Advanced Research

09/2004

PROJECT facts

U.S. DEPARTMENT OF ENERGY
OFFICE OF FOSSIL ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY

COMPUTATIONAL FLUID DYNAMICS BASED INVESTIGATION OF SENSITIVITY OF FURNACE OPERATIONAL CONDITIONS TO BURNER FLOW CONTROLS

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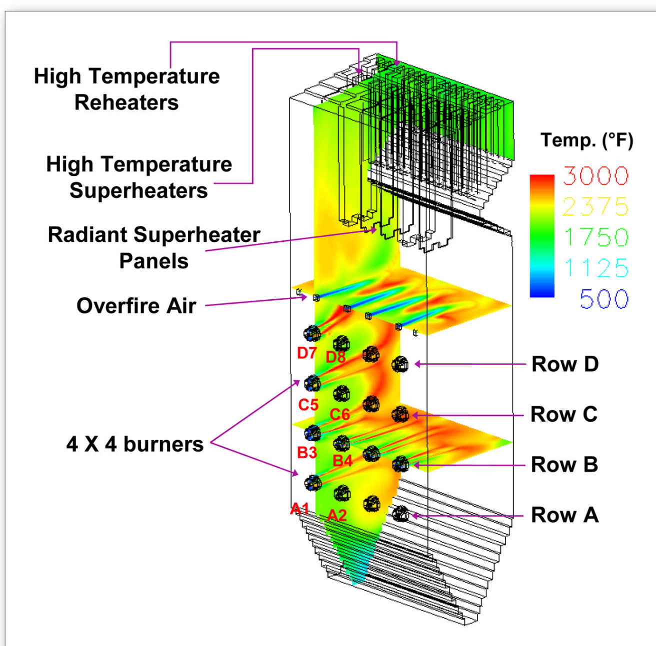
Description

The electric utility industry has been moving toward installation of improved methods of burner flow measurement and control to optimize combustion for reduced emissions and improved operability in coal-fired boilers. An important yet unresolved question is what level of control is required. For example, do flows need to be very tightly controlled at each burner or are multi-burner controls sufficient? The investigation of furnace sensitivities to burner flows through bench or pilot scale testing can be time-consuming and expensive, and the amount of information acquired through such testing is often limited. Testing these sensitivities in fully operating boilers is difficult due to the dynamic nature of boiler operation, which precludes the well-controlled testing warranted in this type of investigation.



Predicted gas temperature distribution for 150 MW front-wall fired coal boiler selected as part of this project.

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PROJECT COST

Total	$250,000
DOE	$200,000
EPRI	$ 50,000

PROJECT DURATION

11/01/2002 -10/31/2004

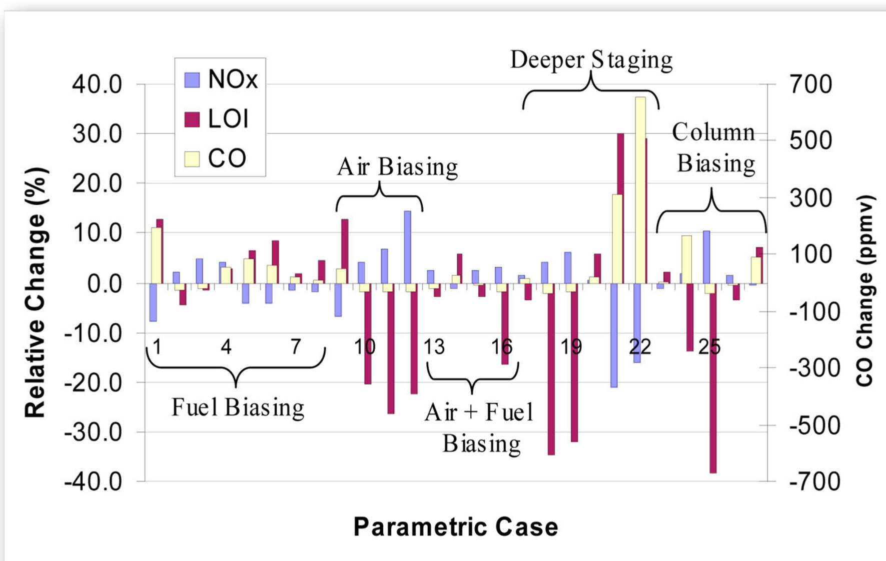
WEBSITES

www.netl.doe.gov/coal

The objective of this project is to use computational fluid dynamic (CFD) modeling to quantify the impacts of variations of burner air and fuel flows on furnace operating parameters. CFD modeling provides a strategy for investigation of these sensitivities under well controlled conditions. We are utilizing Reaction Engineering International's (REI) three dimensional, multiphase, turbulent reacting flow code GLACIER to perform the analyses on single wall-fired, opposed wall-fired, tangentially-fired, and cyclone-fired coal boilers. The baseline furnace models are being selected from REI's existing database of well over 100 furnaces so that the project emphasis can be on parametric variations to estimate sensitivities. Parametric cases are being defined in a manner that meaningful sensitivity coefficients for NO_X and LOI can be computed.

Accomplishments

Parametric simulations have been completed for a Riley 150 MW front wall fired boiler equipped with overfire air and Riley CCV burners. Simulations have assumed row by row or column by column biases in air, fuel, or combined air and fuel flows. Flow biases up to 25% of the baseline flows were evaluated. Results indicate a more significant impact of secondary air biases on NO_X and LOI than either fuel or combined fuel and air biases. Sensitivity coefficients have been computed to quantify rates of change of NO_X and LOI with respect to changes in burner stoichiometric ratio. These values provide a mechanism for furnace optimization and will be compared with those obtained for the other furnace configurations to be evaluated in this project. Parametric simulations are in process for a 500 MW Foster Wheeler opposed wall-fired boiler equipped with overfire air and low NO_X burners and a 600 MW Combustion Engineering tangentially-fired boiler equipped with a LNCFS III low NO_X firing system.



Predicted changes to furnace exit NO_X, CO, and LOI for all parametric cases in comparison with the baseline case for the 150 MW front wall-fired boiler.