Design, Installation, and Testing of Aqueous Urea Based SNCR Performance in Conectiv's Indian River Units 3 and 4

Michael Zoccola, *Conectiv*
Victor Ciarlante and Mark Sankey, *Hamon Research-Cottrell*
Marc C. Cremer, *Reaction Engineering International*

SUMMARY

Project Start

In October of 1998, Conectiv awarded a contract to Hamon-Research Cottrell (HRC) to supply a urea based SNCR system on Units #3 (IR #3) and #4 (IR #4) at their Indian River Station, located in Millsboro, DE. The goal was to obtain moderate reductions in NOx (25 - 35 %) during the ozone season by injecting an aqueous urea reagent into the upper furnace. The Selective Non-Catalytic Reduction (SNCR) system was to be based on a technology developed by EPRI and Fuel Tech.

Unit Description

IR #3 is a 178 MWe B&W balanced-draft, front wall fired boiler. IR #4 is a 440 MWe DB Riley turbo, opposed wall fired boiler. Both boilers burn an Eastern Bituminous coal as their primary fuel. Several years before installing SNCR, both units had been retrofitted with Low NOx Burners and over fire air ports. The uncontrolled NOx prior to retrofitting SNCR was 0.46 lb/MMBTU on IR #3 and 0.44 lb/MMBTU on IR #4.

Boiler Testing and CFD Modeling

Boiler testing, which included obtaining profiles of gas temperature, NOx, CO, and O_2 at various elevations, was performed by HRC in March of 1998. The data collected was used to aid in the design of the injection systems and for calibrating the computational fluid dynamics (CFD) model, which was performed by Reaction Engineering International (REI). The CFD model combined the results of a lower furnace model, which analyzed the combustion process, with that of the upper furnace portion in which reagent was injected. The modeling took into account the operating load range, which varied from 25 to 100 %.

Identifying Injection Schemes

Conectiv, HRC and REI worked closely together to design an injection strategy that met the performance objectives while facilitating installation and minimizing impact on boiler operation, such as soot blower performance.

For IR #3, a total of 4 zones of injectors were selected, incorporating 22 wall mounted injectors and 2 Multiple Nozzle Lances (MNL) injectors installed between the superheat pendants. The MNLs span the entire 36 ft width of the boiler. The extraordinary challenge facing the injection design on this boiler was the simultaneous installation of rear over-fire air ports with SNCR. The modeling had to consider the projected impact of these modifications on SNCR performance.

For IR #4, a total of 5 zones of injectors were selected, incorporating 40 wall mounted injectors and 4 MNL injectors. The lances had an approximate inserted length of 27 ft, which was determined to be the maximum length possible due to structural constraints - the MNL is basically a cantilevered beam supported only on the outside of the boiler. To accommodate the 40 ft overall length (including injection lance and retraction mechanism), one side of the boiler building had to be expanded ("bumped-out") at two platform elevations. IR #4 is one of the largest boilers in commercial operation that has been installed with SNCR.

Engineering

The engineering phase began in October of 1999 and was to meet a very ambitious 3-month schedule. Along with the SNCR piping skids and injectors and MNLs, several auxiliary systems needed to be designed. These systems included a wastewater treatment system, a compressed air system, an electrical substation, a closed-cycle cooling system, a PLC based control system, and modification of existing Bailey DCS. The wastewater treatment system utilized an electrostatic separation device (EDR) to treat wastewater at the plant for use as dilution water supplied to the injectors. A 175,000 gallon steel tank was used to store the treated water. Two water-cooled compressors were added to meet the service and instrument air requirements of the injectors and other system components. A separate electrical substation room was built to house motor control centers, PLC and supplementary electrical equipment to serve the SNCR and auxiliary systems. To provide cooling for the MNL injectors and compressors, a closed-cycle cooling system utilizing an ethylene glycol solution was installed. The system incorporated two air-cooled heat exchangers installed near the boiler FD fans. The hot discharge of the heat exchangers was directed to the FD fan inlet to aid in the performance of FD fans.

As a cost and time saving measure, Conectiv decided to have HRC select and design the auxiliary systems, excluding the EDR, along with the SNCR specific components.

Installation

Installation of all equipment was handled by Conectiv and was completed in the Spring of 2000. HRC supplied Conectiv with a complete mechanical, electrical and structural installation specification, which Conectiv used to solicit competitive bids. To meet Conectiv's overall system needs, the installation had to be completed in time for the peak summer months. Conectiv was able to accomplish this task in part by arranging effective business alliances with its contractors.

Start-up and Operation

Start-up of IR #3 was completed in late April of 2000. The SNCR system has operated for a 6-month period (May-October, 2000). An average NOx reduction of 26% is being achieved.

Start-up of IR #4 was completed in late June of 2000. The SNCR system has operated for a 4-month period (July-October, 2000). An average NOx reduction of 34% is being achieved.

During start-up, ammonia slip was measured across each of two ducts (per unit) at the inlet to the precipitators using an EPA standard wet chemistry batch method. The plant has reported no increase in pressure drop across the air heaters, or difficulties in selling ash due to ammonia slip. The plant intends to continue to operate SNCR on both boilers during future ozone seasons.

Regarding maintenance issues, besides normal maintenance of standard piping components, the plant has had to perform periodic maintenance on the wall and MNL injectors.