

# Dust Suppression In Coal Ash Applications

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KEYWORDS: dust, dust suppression, dust control, fugitive material, fly ash, (dry) ash control

It's been over four years since more than a billion gallons of coal ash slurry spilled through a failed dike at Tennessee Valley Authority's Kingston power plant in eastern Tennessee, and the U.S. EPA finally appears poised to introduce tougher standards for ash handling in 2013. Two options have been under consideration, both falling under the Resource Conservation and Recovery Act (RCRA). One would list ash residuals as special wastes, subject to RCRA Subtitle C, while the other would classify them under Subtitle D as non-hazardous wastes. Both approaches are considered to have advantages and drawbacks.

Regardless of which option is ultimately chosen, the proposed rules will likely require coal-fired power plants to eliminate wet ash handling and phase out surface impoundments (ponds) within a specified time frame. Anticipating the tougher guidelines, some utilities (including TVA) are already converting to dry systems as local markets for re-use have emerged, enabling them to sell some of their waste ash to concrete suppliers.

It has been estimated that 2/3 of fly ash ponds have been converted to dry systems, while less than 10% of bottom ash storage facilities have made the switch. The rest are doubtless studying the cost of converting to dry ash storage systems and bracing for the regulatory changes. According to a 2010 EPA study, the cost of compliance could exceed \$20 billion industry-wide.

The change from wet to dry is primarily a matter of how the post-combustion solids are handled. Wet-ash plants typically used a water wash to remove any remaining ash and store the slurry in large, man-made ponds. In contrast, dry ash is likely to be vacuumed out and either recycled for other uses, stored in structures or buried in a landfill.

As with any new material handling system, there's bound to be a learning curve as new equipment and procedures come online. One issue that utilities are sure to face is dust management from dry ash handling, transport and storage. If not adequately controlled, dry coal ash (especially fly ash) can be easily energized by the wind, allowing potentially hazardous fugitive dust to migrate off-site.

The makeup of fly ash dust can vary widely, depending on the coal being burned, but all fly ash contains significant amounts of silica, in both crystalline and amorphous form. "Silica" refers to the mineral compound silicon dioxide (SiO<sub>2</sub>). Amorphous silica tends to

be spherical and smooth in shape, while the crystalline form is pointed and far more hazardous. Crystalline silica has been cited as a cause of the disabling and irreversible lung condition known as *silicosis*. It has also been classified as a Group I carcinogen (Carcinogenic to Humans) by the International Agency for Research on Cancer (IARC, 1997).

Chronic silicosis can remain undetected for years or even decades. It is a cumulative and often fatal condition, and as it progresses, symptoms typically include shortness of breath, cough and weakness. Over time, the body's ability to fight infection is compromised and victims become susceptible to other illnesses, such as tuberculosis. Affected individuals frequently experience fever, weight loss, chest pains and eventually respiratory failure. Exposure to crystalline silica has also been linked to lung cancer, kidney disease, reduced lung function and other disorders.

In addition, inhaled dust can irritate airways and exacerbate conditions such as asthma and emphysema. Fly ash also contains trace amounts of a number of toxins and heavy metals, including arsenic, lead and mercury. From a purely financial perspective, when equipment air intake includes significant amounts of dust, it can also lead to more frequent maintenance and greater engine wear, causing operating costs to rise.

## SUPPRESSION

The most common methods for controlling open-area dust are *surface wetting* and *airborne capture*. With surface suppression, the goal is to prevent dust problems by wetting the source before particles can become airborne. Airborne capture is more difficult, requiring some form of technology that can force the particles to the ground and keep them there.

One technology showing promise in coal ash applications is atomized misting equipment that creates millions of tiny water droplets launched by a powerful fan, facilitating a collision with airborne dust particles and driving them to the ground. The design is one of the few techniques capable of delivering dust control by surface wetting AND airborne particle capture.



**Figure 1:** Atomized spray is one of the few suppression technologies capable of delivering dust control by surface wetting AND airborne capture.

Equipment sizes range from modestly-sized units that can deliver exceptional coverage of a 30,000 square foot area (2,787 square meters) from a standard 5/8" garden hose up to massive designs that stand more than eight feet tall, fed by a fire hose. Full-oscillation models have been found capable of creating a dust-trapping blanket over as much as 280,000 square feet (more than 26,000 square meters) from a single location (that's almost SIX football fields), allowing even the largest operations to maintain sufficient moisture in storage piles to prevent migration.



**Figure 2:** The largest atomized misters can cover as much as 280,000 square feet (more than 26,000 square meters) with a single machine to prevent dust migration.

## CHALLENGES

Controlling fly ash particles has always been a challenge, largely because of two physical properties. The first is the inherently water repellent nature (hydrophobicity) of the material. With little natural affinity for moisture, fly ash tends to shed water droplets rather than absorb them, so the particles remain dry and potentially mobile. The second is the size of the particles themselves: usually just 5-12 microns, which is roughly the same as talcum powder. To put that in perspective, a human hair typically ranges from 50-100 microns in diameter.

Fly ash dust is so fine and lightweight that it easily becomes airborne, and unless acted upon by some outside force, the particles can hang in the air for extended periods, resisting settling and potentially migrating off-site. To combat the problem, some suppliers of atomized misting equipment have designed their machines to be outfitted with optional dosing pumps, allowing material handlers to precisely meter in surfactants, tackifiers or other additives for superior particle control. Even minute amounts of a surfactant can reduce the contact angle of pure water by more than 50%, producing greater numbers of smaller droplets and improved particle control.

Machines can also be equipped with booster pumps that can increase just 10 psi (0.7 kg/sq. cm) of water pressure to 150 psi (10.55 kg/sq. cm) or more, which has a direct impact on performance. Some designs are available with optional filters that allow the

use of non-potable water. If the equipment is well designed, the use of pressurized air should not be required to achieve efficient suppression, avoiding the need for compressors.

Units can also be tower mounted to increase the range and coverage area, delivering precise aiming and overlapping coverage to ensure adequate control. The elevated misting units can be pointed downward on stored ash, trapping dust particles before they disperse into the air.



**Figure 3:** Recent developments include a tower mount design that delivers precise targeting while freeing up ground space for vehicles and other equipment.

New developments include user-defined software that can network multiple units together, providing a level of automation that helps save time and conserve manpower. These “intelligent” systems can be programmed to manage start/stop cycles based on dust monitor readings, motion sensors, weather input or operator remote control. The technology allows equipment users to automatically adjust elevation, oscillation range and other features on any number of machines to improve suppression performance and free up manpower for other tasks.

To conserve water and energy, a solenoid-activated valve can be installed in the water line, allowing users to activate suppression equipment at specific times. For example, the solenoid can be activated by control lever or flow sensor to operate only when conveyor belts are loaded and running. The latest equipment designs can allow a user to automatically start or stop machines when specific airborne particulate levels are

reached. Users can monitor and track local weather patterns, adjusting the units as needed throughout their shift, and the software can even be programmed to monitor and control video security systems, lighting, HVAC and other inputs.

## GETTING RESULTS

The most impressive results have been demonstrated through the use of multiple units, mounted at heights that improve performance and aiming. By triangulating the oscillation arcs of several machines, users can create a blanket of mist that effectively targets ash piles and concentrates suppression where it's needed most. These dust management networks deliver a solution that's specifically engineered to function in each individual application, one that's easily implemented by staff members to achieve consistent performance.



**Figure 4:** By triangulating the oscillation arcs of several machines, users can effectively concentrate suppression where it's needed most.

Some atomized misting designs are also engineered to allow a wide range of customizations when particle sizes or service environments dictate. By using a variety of nozzle sizes, shapes, patterns and flow, some equipment manufacturers can tailor the mist output to suit specific dust particle sizes and operating conditions. Additional nozzles can be incorporated into the misting ring to increase droplet production, and changes can be made to the nozzle sizes or configuration. These modifications can produce a wider range of droplet sizes, in greater numbers, allowing a larger volume of water to be used and translating to improved overall suppression efficiency. The technique can also be used to produce droplets in a specific size range, to improve the effectiveness in fly ash applications.

While there are many atomized mist equipment manufacturers, the designs vary widely in effectiveness and reliability. For extended life in the tough service environment of dry

ash handling, the most durable models seem to be those using a straightforward, direct-drive fan motor. These typically have no drive belts, diesel engines or complex gear systems that could present dependability problems over time. Despite their impressive size, the highest-quality machines often require minimal maintenance: lubrication of fan motor bearings may be as infrequent as 10,000 hour intervals, while sealed oscillation motors can be lubricated for life.

Like a physician, the most knowledgeable equipment supplier is likely to be the specialist. It stands to reason that a manufacturer who adopts dust control as one of many product lines must divide its resources to support all of those products, whether it be in R&D, technical service or repair parts. In contrast, a supplier whose sole business is dust control will have a very narrow focus, with every employee concentrating on functions related to that single purpose. Customers benefit from support personnel with extensive experience and daily contact with dust suppression issues.