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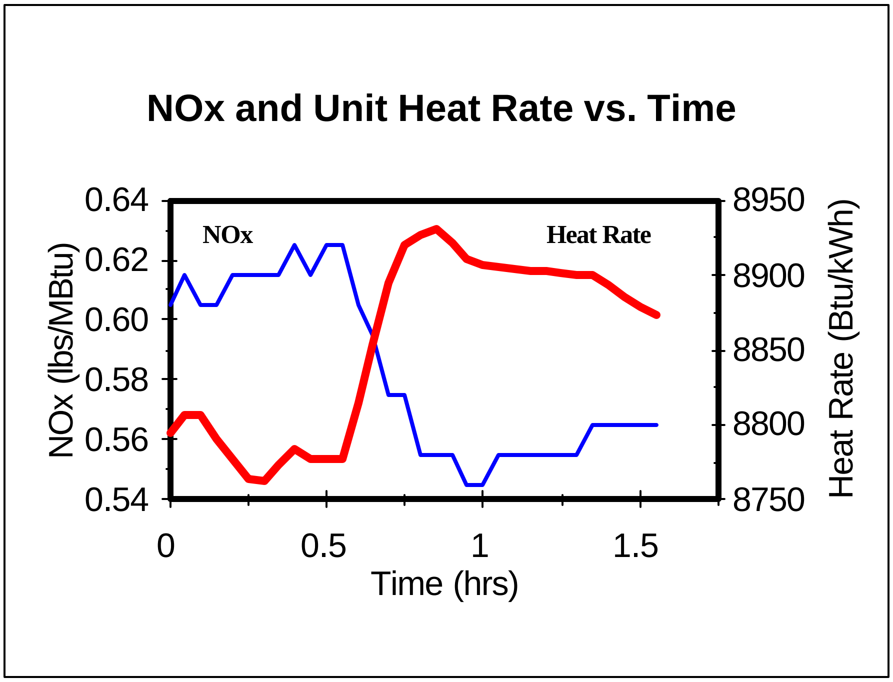
OPTIMIZE SOOTBLOWING TO REDUCE NO_x AND IMPROVE HEAT RATE

Sootblowing is an often-neglected aspect of the operation of a pulverized coal boiler, yet the way sootblowers are used can have a significant impact on the financial bottom line. Recent studies performed by the Energy Research Center show how optimizing sootblowing practice can help reduce emissions and improve unit heat rate.

In most pulverized coal boilers, slag from coal ash builds up on the walls of the furnace. Left unattended, the deposits can become unmanageable in size and require an expensive outage for removal. The deposits also reduce the amount of heat transfer in the waterwall region, resulting in increased gas temperatures leaving the furnace. The higher gas temperatures at the inlet to the convection pass result in increased rates of heat transfer in the superheater and reheater sections of the boiler and higher main steam and hot reheat steam temperatures. If slagging is allowed to progress too far, measures must be taken to reduce the steam temperatures. At many units this is done through the use of attemperating sprays, with a resulting deterioration in unit heat rate. The higher furnace gas temperatures associated with the presence of slag deposits also result in greater rates of NO_x production. In some cases, this makes it difficult for the boiler to meet NO_x regulations.



This sootblow event, which began at 0.5 hours, reduced NO_x by 0.06 lb/MBtu and increased heat rate by over 100 Btu/kWh.

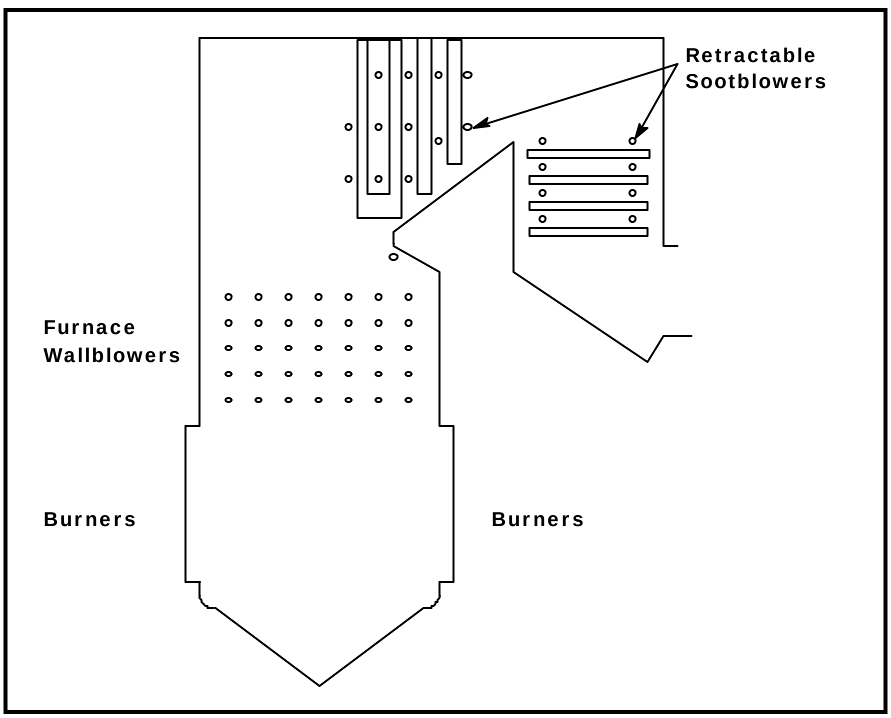
Boiler operators are typically provided with little or no information on ash deposition levels or with much guidance regarding how to optimize sootblowing operations. The challenge in the development of a sootblowing strategy is to determine which portions of the boiler to clean and on what schedule. This should be done considering the trade-offs between NO_x, steam temperatures, heat rate, and other factors such as opacity, tube life, and steam consumption.

Working with personnel from the Potomac Electric Power Company, the Energy Research Center performed studies at two tangentially-fired boilers to determine the trade-offs associated with different sootblowing strategies. This was done in an effort to develop improved sootblowing schedules for use by the plant operators. These studies were carried out by Dr. Carlos Romero, a research engineer in the Energy Research Center, and Don Pavinski, a graduate student in Mechanical Engineering and Mechanics.

The field investigations were conducted at Morgantown Unit 2 and Potomac River Unit 4. Morgantown Unit 2 is a 580 MW unit with a tangentially fired supercritical boiler with single reheat. Sootblowing, attemperating sprays and variable burner tilt angles are used for steam temperature control. Potomac River Unit 4 has a nominal full load rating of 108 MW with a subcritical tangentially-fired boiler. Due to marginal heat transfer surface area in the convective pass, this boiler relies on burner tilt control and sootblowing practice to maintain steam temperatures.

According to Romero, "The ability to determine the most suitable conditions for sootblowing depends on having access to information which reflects the slagging and fouling condition of the boiler. There are several possible approaches for monitoring slagging and fouling. For example, this can be done through use of computer programs which calculate the rates of heat transfer in the various parts of the boiler, or through direct measurement of furnace gas temperatures. Other approaches make use of measurement of local values of furnace heat flux or tube wall temperature or visual observation of the furnace walls."

"In this particular study, we used calculations available on the Plant Monitoring Workstation. These calculations use standard plant instrumentation for steam temperatures, pressures and flow rates. The analysis also requires information on the flue gas temperature at the economizer exit, flue gas flow rate, and information such as burner tilt position to calculate radiant heat transfer in the furnace. Using a series of heat balance calculations, information on gas temperature, boiler section heat absorption and cleanliness factor are determined through-out the boiler. The cleanliness factor, which is obtained from the ratio of the actual rate of heat transfer to the heat transfer which would occur with a deposit-free heat exchanger, can vary from zero to 100 percent.



The impact of furnace sootblowing on NO_x and heat rate depends strongly on sootblower location. This figure shows typical sootblower locations in a large coal-fired furnace.

Higher values of cleanliness factor are associated with heat exchangers which are relatively deposit-free. Separate cleanliness factors were obtained for the waterwall region, reheater and superheaters to indicate the degree of slagging or fouling in each."

An important aspect of the study was the information it provided on the effect of furnace sootblower location on NO_x and steam temperatures. Using on-line data on boiler section cleanliness, NO_x, opacity, steam temperatures and attemperating spray flow rates, Romero and Pavinski ran field tests to gather data on the effect of sootblower location on boiler operations. By activating different sootblowers, they were able to determine the effects of different combinations of sootblowers on emissions and boiler performance. The results showed that at Morgantown Unit 2, NO_x could be reduced by as much as 0.06 lb/MBtu as a result of sootblowing. Cleaning the waterwalls was also found to cause an increase in heat rate by as much as 100 Btu/KWh, depending on sootblower location. The results also showed there is a critical value of waterwall cleanliness, above which there are no additional NO_x benefits from sootblowing.

Similarly to the work conducted at Morgantown, the data from Potomac River provided information on the effect of furnace sootblower location on NO_x and steam temperature and identified a critical value of waterwall cleanliness factor above which additional sootblowing was found to have little effect on NO_x. It was found that NO_x is not as strong a function of furnace cleanliness at Potomac River as it is at Morgantown. This is due to the differences in the number of wallblowers activated for a cleaning event. In addition, the furnace exit gas temperature is much higher at

Morgantown (2750° versus 2000°F at Potomac River). This causes the thermal NO_x, which is an exponential function of temperature, to be more sensitive to changes in furnace temperature at Morgantown.

Using the trends obtained from analysis of the field test data, Romero and Pavinski developed strategies for cleaning both the waterwalls and convective passes at the two units. The strategies, which account for the load profiles of the units, were developed to provide the largest reductions in NO_x, with minimal impacts on heat rate and opacity.

Opacity excursions can occur during a sootblowing event as debris is released into the gas flow. Since the Morgantown units are particularly susceptible to opacity problems, the sootblowing strategies developed for those units were made to account for the effects of sootblower location, unit load and degree of slagging or fouling on opacity. The field tests showed opacity excursions could be avoided if the change in waterwall cleanliness factor during sootblowing was limited in magnitude. It was also found that cleaning of a reheater or superheater in the convective pass had to be scheduled at reduced load conditions to avoid opacity problems.

Romero notes, "Sootblowing optimization provided an additional benefit for Potomac River. Our review of historic data for that unit had uncovered a persistent problem of transient overshooting of both mainsteam and hot reheat steam temperature during load rampups. These overshoots were frequently as large as 50°F. If allowed to occur over sufficiently long periods of time, these temperature excursions would lead to reduced component life. Our experiments with the furnace wall blowers showed ways of activating selected sootblowers during load rampups to minimize the temperature excursions."

Several levels of sootblowing optimization can be implemented using information of the type developed in this study. The simplest approach involves providing the operators with written instructions on when and where to blow soot. These instructions include a schedule for sootblowing which relies, in part, on measured gas temperatures or calculated cleanliness factors.

If the control system has sufficient capabilities, the sootblowing schedule can be implemented in the control system and used to notify the operators when it is time for them to activate specific sootblowers. Alternately, if complete automation is desired, the control system can be configured to automatically activate the sootblowers at the optimal times. •