PROJECT facts

U.S. Department of Energy
Office of Fossil Energy
National Energy Technology Laboratory

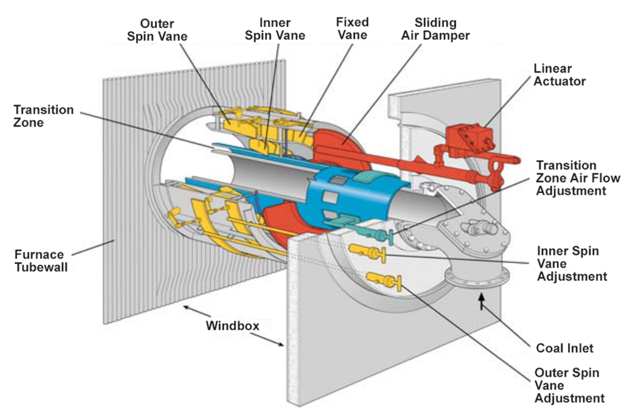
Environmental & Water Resources

11/2004

NO_X Control for Utility Boiler OTR Compliance

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.



Under a cooperative agreement with NETL, Babcock & Wilcox (B&W) and Fuel Tech have joined in an effort to provide an integrated solution for NO_X control technology. The system is compromised of B&W's DRB-4Z™ ultra low-NO_X pulverized coal (PC) burner technology plus Fuel Tech's NOxOUT® urea-based, selective non-catalytic reduction (SNCR) system. The testing has provided insights into mechanisms that can enable SNCR technology to complement the NO_X reduction attainable with ultra low-NO_X burner technology in order to achieve NO_X emissions of 0.15 lb/10^6 Btu for front and opposed wall-fired boilers.

Objectives

The objective of the project is to achieve a NO_X level below 0.15 lb/10^6 Btu (with ammonia slip of less than 5 ppm) using PRB coal, B&W's DRB-4Z™ low-NO_X pulverized coal (PC) burner in combination with dual zone overfire air ports, and Fuel Tech's NOxOUT®. The proposed goal of the combustion system (no SNCR) for this project is a NO_X level at 0.15 lb/10^6 Btu. The NO_X reduction goal for SNCR is 25% from the low-NO_X combustion emission levels. Therefore, overall NO_X

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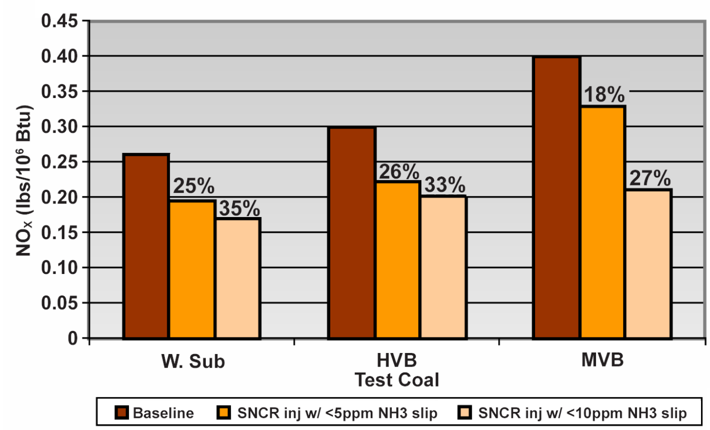
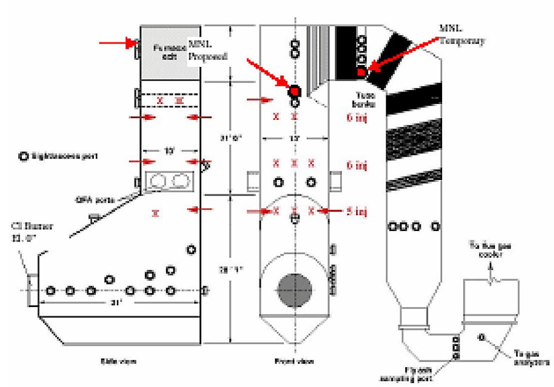
emissions could approach a level of 0.11 lb/10^6 Btu. In addition, an SCR/SNCR hybrid technology will be evaluated using SCR at full load and SNCR at low load conditions. Since the majority of existing commercial SCR units use ammonia, SNCR data with ammonia as a NO_X reducing agent will be obtained at low load conditions.

Description



B&W and Fuel Tech are teaming to evaluate an integrated solution for NO_X control comprised of B&W's DRB-4Z™ low-NO_X PC burner technology and Fuel Tech's NOxOUT®, a selective non-catalytic reduction (SNCR) technology, capable of meeting a target emission limit of 0.15 lb NO_X/10^6 Btu. (B&W under DOE sponsorship developed and commercialized B&W's 4Z™ burner.) Large-scale testing is to continue in B&W's 100-million Btu/hr Clean Environment Development Facility (CEDF) that simulates the conditions of large coal-fired utility boilers.

In a prior DOE sponsored project, three coals were tested: PRB coal, Pittsburgh #8 high volatile bituminous coal, and Middle Kittanning medium-volatile bituminous coal. Under the most challenging boiler temperatures at full load conditions, baseline (unstaged, no air staging) NO_X emissions were 0.26 lb/10^6 Btu for PRB coal, 0.30 for Pittsburgh #8, and 0.40 for Middle Kittanning coal. The SNCR system reduced NO_X emission levels to 0.19, 0.22, and 0.32, respectively. Under the more favorable reduced load conditions, NO_X emissions were lower for both baseline (burner only) and SNCR operation. Baseline NO_X emissions of 0.17 lb/10^6 Btu for PRB coal at 60 million Btu/hr were reduced to 0.13 lb/10^6 Btu by SNCR. The lowest NO_X of 0.09 lb/10^6 Btu was achieved at a 40 million Btu/hr firing rate.



The prior SNCR development work has been performed without OFA and with urea using wall-injectors. In the current project, additional baseline NO_X reductions will be achieved by the utilization of OFA. Improved performance of the SNCR process will be demonstrated with convective pass injection at full load via a convective pass multiple nozzle lance (MNL) in front of the superheater tubes. This technique has the following advantages: 1) lower injection temperature; 2) improved mixing between urea and boiler gases; and 3) achievement of very fine urea particles that evaporate quickly and engage in reducing NO_X.

The cost of the low-NO_X burner/SNCR technology is less than three-quarters of the cost of SCR. Economic analyses have shown that the total levelized costs of low-NO_X burner/SNCR and SCR for a 500 MWe coal-fired boiler with a baseline NO_X emission of 0.5 lb/10^6 Btu are \$406 and \$847/ton of NO_X removed, respectively.

Since SNCR performs very well in low load conditions, a hybrid SCR/SNCR technology can be commercialized to take advantage of the strength of both technologies. The full-load conditions of utility boilers are very challenging environments for SNCR technology, since temperatures are high and residence time is low for reaction. SCR, on the other hand, can achieve over 90% reduction at full load, but there are concerns about catalyst poisoning at low loads due to ammonium bisulfate deposits on the catalyst. If SNCR is used in low load and SCR in full load conditions, the hybrid system will use the strength of both technologies. Since the majority of commercial SCR units use ammonia, the current database should be expanded with testing SNCR with ammonia at low load conditions.

A hybrid SCR/SNCR system will reduce both the operating and capital costs. Operating cost savings will be realized, because when a boiler utilizes an economizer by-pass to maintain catalyst temperature, the boiler suffers an efficiency loss of up to 0.5%. Also, the operating cost will be lower since this proposed technology will prevent a potential maintenance problem with bisulfate deposits. Capital cost savings will be realized by reduction of flue work, dampers, etc., since the economizer by-pass will not be required.