Acoustic Cleaners vs. Steam Sootblowers: The Birchwood Power Facility Story

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Abstract

Typically, rake style steam sootblowers have been utilized to provide cleaning of SCR catalyst beds. While sootblowers can be effective in this application, they are expensive to purchase, install, and operate. With this being the case, in today’s economy acoustic cleaners are specified more often for service on new SCR reactors as well as installed to replace sootblowers on existing SCR reactors.

Over the last 20 years, acoustic horns have been successfully used in a wide range of applications on coal-fired boilers. These applications include air preheaters, boilers, precipitators, and SCR reactors. The economical and operational benefits of using acoustic cleaners versus steam sootblowers on SCR reactors are even more impactful in today’s economic environment. This paper discusses the installation of four BHA® Powerwave® DC-75 acoustic cleaners and their comparison to the use of steam sootblowers at Mirant, Birchwood Power Facility in King George, Va.
Introduction

BHA Powerwave acoustic cleaners are air-operated horns that emit low frequency, high-energy sound waves. The sound waves are produced by air entering the sound generator (Figure 1), causing the only moving part, a titanium diaphragm, to flex. The flexing of the diaphragm generates sound waves that are then amplified by the bell of the acoustic cleaner. These sound waves resonate and dislodge the ash deposits from the surface to which they have bonded. Once the ash has been dislodged by the acoustic energy, the gravity and/or gas flow sweep it away.

Figure 1.
Economical and Operational Benefits of BHA Powerwave Model DC-75 Horns

**Low Initial Investment**
Rake style steam sootblowers, which are commonly used to clean the catalyst layers in SCR reactors, generally cost about $17,000. This is more than four times the average cost of a BHA Powerwave DC-75 acoustic cleaner.

**Low Installation Cost**
BHA Powerwave DC-75s can be installed in an SCR through 16-inch diameter openings located about 18 inches above the catalyst layers. The bell and sound generator will protrude off the reactor wall less than 30 inches (Picture 1). The steam sootblowers, on the other hand, protrude off the reactor wall by more than 10 feet, requiring additional floor grating. The sootblowers also require support steel on the inside and outside of the reactor (Picture 2).

The “plumbing” of the acoustic cleaner installation is simple. A two-inch ID airline is run up the side of the reactor. This is the main air supply line. At each layer of catalyst, a one-inch ID airline (fed by the main air supply line) is mounted across the row of acoustic cleaners installed on the respective layer. At each acoustic cleaner there is a .75-inch “T” connection in the one-inch ID airline. A .75-inch solenoid valve is installed. The sound generator is connected to the solenoid valve with the use of flex hose, and connecting the solenoid valves to the timing system completes the installation. This procedure is much easier and considerably less expensive than the insulated steam line installation requirements for steam sootblowers.
Low Operational Cost

BHA Powerwave acoustic cleaners operate on standard plant air. The air requirements are 70 to 90 psi with an air consumption rate of 60 SCFM when sounding. The typical operating sequence for acoustic cleaners on a SCR reactor is 10 seconds every 10 minutes. It is common to operate two to three acoustic cleaners at the same time. This equates to an average air consumption of one SCF per acoustic cleaner per reactor. It should be noted that the operation of the acoustic cleaners can be spaced out over the 10-minute operating cycle so that no more than four acoustic cleaners are operated each minute on a large reactor requiring 40 acoustic cleaners.

The cost of the air used to operate acoustic cleaners is far less expensive than the high-pressure steam used to operate rake style steam sootblowers. The volume of air required to operate the acoustic cleaners is also far less than the volume of steam consumed by the sootblowers. The cost of operating one acoustic horn based on standard operation (10 seconds every 10 minutes) for one day is 47¢. This cost is calculated in the equation as follows:

Equation:
1:13 SCF per horn x sounding six times per hour = 78 SCF/hr. x 24 hr. = 1,872 SCF/day x 25¢ = 47¢/day x 365 days = $171.56 annualized cost per acoustic cleaner.

Note:
The cost of compressed air is based on industry standard of 25¢ per 1,000 cubic feet of air.

Low Maintenance Cost

Because BHA Powerwave acoustic cleaners have only one moving part (titanium diaphragm), maintenance costs are relatively low. In most cases, the diaphragm lasts over five years. The cost of a replacement diaphragm is less than $300. Replacing the diaphragm is an easy procedure. Simply unbolt the cover plate of the sound generator, remove the used diaphragm, place the new diaphragm into the sound generator and bolt the cover plate back onto the sound generator. This can be done while the reactor is on-line.
The Birchwood Power Facility in King George, VA, started up in the summer of 1996 and is operating one coal-fired boiler with a generating capacity of 250 MW. The coal burned in the boiler is a low sulfur (less than 1%) eastern coal that has an ash load of 8 to 11%. A SCR reactor, scrubber, and reverse air baghouse treat the flue gas from the boiler. The boiler and pollution control equipment were designed and built by Alstom™.

The SCR reactor is using plate to plate catalyst supplied by Siemens Westinghouse Power Corp™. The reactor was started up with 1-½ layers of catalyst. The catalyst was cleaned by three rake style steam sootblowers installed above each level of catalyst, each being operated every 12 hours. The sootblowers were very effective in cleaning the catalyst and the reactor has operated as designed since startup. The deactivation rate of the catalyst has also followed the predictive curve of Siemens™.

In the fall of 2000, four BHA Powerwave DC-75 acoustic cleaners were installed above the first layer of catalyst to compare the cleaning effectiveness of acoustic cleaners to the sootblowers. The acoustic cleaners were programmed to operate for 10 seconds every 10 minutes. In an effort to average the air consumption, one acoustic cleaner was operated every ninety seconds. The sootblowers were not operated on this layer of catalyst during the trial period, which ran from October, 2000 to May, 2001.

The inspection of the reactor during the May outage showed that the acoustic cleaners were as effective as the steam sootblowers in cleaning the catalyst (Picture 3). As a result of this trial, plant personnel purchased the four BHA Powerwave DC-75s that were tested as well as four additional BHA Powerwave DC-75 acoustic cleaners. The additional acoustic cleaners will be used to clean the new third layer of catalyst being installed during this outage.
The decision to purchase the BHA Powerwave acoustic cleaners was justified in the steam cost savings alone. The cost of steam consumed by the six steam sootblowers for cleaning the catalyst at this plant averaged $40.50 per day. As discussed earlier in this paper, the cost to operate one acoustic cleaner is 47¢ per day. The cost of operating all eight of the acoustic cleaners on this reactor is $3.76 per day. At this rate, an annual cost savings of $13,409.60 will result with the use of acoustic cleaners versus steam sootblowers, which gives the plant just over a one-year return on investment for the acoustic cleaners.