SPRAY TECHNOLOGY FOR DUST CONTROL

A GUIDE TO SELECTING THE OPTIMAL SPRAY SYSTEM FOR YOUR APPLICATION

Spraying Systems Co.®
Experts in Spray Technology

EFFECTIVE WET SYSTEMS TO CONTROL DUST

Based on the elements of your operation, there are many factors to take into consideration when considering spray technology as your dust control solution. A few of these factors include: the process and material producing the dust; where in your operation the dust is being generated; and the utilities and resources (electricity, compressed air, water, labor, etc.) available.

Wet systems using spray technology are used for dust prevention (humidity/moisture content in the material is increased to prevent dust from becoming airborne) and dust suppression/capture (humidity/moisture is added to the air to capture dust particles that are already airborne).

These systems use spray nozzles to apply water and/or chemicals such as wetting, foaming and binding agents to dust particles. However, the system configuration varies depending on the goal – dust prevention or airborne dust suppression. Most operations require both prevention and suppression to effectively control dust. It is important to understand the differences between these two systems to ensure proper spray nozzle specification and operation. **See Figures 1 and 2.**

No matter the application, wet systems are a popular choice as they are highly effective and implementation is typically fast and straightforward. Wet systems provide a long-term solution that can provide years of trouble-free performance with regular maintenance.

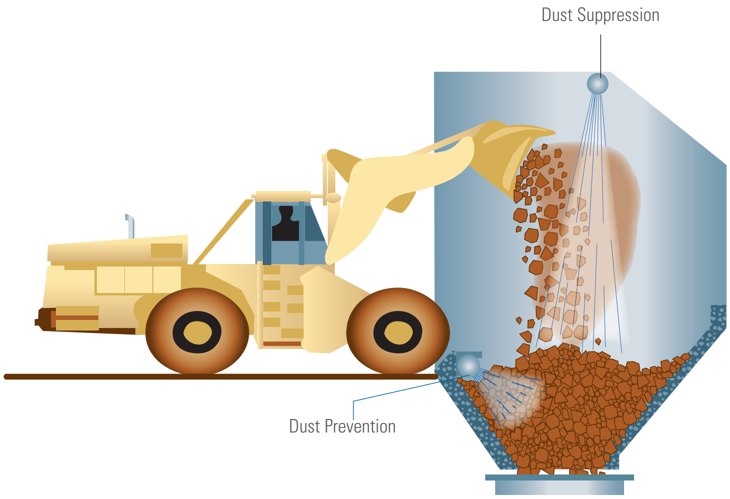

FIGURE 1: Moisture is added directly to the material to prevent dust from becoming airborne. Airborne dust particles are also captured by sprays during material unloading.

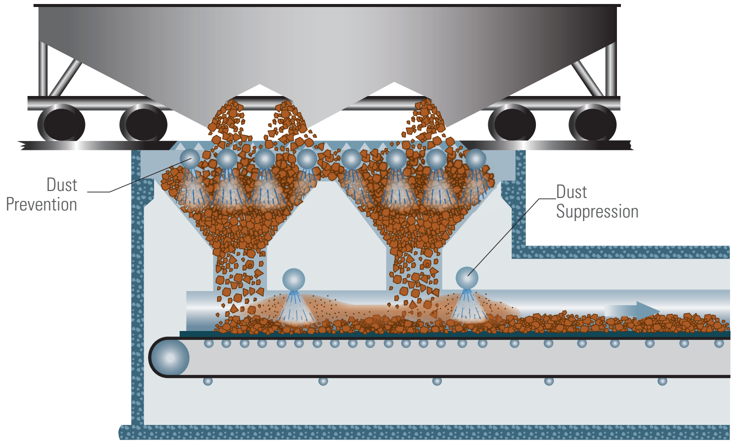

FIGURE 2: Moisture is added to the material to prevent dust as it is transferred from the hopper car to the hopper bin. Sprays are also used to capture airborne dust as the material moves down the conveyor line.

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WORKING WITH A SINGLE SUPPLIER WHO IS AN EXPERT IN ALL FACETS OF SPRAY TECHNOLOGY IS THE BEST WAY TO ENSURE OPTIMAL DUST CONTROL.

Spraying Systems Co. is uniquely qualified to be that supplier. We have:

- A complete range of product solutions:
  - Spray nozzles
  - Accessories
  - Spray bars/headers
- Automated spray controllers and systems
- Decades of experience with dust control in a wide range of industries
- A global sales organization dedicated exclusively to spray technology
- A strong commitment to improving the environment

See pages 10 and 11 for detailed information on our spray technology solutions for dust control.

TYPICAL OPERATIONS

Operations requiring dust prevention:

- Dumping
- Transport
- Transfer points
- Stockpiling/reclaiming

In these operations, moisture can be applied to the material when it is stationary, moving or both.

Operations requiring airborne dust suppression:

- Conveying
- Shearing
- Continuous mining
- Crushing and screening
- Dryers
- Transfer points
- Packaging/filling

Nozzles produce drops to collide with dust particles that are already airborne. The moisture weighs the particles down so they are returned to the material source or ground.

As previously discussed, both dust prevention and dust suppression may be required.

This bulletin is designed to increase your understanding of how to use spray technology for dust control and provide specific information you can use when specifying, operating and maintaining your spray system. **Should you need additional assistance, do not hesitate to contact us. Our local technical experts are always available for consultation.**

Fundamentally, wet dust control systems are the same – all use water sprays. However, that's where the similarities end. There are many variables to consider when specifying a spray system:

- Dust particle size
- Spray drop size
- Spray pattern
- Spray angle
- Operating pressure
- Surface wetting
- Nozzle placement
- Water quality and availability
- Control options

System configuration starts by answering a few critical questions.

IF YOU NEED TO PREVENT DUST:

What material are you adding moisture to?

Materials will respond to moisture differently. It is important to understand exactly how much moisture to add. Too little moisture means you'll still have a dust problem. Too much moisture, and the integrity of the material may be compromised and quality issues will result. For example, when applying moisture to ore, adding one gallon per ton provides adequate wetting and does not cause process and production problems. Too much moisture also means sludge, mud and frustrating, costly and potentially dangerous maintenance problems.

The material also will determine whether chemicals should be added to the water to improve suppression and/or lower overall application costs. Coal, for example, repels water and usually requires the use of chemical additives to increase absorption.

Also, consider the processing stage. Most dust particles created during breakage are not released into the air. The dust stays attached to the surface of the broken material. Adequate wetting is critical to ensure dust stays attached. Keep in mind that partially processed minerals and coal may be more sensitive to moisture than unprocessed material.

Is the material moving or stationary?

Drop size and spray angle can affect surface coverage when spraying stationary material, while drop size and drop velocity affect coverage when spraying moving material. These factors must be considered when selecting and positioning spray nozzles.

IF YOU NEED TO CAPTURE AIRBORNE DUST:

What is the particle size of the dust?

Dust capture is most effective when dust particles collide with water drops of an equivalent size. (See page 6 for drop size information.) Drops that are too large won't collide with the smaller dust particles, and drops that are too small evaporate too quickly and release the captured dust particles. Understanding the particle size of the dust is critical in effective system design. **See Figure 4.**

You can use these general guidelines regarding dust particle size. However, further research may be necessary depending on the material and stage of the material in processing.

PARTICLE DIAMETER IN MICRONS:
Ground limestone: 10 to 1000 µm
Fly ash: 10 to 200 µm
Coal dust: 1 to 100 µm
Carbon black: 0.01 to 0.3 µm
Pulverized coal: 3 to 500 µm

Where is the dust?

Capturing airborne dust with water sprays is most effective in areas with little air turbulence. Depending on the environment, enclosures may be required.

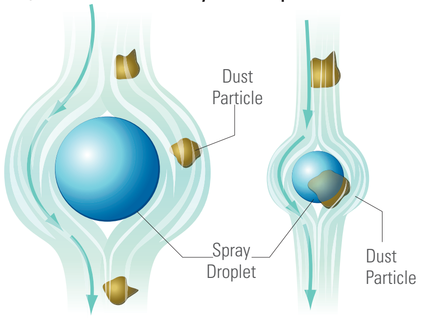


FIGURE 4: If the drop diameter is larger than the dust particle diameter, the dust particle will follow the air stream around the drop. (Shown left.) If the diameters of the drop and the dust particle are comparable, the dust particle will follow the air stream and collide with the drop. (Shown right.)

GENERAL CONSIDERATIONS

Will the dust be returned to the product stream?

If so, the degree of wetting is especially important to avoid quality problems.

Is rollback dust a problem?

Rollback dust usually comes from under the dumping mechanism on front-end loaders, crushers, grinders, cutting heads and entrances to scrubbers. Rollback dust can be a significant problem and may require a separate system for suppression.

What is the quality of the water?

Poor quality water can be problematic in many dust control applications. Strainers may be required – even when using a clean water supply – because contaminants can be introduced to the water from eroding pipes. Poor water quality will also require more frequent nozzle maintenance, increase the nozzle wear rate and shorten service life.

Where will the system be installed?

If freezing temperatures are possible, heaters and floor drains should be considered. Spray equipment may need to be winterized. If wind is a factor, nozzles that produce larger drops are better able to resist drift and should be used.

How important is water conservation?

Water conservation is no longer optional in most areas. It is important to specify nozzles that minimize overspray and water waste.

Controls should be used to ensure the system is active only when needed. Many options are available, ranging from simple solenoid valves for on/off control to sophisticated spray controllers that monitor a wide range of operating conditions and make automatic adjustments.

Is compressed air available?

Air atomizing nozzles mix fluid and compressed air to produce small drops. Small drops evaporate quickly and are desirable for use in operations where wetting is needed but excess moisture cannot be tolerated. Small drops also are required when capture of small airborne dust particles is needed.

What is the spray solution?

- Plain water systems are typically the least expensive and easiest to design and implement
- Adding surfactants to water will lower the surface tension and allows better interaction between water and certain types of dust that resist water absorption
- Foam systems use less water but usually require compressed air
- Binders agglomerate particles together after the moisture evaporates. However, binders can cause clogging and build-up on nozzles, conveyors and other equipment. Water-soluble binders can cause environmental problems should run-off occur. **See Figure 5.**

FIGURE 5: Advantages and Disadvantages of Various Solutions

	PROS	CONS
PLAIN WATER	• Least expensive • Simple to design and operate • Limited carryover effect is possible • When good mixture of water and material is possible, quite effective • Enclosure tightness isn't critical	• Can't use with products that can't tolerate excess moisture • Some materials repel water • Can't use if freezing temperatures are possible • Requires large volumes of water and overwetting is common • Water evaporates – reapplication is necessary
SURFACTANTS	• Dust control efficiency can be higher than plain water • Equivalent efficiency may be possible using less water	• Not all materials tolerate surfactants • Material is contaminated with surfactants • Higher capital, operating and maintenance costs
FOAM	• Best efficiency when effective mixing of foam and material can be achieved • Moisture addition is low	• Material is contaminated with foam • Compressed air is usually required • Higher capital, operating and maintenance costs
BINDERS	• Eliminates the need for re-application • Best efficiency in multiple transfer points	• May cause production problems and nozzle/equipment damage • Higher capital, operating and maintenance costs

SPRAY NOZZLE SPECIFICATION DEPENDS ON MANY FACTORS

While the following general guidelines will help you get started, it is recommended that you contact a firm specializing in spray technology to ensure you get the performance you need for your specific environment and operating conditions.

UNDERSTAND THE ROLE OF 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 drop sizes, which comprises the drop size distribution. **See Figure 6.**

Many factors can affect drop size, including liquid properties, nozzle capacity, spray pressure and spray angle.

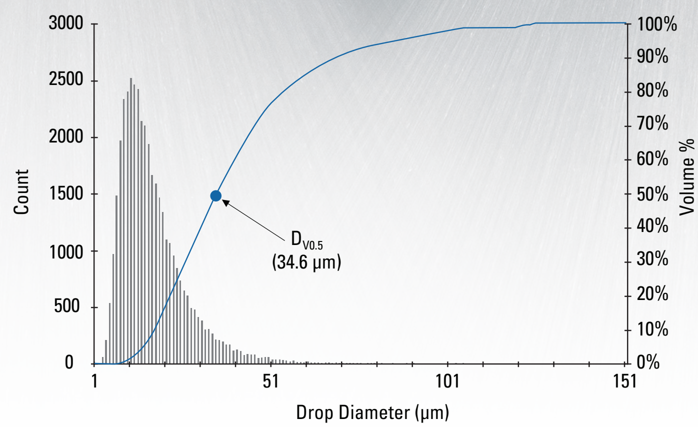
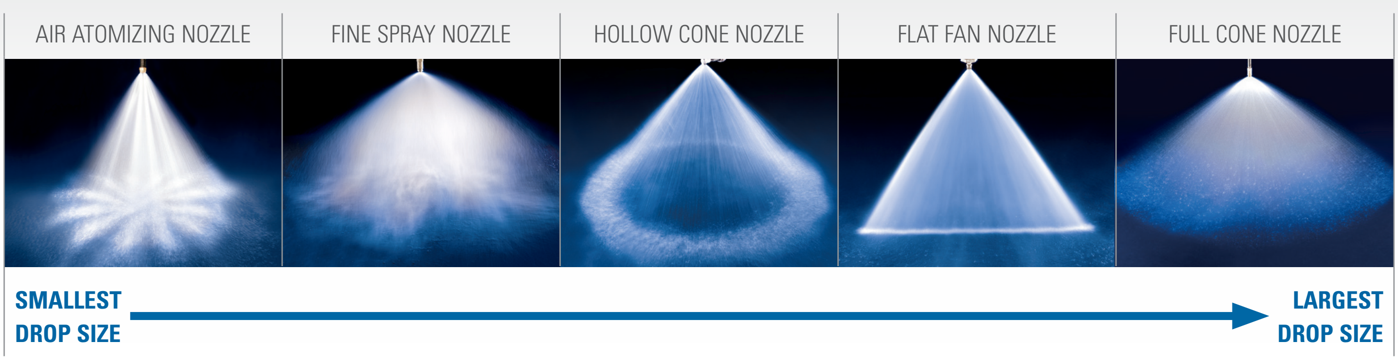


FIGURE 6: $D_{V0.5}$ is the Volume Median Diameter, which is also known as VMD or MVD. $D_{V0.5}$ is a value where 50% of the total volume of liquid sprayed is made up of drops with diameters larger than the median value and 50% smaller than the median value.

LEARN THE BASICS OF DROP SIZE

- Air atomizing nozzles produce the smallest drop sizes, followed by fine spray, hollow cone, flat fan and full cone nozzles (see graphic below)
- Higher pressures yield smaller drops, and lower pressures yield larger drops
- Lower-flow nozzles produce the smallest drops, and higher-flow nozzles produce the largest drops
- Increases in surface tension increase drop size
- Drop velocity is dependent upon drop size. Small drops may have a higher initial velocity, but velocity diminishes quickly. Larger drops retain velocity longer and travel further



NOZZLE TYPES: HYDRAULIC ATOMIZING VS. AIR ATOMIZING

In most operations, drops less than 200 microns are better at suppressing airborne dust particles, which are small as well. Atomization shears the water into small particles, reducing surface tension and increasing the number of drops in a given area.

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 small drops or fog. Using air atomizing nozzles is usually preferable since they produce smaller drops. However, the cost of installing and operating compressed air may be prohibitive in some operations. Hydraulic fine spray nozzles are widely used and yield acceptable performance in many operations. **See Figure 7 for comparison matrix.**

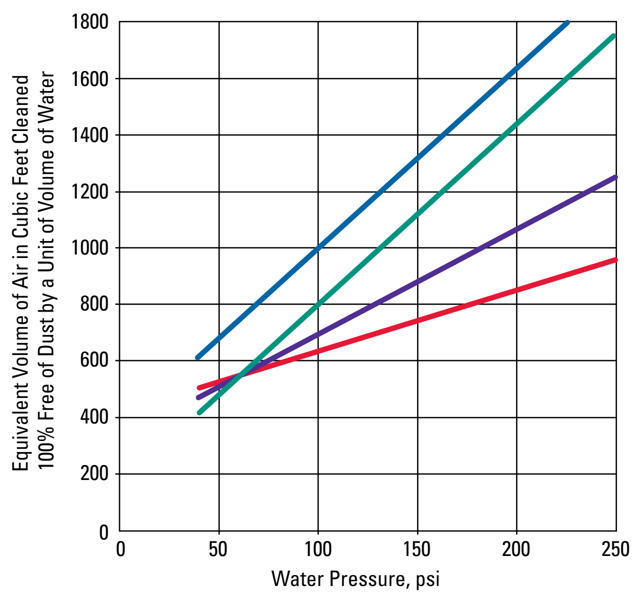
FIGURE 7 : HYDRAULIC FINE SPRAY VS. AIR ATOMIZING NOZZLE COMPARISON

NOZZLE TYPE	PROS	CONS
HYDRAULIC FINE SPRAY  (Wall-Mount)	• Simple installation • Lower operating costs – no compressed air required	• Operating at high pressures increases electrical consumption and increases pump wear • Water quality is critical. Small orifices are prone to clogging by small contaminants • Best used in enclosed areas with little turbulence
AIR ATOMIZING 	• Smaller drop size • Larger flow passages and less clogging	• Expense of compressed air • Possibility of injecting additional air into the area – increased velocity could stimulate additional dust movement • Best used in enclosed areas with little turbulence

For dust prevention, standard hydraulic nozzles that produce drops between 200 and 1200 µm are generally used. For suppression of airborne dust, air atomizing nozzles or hydraulic fine spray nozzles that produce drops between 20 and 200 µm are used. Figure 8 illustrates the effectiveness of airborne dust suppression by nozzle type.

FIGURE 8:

- ATOMIZING NOZZLE
- HOLLOW CONE NOZZLE
- FULL CONE NOZZLE
- FLAT SPRAY NOZZLE



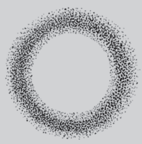
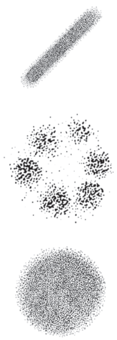
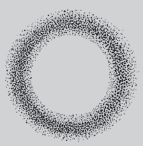
Bureau of Mines Technology News 150, July 1982, "Dust Knockdown Performance of Water Spray Nozzles"

SPRAY PATTERN SELECTION

Operating conditions will determine which nozzle style and spray pattern will offer the best performance. Figure 9 provides an overview that can help you narrow the options, but be sure to consult performance tables and drop size data to refine your selection.

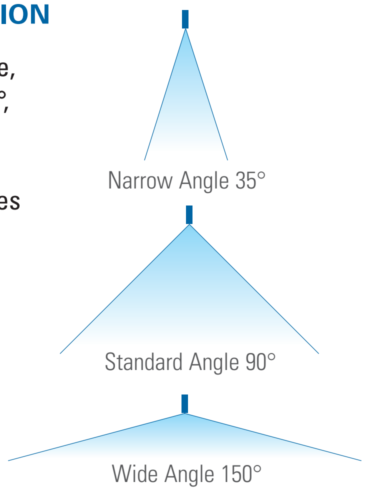
For details on the full selection of Spraying Systems spray nozzles, see page 10.

FIGURE 9: SPRAY NOZZLE TYPES

SPRAY NOZZLE TYPE	SOLUTION	APPLICATIONS	FEATURES	SPRAY PATTERN	APPLICABLE SPRAYING SYSTEMS NOZZLES
HOLLOW CONE	Dust Prevention/ Airborne Dust Suppression	• Transfer Points • Transport Areas/Roads • Jaw Crushers	• Large nozzle orifices that reduce clogging • Small drop size – generally smaller than other nozzle types • Typically used in locations where dust is widely dispersed		• WhirlJet® In-line BD and Right-Angle Series Hollow Cone Hydraulic Nozzles • SpiralJet® Series Hydraulic Nozzles
FLAT SPRAY	Dust Prevention	• Stockpiles	• Small- to medium-size drops • Typically used in narrow or rectangular enclosed spaces		• VeeJet® Series Flat Spray Hydraulic Nozzles
FULL CONE	Dust Prevention	• Stackers, Reclaimers • Transfer Points	• High velocity over a distance • Medium- to large-size drops • Commonly used when nozzles must be located a good distance away from the area where dust suppression is needed or to clear mechanical obstructions		• FullJet® Series Full Cone Hydraulic Nozzles • SpiralJet® Series Hydraulic Nozzles
AIR ATOMIZING	Airborne Dust Suppression	• Jaw Crushers • Loading Terminals • Primary Dump Hopper • Transfer Points	• Small drops • Commonly used to capture small dust particles in enclosed areas to minimize drift		• J Series Air Atomizing and Automatic Nozzles
HYDRAULIC FINE SPRAY	Dust Prevention/ Airborne Dust Suppression	• Stackers, Reclaimers • Stockpiles • Transfer Points • Jaw Crushers • Loading Terminals • Primary Dump Hopper	• Small drops • Commonly used to capture small dust particles in enclosed areas to minimize drift		• Fine Spray Hollow Cone Hydraulic Atomizing Nozzles • FogJet® Series Multiple Orifice Hydraulic Fine Nozzles

SPRAY ANGLE SELECTION

The spray angle of the nozzle, which ranges from 0° to 175°, is dependent upon the application, including spray pattern, the number of nozzles used and nozzle placement.



OPERATING PRESSURE

The ideal operating pressure is dependent upon many application-specific variables. However, these basic principles should help you decide:

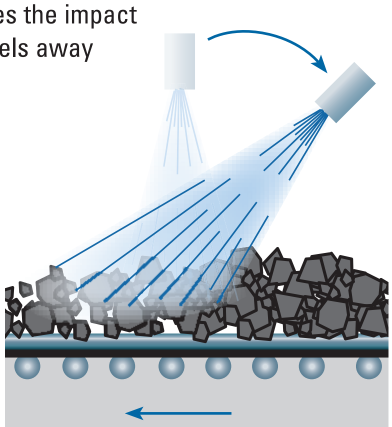
- Increasing pressure decreases drop size
- High-pressure sprays are better suited for enclosed areas
- Nozzles operating at higher pressures should be placed close to the dust source to minimize the amount of air set in motion along the spray path

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, which is influenced by operating pressure, also can increase surface wetting. 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.

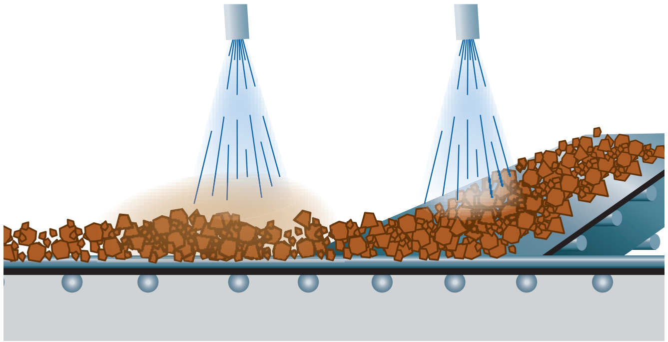
Decrease the contact angle of the spray on the material as shown here to increase surface wetting.



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 rather than the material. These nozzles are generally placed at the end of transfer points so the material load can settle and positioned so they are spraying above the material and not on it.



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.

ADDITIONAL CONSIDERATIONS:

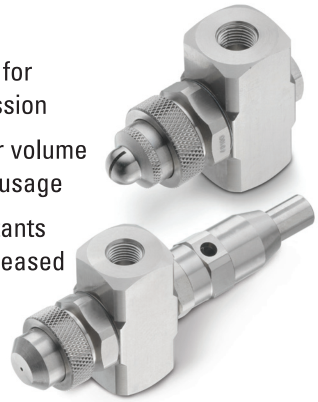
- Keep nozzles out of the range of equipment or falling debris that could cause damage
- Be sure nozzles are accessible for maintenance
- The precise placement of nozzles will depend on many factors. Consult with your nozzle supplier for recommendations

WATER QUALITY

Water hardness increases its surface tension and may increase the amount of water needed for adequate wetting.

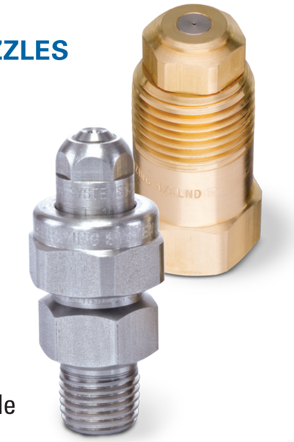
Contaminants in the water source may influence the nozzle selection process. If water contains debris, consider using maximum, free passage nozzles and/or filtering water to less than 50% of the maximum free passage size of the nozzle to minimize clogging and excessive nozzle wear.

AIR ATOMIZING AND AUTOMATIC NOZZLES
J SERIES NOZZLES



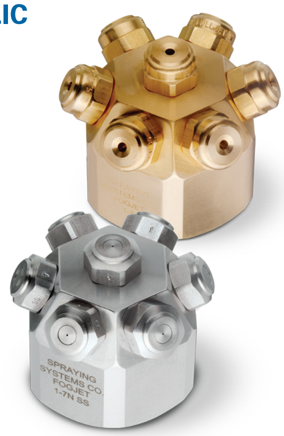
- Extra small drop size – ideal for use in airborne dust suppression
- Provides greater wetting per volume of liquid and reduces water usage
- Suitable for use with surfactants for greater wetting and decreased water consumption

FINE SPRAY HOLLOW CONE HYDRAULIC ATOMIZING NOZZLES
LN NOZZLES



- Extra small drop size – ideal for use in airborne dust suppression
- Standard and wide-angle spray patterns available
- Suitable for use with poor-quality water – versions with integral strainers available
- UniJet® nozzles feature replaceable spray tips; bodies are re-used

MULTIPLE ORIFICE HYDRAULIC FINE SPRAY NOZZLES
FOGJET® NOZZLES

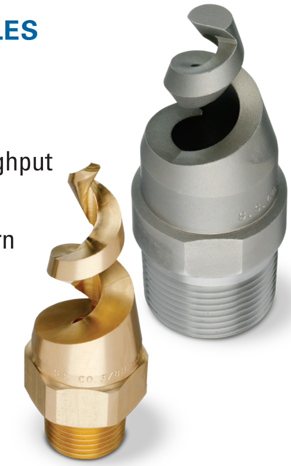


- Small drop size – ideal for use in airborne dust suppression and some dust prevention operations
- Produces a fine mist or fog over a large area
- Suitable for use with poor-quality water when a TW line strainer is placed upstream of the nozzle

HOLLOW CONE HYDRAULIC NOZZLES
WHIRLJET® IN-LINE BD AND RIGHT-ANGLE NOZZLES

- Small to medium drop size
- Uniform distribution over a wide range of flow rates
- Lower-profile projection for installation in a tee or pipe header

HYDRAULIC SPRAY NOZZLES
SPIRALJET® NOZZLES



- Medium to large drop size
- Provides maximum liquid throughput for any given pipe size
- Full or hollow cone spray pattern
- Extra-large, free passage versions available

FULL CONE HYDRAULIC NOZZLES
FULLJET® NOZZLES

- Medium to large drop size
- More impact than other nozzles
- Removable caps and vanes for easy inspection and cleaning on many models
- Maximum free passage (MFP) models for clog-free performance available

FLAT SPRAY HYDRAULIC NOZZLES
VEEJET® NOZZLES

- Small to medium drop size
- Narrow to wide spray angles
- Unobstructed flow passages to minimize clogging

T-STYLE STRAINERS

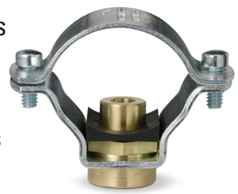
- Large open screen area for efficient liquid straining
- Designed for minimal maintenance
- Cleaning options: Removable bottom cap or plug for complete withdrawal of entire screen assembly; bottom pipe plug can be replaced with a drain cock for quick-flush cleaning; removable guide bowls and more

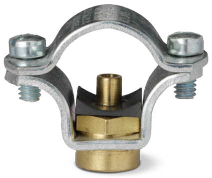
36275 ADJUSTABLE BALL FITTINGS

- Use to minimize overspray and ensure precise spray placement
- Simplifies nozzle positioning without disturbing pipe connections
- Smooth, finished surfaces eliminate leaking

SPLIT-EYELET CONNECTORS

- Use to install nozzles, gauges and hoses in piping systems quickly and easily
- Eliminates body rotation within the flange when installing/removing nozzles
- Eliminates need for taping holes and provides superior thread engagement to eliminate stripped threads
- Reduces sediment and clogging – inlet extends into the pipe



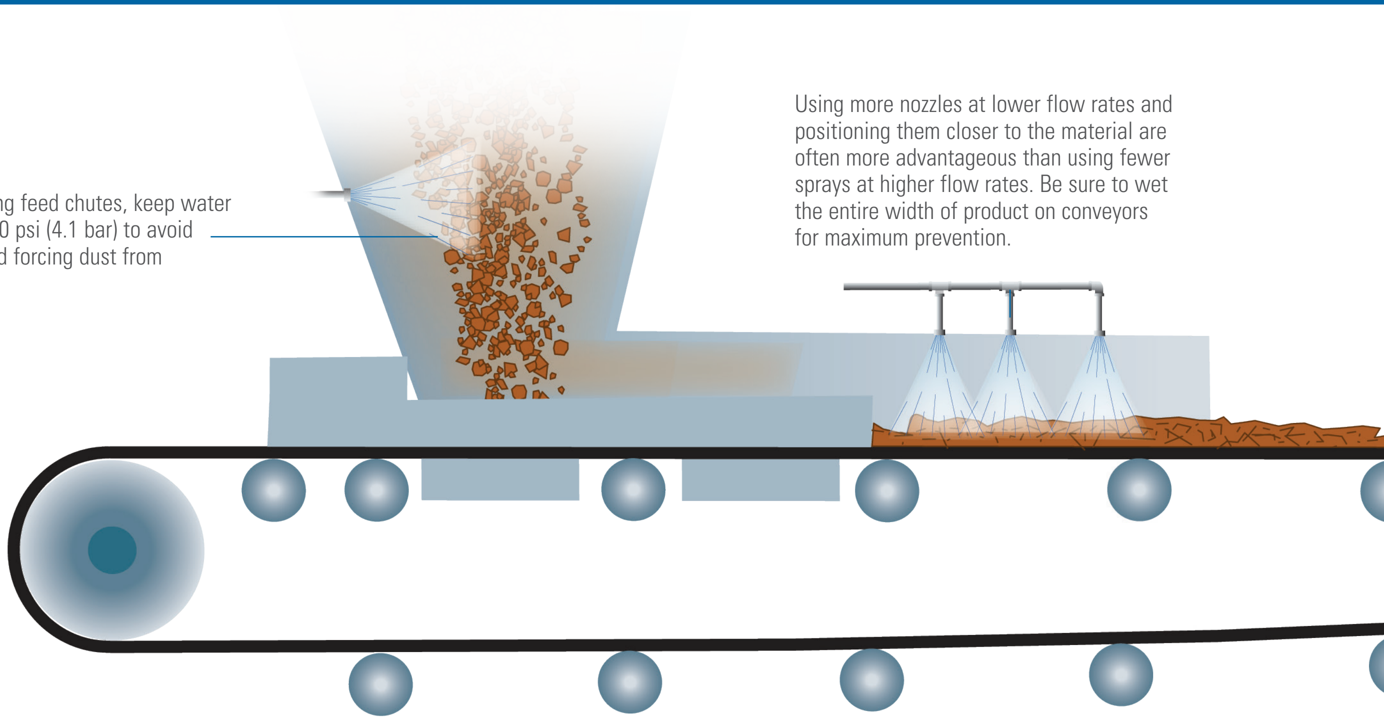


AUTOJET® DUST CONTROL SYSTEMS

Systems vary by region

- Pre-packaged, pre-assembled and pre-tested system ready for use immediately upon delivery
- Can operate one or many nozzles, manifolds or headers
- Automated injection of chemical additives minimizes waste and ensures consistent application
- Choice of spray nozzles – wide range

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 are often more advantageous than using fewer sprays at higher flow rates. Be sure to wet the entire width of product on conveyors for maximum prevention.

SOLVING COMMON PROBLEMS

It is easy to detect problems in wet dust control systems. Dust is still prevalent or the material is too wet and new problems occur such as quality issues and excessive maintenance. Unfortunately, the solutions to these problems aren't always straightforward and depend on the specifics of the operation. However, the guidelines that follow should prove useful.

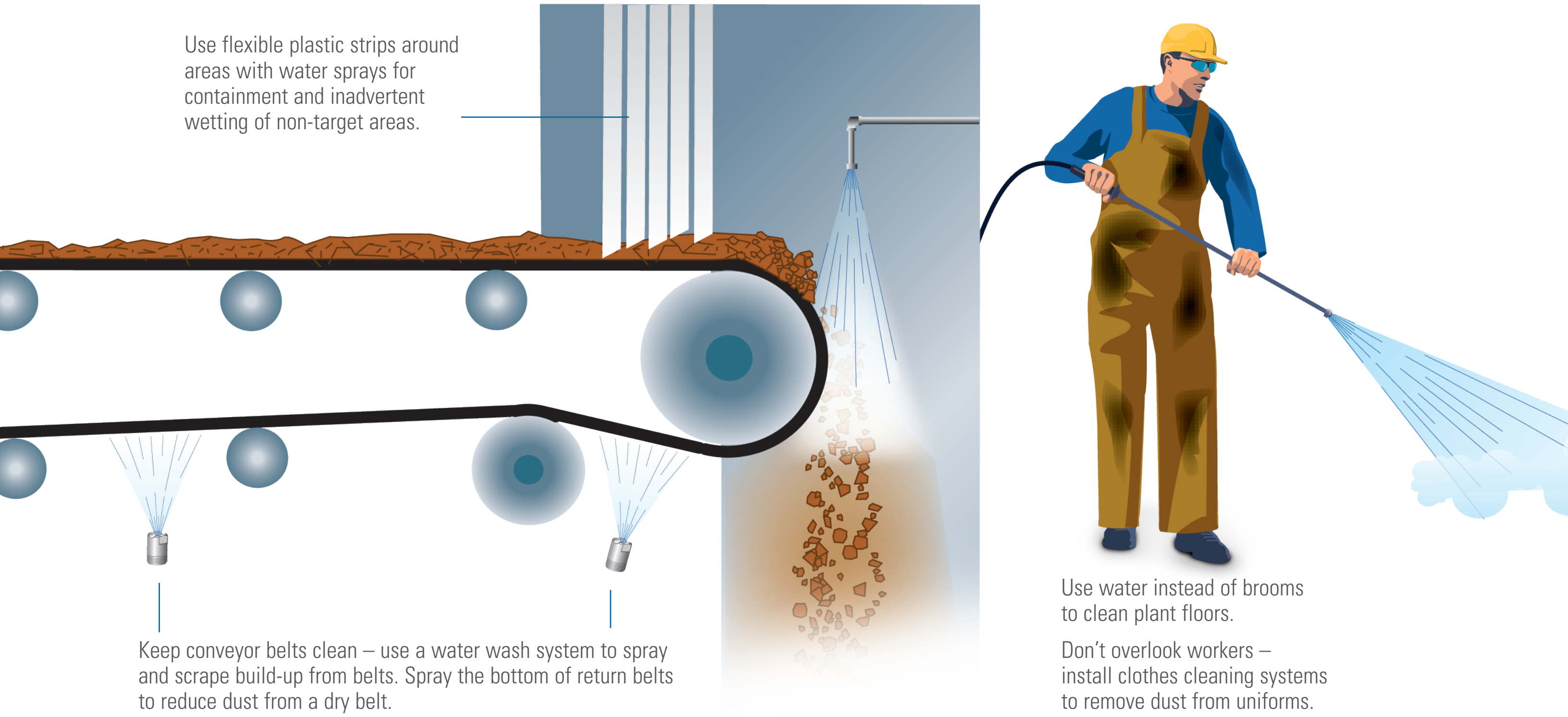
PROBLEMS:

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

SOLUTIONS:

To reduce the amount of water being applied:

- ☐ Reduce flow rate
- ☐ Use fewer nozzles
- ☐ Check nozzles for wear – capacity will increase as nozzle orifices wear
- ☐ Consider spray control to ensure nozzles are spraying only when required



PROBLEM:

Too much dust

SOLUTIONS:

- ☐ Increase flow rate
- ☐ Increase the number of nozzles used
- ☐ Adjust nozzle placement to assure sprays are reaching the target area
- ☐ Consider enclosures to protect nozzles from air/wind or use nozzles with 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

PROBLEM:

Handling material is difficult

SOLUTIONS:

- ☐ Inspect material. Uneven application of water will result in material inconsistency. Reposition nozzles for more uniform coverage
- ☐ Consider a change in nozzle type or spray angle to ensure consistent coverage

EQUIPMENT MANUFACTURER KEEPS WORKERS AND ENVIRONMENT SAFE WITH DUST CONTROL SYSTEM

Problem: A leading manufacturer of bulk handling equipment in Brazil needed a system to control iron ore dust. When the rail cars are used by customers, they are inverted for unloading so the iron falls from the cars into chutes. The manufacturer's customers could be jeopardizing the health of its employees and facing significant environmental fines without effective dust control.

Solution: The Spraying Systems Co. solution was a fluid delivery system including pumps, filtration and three spray manifolds.

The dust control system uses more than three hundred hydraulic nozzles and eliminates the need for the costly compressed air often required in other systems. Centrifugal pumps supply water to the spray manifolds and liquid line strainers are used to prevent nozzle clogging and reduce on-going maintenance.

RESULTS

- **Effectively suppressed dust**
- **A safe work environment**
- **Avoiding several hundred thousand dollars per year in fines**

COAL PRODUCER IMPROVES SAFETY AND OPENS NEW MINING AREAS WITH ADVANCED WATER SPRAY TECHNOLOGY

Problem: A leading coal producer in the USA needed to dissipate methane gas in an underground mine to eliminate the possibility of ignition. Certain areas of the mine near methane well sites were considered unsafe because of the higher concentration of methane gas. Saturating the air to a specific humidity prevents the methane from igniting. The hydraulic nozzles used on the continuous miners were unable to produce the small droplets required to humidify the air.

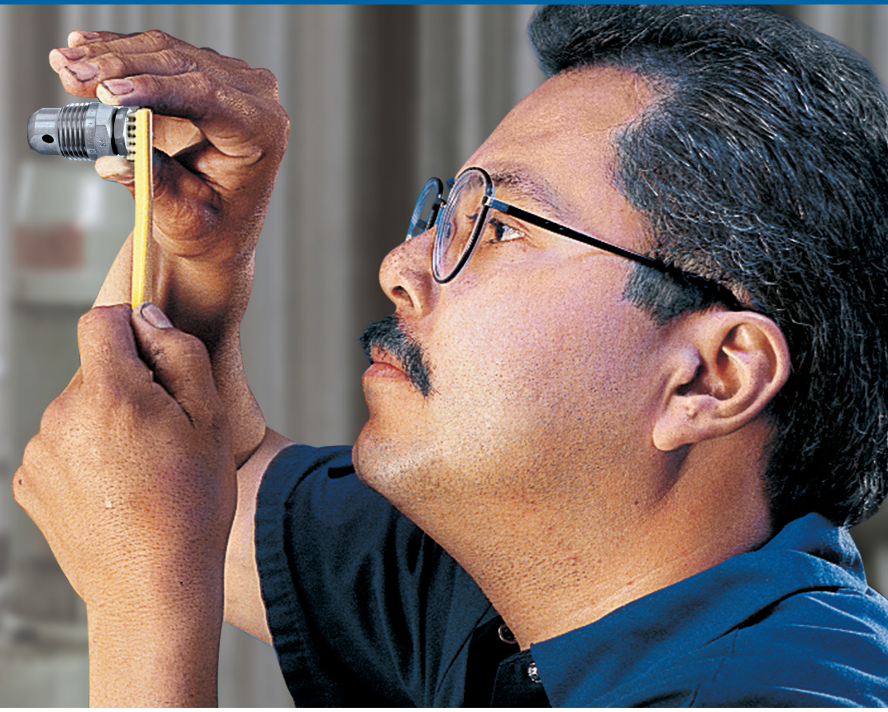
Solution: Spraying Systems Co.'s FloMax® air atomizing nozzles provided the ideal solution. FloMax nozzles produce very small droplets, between 40 and 60 microns, at low flow rates for effective dust control and humidification. The nozzles are mounted on the continuous miner in seven banks of five nozzles each. During operation, these nozzles create a curtain of fine mist that suppresses dust, dissipates the methane gas and prevents the possibility of ignition.

RESULTS

- **Improved safety**
- **Mine previously untapped areas**
- **System payback: two weeks**

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. How quickly wear occurs is dependent upon a variety of application-specific factors. Other factors that can negatively impact spray nozzle performance are plugging, corrosion, scale build-up and caking. Establishing and implementing a nozzle maintenance program is the most effective way to prevent and minimize costly spray nozzle problems.



PLUGGING/CLOGGING

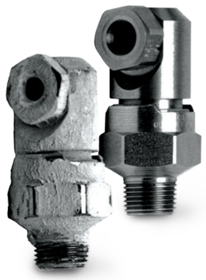
- Use proper water clarification devices
- Use strainers
- Be sure to specify nozzles with adequate free passage
- Conduct maintenance on a regular basis

CORROSION

- Specify nozzles in the appropriate materials for the solutions being sprayed
- Scale build-up
- Control hardness level of the water
- Use chemical additives as needed
- Conduct maintenance on a regular basis

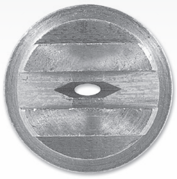
CAKING

- Conduct maintenance on a regular basis to remove build-up inside the nozzle or on the exterior

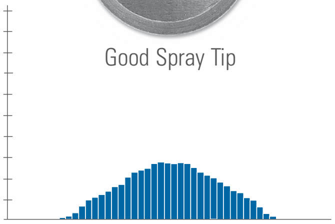


MAINTENANCE TIPS

- Determine the optimal maintenance schedule based on the specifics of your operations
- Examine spray patterns and watch for changes in spray angles, distribution and heavy edges
- Wear may be hard to detect so go beyond visually inspecting nozzles. Check flow rate and spray pressure at a system level
- The nozzle orifice is precision engineered, so be careful to avoid damage, or replacement will be necessary
- Cleaning tools should be significantly softer than the construction material of the nozzles. Use a toothbrush or toothpick – never clean the orifice with metal objects
- Soak in mild solvent to loosen debris for easier removal with proper equipment

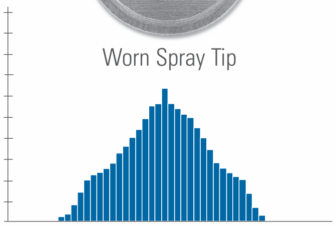


Good Spray Tip



Correct Spray Distribution

Worn Spray Tip



Worn Nozzle Spray Distribution

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