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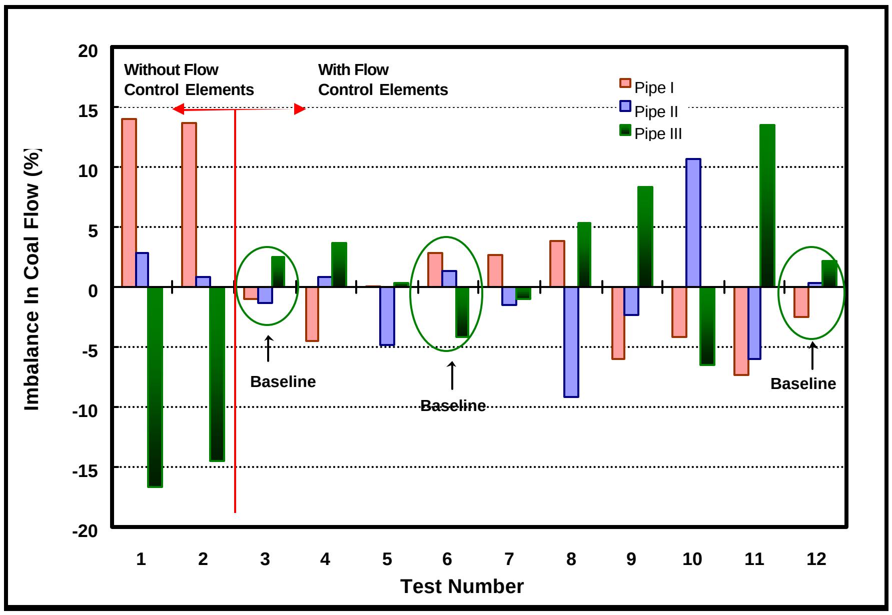
FIELD TESTS CONFIRM EFFECTIVENESS OF BURNER BALANCING TECHNOLOGY

Burner balancing is one of the steps that should be taken as a utility company works to improve combustion and reduce emissions from its coal-fired boilers. Among other things, this requires that all the coal pipes connected to a pulverizer carry the same coal flow rate and the same flow rate of primary air. While orifices can be used to balance primary air flow rates, until now there has been no good way of balancing the coal flows. Recent research at the Energy Research Center has resulted in the development of a technology which makes it easy to balance coal flows among burners. Field tests, which followed installation of the technology at two power plants, confirm the effectiveness of this approach.

The ERC research program on burner balancing has been led by Dr. Edward Levy, Director of the Center, Dr. Harun Bilirgen, Research Scientist, and Dr. Ali Yilmaz (now with Riley Power, Inc.) and has also involved a group of Masters and Ph.D. level graduate students from Mechanical Engineering and Mechanics.

According to Levy, “One of the more common coal pipe arrangements is found with pulverizer designs where all the coal flows from the pulverizer through one pipe. The flow is then split into two or more pipes at a splitter box, usually with a riffler to reduce coal flow maldistributions.



Coal Flow Imbalance Was Reduced to less than ±4 Percent in this Field Trial of a Three-Way Splitter

Starting with a conceptual design and laboratory experimentation, we’ve developed an adjustable device to control the distribution of coal flow among the outlet pipes from the splitter junction. The hardware, which can be retrofitted easily into an existing coal pipe network, requires use of a riffler with specially designed adjustable flow control elements positioned just upstream of the riffler. The flow control elements have been designed to make it possible to balance the coal flows without affecting the primary air flow balance and this can be done while the pulverizer is on-line.”

After laboratory testing and development (See Lehigh Energy Update, Vol. 17, No. 2, October 1999), the coal flow control technology was installed and tested at two coal-fired power plants.

One installation involves a boiler with CE Raymond Bowl mills with exhauster fans. Three-way splitters with rifflers at the exit of the exhauster fan distribute the coal from each mill to three burner lines. The three-way riffler consists of 24 one-inch-wide flow channels. Each channel directs the mixture of coal and air to a designated burner line.

The flow control elements were installed upstream of the riffler to change the distribution of the coal flows among the three outlet pipes. As the positioning rods connected to the flow control elements were adjusted, the particle concentration distribution pattern at the inlet to the riffler changed, affecting coal flow rates in each pipe outlet. Measurements were performed on one mill using instruments to measure primary air velocities and coal flow rates.

Bilirgen adds, "Without flow control elements, the maximum imbalances, which occurred in pipes 1 and 3, were -17 percent and +14 percent (see Figure). When the flow control elements were installed, they were adjusted to the so-called "baseline" or "neutral" position. This position had been shown in laboratory tests to give very close to the best coal flow balance among the outlet pipes. Tests 3, 6 and 12 represent the coal flow imbalances corresponding to the neutral (baseline) settings of the flow control elements, and these were within ±4 percent for all three tests, which indicates repeatable results when the flow control elements are adjusted to various positions.

Our data show that most changes in flow controller settings from the baseline resulted in deterioration in coal flow balance. The data also show that each time the elements were restored to the baseline position (Tests 6 and 12), the imbalance decreased back to ±4 percent.

Our measurements also showed that the air flow distributions between outlet pipes were not affected by the adjustments to the flow control elements. We find that the insensitivity of air flow distribution to flow controller setting greatly simplifies the balancing process. This makes it possible to first balance the dirty air flow using orifices in the outlet pipes and then balance coal flow using the adjustable coal flow balancing system."

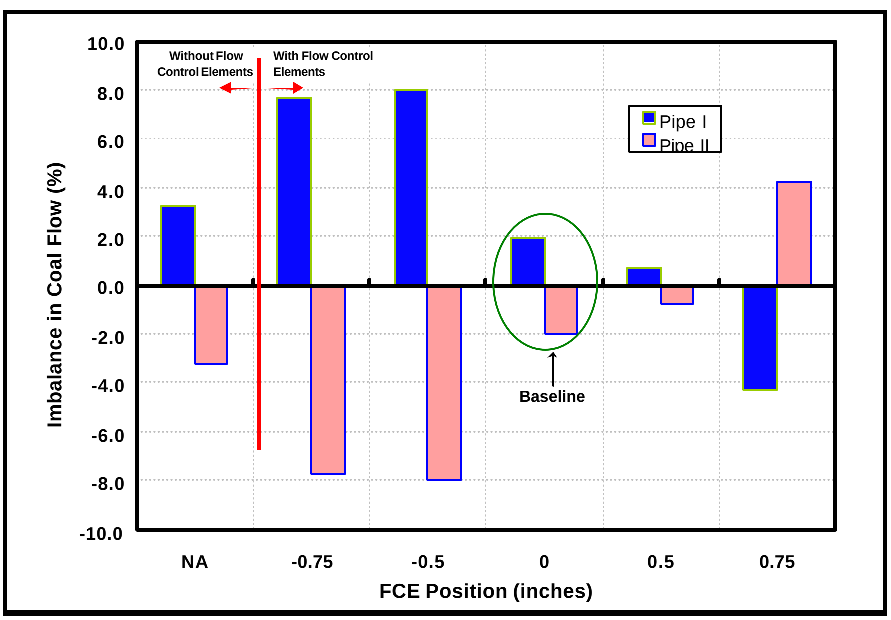
Levy continues, "The coal flow control system has also been tested on a rear wall-fired boiler, which utilizes four Riley Power Inc. (RPI) Atrita® mills to pulverize the coal and deliver it to eight burners. Two-way splitters with rifflers are installed at the exit of the exhauster fans to distribute the coal between the burner lines. The riffler in the two-way splitter consists of 14 one-inch-wide flow channels. Each channel directs the mixture of coal and air to a designated burner line.

In a collaborative effort, Riley Power Inc. (formerly Babcock Borsig Power, Inc.) designed, manufactured and installed the balancing system on all four mills. Results from measurements on D mill are reported here, with these measurements made by a Riley/Lehigh University team.

The first test was performed before installing the flow control elements, and the remainder were performed at various positions of the flow control elements (see Figure). As the flow control elements were moved from the negative position (- 0.75 inches) to the positive direction, the pipe-to-pipe coal flow imbalance decreased from ±8% to ±1%. The data showed the air flow distributions between two pipes were only slightly affected by the adjustments to the flow control elements. Measurements were also made of pressure drop due to the coal flow elements as a function of mill loading (damper position). The additional pressure drops across the flow control element were between 0.4 and 0.8 inches of water."

Bilirgen adds, "We also observed the flame characteristics and recorded them as adjustments were made to the flow control element positions. Observations indicated that there were considerable changes in the flame color as a function of the flow control element position, with the flame color of individual burners going from bright to dark orange. This is confirmation of the importance of coal flow balancing on combustion. We were able to change from fuel-lean to fuel-rich conditions, simply by adjusting the coal flow distribution."

Following these tests, the flow control system was installed on the



The Coal Flow Imbalance Was Reduced to less than ±2 Percent at a Boiler with Two-Way Pipe Splits other three mills at this station. Riley Power and the utility plan to investigate the effect of coal balancing and burner adjustment on the NO_x, CO emissions and the amount of unburned carbon in fly ash in the next phase of the project.

Levy concludes, "The positive results we've obtained from these two full-scale tests have convinced us our coal pipe balancing technique works quite well. The retrofits were relatively inexpensive and the process of adjusting the coal flows was extremely easy to do. We plan to license the technology for manufacture and installation to a boiler equipment company, and we look forward to having other utilities make use of the technology on their boilers." #

For more information either on sootblowing or burner balancing, please contact John Sale at (610) 758-4545 or by E-mail at jws3@lehigh.edu.

RESEARCHERS' PROFILES

- Dr. Harun Bilirgen has a Ph.D. in Mechanical Engineering and is a Research Scientist in the Energy Research Center. His Ph.D. dissertation focused on the fluid mechanics of gas-particle flow systems.
- Dr. Edward Levy has a Ph.D. in Mechanical Engineering and is Professor of Mechanical Engineering and Mechanics and Director of the Energy Research Center.
- Dr. Carlos Romero is an Associate Director of the Energy Research Center with a Ph.D. in Mechanical Engineering. He is a specialist in combustion kinetics and emissions control.
- Dr. Nenad Sarunac has a Ph.D. in Mechanical Engineering and is an Associate Director of the Energy Research Center. His research focuses on power plant heat rate improvement, emissions control and process optimization.