USING SOOTBLOWING TO HELP CONTROL NO\textsubscript{x}

At almost all pulverized coal boilers, decisions on when to activate furnace sootblowers are based on the need to control steam temperatures and prevent excessive accumulations of slag. However, sootblowing also has an impact on NO\textsubscript{x} emissions. As a result, optimized furnace sootblowing practice can be used as a tool to help reduce the high cost of controlling NO\textsubscript{x} during the ozone season.

The link between furnace slagging and NO\textsubscript{x} is due to the effect of flame temperature on the rate of NO\textsubscript{x} formation. Utility boilers are characterized by high volumetric heat release and high temperature flame zones. Heavy slag deposits in the waterwall regions of these boilers reduce local radiation heat transfer, causing an increase in flame temperature. As the furnace gas temperature increases, NO\textsubscript{x} also increases.

The effect of slagging on NO\textsubscript{x} formation can easily be seen by monitoring NO\textsubscript{x} emissions while the unit is held at steady, full-load conditions. When the wall blowers are activated, the NO\textsubscript{x} drops abruptly and then increases slowly with time until the furnace waterwalls are once again cleaned. The magnitude of the change of NO\textsubscript{x} with sootblowing depends on furnace design and type of coal. Data gathered by the Center on pulverized coal boilers firing Eastern bituminous coals show typical decreases in NO\textsubscript{x} due to sootblowing of 0.05 to 0.1 lb/MBtu.

When removing slag for NO\textsubscript{x} control, consideration also has to be given to the effect of sootblowing practice on steam temperatures and heat rate. Maintaining high levels of waterwall cleanliness as a NO\textsubscript{x} control measure can result in undesirably low steam temperatures in some boilers, with a correspondingly high heat rate penalty. The function of sootblow optimization is to determine which blowers to activate and on what schedule such that the desired reductions in NO\textsubscript{x} can be achieved while limiting the steam temperature and heat rate impacts to manageable levels.

There are additional aspects of sootblow optimization which should be considered. These include the effect of sootblowing on opacity, the use of sootblowing to prevent steam temperature overshoots during load swings, and the need to avoid high rates of tube wastage in the vicinity of the sootblowers due to excessive wall blowing.

The Center approach to sootblowing optimization involves a combination of plant testing and analysis. In order to know which furnace sootblowers to activate and on what schedule, it is necessary to have information on the degree of slag buildup and on the effects of individual sootblowers on slagging. This requires the availability of online data involving parameters such as furnace exit gas temperature or the waterwall cleanliness factor. Furnace gas temperature can be measured directly using instrumentation installed at the furnace exit or calculated using heat transfer
principles. Furnace cleanliness factors are calculated from measured values of economizer exit gas temperature, flue gas flow rate and rates of heat absorption in the various heat exchange sections in the convective part of the boiler.

Once data are available for characterizing the effects of sootblowing on slagging, a series of field tests is carried out to determine the impacts of utilizing different combinations of wall blowers on steam temperature, heat rate and NO\textsubscript{x} emissions. The data are analyzed, additional tests are carried out, and from this, an optimized sootblowing strategy is developed for that boiler.

In the simplest approach, the operators are provided with written instructions on when and where to blow soot. These instructions include a schedule for sootblowing which relies in part on indications of furnace slagging. In the case of boilers which have control systems with sufficiently sophisticated capabilities, the sootblowing schedule can be automated using the programming capabilities of the control system.

Both of the approaches described above require the development of a sootblowing schedule. A more sophisticated approach makes use of the field data gathered during the sootblow testing, and online data on furnace cleanliness factors or furnace gas temperatures. These data are processed by a software package containing an expert system and neural networks. The code is linked to the sootblowers to provide intelligent automatic on-line sootblower control.

The economic benefits of optimizing sootblowing practice can be substantial. For example, test results obtained for a 100 MW boiler show that by increasing the frequency of use of the sootblowers, there would be a 20 Btu/kWh heat rate penalty and a 0.02 lb/MBtu NO\textsubscript{x} reduction. Assuming fuel costs of $1.50/MBtu and NO\textsubscript{x} credits at $2,000/ton, this translates into a $7,000 fuel penalty and a $46,000 savings due to lower NO\textsubscript{x} emissions during the five month ozone season. Obviously, the potential for savings increases with the size of the unit and it also depends heavily on the cost of NO\textsubscript{x} credits. Total net savings can exceed $250,000/year for large capacity units.

Sootblowing optimization is but one of several operations-related techniques which can be used to reduce the cost of complying with NO\textsubscript{x} regulations during the ozone season. Others include combustion optimization, improvement in CEM flow measurement accuracy, and modifications in coal procurement practice. Together, these methods can be used to reduce NO\textsubscript{x} units by anywhere from 15 to 35 percent, depending on the circumstances. É