# Case Study in Retrofitting an SCR System

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## Introduction

Our client has installed a new state-of-the-art continuous heat treating and galvanizing line to coat zinc onto steel coil. Once the steel surfaces are cleaned, the steel strip passes through a continuous natural gas-fired annealing furnace. The steel strip is radiant-heated in a controlled atmosphere and temperature to develop the desired metallurgical properties in the steel. Once the strip passes through the furnace, it enters the molten zinc galvanizing bath and is finally air-cooled before being re-coiled.

Chester Engineers (Chester) was retained to integrate into the system BACT control technology for nitrogen oxide emissions. After evaluation of various technologies, post-combustion controls were selected as BACT. The controls included a combination of urea injection followed by two catalyst beds in series. Our client was required to control the $NO_x$ emissions on the new annealing furnace and then to retrofit a similar system on an existing annealing furnace. The new system is now in operation; the retrofit system on the original furnace is presently under construction with start-up projected for the summer of 1999.

## Conceptual and Detailed Development

Retrofitting of the system and achieving the required $NO_x$ reduction were the main challenges that Chester faced. Only 25 feet of duct were available for retrofitting the entire system. The lack of distance and residence time available for urea to convert to ammonia required the injection of urea into the exhausts of four of the eight sections of the furnace at 950 to 1100°F and then dilute the air to 700°F before it entered the catalyst beds.

The upper design temperature limit of the catalyst was 775°F. Once the eight heat zone exhausts mixed together, the temperature could not exceed 800°F, the maximum design temperature of the fans. The furnace manufacturer provided dilution air dampers controlled by thermocouples located prior to the fans. Due to concerns that the main header dilution dampers might over-cool the gases, supplemental natural gas-fired burners were included following the dampers to raise gas temperature by approximately 100°F. Since start-up of the system in November 1998, the burners have been running approximately 20 percent of the time.

The >90% $NO_x$ control requirement that had been specified presented another challenging task, requiring the installation of two catalyst beds in an area where fully developed flow does not exist. Situating the two beds in series made this system the first of this type to be installed in this country.

Significant improvements were made to the $NO_x$ control system that will be retrofitted on the existing furnace. The total exhaust (66,000 acfm at 480°F) will be routed to an air heater followed by urea injection and two catalyst beds in series. A bypass dilution duct and damper will be installed as a precautionary measure to protect the catalyst beds from being exposed to high temperatures. This design will allow for effective control of the temperature and operation of the system.

The system called for extensive use of modular construction and skid mounting of key components. In addition to the supplemental heater, components include a metering module for liquid urea, catalyst housing and catalyst beds, monitoring instrumentation, and a data acquisition system (DAS) for logging and reporting of system operating data and emission levels.

## System Construction, Start-up, and Optimization

No unusual difficulties were encountered during the construction of the structural steel and mechanical equipment on the $NO_x$ control system for the new furnace. However, the input and output signals from the various components, especially the DAS and the monitoring instruments, needed to be adjusted in the field to take full advantage of the DAS unit and to allow the DAS to control the monitoring instrument calibration and zero cycle.

The $NO_x$ system has been required to operate at higher than expected turndown ratios on the new furnace. The furnace employs less steady-state firing than had been anticipated. However, after an initial period of fine-tuning, the controls on the metering module have been able to adjust the urea injection rate as required.

The new furnace initially operated at exhaust gas temperatures below design. However, after the dilution dampers were brought under control and a few thermocouples were moved to reflect a representative average gas temperature, it has been possible to control the catalyst beds within 10°F of the desired set point. A combustibles analyzer at the fan inlet has not indicated the need to shut down the supplemental heater to protect the catalyst beds from damage or overheating from combustion of unburned compounds.

The SCR unit regularly achieves over 90% total $NO_x$ removal. Average emissions have been well below the permit limits, as verified by emission tests. The system pressure drop is below the 5-inch $H_2O$ design criteria. Although the extensive efforts at controlling the key operating temperatures have resulted in stable and near-optimum temperatures throughout the $NO_x$ control system, reduction of $NO_x$ appears to be efficient over a wide operating range.

During the first few months of operation, it has been helpful to have clear ownership of the system operation by a core group within the plant staff. Remote alarms in the control room are necessary to ensure consistent system operation and rapid response to operating problems.