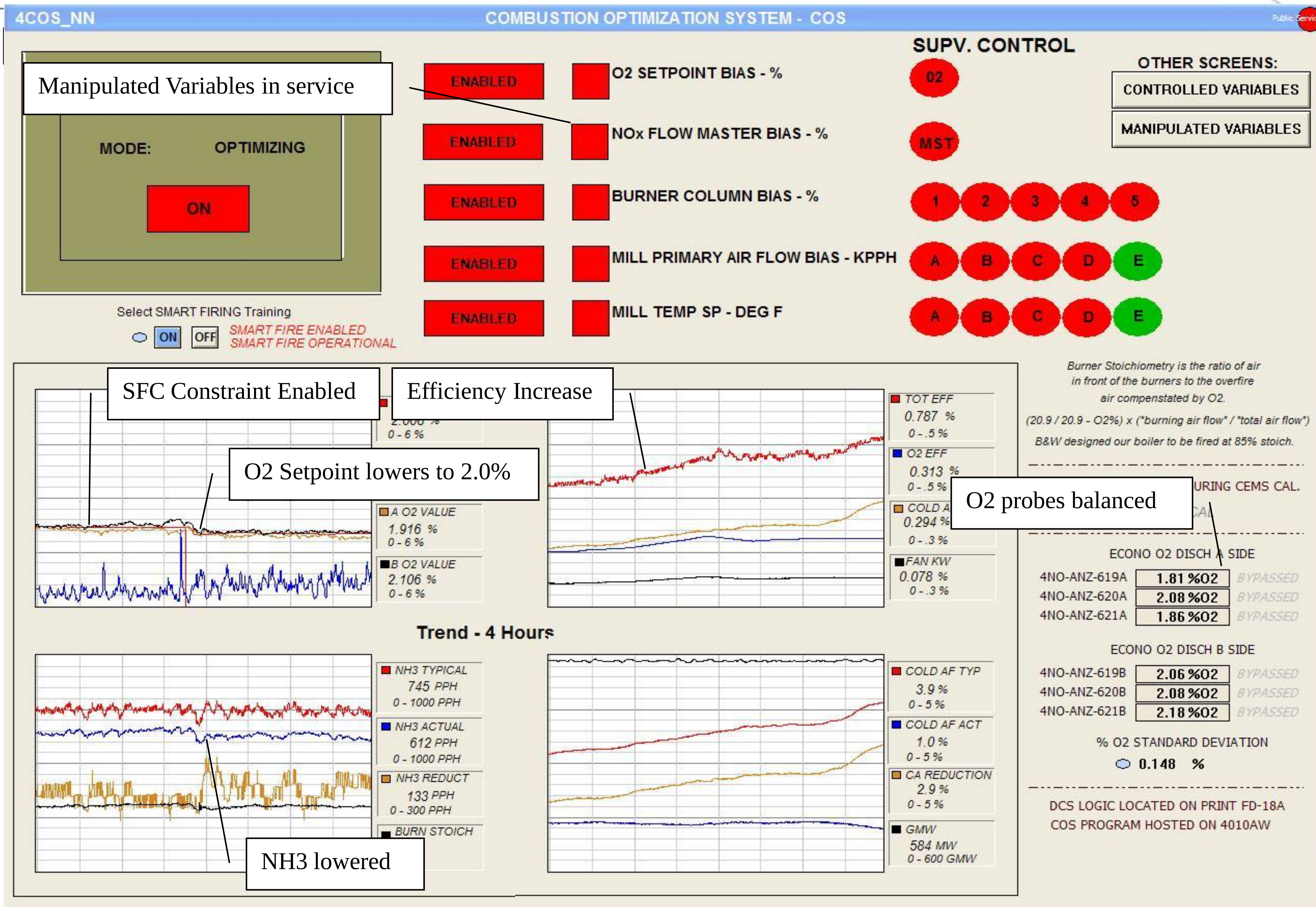
Adapting APC Combustion Optimization System

- Objective – Identify whether further improvements to unit efficiency were possible & if so, maintain these further improvements
  - Lower unit heat rate
  - Reduce furnace NO_x emissions and reduce SCR ammonia consumption
  - Sustain benefits dynamically during both steady load and dispatching operation.
- Apply the Delta heat Rate methodology to quantify the heat rate benefits
  - Assessment included dry gas losses, FD & ID fan power, furnace NO_x emissions and ammonia consumption

Adapting APC Combustion Optimization System

- Methodology
  - Utilize the existing APC COS as the base APC system
  - Provide automatic small amplitude modulation of the air registers without operator intervention
  - Automatically adapt the APC COS for tighter O_2 distribution and lower NO_x and CO

Operator Graphic during Adapting System Commissioning



Adapting APC Combustion Optimization System –Results During Commissioning

- The trends illustrate the following
  - Reduction in O_2 minimum setpoint from 2.2% to 2%.
  - The transition to lower O_2 maintained average CO within constraint
  - Reduced SCR inlet NO_x
  - Reduced ammonia consumption
  - Increased efficiency due to lower O_2 and fan power and the equivalent ammonia savings
  - The reduction in CO followed the adjustment in COS constraints and models resulting from the operation of the system.
  - This reduction in CO allowed the operation at lower O_2.

Adapting APC Combustion Optimization System – Performance Results

- Comparison of four weeks of operational data prior to commissioning of system operation to one week following Adapting APC operation

	Average O_2 (%)	**Average NO_x at SCR Inlet (% of Baseline)**
Base Case: COS running prior to Adapting System	2.371	100%
COS following Adapting System	2.056	98.4%
Further Improvement due to Adapting System	**0.316%**	**1.6%**

Adapting APC Combustion Optimization System – Benefits

- Incremental heat rate improvement of approximately 0.12% based on the Delta Heat Rate Methodology
- A reduction in ammonia flow of ~1.6% based on a comparison of performance data prior to and post system operation

Conclusions

- An automated method to adapt APC models provides an opportunity to achieve and sustain further benefits from and a combustion optimization system beyond traditional APC
- Such a system can adapt for coal roping and other phenomena that adversely influence coal distribution in large furnaces

Setting the Standard for Automation™

ISA

invensys Operations Management

WPS

Smart Firing Control System

Corey Houn & Bernard Begley, Wisconsin Public Service

Don Labbe, Tom Kinney, Alan Morrow & Andy Speziale, Invensys Operations Management

55th Annual ISA Power Industry Division Symposium

4-6 June 2012, Austin, Texas