Optimize sootblowing to reduce NO\textsubscript{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\textsubscript{x} production. In some cases, this makes it difficult for the boiler to meet NO\textsubscript{x} regulations.

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\textsubscript{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
The impact of furnace sootblowing on NO\textsubscript{x} and heat rate depends strongly on sootblower location. This figure shows typical sootblower locations in a large coal-fired furnace.
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.