Devising an Effective and Affordable Dust Suppression Strategy Using Water Sprays

By Robert Franta, Spraying Systems Co.

Dealing with dust is no longer optional in most regions of the world but when it comes to dust suppression systems, options abound. Making the best choice for your operations can get complicated since there are dozens of factors to consider. The more you know about dust and the various techniques to control it, the greater your chances are of specifying a system that will get the job done at the lowest possible cost. In the sections that follow, we'll delve into dust and review how to go about devising astrategy for dealing with it.

Why Water Spray Dust Suppression Usually the Way to Go

In most operations, wet dust suppression spray systems offer significant advantages over ventilation/exhaust systems or structuralenclosures. By comparison, wet dust suppression spray systems are:

- Highly effective
- More economical to operate
- Quickly installed and offer straightforward operation
- More durable
- Reliable and offer consistent performance with routine maintenance

Depending on the type, volume, and location of the dust, wet dust suppression systems are sometimes used in conjunction with other technologies. Whether used solo or in tandem with other systems, there are many variables to consider when specifying a water spray system. The first step is to assessyour operations and determine the appropriate strategies for dealing with dust.

Dust Suppression: Prevention, Suppression or a Bit of Both

Wet dust systems use spray nozzles to apply humidity,water, and/or chemicals to:

- The dust source to prevent the dust from becoming airborne
- Airborne dust particles to suppress or capture the dust and minimize the distance it travels

The system requirements for dust prevention are very different than the requirements for dust suppression even though both are applying moisture. It's important to understand the differences between the two to ensure optimal performance.

When the goal is to prevent dust, the following factors must be considered to ensure a positive result

- Materials respond to moisture differently. For example, when applying moisture to ore, one gallon per ton usually provides adequate wetting. On the other hand, coal repels water and will require the use of more moisture and chemical additives to increase absorption. Precision application of moisture is essential. Too little moisture results in airborne dust. Too much moisture may compromise the integrity of the material, cause costly production problems and equipment damage and create dangerous sludge – a maintenance nightmare.
- Most dust particles created during breakage are not released into the air. The dust stays attached to the material and adequate wetting is required to ensure it stays attached. Keep in mind that partially processed minerals and coal may be more sensitive to moisture than unprocessed material.
- If the material being sprayed is stationary, as on a storage pile, drop size and spray angle are critical. If the material is moving, as on a conveyor, drop size and drop velocity are the top concerns.

When dust is airborne and needs to be suppressed (also referred to as captured or knocked down), it is important to match liquid drop size to the particle size of the dust

Drops that are larger than the dust particle avoid collision with the dust. When drops are smaller than the dust particle, they may collide, but the drops evaporate too quickly and release the captured particles. The greatest chance for dust suppression occurs when the diameter of the drop size and dust particle are comparable . Also keep in mindthat dust suppression is most effective in areas where there is little air turbulence.

The Secret to Success: Specifying the Proper Spray Nozzle

Once you've assessed your operation and have a basic plan for where and how you need to control dust suppression, the next step is to choose spray nozzles that will deliver the desired performance. Here's an overview of the factors to consider when evaluating nozzles.

✓ Drop size

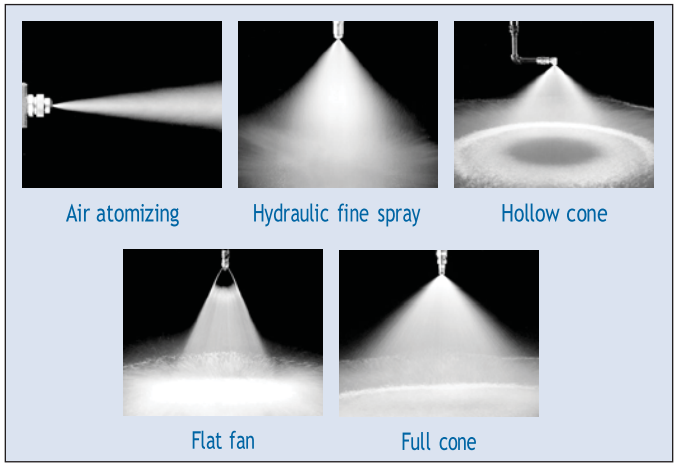
Drop size refers to the size of the individual drops that comprise a nozzle's spray pattern. Each spray pattern provides a range of liquid drop sizes. Many factors can affect drop size such as liquid properties, nozzle capacity, spray pressure and spray angle.

Air atomizing nozzles produce the smallest drop sizes followed by hydraulic fine spray, hollow cone, flat fan, and full cone nozzles. See Figure 3.

For dust suppression, drops between 20 and 200 µm are typically required as airborne dust particles are usually in this size range. To produce this very small drop size, a higher degree of atomization is required. Atomization is achieved by pumping water through nozzles at high pressure or by using a combination of compressed air and water pumped at lower pressure to produce very small drops or fog.

If compressed air is available and economically feasible, air atomizing nozzles are generally a better choice. They produce smaller drops and have larger flow passages than hydraulic fine spray nozzles which helps to reduce clogging.

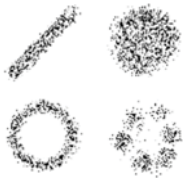
FIGURE 3: Spray nozzle patterns



✓ Spray pattern

Your specific operating conditions will ultimately determine which nozzle style and spray pattern is best for the dust suppression you require. Figure 4 provides an overview of the options and some guidelines for use but be sure to check published performance data to verify flow rates and drop size at the operating pressures you'll be using.

FIGURE 4: Guidelines for spray pattern selection

TYPE	DESCRIPTION		DROP SIZE	COMMON USES	TYPICAL APPLICATIONS
Hydraulic hollow cone	Circular ring of water		Small	Used in areas where dust is widely dispersed	Transfer points Transport roads Jaw crushers
Hydraulic flat fan	Tapered edge, rectangular or even spray		Small to medium	Used in narrow or enclosed spaces	Stockpiles
Hydraulic full cone	Round pattern		Medium to large	Used in areas where nozzles must be located a good distance from the dust source	Stackers, reclaimers Transfer points
Air atomizing	Round, full or flat		Very small	Used in enclosed areas to minimize drift	Jaw crushers Loading terminals Dump hopper Transfer points
Hydraulic fine spray	Round pattern or circular ring		Very small	Used in enclosed areas to minimize drift and when a light fog is required	Stackers, reclaimers Stockpiles Transfer points Jaw crushers Loading terminals Dump hopper

Dust Control: Nozzle Selection

✓ Spray angle

Spray angles range from 0° to 175°. The angle you need will be determined by the spray pattern, the number of nozzles used and the nozzle placement.

✓ Operating pressure

Operating pressure and flow rate will be determined by how much moisture you need to apply. Keep these simple rules in mind:

- Increasing pressure decreases drop size
- High pressure sprays are better suited for enclosed areas
- Nozzles operating at higher pressures should be placed close to the dust source to minimize the amount of air set in motion along the spray path

✓ Surface wetting

To increase surface wetting, use nozzles that produce a large number of small drops and decrease the contact angle of the spray on the material. Impact can also increase surface wetting and this can be achieved by increasing operating pressure. Keep in mind that drops normally travel through turbulent air before they hit the material. Friction drag of air reduces the impact velocity as the water travels away from the nozzle orifice.

✓ Nozzle placement at transfer points

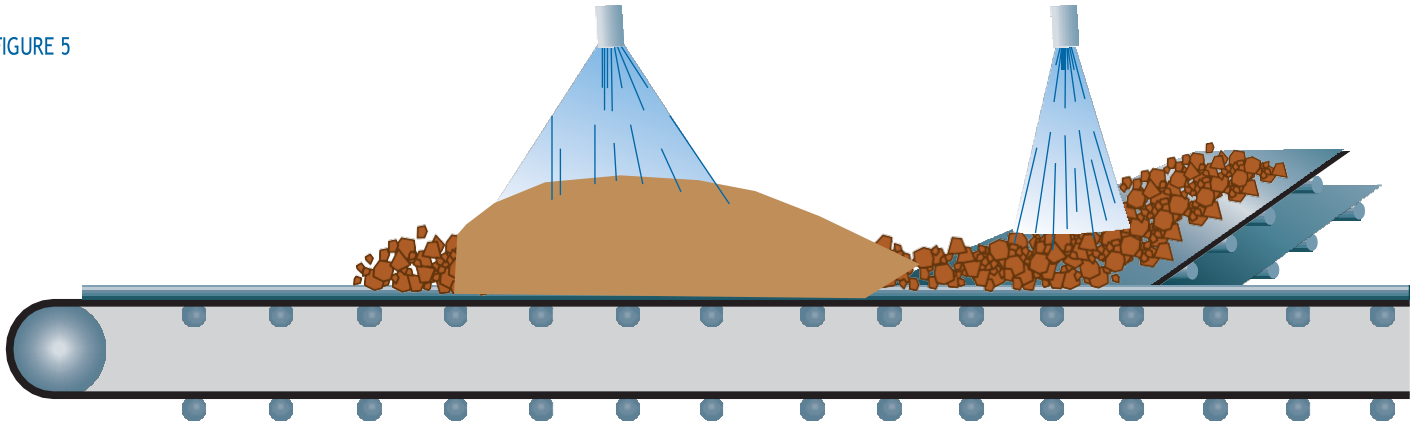
Nozzles being used for dust prevention should be placed as close to the beginning of the transfer point as possible. The force of the moving material helps the water penetrate the material as it moves through the transfer point.

Nozzles in airborne dust suppression systems treat the air around the material and are generally placed at the end of transfer points so the material load can settle. Nozzles are positioned so they are spraying above the material and not on it. See Figure 5.

✓ Additional considerations

- Keep nozzles out of the range of equipment or falling debris that could cause damage
- Be sure nozzles are accessible for maintenance
- Water hardness increases the surface tension of water and may increase the amount of water needed for adequate wetting
- Be aware of the quality of the water source and provide filtration if necessary. Particulate in the system can clog nozzles and increase maintenance and wear

FIGURE 5



Position nozzles at the beginning of the transfer point for dust prevention. Position nozzles to spray the air above the material at the end of the transfer points to suppress airborne dust. The nozzle on the right is spraying directly on the material at the beginning of the transfer point. The nozzle on the left is spraying above the material and is positioned closer to the end of the transfer point.

System Control Options, Optimizing Performance

Don't Overlook System Control

To ensure effective, reliable dust suppression control, consider automated system operation rather than relying on manual operation. The system cost is typically offset quickly through savings on chemicals, water, electricity, labor and better performance as proper wetting is ensured. Turnkey spraysystems monitor operating conditions using sensors as needed to detect material motion, chemical/water usage, temperature, humidity, conveyor speed and more. The sensors send data to the spray controller.

Based on pre-stored logic, the spray controller automatically adjusts the performance of all other system components including pumps, nozzles and other electrical and pneumatic devices. If the controller is unable to make the necessary adjustments or clogged nozzles are detected, alarms are activated for operator intervention.

Turnkey spray systems monitor and automatically adjust system components based on changes in operating conditions

Preventing Problems and Optimizing Performance

Once you've specified your wet dust suppression control system, the nextsteps are installation, operation, and maintenance. Here
are more than a dozen tips that can help ensure long-term, trouble-free performance.

Installation/Operation

- In operations using feed chutes, keep water pressure below 60 psi (4.1 bar) to avoid pressurization and forcing dust from the enclosure
- Using more nozzles at lower flow rates and positioning them closer to the material is usually more effective than using fewer sprays at higher flow rates
- Use flexible plastic strips around areas with water sprays for containment and inadvertent wetting of non-target areas
- Keep conveyor belts clean. Use a water wash system to spray and scrape build-up from belts and spray the bottom of return belts to reduce dust from a dry belt
- Use water instead of brooms to clean plant floors

Troubleshooting

If you experience any of these problems, chances are you are applying more moisture than needed:

- Material is sticking to screen cloth/conveyors
- Sludge accumulation in chutes and areas around transfer points
- Belt slippage

Corrective action:

- Reduce flow rate
- Use fewer nozzles
- Check nozzles for wear. Capacity will increase as nozzle orifices wear. If nozzles are worn, replace them
- Add a spray controller to regulate moisture application

If fugitive dust persists, possible solutions include:

- Increase flow rate
- Increase the number of nozzles used
- Adjust nozzle placement to ensure sprays are reaching the target area
- Consider enclosures to protect nozzles from air/wind or use nozzles that produce larger drops if sprays are drifting off target
- For airborne dust suppression, determine dust particle size and ensure nozzle drop size is comparable
- Inspect nozzles for clogging

If dust suppression is effective but material is becoming difficult to handle, it is likely the moisture is being applied unevenly orinconsistently. Options include:

- Reposition nozzles for more uniform coverage
- Consider a change in nozzle type or spray angle to ensure consistent coverage

Optimizing Performance

Preventive Maintenance

Spray nozzles are designed for long-lasting, trouble-free performance, however, like all precision components, spray nozzles do wear over time. Spray performance can suffer and costs can rise. The best strategy is to inspect nozzles on a regular basis and replace them when needed.

Watch for:

- Plugging/clogging: Use water clarification devices and strainers as needed
- Corrosion: Specify nozzles in the appropriate materials for the solutions being sprayed
- Scale build-up: Control hardness level of the water and use chemical additives if necessary
- Caking: Clean nozzles before build-up interferes with performance. Soak nozzles in water to loosen debris before cleaning
- Changes in spray patterns, spray angles, and distribution: Typical indicators of nozzle wear
- Changes in flow rate and pressure: Signal nozzle wear is present
- Accidental damage during cleaning: Cleaning tools should be significantly softer than the nozzle material – consider using a toothbrush or toothpick. Never clean the orifice with metal objects

New

Corroded

New

Caked

Ensuring Successful Dust Defeat

Following these strategies and guidelines can help you specify a wet dust suppression system. However, because every operation that generates dust is different and there are so many variables, it is always wise to get expert advice. The leading spray technology manufacturers typically offer complimentary, on-site evaluations and proposals. In addition, they can provide more detailed information on spray nozzle performance than is availablein supply house catalogs. Investing time with these companies before you finalize your system specifications can yield big dividends and is highly recommended.

About the Author

Robert Franta has been involved with liquid and powder spray technology for almost 30 years as an engineer. His technical expertise includes liquid handling and spraying methods as well as exhaust system design, dust collection and control systems. Robert is currently an engineer with Spraying Systems Co. of Wheaton, Illinois where he is involved with the development of automated liquid spraying system solutions for various industrialmarkets and is a member of the IMA-NA/NIOSH Dust Control Task Force Committee.

About Spraying Systems Co.

Spraying System Co. is the global leader in spray technology. It has the broadest product range in the industry,several manufacturing facilities and sales offices in more than 85 countries. Spray nozzles, turnkey spray systems, custom fabrication and research/testing services comprise the 70-year-old company's offering