Picking a cost effective coal dust control system

Fuel switching usually calls for an upgrade of dust control in coal handling systems. To pick the best control, review them all.

One power plant did it

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Now that the Clean Air Act Amendments' acid rain conformance deadlines are an imminent reality, many power plants have already turned to fuel switching as a solution. Others are considering the switch from midwestern/eastern fuels to western fuels. Although a variety of factors must be evaluated in changing fuels, elevated dust concentrations in systems handling western coals probably heads the list.

Blending two or three different fuels is often anticipated to maintain good boiler performance, meet required stack emissions and avoid deratings. Some utilities also are spot-purchasing coal, which means that coal handling personnel must deal with a multitude of variables associated with each supplier of coal.

High levels of airborne or fugitive dust cause several problems—some direct, others more subtle—and lost revenues can occur for a number of reasons. These include fuel losses in transit, in coal handling systems and from coal piles; penalties from local, state, and federal regulators; higher equipment maintenance and/or replacement; fire and explosion hazards; and increased cost of insurance and medical costs.

To address these concerns, power plant engineers need to gather and sort information to pick the best solutions for their plant sites. Next, it will help them to plot a map that will show the way to a successful program while keeping costs to a minimum (Figure 1).

Determine dust control goals
The first step is to develop site-specific dust control goals. To get goals established:
1. Address fire and/or explosion potential.
2. Determine when and where dust control is needed (during test burns, blending, handling, etc.).
3. Anticipate the ease of dust control system changes. Can the present dust control system handle a possible conveyor modification needed in a fuel switch or blending adjustment?
4. Review costs for equipment and chemicals.
5. Include needs for a clean and healthy work environment to meet OSHA work regulations.
6. Evaluate the degree of fugitive dust from storage piles. Is it a problem?

Table 1. Cost summary for collection and suppression systems.

<table>
<thead>
<tr>
<th>Cost category</th>
<th>Dust collection</th>
<th>Dust suppression</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installation</td>
<td>$6000 to $9000 per 1000 CFM</td>
<td>$60,000 + per control house and $3000 per application point</td>
</tr>
<tr>
<td>Operating</td>
<td>2 to 3 hp per 1000 CFM</td>
<td>Residual: $0.03 to $0.10 per ton Foam: $0.01 per application point Wet: $0.005 per application point 1050 Btu lost per pound of water added</td>
</tr>
<tr>
<td>Maintenance</td>
<td>Bag replacement every 18,000 to 26,000 hours plus normal maintenance</td>
<td>Normal maintenance</td>
</tr>
</tbody>
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Dust collection
Conventional collection systems use slight negative pressures created by air movement to transport airborne particles through ducts to a central collection point. Capture hoods are located in areas where dust is generated and the hoods transport it through ductwork to a central collection point.

One type of collector combines the capture hood and central collection point into one unit. More collection units are necessary, but there is no need for ductwork. Filters separate dust from the air at the central collection point and the collector then discharges the clean air.

The most common dust collection systems use a baghouse as the central collection point. Compressed air, or a reverse air flow through the filter fabric, cleans the filter media. Although less common, mechanical shakers also are used to clean filter fabric.

Control by suppression
Dust suppression systems use strategically located application manifolds to reduce airborne dust levels. The most basic of these systems do not use chemicals to enhance control. However, even the least expensive surfactant can reduce water usage by 10%. Water added to fuel decreases the net heating value of the fuel, therefore, specific chemicals mixed with water will reduce any heat rate loss.

In addition to plain water sprays, there are three general types of dust suppression systems. They are wet suppression, foam suppression, and residual suppression.

Wet suppression consists of a water spray in which a surfactant reduces water surface tension. This allows dust particles to attach to water droplets more easily. The particles then fall to the conveyor or chute due to the weight of the water droplet.

Foam suppression uses air, water, and a foam surfactant to encapsulate airborne dust particles. This system adds very little moisture to the coal. Foam generating systems greatly increase the water's surface area and reduce water surface tension. Tests have proved that the higher surface area and sur-
face tension reduction greatly increase the potential for dust particle capture.

Residual suppression uses binders, humectants, and surfactants to provide long-term dust control for storage piles and downstream coal handling areas. Usually, the residual chemicals are mixed with water and the solution is sprayed on wet.

**Evaluation of costs**

An important factor in all goal-setting evaluations is costs. Equipment and installation costs for collection range from $6000 to $9000 per 1000 cfm. These are installed costs for an average baghouse dust collection system at a transfer chute. The include ductwork, collection hoods, and compressor. Note that conveyor layout can affect the collector size, coal dust return air processing systems, and the air requirements.

Items to consider when designing a dust collection system include: automatic operation, transfer chute design for sizing, ease of maintenance, control interface with existing coal handling equipment, space requirements, moisture, temperature and humidity for the collection environment, and explosion venting.

**Power requirements** are almost directly proportional to air requirements. However, extra auxiliary equipment adds to power requirements, which can range from 2 hp to 3 hp per 1000 cfm. Air to cloth ratios from 3:1 to 7:1 are common.

Air volumes depend on the size of the dust control area and air leakage. Normal design air velocities for coal dust control range from 400 fpm to 500 fpm for collection hoods and 4000 fpm for ductwork.

Under normal conditions, bag life extends from 18,000 to 26,000 hours of operation. Depending on the frequency of operation, bag life can be from two to nine years. This is for 16-ounce polyester, low denier, singed finish bags. Other needed maintenance includes rotary airlock and cleaning system repairs. Maintenance costs depend on the system. Aside from normal wear on spray tips, filters and pump calibration are common.

**Application costs** correlate directly to the type of coal handled, coal flow rate, condition of the coal handling system, conveyor speeds, and desired effectiveness.

A frequent practice is to have the dust suppression vendor conduct maintenance on the system. Aside from normal wear on equipment, monthly maintenance checks of spray tips, filters and pump calibration are common.

Table 1 summarizes the costs to consider for collection and suppression systems. Both methods of dust control have advantages and disadvantages. Knowledge of each type is essential to selection of an effective system. The following list of advantages and disadvantages for each may help.

**Dust collection advantages**

- Dust collection is effective in large unconfined coal handling areas, such as in areas for railcar coal dump hoppers, surge bins, and coal bunkers.
- Collection captures a high percentage of airborne dust, and collection efficiency of airborne dusts reaches nearly 100%.
- Coal moves rapidly through a chute and forces air through just as rapidly. Dust collection overcomes this air movement and effectively captures airborne particulates.
- In general, dust collection requires less operating and maintenance cost, because it does not add moisture to the coal. Moisture reduces the heating value of the coal.
- Housekeeping costs are lower with collection because of its higher efficiency (nearly 100%).

**Dust collection disadvantages**

- Equipment and installation costs and power requirements usually are higher than suppression.
- Handling and treatment of collected dust must be included in the design.
- Collection produces no carryover dust control effects unless the collected dust is treated and handled properly.
- Because collected coal dust is deposited in a hopper, the chance of fire or explosion
increases. The fine particle size of collected coal dust allows it to stay airborne for long periods and dust concentrations inside collectors easily reach the minimum explosion concentration of 35 g/m³. The collection system design must avoid potential ignition sources.

- Depending on the design, dust collection can remove air from enclosed spaces. Air infiltration and heating of makeup air may be necessary.

**Dust suppression advantages**

- Equipment costs are relatively low.
- Suppression systems have dust control carryover effects. Solution applied at one area will reduce dusting in other normally dusty downstream areas.
- Residual suppression products reduce dusting on coal storage piles and prevent or reduce fugitive dusting. Tests show that residual effectiveness lasts for months depending on the suppressant quality.
- The supplier remains interested in the performance of equipment because of the chemical sales.
- In general, power and maintenance costs are less than for collection.
- Suppression systems adapt easily to fit conveyor system changes.

**Dust suppression disadvantages**

- Water added to the coal reduces heating value. It takes 1050 Btu of heat to evaporate each pound of water added to the coal.
- Suppression sprays may not be effective in fast-moving coal streams. The resulting rapid air movement may cause misdirection of suppression sprays.
- Sprays are difficult to apply in large open areas.
- Suppression can increase wet and frozen coal problems if excess moisture is used. Antifreeze additives in suppression chemicals reduce frozen coal problems. However, not all chemicals have antifreeze additives and the equipment needs freeze protection.
- Residual application requires water. Some residual suppression systems need up to three gallons of water per ton of coal.
- Operating costs are higher because of the chemical cost.

**Dust control system performance**

Performance checks on a dust control system ensures employee health and safety, and such checkups also aid system maintenance. Some of the following steps should be completed before installation of the dust control system:

1. Survey the existing coal handling system to identify problem areas. Record locations of loose seals, holes in chutes, operating practices that cause dusting and other dust-producing problems. Interview responsible operating and maintenance parties as part of the survey.
2. Measure dust levels before and after every dust control improvement. Frequent measurements help to take a careful step-by-step approach. In addition, a stepped approach minimizes wasted time. If a turnkey system is involved, require a performance warranty based on OSHA regulations.
3. If possible, test the proposed dust control system before installing it. This is not practical with collection systems unless the system is modeled, there are field test installations, or complete laboratory tests for suppression. With field testing and modeling, measure before and after dust levels. For laboratory suppression testing, measure foam expansion ratios, wettability and complete drop box testing for proposed suppressants. ASTM D547-41 describes a test to determine an index of coal dustiness. It describes a method of measuring float and coarse dust produced by impact.
4. Monitor dust control system costs. Track capital, power, maintenance and housekeeping costs for dust collection systems. Track capital, power, maintenance, housekeeping, water, and chemical costs for suppression.

A coal handling system has many individual areas that make up the total system. There are hoppers, bins, bunkers, silos, transfer chutes, loading points, discharge points, crushers, and various conveyor configurations. Each of these areas has a different control problem. And, many systems require a combination of dust suppression and dust collection. Once the best system has been pinpointed, keeping it working efficiently will pay dividends.

A fuel switch at Union Electric Co.

A successful dust control system selection process was accomplished at Union Electric Co.'s Labadie plant. There are four 600-MW Combustion Engineering, subcritical, balanced draft, pulverized coal-fired units on site.

A switch from Illinois coal to Powder River Basin (PRB) coal increased coal dust levels due to the friable nature of the new coal. Because of the lower densities and Btu values of PRB coals, average conveyor belt speeds were increased by 43% to handle the needed extra fuel feed. This added to the airborne dust level problem.

In the process of developing its goals, the company considered five areas: environmental, regulations, fugitive dust, cost control, and flexibility.

The first—environmental—involved the many transfer houses and conveyor tunnels that became dust and dirt covered from excessive airborne coal dust; a threat to employees.

Next, dust readings indicated that some areas did not meet the 2.0 mg/m³ OSHA regulation and fugitive dusting while unloading trains and stacking out coal to the storage piles was excessive.

Cost effectiveness is always a goal and no less so in dust control. Last but not least, flexibility was needed in this system. Necessary changes to the coal handling system to accommodate PRB coal were not finalized, and PRB coal was being burned at Labadie at the time this project began. A system that could be expanded easily and/or modified to meet changes in the coal handling system was needed.

**Active solutions: dust containment**

As a first step after a dust containment approach was chosen, some system upgrades were undertaken with new equipment installations. Coal reclaim system conveyor capacities were increased from 500 to 850 tph by increasing speed and changing troughing idlers from 35 to 45 deg.

Thirty new belt scrapers were installed to reduce carryback on the return side of conveyors; 30 new impact cradles at conveyor loading points reduced belt flex; and 30 new belt seals were installed at transfer and loading points, which reduced airborne dust levels. Twelve new coal transfer chutes were installed. This accounted for approximately 48% of the total cost of the containment work. Scrapers accounted for approximately 14% of the containment cost; impact cradles, 17%; and belt seals, 21%.

Dust control reduced the escape of some dust, but it did not meet total levels of the goals set forth.

**Dust control method**

Both dust suppression and dust collection then were evaluated. Dust suppression was chosen because of the advantage of residual carryover throughout the coal storage pile and reclaim systems. It was the most cost effective solution to the dusting problem at the Labadie plant. In addition, dust suppression could be expanded easily or modified to fit various coal handling system changes. The goals set forth were met for the coal receiving and coal reclaim systems at Labadie.

As for cost savings, housekeeping time was reduced by approximately 2500 man-hours per year after the dust suppression system went into service. Estimates saw an additional $2.5 million in capital expenditures being needed if dust collection was chosen for the coal receiving and coal reclaim systems. Another $900,000 per year in O&M expenditures would have been required for a collection system. Dust levels were reduced by an average of 60% to 80%, depending on the coal handling area. Respirable dust levels in coal receiving were reduced from approximately 3.5 mg/m³ to 1.7 mg/m³. The coal reclaim area showed reductions from 4.6 mg/m³ to 0.6 mg/m³.

The savings achieved because Labadie met health, safety and fugitive dusting goals are intangible. If nothing was done, these goals would not be met, and it is likely significant costs would have been incurred.

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Reduce boiler NO\textsubscript{x} emissions
China turns to exotic power systems
Choose the right dust control system
Identify project's environmental impacts
Development of an international computer protocol