How to Control Dust

By: Mark Kestner, Ph.D.
National Environmental Service Co., Inc.
7 Hampshire Drive, Mendham, NJ 07945
Tel: 973-543-4586 www.drdust.com

I grew up during the '50's in Cleveland, Ohio. At the time, Cleveland was known as a "two-shirt town". If you had a white collar job, you changed shirts at lunchtime because the one you wore in the morning was blackened with soot from the steel mills. The Cuyahoga River, running right through heart of the city, actually caught fire one day to the lasting disgrace of industry that had for decades used it as a dumping ground for the most noxious oils and chemicals.

Then came the Clean Air and Clean Water Acts in the 1970's. In spite of the dire predictions of industry, environmental regulation didn't kill the Cleveland economy – it brought my town and many other "rustbelt" cities back to life. People could breathe again.

That respirable airborne particulate results in increased death rates is beyond dispute. Especially if the particulate is soot from a combustion process like diesel exhaust or contains carcinogenic substances like crystalline silica. As a result, regulation now requires industrial processes to obtain a permit to operate at an approved emission rate and meet increasingly stringent emission standards.

Quarries have to battle dust everyday. The mines in New Jersey, Connecticut and the Hudson Valley that built New York's skyline are under attack now by a growing chorus of property and business owners. Even though these are the same pits that supplied the iron and lead for the guns and bullets of Washington's army two hundred and fifty years ago, these quarries are now in "their backyard".

Mining is a tough business. High explosives blast rock from the ground and huge machines crush it into sand, stone, and gravel. But all that processing creates dust - dust that the public doesn't want to see and miners don't want to breathe. "Black lung" was a rallying point for the fledgling United Mine Workers of John L. Lewis who fought the early battles for better working conditions in the coalfields of Appalachia. Today, dust emissions are regulated and strict air quality standards protect the environment.

Today, plant operators have to satisfy the demand for more infrastructure and clean air. Quarries that were out in the New Jersey countryside 30 or 40 years ago are now ringed by "McMansions" occupied by savvy professionals who want the potholes fixed but don't want to see those dirty trucks.

What should a plant manager do?

First of all, forget about all the regulations and standards that you don't really need to know to solve your problem. Think about dust control in terms you understand. Dust and spillage occur because material handling and processing systems leak. Plug the leaks and you'll put more tons into trucks. When you start to think about controlling the dust by controlling the process you are much more likely to come up with practical solutions that are easy to integrate into your operations.

Good Process Control <u>is</u> Good Dust Control

Good process control and good dust control are just two sides of the same coin. And I don't use that term loosely. There are lots of ways to make more money by complying with regulation. Some customers like wetter base rock and water going across the scale can pay for a spray system in a couple of years. I know of several examples where mines have been paid to use waste products as dust suppressants-especially for roads. This allows the chemical company to avoid the higher cost of disposal by burial or incineration. Many cement companies profit from burning hazardous wastes or tires, quarries can profit by using off-spec or waste chemicals.

If you do not understand the relationship between process and pollution control you are much more likely to make mistakes that will ultimately cost production and lose money. One common error is to spend as little as possible on the environment. I gave a talk once to a gathering of producers and while most were attentive, there were three fellas laughing in the back of the room. "What's so funny." I say. "Well, Doc," comes the reply, "We just use a hose to soak the hell outta the rock whenever the inspector shows up!" Turns out that their VE (visible emission) test took three days during which this little 500 tph plant churned out 12,000 tons of mud and off-spec rock. At $3/ton that's about $40,000 down the drain. That's what I call "voodoo" economics.

If you still don't get it, you may make the other common error of waiting until you get forced to comply. That's a sure fire way to develop an adversarial relationship with your neighbors and the state that will add penalties and fines to your list of accomplishments. If you don't solve the problem, the regulators will do it for you by forcing the plant to use control measures that are much more costly and cumbersome.

Instead of whining about environmental compliance, find ways to turn the lemon of regulation into the lemonade of profits. Believe it or not, some dust control measures are actually good for production. For example, choke feeding a crusher not maximizes its productivity but also keeps the dust down because the machine is moving more rock and less air. Likewise, operating the plant smoothly at a consistent rate improves production with no down time when crushers "windmill" and really kick up some dust. I've seen haul trucks race to the primary at 45 mph trailing a cloud of dust only to sit for five minutes to unload when a more rational speed might have gotten the truck there in time to unload without putting a greater burden on the plant to water the road or treat it with expensive chemicals.

There are all kinds of simple things you can do that don't cost a dime that can have a big impact on dust levels. But it all has to come from the top down. There are many companies that peacefully co-exist with their neighbors because their owners care about the way their plant looks and want to protect worker health. Many quarries are family business and these smaller outfits are some of the safest and cleanest I know because no one wants to see their brother or cousin get sick or hurt. Bottom line: I've seen plenty of crushing plants comply with clean air standards without ruining their business.

Unfortunately, I also see plenty of plants that only turn on the water when they see the inspector coming and their operators spend their day working in dust and mud. Even in this day and age, I still encounter plant managers for some of the biggest producers who won't take the time to shake my hand or spend a few minutes talking about how we can work together to control dust and improve their production. If the man at the top doesn't value the environment, the whole plant will be corrupted by his attitude.

Several years ago, I actually had an owner tell me in all seriousness that silica dust is good for you because its like that Comet cleanser and scours your lungs out. It is this "culture of dirt" that teaches that "real" men thrive in the dust and that environmental protection is the enemy of production. Many of the steel company executives in Cleveland took great pride in their business cards that pictured the fire and brimstone of blast furnaces as a sign of economic health and personal wealth.

They could not have been more wrong. Clean air and water are just as vital to our survival as "smart" bombs are to our security. The mining industry can be proud of the contribution it makes to the infrastructure that has made us the only superpower. When you make the commitment to control dust with improved process controls you are on your way to a cleaner, more productive, and profitable plant. And, you can take pride in the fact that our children will have secure and healthy country to pass to their children.

Operating Practices Can Control Dust and Increase Production

One of the most effective tools that you can use to control dust is good operating practice. I've always been impressed by the great diversity of methods and machinery used to produce sand, stone, and gravel. Every plant seems to do something just a little bit different. But one thing all plants that have successfully complied with air quality standards have in common are operators that have been trained to take personal responsibility for dust control. They are your front line in the battle to protect the environment and improve production.

Years ago, I was at a shipping terminal on the Ohio River which handled all kinds of bulk materials - coal, stone, gypsum and many metal alloys used in foundry products. Because these were very dusty and contained metals like chromium, the PA DEP required the plant to enclose the area where trucks were loaded and vent emissions to a baghouse. However, even this wasn't enough to contain all the dust from some of the finer materials and the DEP wanted the plant to install a spray curtain over the loading bay to suppress dust that the loader dragged out as it retreated.

As I was trying to figure out how to design this spray system, a truck entered the plant and headed right over to the loader at the warehouse. Turns out the truck driver and loader operator were buddies. The trucker was in a big all-fired hurry and pleaded with his pal to load him up right there in the open yard so he could get going without waiting in line. The loader obliged and sent a big puff of dust up into the air when he dropped the first bucket. I guess he figured it would only take a minute or two to load up and that nobody would notice.

Unfortunately, this puff of dust didn't escape the attention of a DEP inspector who just happened to be on his way to a power plant down river. He wheeled into the terminal and wrote a Notice of Violation (NOV) on the spot that cost the company $4,000 and the loader operator his job. The incident was particularly frustrating because the company had invested thousands of dollars in dust control equipment only to have their efforts thwarted by an operator's lapse in judgement.

Mistakes like this are not unusual. Many NOV's are issued not because a quarry hadn't made the investment in control equipment, but because operators misuse, abuse or ignore it. You can argue that its tough to find qualified operators, but it's not just stupidity. Sometimes employees just won't do the right thing. A young plant operator once told me that there was no way he was going to turn on the spray system because his granddaddy (who spent 40 years in the same pit) taught him that "water was the worst thing in the world for rock".

How do You Get to Carnegie Hall? Practice, Practice, Practice

Ask yourself this question – what's the difference between a $1,000,000 race horse and a $10,000 race horse? Does the $1,000,000 horse run 1,000 times as fast? I don't think so. The difference is that single inch that gets the winner across the finish line first. It's no accident that quarries that successfully comply with air quality standards and keep the peace with their neighbors all have one thing in common - operators with the right stuff. They aren't paid anymore and they aren't any smarter than any other operators. But they have been taught it's the little things that count. Winners like that will break production records and still keep the plant clean.

It doesn't cost a dime to tell someone to change their behavior. Have a problem with road dust? Slow the trucks down. You don't have to water or use chemicals if operators don't make dust to begin with. Unless there's just a lot of silt on the surface, trucks won't make dust if they keep their speed below 15 mph. No doubt it is tough to control independent truckers but anything you can do to keep speed down is going to help reduce your reliance on more expensive measures like vacuuming, watering, or chemical treatment.

There is a right way and a wrong way to handle bulk materials and operators need to be trained in methods that will minimize dust. Take truck loading. Your loader operators should be trained to avoid overfilling their bucket and spilling stone on the carry over to the truck. I know of a couple of quarries that have the loader take a cut from a pile just to see how dusty it is. If it looks like a problem, a tanker will run over and wet the pile down. If your quarry is in the New York, Chicago, or Los Angeles any other big metro area, these are simply the kinds of operating practices you have to use to avoid complaints, lawsuits and violations.

Fugitive emissions from stockpiles can also be reduced through good operating practice. These measures may not solve the problem completely but will reduce reliance upon more expensive controls. For example, try to keep piles as low to the ground as possible. Piles higher than about 35 ft. are more susceptible to wind erosion. Erosion increases above this level because the winds aloft are not broken by trees or topography. Pile surfaces should be as smooth as possible to reduce wind erosion. An irregular pile surface will create turbulence that aggravates dust. When reclaiming, loaders should work on the lee side of the pile where its activity is sheltered from the wind.

Dust Control Measures Boost Production

Believe it or not, some operating practices that control dust can also push more rock through the plant. Choke feeding crushers is one example. Operating crushers at full capacity reduces air flow through the machine. Underfed crushers will make more dust – especially horizontal or vertical shaft impactors. Impactors run at much higher speed, crusher finer and move much more air than jaw, cone, or gyratory crushers. Operating crushers at capacity not only helps to control dust but improves productivity.

Avoiding interruptions in process flow is another important control measure. The burst of visible dust emissions that occurs when an impactor is running empty and "windmilling" can be ten times the intensity of emissions when the machine is loaded. Unloaded screens, feeders and fast moving conveyors will keep dust suspended. Operators have to be alert to tramp metal or oversize rock that will jam feeders or trip crushers.

Maybe you're stuck with a plant that's been pieced together like some Frankenstein with a tiny rock box, huge primary impactor and not enough screen cloth. It's not unusual to find a crushing spread pasted together with mis-matched machinery like this. Some of the ones I've seen can't run for more than a couple of hours before something breaks, jams or overloads and the place sputters and wheezes with dust as it grinds to a halt. Whatever your problem happens to be, do whatever it takes to run at a consistent process flow rate – you will reduce wear and tear on your machinery and the plant will make less dust.

Take Personal Responsibility for Dust Control

Good Operating Practices

Dust Source	Good Engineering Practice
Paved and Unpaved Roads	Speed control Avoid sharp turns or rapid accelerations Clean up spillage promptly Report violators Inspect tarps and tailgates
Stockpiles	Minimize inventory on the ground Maintain smooth pile topography Reclaim on sheltered side of piles Avoid overfilling loader buckets Minimize pile heights
Material Handling	Avoid interruptions in process flow Choke feed crushers Clean up spillage Keep equipment clean Shut-down in high winds

The way operators behave directly affects the ability of the plant to comply with regulation and be a good neighbor. Management has to set the example. Operators are much more likely to obey speed limits if they see their superintendent slow down his vehicle. If workers see a Plant Manager use earplugs and a face mask when it's noisy and dusty, they'll start to use them more often too. Managers need to get out into the plant and make sure that personnel take environmental compliance seriously.

If you are an environmental manager or engineer, get dirty. Most operators figure you don't know the first dang thing about crushing rock so show them otherwise. Get to know the production side and show operators that you are willing to work side by side with them. Check those spray nozzles yourself and clean them if they need it. Maybe it's not in your job description but that kind of initiative sets the right kind of example and earns you respect.

Operators also need to be alert to potential problems and able to report it to someone that they can trust to take action. If an operator looks up at the face and sees a cloud of dust from a drill trying to run without the water on, he should report it before one of your neighbors with an axe to grind sees it through his binoculars. If the wind kicks up and an operator sees visible dust blowing across the property line, he should get on the radio to his boss so that his superior can make the right decision. If someone in the scale house sees an untarped truck or a leaking tailgate they need to record the plate number in a log and inform the owner of the problem and the consequences of continued negligence.

I was once asked by a customer to come out to his plant and figure out what was wrong with a spray system we had installed a few months earlier. When I got into the control tower and looked down into the primary jaw crusher, I saw that a nozzle had been crushed by a stray rock. I asked how long it had been broken and he replied about six weeks. "Six weeks! Well, why hadn't it been fixed?" He replied, "Not my job, man".

The fact is that pollution control is everybody's job. Management has to set the example and labor has to follow if the aggregate industry is going to survive in urban America. There should be no doubt about the fervor of opposition to mining. Quarries are under assault in cities across the country and your operators are your front line of defense. If you can inspire them to protect the environment as enthusiastically as you want them to pursue production goals you've won half the battle.

Good Engineering Practice Contains Dust Emissions

Some 30 years ago at a coal mine in Wyoming an engineer was scratching his head trying to figure out how to control dust when a baghouse dumped fines back onto a conveyor. He'd been told by several vendors that he'd have to put in an elaborate enclosure and use surfactants or foaming agents to control these emissions – and it wasn't going to be cheap. But he had a different idea. Being a farm-boy and a good Christian, he invented a plow that split the coal stream like Moses split the Red Sea and buried the dust at the point of return. Problem solved.

Engineered solutions to the practical problems of dust control, like the dust plow, are the best method of reducing your reliance on more expensive dust control measures, like chemical suppressants or baghouses. The prevention and containment of dust and spillage by good engineering practice comprises a large category of control measures that range from simple curtains for transfer points to landscape architectures that shelter and beautify.

Design for the worst case

In an average year, I visit about 60 aggregate plants and I've always been impressed with the fact that no two are alike. Crushing rock is a real art and this diversity reflects the nuances of geology, markets, and equipment design. Modern aggregate plants are marvels of speed and efficiency. However, the goal of more rock at lower cost can backfire when accomplished at the expense of safety and environmental protection.

I was once asked to take a look at screening plant processing nitrates in the Atacama desert of South America. In this remote location, the engineers figured they could just let the plant rock and roll. And it did. The dust was so bad that air filters on every engine had to be changed twice daily and after six months most of the mobile equipment was out of service with worn out motors.

Dust can bite back when engineers don't design for the worst case. The covers and enclosures that this mine was so anxious to eliminate would have kept the plant on-line and saved a lot of money in replacement parts.

To keep costs down, engineers take shortcuts. Conveyors can be shortened if they load closer to the tail pulley and items like dust skirts, curtains and scrapers are often absent from the final design. And these are new plants. Older plants can be so shot full of holes that operators spend hours cleaning up. It costs lots of money for a crew to shovel, bobcat and sweep. Just a few man-hours a day translates into thousands of dollars a year. Believe me, if your accountants had to do the shoveling you wouldn't get an argument about buying that new scraper .

Load points need to be enclosed

Whenever stone is loaded onto a conveyor the potential for spillage and dust exists. Load points should be enclosed on three sides, covered, skirted and fitted with a dust curtain. Examples of such load points are crusher and screen discharge chutes to conveyors as well as belt-to-belt transfer points. Much of this work can be done with in-house labor and materials, like scrap steel and used rubber.

Crusher discharges may require significantly more enclosure, particularly horizontal and vertical shaft impactors that move a lot of air. With machines like these there is a much greater potential that stone will spill and dust will leak. Impact beds that ensure a flat profile and dual belt skirts are often necessary to solve the problem. New designs feature soft rubber skirting that folds against the conveyor to give an air tight seal. Increasing the cross-sectional area of the enclosure and extending it several feet can also help to slow the air stream down.

Good Engineering Practices

Dust Source	Good Engineering Practice
Material Handling	
1. Load Points	Enclose on three sides and cover Install belts skirts and dust curtains Use multiple blade belt scrapers Impact beds under crushers Dual skirts under HIS and VSI crushers Do not load too close to tail pulleys
2. Stacking Conveyors	Articulated stackers that minimize drop height Install head box with dust curtain Telescopic spout Stack-out tubes
3. Feed Hoppers	Partial enclosure to shelter from wind
4. Screens	Covers
Piles	
1. Surge Piles 2. Product Piles	Shelter in-pit Berms, fences or wind screens Barricades to contain pile Complete enclosure
Paved and Unpaved Roads	Barricades to restrict traffic flow Fencing and screens to reduce wind speed

Because screens are elevated and vibrate at high frequency, dust emissions can be very visible and tend to stay suspended. Screen covers can help control emissions. All kinds of designs are available ranging from simple canvas tarps to lift-off covers. Screens can be very sensitive to moisture and covers can help to reduce the amount of water for dust suppression.

To control dust from stacking operations, articulated conveyors can be used to reduce the drop distance. Partial enclosure with a head box and rubber curtains helps shield the process stream from the wind. Complete enclosure is possible using telescopic chutes or stack-out tubes which contain the flow all the way onto the pile. Telescopic chutes can be equipped with sensors that maintain a fixed distance to the pile or with vacuum returns to collect dust produced by breakage when stone impacts the surface.

Feed hoppers are a final example of a load point that can benefit from improved engineering. But large hoppers are tough to completely enclose without obscuring the view of the operator or restricting the movement of hammers used to break oversize rock. Partial enclosures using elevated sidewalls, fences or screens can help a great deal especially when the prevailing winds are strong and predictable.

Berms, windbreaks and screens can protect piles

Completely enclosing piles is generally not possible because they are so active. Instead, good engineering practice takes advantage of the topography. Locating the plant in-pit is one of the best methods of protecting piles from the wind and containing emissions on the property.

If there are not natural barriers, windbreaks or screens may be necessary. Berms and fences are solid structures that push wind over or around piles. Screens are porous structures designed to reduce wind speed across the pile surface. Windbreaks and screens can be quite effective if they are positioned in proper relationship to dust sources. However, they may aggravate emissions if they are misplaced and create turbulence. For large stationary plants with multiple sources, there are computer models to help determine the height and placement of any windbreak or screen.

Landscape architecture is an important part of plant design. Your neighbors don’t want to see your quarry and control measures used to reduce wind erosion also keeps them out of sight. Building a berm with some trees and shrubs will improve plant appearance and show a skeptical public that your site can actually support plant life.

Control truck traffic and road dust

Plant roads should be designed to get rock from the face and stone out of piles as directly as possible. Fewer vehicle-miles traveled means less dust so routes should be as short as possible. Short routes also speed production and deliveries. To prevent drivers from wandering through the plant, barricades like boulders or Jersey blocks can be used to keep traffic on designated routes.

Pay attention to the gradation of the road surface. The silt content of the surface is directly proportional to its potential to emit dust. Altering the gradation of the surface can have a tremendous effect on dust emissions from unpaved roads. Putting down some chips to stabilize the surface will reduce the frequency of watering or the use of chemical suppressants.

Be careful how you lay out paved roads. Paved surface produces a lot less dust but only if you keep it clean. Access to paved roads from unpaved areas should be restricted so that any trackout of mud or dirt is confined. Paving areas that permit access from several directions or allow trucks to criss-cross the pavement from one dirt road to another makes cleaning or treatment much more difficult.

Demand machinery that makes less dust

All new aggregate processing plants have to meet New Source Performance Standards (NSPS) in order to obtain an operating permit. The annual fee for an operating permit is calculated based upon the potential of the plant to emit dust. Good engineering practices reduce the potential for emissions and decrease permit fees. This market-based regulatory approach implemented by recent amendments to the Clean Air Act provides a financial incentive to control emissions.

Some crusher manufacturers have already developed designs that minimize dust. One VSI manufacturer incorporates a dust recirculation system into their design that keeps fines out of the air stream. Others have equipped their machines with curtains or baffles to redirect air flow. Because of the short residence time of stone in impactors, it is especially important to introduce spray droplets directly into the crushing zone and some newer machines feature ports that offer better access and protection for nozzles.

In the future, mining companies will tend to purchase equipment that produces less dust. I think this is part of the reason high speed cone crushers have taken market share from vertical shaft impactors. As permit fees charge more and more for every ton of potential emissions, the demand for cleaner, less dusty production machinery will increase.

Engineering firms and equipment manufacturers have a special responsibility to help the aggregate industry achieve air quality standards because good dust control is nothing more than good process control. If you can appreciate this fact and translate it into good engineering practice, the only dust you'll make is the dust you leave your competition in.

Spray Systems and Baghouses Suppress and Collect Dust

If you are very lucky, good operating and engineering practices may get you into compliance. However, most plants have to use a spray systems or a baghouse as the primary method of controlling dust from crushing and screening operations.

Spray systems suppress, baghouses collect

Water spray systems control dust in two ways. First, spray droplets knock down dust particles in the air. The higher the pressure and the smaller the droplet, the greater will be the suppressive effect. Secondly, spray systems add moisture to the process that prevents dust from occurring downstream. How much moisture depends primarily on spray pressure and number of nozzles in service. A good commercial high pressure spray system will add no more than about 0.5% moisture to the process- just about a gallon per ton. However, a garden hose at 40 psi will add a lot more because it lacks the atomization necessary to suppress airborne dust and the power to penetrate a material stream.

Baghouses control dust by collecting it. They are used to filter contaminated air from a "point source", transport the collected dust to a central hopper for disposal and return clean air to the environment. Their efficiency depends primarily on intake air velocity and degree of source enclosure. Large open sources like truck hoppers are more difficult to enclose than a screen deck for example. And, unlike spray systems, baghouses do not prevent dust emissions from downstream sources because the amount of airborne dust they collect is only a small portion of all the fine particles in the process stream.

Both spray systems and baghouses can effectively control dust. Indeed, many modern crushing plants use a combination of the two. Whether you use one, the other or both depends on how your permit is written, the effect of moisture on your production process, and your budget.

All new aggregate processing plants must obtain an operating permit. This permit is a license to emit a fixed amount of particulate pollution calculated using estimates of emission factors and control efficiencies. If your emissions exceed New Source Performance Standards (NSPS), you may be required to restrict operating hours or limit production rates. Once the state is assured that the facility will comply with NSPS it will issue the permit and assess an annual fee based on the amount of total potential controlled emissions calculated in tons/yr. This market-based approach is designed to charge the producer for the right to pollute and provide a financial incentive to use cleaner production machinery and more efficient control measures.

Most states allow aggregate plants to use RACM (Reasonably Available Control Measures). However, if you are in a non-attainment area for particulate, the permitting agency may require more stringent control that uses BACM (Best Available Control Measures). Traditionally, regulatory agencies have considered source enclosure and ventilation to a baghouse BACM and the most efficient method for particulate control. However, baghouses are not practical for every source and most, if not all, state EPAs now also include spray systems as a BACM. Even the California South Coast Air Quality Management District (SCAQMD) now has permitted spray systems for crusher dust control.

Take moisture into account.

The effect of moisture on your operations has much to do with the decision to go wet or dry. Spray systems should add just enough moisture to kill the dust but not enough to reduce screen efficiency or throw products off-spec. I often ask plant operators if there aren't just a few days during the year, maybe a day or two after a rainfall, when the plant runs just right – no visible dust and all products in spec. If the answer is yes, it's a pretty good indicator that the plant should be able operate in compliance at design capacity using a wet suppression system. What he is telling me is that there is an optimal moisture content which is high enough to prevent dust but low enough to prevent production problems.

If the answer is no, dry collection with a baghouse is the alternative. Some rock just reacts badly to water. For example, if there is a lot of clay or shale in the stone, fines may tend to pack-in to crushers or plug chutes even when only slightly wet. The problem may also be compounded by defects in plant design like insufficient screen area or undersized bins. In either case, it may not be possible to use wet suppression particularly when processing finer sizes. It is not unusual to find a primary plant equipped with a spray system while the finish plant uses a dry collector – especially if air classifiers are used for product separations. Dry collection may be the only option for dust sources that would bottleneck production if moisture is introduced.

The cost of control is also an important factor. While less efficient in smaller size ranges, wet suppression systems are much less capital intensive. Indeed, the cost of spray system equipment for a large stationary aggregate plant may be less than 2% of the cost of the total facility. Baghouses are significantly more expensive. The cost of the collector and source enclosure may be ten times that of a spray system. You have to determine whether the additional dollars will be offset by higher production rates over the lifetime of the plant.

Spray systems for visible dust, baghouses for respirable particulate

Spray system control efficiency falls with decreasing particle size. A typical high pressure spray system will produce a majority of droplets in the 20-40 micron range. Very small particles, especially PM2.5, are tough to knock down with droplets that are much larger. Baghouses can collect these fine particles better than most spray systems can suppress them. As a result, baghouses are the preferred method for control of hazardous or toxic dusts.

The technology of wet suppression systems has grown to include the use of chemicals, higher pressures, or air-atomization all in an attempt to improve control efficiency. Surfactants, or wetting agents, have been used since the 1950's to boost the performance of water spray systems on dusts that are hard to wet, like coal. Surfactants increase the rate at which a water droplet wets dust particles but are of limited usefulness on materials like stone that are much easier to wet than coal or coke.

Foaming agents for dust control were developed in the 1970's and have become an important commercial method for dust control in the coal industry. Foam bubbles are under a great deal of stress and, when they are burst by mechanical contact, they shatter into hundreds of tiny droplets. This results in improved moisture distribution at reduced water consumption rates which made them attractive to coal-fired power plants. Because these chemicals have BTU value, utilities have been able to pass their costs along to ratepayers. In the aggregate industry, treatment costs of 5 to 15 cents per ton have limited their market.

Water spray systems have employed higher and higher pressures to reduce droplet size and improve performance. Commercial water spray systems that operate in excess of 200 psi can achieve control efficiencies at water consumption rates on par with foam systems. While less efficient than baghouses for the finest dusts, lower cost water spray systems will remain the workhorse of visible dust control in the aggregate industry.

New, more stringent, regulation of respirable silica-containing dust has provided greater impetus to the use of dry collection and air filtration systems for personnel protection. Silica is a known carcinogen and the evidence linking death rates to fine paticulate exposure is no longer disputed. Of special concern are particles of soot produced by combustion processes, hence the new regulations targeting diesel exhaust. Dry collection is the best method of protecting workers from hazardous dust in control rooms, mobile equipment cabs or enclosed work areas.

Advantages and Disadvantages

Wet suppression systems suffer from two main disadvantages. First, the addition of too much moisture or additive can hurt production. Excessive moisture can reduce screen efficiency and throw products out of spec. Chemical additives may upset water chemistry in clarifiers or alter physical properties. Foaming agents, for example, can affect the air-entraining properties of concrete.

Secondly, wet suppression systems are tough to use in cold weather. When temperatures drop into the low 20's, spray nozzles may freeze on-line and any water frozen in piping can cause them to burst. Heat-tracing or the use of anti-freeze agents is usually impractical because of their higher cost and there are very few examples of spray systems that operate continuously in subfreezing temperatures. Baghouses are much less susceptible to cold weather operating problems. The greatest danger is condensation in ductwork or on filter bags that can lead to corrosion or performance losses.

While baghouses offer the distinct advantages of dry processing and better cold-weather performance, they too have their disadvantages. First of all, they are not practical for all sources. Large truck hoppers are tough to enclose and vent to a collector and many operators do not like block their view of screen decks or other critical areas with covers or enclosures. Stacking conveyors are also extremely difficult to adapt to dry collection systems which employ telescopic spouts with vacuum returns. These are much more expensive and difficult to maintain than the alternative wet suppression system.

Secondly, disposing of the collected dust can create another major source of emissions. Putting the dust back into the process may simply move the dust problem downstream. The successful application of fabric filtration systems requires that the collected dust is either taken out of the process altogether for disposal or returned in a manner that prevents re-entrainment.

Conclusion

Good operating and engineering practices, wet suppression and dry collection systems are the four horsemen of dust control. Good operating and engineering practices are the most cost-effective controls because they rely on in-house labor and material. Wet suppression systems are inexpensive and easy to maintain making them the primary control measure for the majority of aggregate plants. Dry collection is the best control strategy for hazardous dusts or processes that cannot tolerate moisture. Picking the horses for your team and making them run together in a comprehensive dust control plan that doesn't sacrifice productivity for compliance is the real challenge to aggregate managers.