LEHIGH ENERGY UPDATE

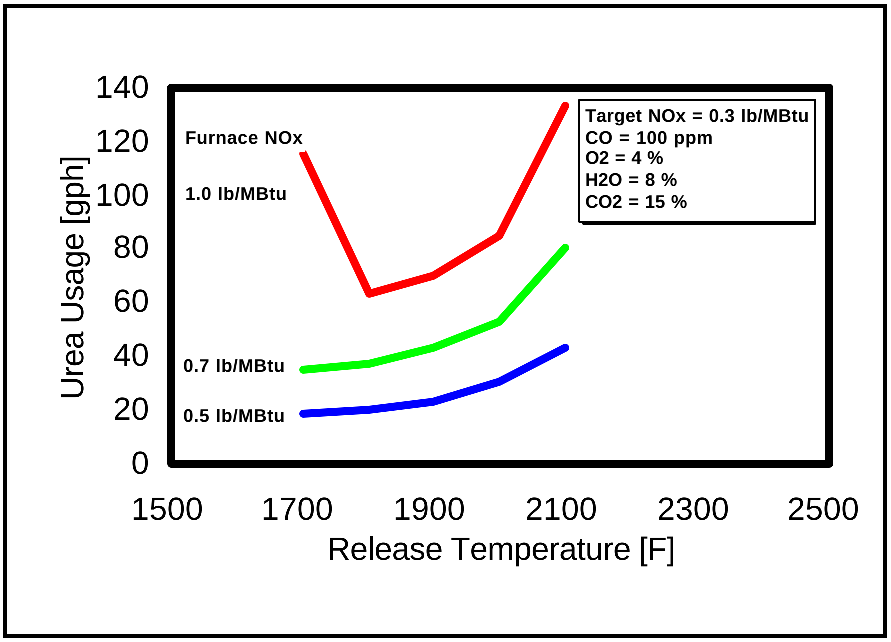
April 1998, Vol. 16 (2)

COMBINING SNCR WITH COMBUSTION OPTIMIZATION FOR COST EFFECTIVE NO_x CONTROL

Of the available techniques for controlling NO_x emissions from utility boilers, the selective non-catalytic reduction (SNCR) process requires fewer capital expenditures than most of the alternatives. However, its relatively high operating costs, driven by reagent consumption, make it important that reagent usage be reduced as much as possible. A recent study performed by the Energy Research Center (ERC) demonstrates the benefits of optimizing combustion as a means of lowering SNCR operating costs.

SNCR involves injection of ammonia or urea into the upper part of the furnace to convert NO_x produced during combustion to N_2. The performance of the SNCR system is a strong function of temperature and reagent injection rate. It also depends, in a significant way, on parameters such as baseline furnace NO_x level, furnace CO and O_2 concentrations, and gas residence time. SNCR can be an effective technique for NO_x control in applications with the right combinations of parameters such as temperature and NO_x concentration in the furnace.

One technique for reducing reagent consumption involves adjustment of the boiler control settings (for example, economizer O_2 level, burner tilt angle, air register settings and mill loading patterns) to reduce baseline furnace NO_x level and establish a furnace environment which favors the SNCR reactions.



Impact of Boiler Control Settings on SNCR System Performance with Stack NO_x Emissions Held Constant at 0.3 lb/MBtu.

To develop a means of predicting the effects of boiler operations on the SNCR reactions, Carlos Romero, a Research Engineer with the ERC developed a computer code which predicts the rates at which NO_x is converted into other species as a consequence of urea or ammonia injection. The code was then used to predict the effects of furnace temperature, baseline furnace NO_x level and CO and O_2 concentrations on the urea injection rates required to reduce stack NO_x emissions to compliance levels.

According to Romero, “The results of our simulations showed urea usage depends most strongly on gas temperature and baseline NO_x level entering the SNCR reaction zone. The SNCR process is relatively ineffective at temperatures below 1600°F and above 2200°F. At temperatures which are too low, excessive amounts of ammonia are released to the atmosphere with the stack gas, because of incomplete reagent dissociation. At temperatures above 2200°F, the reactions favor NO_x formation and significantly higher reagent injection rates are required to meet the target NO_x levels."

"However, the code also showed that if the system is operated within this temperature window, very strong reductions in the required urea injection rate occur with reductions in baseline furnace NO_x level."

One of the side effects of the SNCR process is the presence of ammonia in the stack gas. If the flue gas ammonia concentrations are too high, this phenomenon, referred to as "ammonia slip," can lead to corrosion and fouling of air preheaters and ammonia adsorption on fly ash. The computer simulations showed fewer problems of this type should occur with the reduced reagent usage which accompanies lower baseline furnace NO_x levels.

Late in 1996, the ERC conducted tests on a 80 MW coal-fired tangential boiler to measure the effect of changes in boiler operations on SNCR performance. Prior to the tests, the SNCR vendor had installed a urea injection system and adjusted the system to meet NO_x and ammonia slip performance guarantees. The vendor's tests were performed with boiler control settings which were typical of those which the plant had traditionally used. These resulted in a baseline furnace NO_x level of 0.67 lb/MBtu, and at these conditions, the SNCR system required 128 gallons/hr of urea to control NO_x to 0.38 lb/MBtu. Over several weeks of testing, staff from the ERC optimized boiler operations and the operation of the SNCR system. Three new combinations of boiler control settings were tested which reduced the furnace NO_x emissions to the 0.58 to 0.6 lb/MBtu range. When the SNCR system was then turned on, the urea required to achieve a target NO_x level of 0.38 lb/MBtu was found to range down to 61 gallon/hr. This is one half of the urea injection rate required with the boiler operating with the traditional boiler control settings.

The reduction in urea consumption was accompanied by an increase in net unit heat rate, principally from lower steam temperatures and higher levels of unburned carbon. However, calculations showed the savings in urea relative to the baseline were substantially greater than the resulting fuel cost penalty.

According to Romero, "The annual savings associated with optimizing both the operation of the boiler and the SNCR system will depend on factors such as unit capacity factor, percentage reduction in urea consumption, and the price of urea. For the boiler which was tested in this study, these savings are in the range of several hundred thousand dollars per year."

Romero adds, "The results from our studies demonstrate it is possible to achieve substantial savings by combining an optimization of boiler operating conditions and of the SNCR system. As SNCR becomes more widely used as a NO_x control technique, we believe methods for reducing SNCR operating costs will become a relatively high priority for the utility industry." •