

How to diagnose and solve ducting problems in your dust collection system

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Plants that handle bulk solids rely on dust collection systems not only to keep the workplace clean and healthy for workers, but to protect equipment and other valuable assets from fires and explosions. Yet more often than not, these dust collection systems underperform, leading to an unhealthy work environment, expensive ongoing maintenance, and premature equipment failure. This article explains how to diagnose problems with your dust collection system's ducting system, a common trouble source. Sections explain how poor design, fabrication, and installation can lead to these problems and what you can do to remedy them.

Poorly performing dust collection systems are common in bulk solids handling plants. In fact, as many as 90 percent of the systems presently installed in US plants don't perform up to expectations. Of these, up to 80 percent have performance problems associated with the ducting system, which includes the pickup hoods (also called *capture hoods*), dust containment enclosures (like chutes and belt conveyor skirting), and ducting. Unfortunately, these performance problems lead many plants to place unjustifiable blame on the dust collector itself.

The first sign that a dust collection system is performing poorly is an unacceptably high level of dust in the workplace. This results in an unhealthy environment for workers and increases the risks of a fire or explosion. If a newly installed system has an improperly selected collection air volume, the poor performance shows up immediately

after startup. But evidence of other design problems often doesn't show up for weeks or months.

Plant staff often assume these longer-term problems are normal and that fixing them is a typical maintenance task. But this is simply not the case: A properly engineered dust collection system performs well and requires little maintenance once it's properly configured, installed, and balanced.

Simple field checks can usually pinpoint dust collection system problems. The following information describes field checks that can help you discover potential problems with your system's ducting system.

Field checks for finding ducting problems

Start by taking some differential pressure (also called *pressure drop* or ΔP) readings, which measure the difference between static pressures upstream (on the dirty side) and downstream (on the clean side) of your dust collector's filters.

If your baghouse or cartridge collector is typical, it will have a permanently mounted differential pressure gauge that's piped across the tubesheet. Before taking your ΔP reading, first disconnect the fittings and blow through the piping to make sure that the gauge isn't plugged with dust. Then take the readings.

If the ΔP reading is much higher than 4 to 6 inches water gauge from the collector air inlet to the air outlet, or is much higher than 2 to 4 inches water gauge across the tubesheet, look for partially blinded filters. One quick test is to inspect each filter's clean side. If it's coated with dust,

it's probably partially blinded. But this can be difficult to spot visually, and you may have to send the filters to a lab for permeability flow tests. The tests analyze the airflow through a unit of filter area to determine whether the filter fabric is partially blinded.

If your readings indicate the ΔP is normal (4 to 6 inches water gauge from the collector's inlet to the outlet or 2 to 4 inches water gauge across the tubesheet) or lower than normal while the static pressure reading on the collector housing has a high negative value, most likely the ducting system is partially plugged.

If your dust collector doesn't have a permanently mounted differential pressure gauge, you'll need to use a handheld manometer to take a static pressure reading at the collector air inlet. Again, a high negative reading can mean the ducting is plugged; a low reading can mean the collector is plugged.

If your dust collection system shuts down because both the collector and ducting are completely plugged with dust, you can't take ΔP or static pressure readings. In such a case, a combination of bad ducting design and poor equipment selection is almost certainly the problem. To determine the cause, focus on the ducting system because this is most likely where the trouble started.

If you suspect the ducting is plugged, where possible, check the inside of the ducting through inspection doors and cleanout ports. Look for signs of condensation or dust buildup. Dust accumulated around the ducting perimeter, like a clogged artery, indicates condensation-induced plugging. Dust settled in the ducting bottom is a sign of low transport velocity. If the ducting has no doors or ports, you can conduct a tap test by tapping on the ducting and listening; a dull thud or dampened tone can indicate partial duct plugging.

Effective versus ineffective ducting system design

Before you can use the results of your field checks to find the source of plugging problems, it helps to understand what makes a ducting system design effective or ineffective.

Effective versus ineffective design. An effective ducting system serves as a conduit for conveying dust-laden air at low pressures and is designed for natural airflow distribution, requiring minimal use of blast gates (adjustable dampers with a flat plate that slides across the ducting) to achieve balanced airflow. Most designers use standard computer design programs¹ to design a ducting system with balanced airflow.

In contrast, an ineffective, poorly designed ducting system relies primarily on blast gates to force balanced airflow.

With an only marginally correct collection air volume, the poorly designed system invites tampering by operators who attempt to improve airflow distribution by taking a hammer to the blast gates. Such tampering without taking any airflow measurements almost always results in plugging because a change in resistance to airflow will positively or negatively affect all the other ducting system branches and reduce air velocity in the system. As the system fan's performance begins to climb its characteristic pressure-versus-volume curve, the airflow is restricted, causing the airflow to redistribute itself through the ducting system. This gradually spreads the plugging throughout the system.

Common design problems that lead to plugging. Various ducting design flaws can lead to plugging. The flaws commonly include the use of butterfly dampers, undersized and poorly located pickup hoods, ducting without thermal insulation, and low air volume.

Butterfly dampers: Using a butterfly damper in the ducting for air volume control and airflow balancing when the system handles a heavy dust loading (greater than 3 grains per cubic foot) can cause the dust to fall out of the airstream, because the damper's valve plate and shaft partially obstruct the ducting. Using a blast gate for heavy dust loadings can prevent this problem because the blast gate's flat plate completely pulls through the opening, preventing any obstruction. For a heavy-loading application, install the blast gate in a vertical ducting run immediately upstream of the pickup hood.

Undersized and poorly located pickup hoods: If an undersized pickup hood is located at a source of dust-generating turbulence — such as at a transfer chute's end or a bucket elevator's discharge — the resulting dust loading can be



A well-designed dust containment enclosure at the loading zone and properly sized ducting with large pickup hoods make an effective ducting system for this coal-conveying tripper deck.

greater than your dust collection system is designed to handle. You can often detect heavy dust loading by observing the dust collector's operation. For instance, a high but stable ΔP across the collector or a rapid pulse-cleaning cycle can indicate excessive dust loading. If your filter life is short or your system can't meet stack emissions requirements because of the excessive dust loading, moving some pickup hoods and designing them to reduce the entrained dust loading can be cost-effective solutions. For instance, for an enclosed transfer point such as at a conveyor-to-conveyor transfer, you can design the enclosure to function as an extension of the pickup hood. This design allows maximum stilling of the airborne dust before the hood captures it, minimizing the dust load to the collector and allowing the dust collection ducting to provide a mechanical means of controlling airflow.

Ducting without thermal insulation: Ducting that's connected to process equipment or that handles a product that humidifies the air is often not thermally insulated. Whether your plant is located in a cold climate or not, if the humidified collection air's dew-point temperature is greater than the surrounding ambient air temperature, vapor condensation mixed with deposited dust will gradually reduce the ducting's working diameter in the form of concentric rings. Once the fan can no longer maintain a minimum conveying velocity through the restricted ducting, the dust collection system's performance also rapidly deteriorates. This reduced airflow is revealed in increased dust emissions in the transfer chutes and other dust containment enclosures. You can remedy these problems by adding insulation to the ducting.

Low air volume: Often the dust collection system's actual air volume is less than the design volume because of features built into the system that degrade system performance. A common design flaw is a poor ducting entry into



This long, straight fan entry (fan shown at ground level on building's front left corner) is equipped with a radial inlet damper to provide high-efficiency airflow through the baghouse dust collection system.

a centrifugal fan. A poorly designed fan entry can reduce the fan's volumetric capacity by as much as 15 percent, requiring a nearly 40 percent increase in the fan's static pressure rating to compensate for this loss. Such conditions often go undetected because no one bothers to confirm design airflow through the ducting system at installation. An especially poor fan entry that's often used to save space is a mitred inlet box connected to a centrifugal fan without turning vanes; such a box really kills fan performance. If the resulting reduced air volume remains undetected, the reduced conveying velocity will cause the ducting to start plugging again as soon as you've cleaned the last plug out. To remedy this problem, switch to a fan with turning vanes or redesign the fan entry. When specifying your fan and designing the fan entry, refer to *AMCA Publication 201-90: Fans and Systems*² for further details on system effects.

Finding the source of plugging problems

Use the results of your field checks and your understanding of common ducting system design problems to determine why your ducting is plugging. The following list of plugging causes can serve as a checklist for finding your problem's source.

Branch ducting that enters the bottom of the main horizontal ducting run. Heavier dust particles that fall out of the airstream in the horizontal ducting run will eventually plug this branch entry. To solve this problem, raise the branch ducting's entry into the main ducting run.

Branch ducting that enters the main ducting run without an expanding transition, enters at an elbow, or enters at an angle greater than 45 degrees. The airstreams from the branch and main ducting must merge in an expanded transition — a transition in the main ducting that expands at about 15 degrees — to minimize air turbulence and prevent the entrained dust particles from falling out of the airstream and plugging the ducting. Branch ducting that enters at an elbow in the main ducting run or at an angle greater than 45 degrees has no expanding transition. Avoid a branch ducting entry at an elbow, and if the branch ducting must enter the main ducting at an angle, make the angle between 30 and 45 degrees to minimize turbulence.

Two branches entering the dust collector housing. When two branches of ducting enter the collector, it's almost impossible to balance system airflow, and one branch (or both) will become plugged. Solve this problem by running one new branch into the collector and running both original branches into this new branch, outside the collector.

Highly throttled blast gates in horizontal ducting runs. When blast gates in horizontal ducting runs are throttled way down, they create air turbulence that causes dust particles to fall out of the airstream, and this can eventually plug the ducting. To prevent this problem, where possible

locate blast gates in a vertical ducting run and as close as possible to the pickup hood.

Ducting elbows with a short radius. Short-radius ducting elbows, as shown in Figure 1a on the ducting for a baghouse, create more air turbulence, increasing the possibility of plugging. Replace these elbows with long-radius elbows that have a centerline radius of at least 1.5 diameters and, if possible, 2.5 diameters. The long-radius elbow on the main ducting run shown in Figure 1b replaces the

original elbow, reducing air turbulence and the potential for plugging.

Inclined ducting runs. Heavier dust particles entrained in the airstream actually move in trajectories, “bouncing” along horizontal ducting runs. In inclined ducting, these bouncing particles tend to roll back down the incline, eventually causing plugging at the incline’s start. To remedy the problem, you can either replace the inclined ducting with one horizontal and one vertical run (as shown in Figure 1) or increase the air velocity through the ducting system.

Flat, wide, rectangular ducting. Flat, wide, rectangular ducting is commonly used to save space in clean air ducting, such as that in heating, ventilation, and air conditioning (HVAC) systems. But it’s generally not used in ducting systems for conveying dust-laden air because it’s difficult to maintain a uniform air velocity in the rectangular ducting and plugs form more easily in it. Switch to round ducting whenever possible.

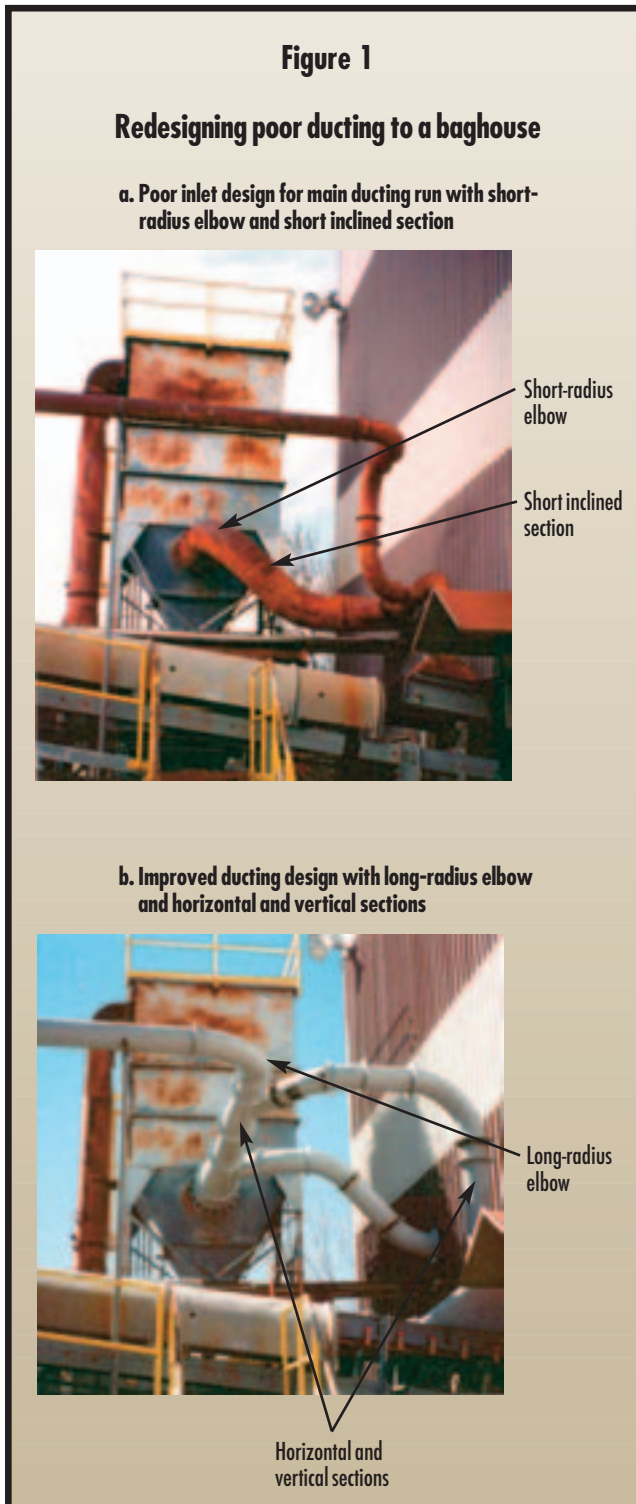
Train your operators and maintenance workers to prevent plugging by keeping the doors shut.

Ducting systems without flow-balancing hardware. When your vertical ducting runs have no blast gates or bleeder valves to control airflow at each pickup hood, you can’t force the air to flow any differently than it naturally would in the ducting system, and thus you can’t balance the system airflow. Solve this problem by adding blast gates and bleeder valves in vertical ducting runs near pickup hoods.

Open inspection doors and cleanout ports. Open inspection doors and cleanout ports reduce the air velocity through the ducting system. Train your operators and maintenance workers to prevent plugging by keeping the doors shut.

Pickup hoods located immediately over dust-generating sources when no dust enclosure is provided. Without a dust containment enclosure (such as a chute or skirting) at a dust-generating source, a pickup hood just above the source won’t be able to effectively capture the heavy dust loading. To solve this problem, install a properly designed dust enclosure at the source or move the pickup hood farther away from it.

Lack of ducting insulation. As discussed in the last section, in some applications poorly insulated ducting can



lead to condensation and material buildup inside the ducting, eventually plugging the duct. If your system has uninsulated ducting that handles moist products, runs from processes that humidify air, or runs from heated to non-heated areas, insulate the ducting. Depending on your ducting system layout, you can typically add the insulation without having to take the dust collection system offline.

Worn, degraded ducting. Worn ducting with dents, holes, or extensive corrosion — or all of these problems — can't maintain air velocity and can lead to plugging. Solve this problem by repairing or replacing damaged ducting runs.

A final word

Remember: Your dust collection system's primary function is to prevent dust from escaping into the environment, *not* to collect dust. This means you need to minimize the amount of dust entrained by the ducting system and cycled to your dust collector, while providing maximum control of dust emissions in your workplace. Treat your dust collection system as the system it is, with one individual or team responsible for its performance, rather than as a collection of parts and pieces designed, supplied, and installed by multiple vendors. When you treat it as a system, your dust collection system can achieve peak performance with minimal maintenance and maximum service life.

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References

1. Several computer design programs for dust collection systems are available; contact the authors for more information about them.
2. Available from Air Movement and Control Association (AMCA) International, 30 West University Drive, Arlington Heights, IL 60004-1893; 847-394-0150, fax 847-253-0088 (www.amca.org).

For further reading

Find more information on dust collection in articles listed under "Dust collection and dust control" in *Powder and Bulk Engineering's* comprehensive article index at www.powderbulk.com and in the December 2003 issue.

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