LEHIGH ENERGY UPDATE

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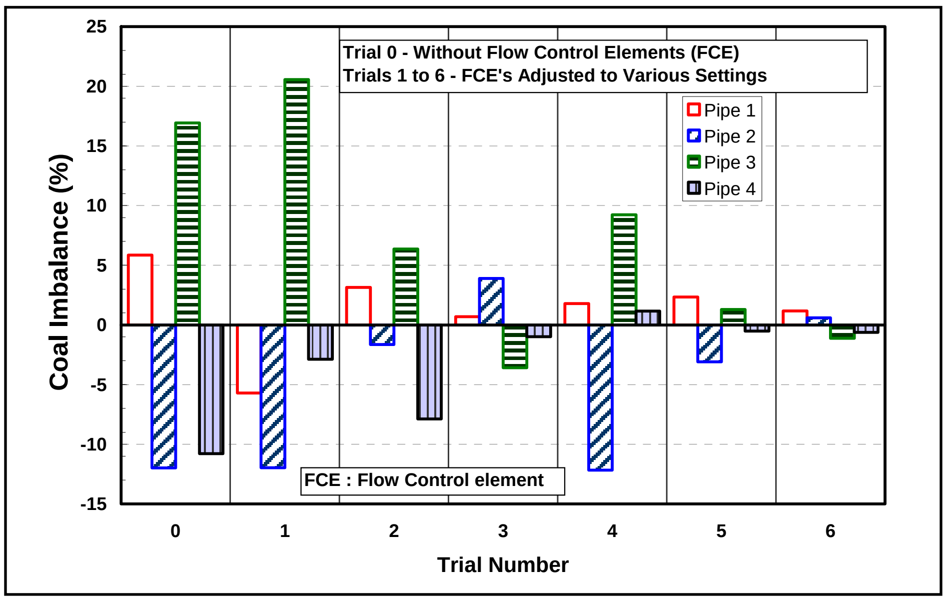
NEW COAL-FLOW BALANCING TECHNOLOGY READY FOR FIELD TRIAL

It is widely recognized within the electric power generation industry that it is important to have balanced coal and air flows to the burners of a pulverized coal boiler. Balanced coal flow results in more efficient combustion, reduced emissions of air pollutants, and fewer problems of water wall tube wastage and burner damage due to locally reducing zones in the furnace. A new technology for balancing the distribution of coal flow rates among burners has been developed by a project team led by Dr. Harun Bilirgen of the Energy Research Center.

Bilirgen explains, “Pressurized vertical spindle mills have anywhere from 2 to 10 coal pipes connected to the top of the pulverizer discharge turret. Imbalances in pipe-to-pipe coal flow rates may arise due to nonuniformities in the coal and air flow patterns within the pulverizer. With research funding from the Babcock & Wilcox Power Generation Group, Inc. (B&W), we’ve developed adjustable coal flow control mechanisms for reducing pipe-to-pipe coal flow nonuniformities. Our coal flow control mechanisms are positioned inside the pulverizer and make it possible to perform on-line adjustments of the outlet coal flow distribution.”

The research began with computational fluid dynamic (CFD) simulations of coal and air flow patterns inside of pulverizers. These studies highlighted those regions within a pulverizer which would be most effective for modifying the outlet coal flow patterns.

Bilirgen’s team then designed and built a 1/7 scale model of the upper portion of a B&W mill and ran laboratory tests on pulverizer models with both four and six outlet pipes. The laboratory test program included experiments with flow control elements of different designs, flow control elements positioned at different locations



Results from a coal-flow balancing test on a laboratory-scale pulverizer with four outlet pipes. Beginning with a maximum pipe-to-pipe coal flow imbalance of -12/+17 percent, the imbalance was reduced to less than ±2 percent after six iterations.

within the mill and flow control elements at various orientations with respect to the vertical centerline of the pulverizer. The test results demonstrate the ability to achieve close control over pipe-to-pipe coal flow distribution with this approach. In one coal flow balancing trial, there was an initial imbalance of +17 to -12% without any flow control elements. This was then reduced to less than +/- 2% through installation of flow control elements and the sequential adjustment of the control elements to achieve improved balance.

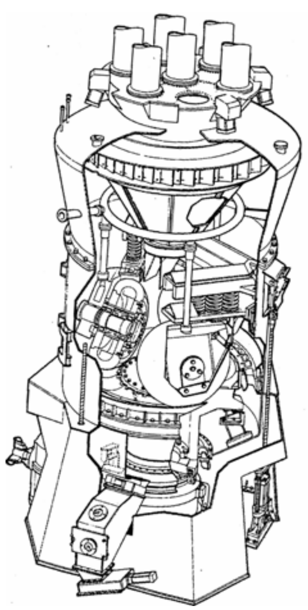
For best results, it is important that adjustments to a coal flow control mechanism do not result in significant changes to the pipe-to-pipe distribution of primary air. An attached figure shows the sequential change in primary air flow distribution as the coal flow balancing process was carried out. The results show less than a +/- four percent change in air flow distribution occurred. This makes it possible to balance coal flow distribution without the need for changes to orifices to restore a balanced primary air flow rate. The Lehigh coal flow controller can be retrofitted into existing pulverizers and the addition of the coal flow controller causes only a very small increase in pressure drop within the coal and primary air flow system. Measurements in laboratory trials show incremental pressure drops ranging from close to zero to less than 0.6 inches H_2O.

An important aspect of the Lehigh coal flow controller approach is that the controller can be operated with either manual or automated on-line measurements of coal flow rate in the various outlet pipes. Or alternatively, on-line instrumentation to measure combustion characteristics of individual flames could be used to provide continuous data on the effects of controller positions on combustion and/or emissions.

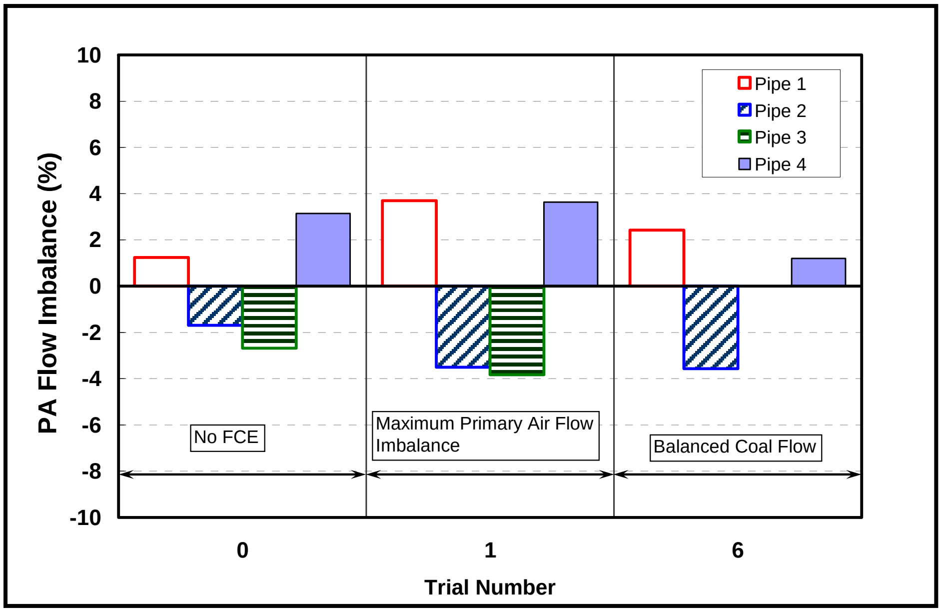
B&W and Lehigh have teamed to develop design concepts for integrating the controller into full size commercial scale pressurized, vertical spindle pulverizers, and they are looking for power plants where the technology can be installed on a mill and its ability to control coal flow rate distribution can be demonstrated.

As already noted, the coal-flow control technology described in this article was developed to be used with pulverizers which have a multiplicity of coal pipes connected to the top of the discharge turret.

In earlier research, Drs. Bilirgen and Levy developed patented coal flow controllers which are used at splitter junctions in coal pipes, where a single pipe is split into two or more coal flow streams. In this case, each coal flow control system consists of a specially designed riffler with adjustable coal flow control elements just upstream of the riffler. The coal flow control elements are designed to make it possible to balance coal flows without affecting either primary air flow balance or pressure drop, and this is done while the pulverizer is on-line. To date, 58 coal flow balancing systems have been installed for use at coal pipe splitter junctions, and all have produced very positive results. ■



Sketch of B&W MPS Mill with six outlet coal pipes.



Adjustments to coal flow control elements have a negligible effect on distribution of primary air flow among the outlet coal pipes.

EXAMPLES OF RECENTLY INITIATED RESEARCH PROJECTS

- "Application of Condensing Heat Exchangers to Carbon Dioxide Purification/Compression Systems"
- "Use of Waste and CO_2 Compression Heat to Reduce Penalty due to Post-Combustion CO_2 Capture"
- "Coal Flow Balancing at a Coal-Fired Power Plant"
- "Modeling of Air Preheaters to Determine Effects of Inlet Air Temperature and Air Preheater Design on Deposition Zones of Sulfuric Acid and Ammonium Bisulfate"
- "Development and Evaluation of a Particle Flow Distributor for Sorbent Injection Systems"
- "Study of Elemental Mercury Re-Emissions from a Laboratory-Scale FGD Scrubber"
- "Screening of Sorbents for Mercury Emissions Control"

RESEARCHERS' PROFILES

- ***Dr. Harun Bilirgen*** is Senior Research Scientist in the Energy Research Center and his research focuses on emissions control and performance improvement of coal-fired power plants.
- ***Dr. Hugo Caram*** is Professor of Chemical Engineering. His research is in the areas of mass transfer, chemical reactor design and chemical thermodynamics.
- ***Dr. John DuPont*** is Professor in the Materials Science & Engineering Department and Associate Director of the Energy Research Center. His research interests are in welding, corrosion, and alloy development.
- ***Dr. Edward Levy*** is Professor of Mechanical Engineering and Mechanics and Director of the Energy Research Center. His research deals with emissions control and performance improvement in coal-fired power plants.
- ***Jeffrey Farren and Andrew Stockdale*** are Ph.D. students in the Materials Science & Engineering Department.