PROJECT facts

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

Environmental & Water Resources

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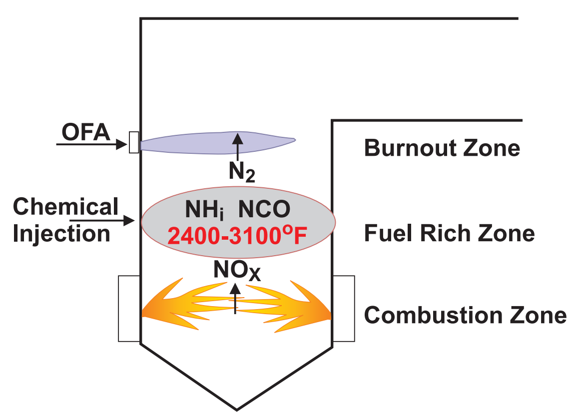
NO_X CONTROL OPTIONS AND INTEGRATION FOR U.S. COAL FIRED BOILERS (RICH REAGENT INJECTION)

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, Reaction Engineering International (REI) is conducting an effort to develop cost effective analysis tools and techniques for demonstrating and evaluating low NO_X control strategies and their possible impact on boiler performance for firing U.S. coals. The project addresses low NO_X issues dealing with waterwall corrosion, soot formation, ammonia on fly ash, deactivation of SCR catalysts, and the optimization of EPRI's Rich Reagent Injection (RRI) NO_X control technology which is highlighted in this fact sheet. With support from EPRI's Cyclone NO_X Control Interest Group (CNCIG), REI has developed, implemented, and tested an enhanced chemistry model with their proprietary Computational Fluid Dynamics (CFD) code *GLACIER* to simulate RRI. The concept of RRI as applied to staged cyclone fired furnaces is to use a nitrogen-containing additive to increase the NO_X reduction rate in the lower furnace.



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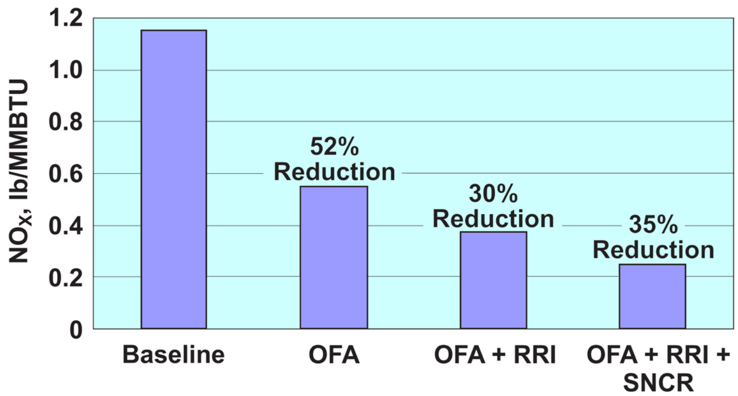
Objectives

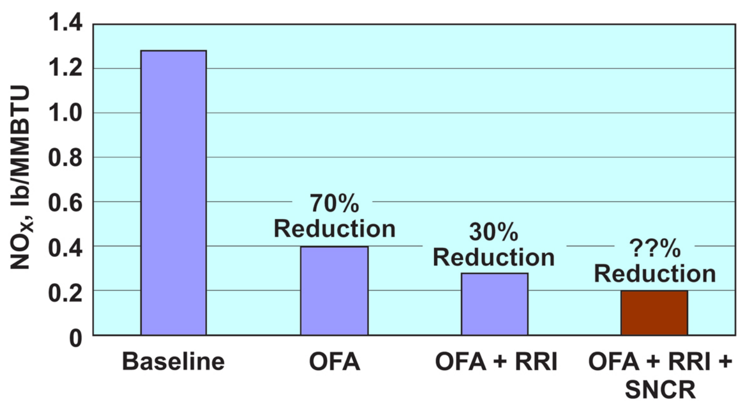
The objective of the project is to optimize the performance of, and reduce the technical risks associated with the combined application of low NO_X firing systems and post-combustion controls that might be selected to meet targeted NO_X emissions of 0.15 lb/MMBtu and below.

Description

Cyclone burners create an intense flame that melts the ash to form slag. The high temperature generated by this burner results in higher uncontrolled NO_X emissions, typically exceeding 1.2 lb/MMBtu. Research has shown that the injection of ammonia (NH_3) or urea into the high temperature NO_X-containing flue gases can lead to significant noncatalytic NO_X reductions. Field-testing of RRI has been successfully completed at the commercial scale at Conectiv's 138 MW B.L. England Unit 1 and AmerenUE's 500 MW Sioux Unit 1.



At Conectiv's B.L. England Unit 1, prior installation of overfire air (OFA) and SNCR had reduced uncontrolled NO_X emissions from 1.2 lb/MMBtu to 0.35 lb/MMBtu. REI's combustion simulation software was used to design an amine-based injection system for the staged lower furnace and to evaluate NO_X reduction performance of the RRI system. Field-testing confirmed modeling predictions and demonstrated that the RRI system alone could achieve 25-30% NO_X reduction beyond OFA levels with less than 1 ppm ammonia slip and that the inclusion of SNCR could achieve an additional 35% NO_X reduction to 0.25 lb/MMBtu with less than 5 ppm NH_3 slip.



The objective of the testing at AmerenUE's Sioux Unit 1 was to determine whether similar performance could be obtained with RRI in a significantly larger unit. The field test results were found to be consistent with the CFD model predictions. Both showed that NO_X reductions of 30% from full load baseline emissions of 0.38 lb/MMBtu with OFA to 0.27 lb/MMBtu were achievable with RRI. These reductions were achieved with no predicted or measurable ammonia slip. Modeling of this unit also suggests that NOx reductions could be improved through modification of flue gas recirculation (FGR) operation, reduction of lower furnace stoichiometry or utilization of SNCR. Although the target emissions of 0.15 lb/MMBtu were ambitious for this style of burner, these results are substantial when compared to the Title IV NO_X limit of 0.86 lb/MMBtu for cyclone-fired boilers. These units, which account for only 8% of the U.S. generating capacity, emit nearly 20% of the coal-fired NO_X emissions.