PROJECT facts

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

Environmental & Water Resources

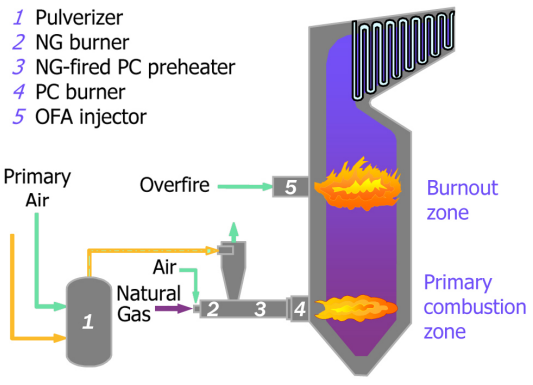
11/2004

METHANE DE-NOX® FOR PC BOILERS

Background

Enacted regulations pertaining to the NO_X SIP Call and potential future regulations in proposed legislation such as the President's Clear Skies Act or EPA's Clean Air Interstate Rule require power producers to seek the most cost effective methods to achieve compliance. In order to address present and anticipated NO_X emissions control legislation targeting the current fleet of U.S. coal-fired boilers, the Department of Energy's (DOE) Innovations for Existing Plants (IEP) Program develops advanced, low cost, NO_X control technologies. Managed by the DOE's National Energy Technology Laboratory (NETL), the IEP Program develops these technologies in order to keep coal a viable part of the national energy mix. Such technologies address issues of health, ground-level ozone, ambient fine particulates, visibility, eutrophication, climate change, as well as "acid rain" precursors.

The METHANE de-NOX® NO_X reduction process for PC boilers is being developed by the Gas Technology Institute (GTI) under a Cooperative Agreement with NETL to provide a cost effective, combustion-based alternative to SCR. GTI's proven METHANE de-NOX® reburn technology is combined with a pulverized coal-preheating approach developed for utility PC boilers by the All-Russian Thermal Engineering Institute (VTI). The technology consists of a burner modification that preheats pulverized coal to elevated temperatures (up to 1500°F) prior to coal combustion. This releases coal volatiles, including fuel-bound nitrogen compounds, into a controlled reducing environment inside of a natural gas-fired PC preheat combustor, which reduces the coal-derived nitrogen compounds to molecular N_2. The preheated coal is converted to a mixture of char and gaseous volatile matter, which is then fired through the main burner into the boiler furnace. The quantity of natural gas fuel required for PC preheating is in the range of 3 to 5% of the total burner heat input. GTI and VTI are joined in the project by Babcock Power Inc. (BPI), which provides commercial PC burner design expertise and testing facilities for 3- and 100-MMBtu/h preheat burner prototypes in their respective Pilot-Scale Combustion Facility (PSCF) and Coal Burner Test Facility (CBTF) in Worcester, MA.



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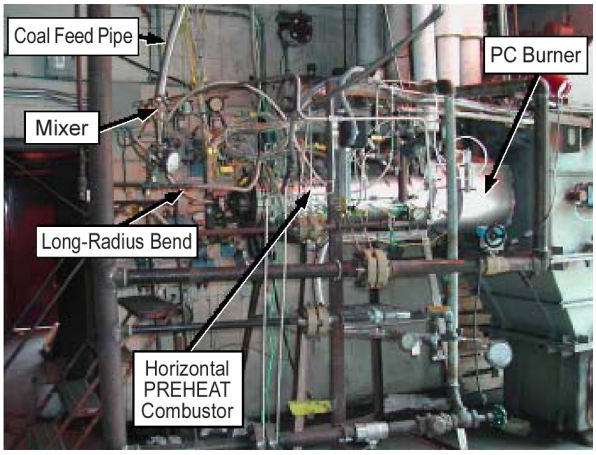
Objectives

The overall project objective is the development and validation of an innovative combustion system, based on a novel coal preheating concept prior to combustion, that can reduce NO_X emissions to 0.15 lb/million Btu or less on utility pulverized coal (PC) boilers. This NO_X reduction should be achieved without loss of boiler efficiency or operating stability, and at more than 25% lower levelized cost than state-of-the-art SCR technology.

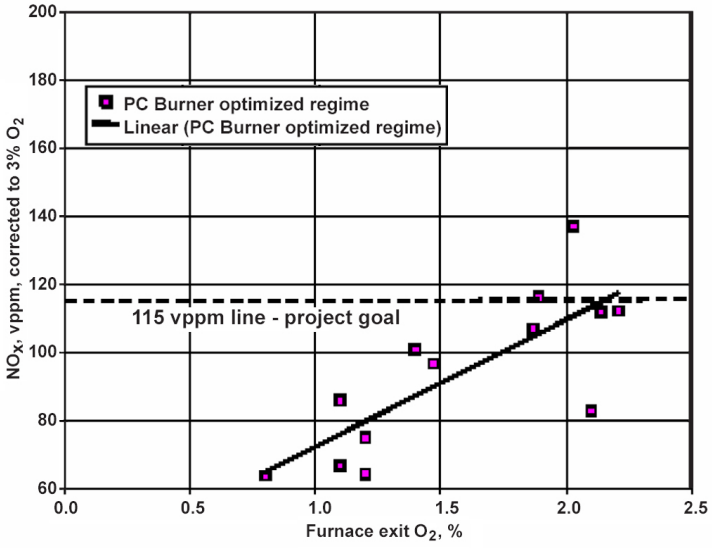
Description

The advanced PC preheating combustion system being developed in this project for direct-fired PC boilers combines the modified VTI preheat burner approach with elements of GTI's successful METHANE de-NOX® technology for NO_X reduction in stoker boilers. The new PC preheating system combines several NO_X reduction strategies into an integrated system, including a novel PC burner design using natural gas-fired coal preheating, and internal and external combustion staging in the primary and secondary combustion zones.



Design, installation, shakedown and initial PRB coal testing of a 3-million Btu/h pilot system at BPI's PSCF demonstrated that the PC preheat process has a significant effect on final NO_X formation in the coal burner. Computational Fluid Dynamics (CFD) modeling was used extensively in the pilot system design for both the gas combustor and PC burner. Modifications to both the pilot system gas-fired combustor and the PC burner led to NO_X reduction with PRB coal to levels below 100 ppmv with CO in the range of 35-112 ppmv without any furnace air staging. Pilot testing with PRB coal is complete.

Initial pilot testing with a bituminous caking coal resulted in deposition and plugging by caked material on the inside of the gas combustor. A series of modifications to the combustor configuration and operation have been developed and tested. One of these approaches was successful in sustaining operation with the caking coal up to 85% of the targeted fuel input, although some deposition and LOI issues remained. Additional pilot testing is planned with the caking coal to test solutions to these problems. While not measured under steady-state operating conditions, NO_X results from the caking coal tests were promising, with NO_X levels approaching 100 ppmv with 6% oxygen in the flue gas at the furnace exit. These NO_X results indicate that even greater NO_X reduction is possible than that achieved with the PRB coal tested.



Pilot testing will be followed by design, construction and testing of a 100 MMBtu/h commercial prototype system in BPI's 29 MWt CBTF. A CFD model of the CBTF furnace will be developed and validated during the commercial prototype testing. The pilot-validated model will be used to guide the scale-up of the system. When validated through CBTF testing, the model will form a valuable design tool for future commercial installations.

The design of a 100 MMBtu/h test unit for PRB coal is complete. Fabrication and installation of the test unit has been initiated. Completion of the design for the 100 MMBtu/h preheat combustor for the caking coal is on hold pending completion of the additional pilot testing. Testing in the CBTF is scheduled for the Summer of 2004.