

Getting the most out of your dust collection system

Rick Kreczmer Camfil Air Pollution Control

Optimizing your dust collection system's performance is critical for your plant's safety and efficiency. In this article, I'll discuss factors you should consider to get the most out of your dust collection system.

Dust collection systems are a major capital investment for bulk solids manufacturers and processors. Understanding the key concepts of dust filtration can help you select the best filters for your application and optimize your system's performance, which will increase the system's overall efficiency and safety, reduce energy use and operating costs, and improve your return on investment.

Pressure drop

The most critical factor to monitor when analyzing dust collection system performance is *pressure drop*. Pressure drop is a measure of a system's resistance to airflow. The ductwork outside of the dust collector has a static pressure drop determined by the duct length, configuration, and other factors. Inside the dust collector, however, the pressure drop is the air pressure differential between the dirty-air side and the clean-air side of the filters. When you buy a dust collection system, your supplier should provide you with a fan performance curve that charts your system's airflow (in cubic feet per minute) as a function of static resistance and indicates the optimal air pressure range for your filters.

During normal operation, the pressure drop across your dust collector's filters will steadily increase as dust builds up on the filter media. As the filters load with dust, the resistance to airflow increases, forcing the system fan to work harder. If your system uses a constant-rate fan, the fan speed will need to be set at a high enough rate to move the required air volume with the filters fully loaded with dust. This means that when the filters are clean or only slightly loaded with dust, the fan will be moving more air than necessary, which wastes energy and causes excess wear to the filters. A

variable-frequency drive can solve this problem by automatically adjusting the fan speed to suit the pressure drop and maintain the desired airflow.

Pulse-jet cleaning

A typical dust collection system has a pulse-jet cleaning system that periodically cleans the filters during operation to extend their usable life. A pulse-jet cleaning system uses short bursts of compressed air directed at the filters' clean side, counter-current to the dust collection system airflow, to dislodge accumulated dust from the filter media. The dislodged dust then settles to the bottom of the dust collector hopper and is discharged.

To thoroughly clean the filters, the system should use clean, dry air compressed to between 90 and 100 psi. Pressure lower than that may not effectively clean the filters, and pressure higher than the recommended range may stress, tear, or damage the filter media. The amount of compressed air required will vary depending on the filter design.

The compressed air supply should be kept at a dew point of -35°F or condensation may form in the compressed air line. Water or oil in the compressed air will be absorbed by the filter media and will mix with the dust, increasing pressure drop, decreasing filter performance, and possibly causing the filter media to fail. The compressed air line should also be equipped with a manual shut-off valve, a filter-separator, an air regulator, and a pressure gauge, all located close to the dust collector.

Efficient pulse-jet cleaning can lower the dust collection system's energy and maintenance costs, while overcleaning the filters can cause higher emissions, shorter filter life, and higher energy costs due to overuse of compressed air. To ensure efficient cleaning, the system operation must be optimized to suit the dust type and the filter design.

Many cleaning systems allow the operator to select either *continuous* or *on-demand* cleaning, depending on the application. With continuous cleaning, the

cleaning system turns on and off at regular preset intervals. This is suited for porous dusts such as silica and other minerals, high dust-loading applications such as thermal spray or plasma cutting, or lightweight dusts such as fumed silica or paper fines. Most other dust types work well with on-demand cleaning in which the cleaning system monitors the pressure drop across the filters, activates the pulse-jet cleaning when the pressure drop reaches a preprogrammed high setpoint, and turns off the pulse-jet cleaning when the pressure drop reaches a preprogrammed low setpoint.

On-demand cleaning allows you to operate the dust collector in a very narrow pressure drop range. This uses less compressed air than continuous cleaning and optimizes filter cleaning efficiency and filter life. Note that the on-demand settings will need to be adjusted occasionally to compensate for a slow but continual rise in the “clean” pressure drop value as more and more dust particles become embedded in the filter media over the life of the filters.

Mechanisms of filtration

A dust collector separates airborne dust particles from the airstream using one or more of the basic mechanisms of filtration. The five main filtration mechanisms are:

Straining-sieving. Straining or sieving occurs when the openings between the filter media members (such as fibers, screen mesh, or corrugated metal) are smaller than the diameter of the airborne particles. This mechanism occurs with most filter designs and is entirely dependent on particle size and media spacing and density.

Inertial separation. Inertial separation uses a rapid change in air direction and the principles of inertia to separate the dust particles from the airstream. This principle is normally applied when there is a high concentration of coarse particles and is often used as a prefiltration mode upstream from higher-efficiency filters.

Interception. Interception occurs when a particle makes contact with the filter media and becomes attached.

Diffusion. Diffusion occurs when the random motion of a particle in the airstream causes it to contact a fiber. The greater the surface area of the filter media, the greater the chances of particle capture.

Electrostatic attraction. Electrostatic attraction is typically used by filters with large-diameter fiber media

to increase the filter’s efficiency at capturing fine particles. Large-fiber media is normally chosen due to low cost and low airflow resistance but is generally not very efficient at capturing fine particles. Adding an electrostatic charge to the fibers improves dust capture, but this benefit often fades over time as captured particles occupy the charged sites on the fiber surfaces and neutralize the electrostatic charge.

Filter media

Pleated cartridge filter media is typically made from either a nonwoven cellulosic blend or a synthetic polyester or polyester-silicon blend. The choice is usually driven by dust type, operating temperatures, and the amount of moisture in the process. Nonwoven cellulosic blend media is the most economical choice for dry dust collection applications at operating temperatures up to 160°F (71°C). Synthetic polyester or polyester-silicon blend media is lightweight and can handle dry applications with maximum operating temperatures ranging from 180°F (82°C) up to 265°F (129°C). Both media types are washable and can recover from a moisture excursion, but they aren’t intended for wet applications.

These base media materials can also be treated in a number of ways to improve performance or suit certain applications. Filter media treatments include:

Nanofibers. A nano coating, or layer of nanofibers applied on top of the filter’s base media, promotes surface loading of fine dust and prevents the dust from penetrating deeply into the base media. This translates into better dust release during cleaning cycles and lower pressure drop readings, which can increase filter life and save energy.



Open- or wide-pleated filters allow collected dust to easily release from the filter media during pulse-jet cleaning.

Flame-retardant treatment. Standard and nano filter media can also be treated with a flame-retardant chemical compound for applications where there is a fire or explosion risk.

Antistatic media. Conductive or antistatic filter media may be used in applications where the conveyed dust may generate a static charge that requires dissipation. Typically, antistatic properties are achieved by impregnating a cellulose filter media with a carbon coating or a synthetic filter with an aluminized coating or carbon grid. Applications for antistatic filters include fumed silica dust; plastic, PVC, or composite dusts; and carbon black or toner dusts. Antistatic filter media can also be helpful in achieving NFPA compliance in explosive dust applications because the filter reduces the risk of static electricity igniting the airborne dust particles.

With any filter media, an open- or wide-pleat design, where the filter pleats aren't packed tightly together, will provide more efficient airflow through the filter and allow the collected dust to more easily release from the filter media. Tightly packed pleats increase the filter's resistance to airflow and prevent the pulse-jet cleaning system from ejecting all of the dust that's accumulated between the pleats.

A wide-pleat filter may contain less total media surface area than a filter with tightly packed pleats, but the entire surface area is usable. Wide-pleat filters will often require less compressed air for cleaning than tightly packed filters because the greater amount of *usable* surface area allows the filter to hold more dust before needing to be cleaned. Some wide-pleat filters use synthetic-bead pleat separators to keep the pleats open and prevent the media from folding over on itself, which causes the filter to plug.

Dust characteristics

The best filters for your application will largely be determined by your dust's characteristics. Having samples of your dust tested by a lab can help you make an informed decision on the right cartridge filters and media to mitigate dust hazards and optimize your system's efficiency. Available tests include:

Particle size analysis. A particle size analysis helps you determine the filtration efficiency required for your dust to ensure that your system meets emissions standards.

Video microscope. A video microscope provides a visual analysis of your dust's particle shape and other



Having your dust tested will help ensure that you select the right filters for your dust collection system.

physical characteristics, which are key to proper filter selection.

Pycnometer. A pycnometer determines the dust's true *specific gravity*, which is the ratio of the density of the dust to the density of water. Knowing your dust's specific gravity can help you determine the efficiency of various cyclone dust collector designs.

Moisture analysis. Moisture analysis identifies your dust's hygroscopicity, or tendency to absorb moisture. Hygroscopic dusts tend to be sticky and can clog certain types of filters, so this characteristic is essential for selecting effective filter media.

Abrasion testing. Knowing your dust's relative abrasiveness helps determine potential wear to the filters as well as the optimal design and construction materials for other components of your dust collection system, such as valves, inlets, and ductwork.

Explosibility testing. Explosibility testing determines whether your dust is combustible and to what degree, which helps to determine whether your application requires conductive filters.

Meeting emissions requirements

Make sure your filters enable your facility to meet federal, state, and local emissions regulations. Failure to comply with emissions requirements may risk the health and safety of workers, cause production shutdowns, and result in fines or even litigation. Ask your dust collector supplier to provide a written guarantee stating the system's maximum emissions rate.

Note that filter efficiency stated as a percentage isn't an acceptable substitute for maximum emissions rate, even if the supplier promises 99.9 percent efficiency. OSHA only cares that the amount of dust in the air is below the permissible exposure limits established for hundreds of dusts ranging from nonspecific, or "nuisance" dusts, to highly toxic substances.

The recently published *ANSI/ASHRAE Standard 199-2016: Method of Testing the Performance of Industrial Pulse Cleaned Dust Collectors*,¹ is designed to help manufacturers that produce dust to evaluate collection equipment with much greater accuracy. The test measures four key performance parameters: emissions, pressure drop, compressed-air usage, and emission reading.

Before this standard was enacted, there was no appropriate test standard to measure the effectiveness of dust collectors and filters, so manufacturers couldn't

get the data required for apples-to-apples comparisons of how different dust collector designs and filter options would affect factors such as emissions and energy consumption. **PBE**

References

1. Available at <https://webstore.ansi.org/>.

For further reading

Find more information on this topic in articles listed under "Dust collection and dust control" in *Powder and Bulk Engineering's* article index in the December 2016 issue or the Article Archive on *PBE's* website, www.powderbulk.com. (All articles listed in the archive are available for free download to registered users.)

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