WHITE PAPER

How to Select Dust Collector Filters That Reduce Operating Costs

Today's concerns about cost control, strict air quality standards and combustible dust regulations make it more important than ever to select the best dust collector filter for your application. This white paper reviews the general types of filter media and offers tips on selecting the best filters to achieve cost savings, operating efficiency and compliance.

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AIR POLLUTION CONTROL

Most of today's dry industrial processing applications use cartridge-style dust collection systems, but there are many different types of filter cartridges that fit these systems. It's more important than ever to choose the best dust collector filter for your process because of tighter cost controls and more strict air quality and combustible dust regulations.

Making an informed choice can improve your collector's dust capture efficiency and reliability while reducing energy and maintenance requirements.

Types of Filter Media

There are two basic categories of media commonly used in pleated cartridge filters. The choice of which to use is driven mainly by dust type, operating temperature, and the level of moisture in the process. Below details the two and treatments that can enhance their performance:

1) "Cellulose" or nonwoven cellulosic blend: This media is the most economical choice for dry dust collection applications with operating temperatures up to 160 °F (71 °C). The media fibers can be treated with a resin or coated with a material to provide moisture resistance, but cellulose media is not as resistant to moisture as synthetic polyester media.

Base media with nano fiber coating

2) "Spunbond" or synthetic polyester media or polyester-silicon blend: This lightweight, washable media can handle dry applications with maximum operating temperatures ranging from 180 °F (82 °C) up to 250 °F (121 °C). These filter cartridges are washable and can recover from occasional moisture, but they aren't intended for wet applications.

Both cellulose and spunbond media can be treated with a layer of nano fibers or polytetrafluoroethylene (PTFE) to boost filter efficiency and provide other benefits. Nano fiber and PTFE filter technology has advanced in recent years, and the latest generations can even perform exceptionally well in the most extreme conditions.

Base media with no coating

When PTFE coatings or nano fibers are applied on top of cellulosic or polyester base media, the coating promotes surface loading of fine dust. This prevents the dust from penetrating deep into the filter's base media and provides superior dust release during the pulse-cleaning cycles. Keeping dust from penetrating deep also keeps pressure drop readings lower through the life of the filter, which uses less energy and enables the filters to last longer.

Standard and coated filter media can also be treated with compounds that deliver special performance properties like flame retardance and conductivity.

Flame-retardant filters – These filters are used in applications where there is a risk of fire or explosion such as plasma and laser cutting, grinding or welding and other metalworking processes. The base cellulose media is saturated in a resin containing fire-retardant chemicals, creating a flame resistant media.

Conductive or antistatic filters – These filters are used in applications where conveyed dusts generate static charges that require dissipation. Most commonly, a cellulose filter is impregnated with a carbon coating, or a synthetic filter is coated with an aluminized material. Applications for these filters include fumed silica dust; plastic, PVC or composite dusts; and carbon black/toner dusts.

Cartridge filters with antistatic media can also be used in explosive dust applications to conform to NFPA requirements and lessen the risk of ignition sources from static electricity charges. In combustible dust applications where the minimum ignition energy of the dust is below 3 millijoules (mJ), the NFPA requires that conductive filters be used that are bonded and grounded to the filter housing.

5 Tips for Selecting Dust Collector Filters

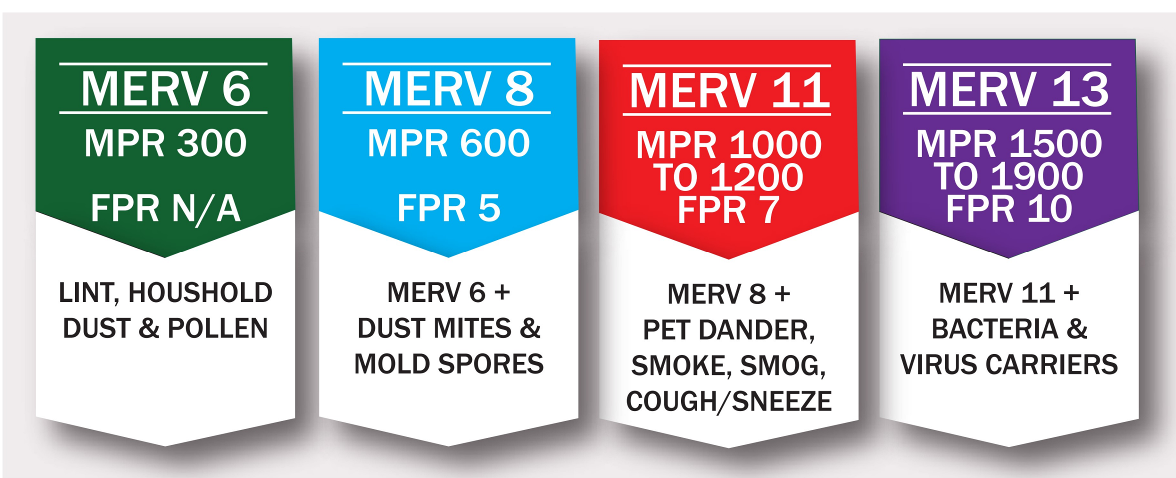
As discussed above, determining the best filter for your application will help you reduce costs, improve operating efficiency, and enable you to achieve air quality compliance. Here are some tips to keep in mind when selecting the proper filter.

1. Understand the different methods of measuring filter efficiency.

Gravimetric analysis, MERV ratings and mass density efficiency are the three methods that dust collector filter manufacturers typically use to express filter efficiency.

Gravimetric analysis examines the weight of the dust particles. For example, filter efficiency might be stated as 99.995% on particles that weigh 0.5 µm or more.

Minimum efficiency reporting value (MERV) reports efficiency using a scale from 1 to 16, with MERV 16 being the highest efficiency. The MERV scale was developed by ASHRAE (American Society of Heating, Refrigeration and Air Conditioning Engineers) for the HVAC filter market, but it is less useful for analyzing dust collector filters that have constantly changing dust buildup. Dust collectors pulse-clean filters each time a dust cake builds up, which changes their efficiency. The filter's efficiency reading before and after a pulse-cleaning are very different though their MERV value remains constant.



Though MERV and gravimetric efficiency ratings are useful tools for comparing filters, don't rely on them solely to determine efficiency. It is more relevant to make sure you are satisfying OSHA or EPA requirements for filter performance. OSHA requirements are important if you are discharging the air and recirculating it indoors downstream of the collector. EPA requirements are important if you are discharging the air outside into the environment.

Mass density efficiency, defined as the weight per unit volume of air, is the best predictor of a filter's OSHA compliance. For example, OSHA might require that emissions will not exceed 5 milligrams per cubic meter at the dust collector's discharge point. Similarly, the EPA doesn't care about percentage efficiency claims; they want to know that emissions will be at or below required thresholds. These thresholds are typically stated as grains per cubic foot or milligrams per cubic meter.

In 2016, ASHRAE adopted a test standard for measuring the performance of dust collector filters. This test standard subjects the filters to dust loading, pulse-cleaning and emissions data that applies to OSHA and EPA regulations. This "real-world data" is a valuable tool in determining which dust collector filters comply with safety and environmental requirements.

Most users are concerned about which efficiency measure(s) to use, but there is a simple way to cut through the confusion and cover your bases. Require your filter supplier to provide a written performance guarantee that states the filters satisfy applicable OSHA or EPA requirements.

2. Test your dust.

For many years, manufacturing professionals have tested samples of dust to provide the data needed make informed decisions about dust collector filters. While dust testing has always been good practice, it is rapidly becoming a necessity in today's regulatory climate.

There are two types of dust testing: bench testing, which pinpoints physical properties of the dust, and explosibility testing, which determines whether a dust is combustible.

Bench testing uses a series of tests that provide valuable data for filter selection.

- *Particle size analysis* reveals the dust's particle size distribution down to the submicron range to determine the filtration efficiency needed to meet emissions standards. This test pinpoints both the count (the number of particles of a given size) and the volume or mass spread of the dust. Knowing both is important because many dusts are mixed.

Bench testing identifies physical properties of the dust, aiding filter selection.

- A *scanning electron microscope* provides visual analysis of the dust shape and characteristics. For example, close inspection will reveal if the dust has a crystalline structure with jagged edges like fumed silica particle or a spherical structure like a metal particle. The microscope can also be used for an elemental analysis, which detects the presence of oil in the dust, changing the filter media recommendation.
- *Moisture analysis* equipment measures a dust's moisture percentage by weight. This information can prevent moisture problems. A *humidity chamber* is used to see how quickly a dust will absorb moisture. Hygroscopic (moisture-absorbent) dust can be sticky and cause filters to plug, so this type of dust might require widely pleated filter cartridges.

Additional bench tests can help determine the optimal design of other dust collection system components. Bench testing isn't always required, but it is highly recommended if there is anything at all unusual about the process and/or the dust.

Explosibility testing determines whether a dust is combustible.

Dust should undergo separate explosibility testing as stated in NFPA Standard 68. If a dust sample is not available, it is permissible to use an equivalent dust (i.e., same particle size, etc.) in an equivalent application to determine combustibility. But once a dust sample becomes available, you should go back and test the dust using either the 20-liter test or $1m^3$ methods described in ASTM E1226-12a or the similar method described in ISO 6184/1.

Using your dust sample, the lab will start with a screening test to determine whether the dust is combustible. If it isn't combustible, testing will stop there. If it is combustible, the lab will conduct further testing on dust cloud parameters to pinpoint the Kst value (defined as the deflagration index of a dust cloud, or rate of pressure rise) and Pmax value (the maximum pressure in a contained explosion).

An engineered test is performed at an official testing facility to confirm that the dust collector can withstand an explosive event.

Explosibility testing determines the explosion protection equipment required for your dust collector, but it can also help with filter selection. For example, testing for the minimum ignition energy can help determine if conductive filters are needed.

3. Evaluate total cost of ownership.

Just because two filter cartridges have the same efficiency rating does not mean they will perform equally. Filter cartridges are not a commodity purchase that should be decided by lowest price. Initial cost is only one factor, and it is not the most important factor in determining the true cost of using one filter versus another. Filter selection requires a "Total Cost of Ownership" (TCO) evaluation.

TCO calculates the total cost of energy, consumables, maintenance and disposal over the life of the filter. Reputable filter suppliers have software to help you perform the calculations. The TCO evaluation will ultimately save you money, time and energy.

The ISO Standard 199 test also aids TCO calculations, so it's ideal to work with a filter manufacturer that has a Standard 199 test rig. That way, they can test different brands and types of filters to compute energy consumption and filter life.

Dust Collector Filter Total Cost of Ownership - Sample Data Collection Worksheet	
How many days will the system operate per year?	365 days
How many hours will the system operate per day?	24 hours
What is the volume of air required to operate the system?	10,400 cfm
How much does a kilowatt-hour cost?	$0.10 per kWh
What is the cost of no production for one hour?	$500
What is the cost of Filter A (conventional-pleat filter)?	$90
What is the cost of Filter B (open-pleat filter)?	$120
How many filter cartridges are in the dust collector?	16
What is the shipping cost per filter?	$10
What is the labor and overhead rate for one hour?	$80
How much does it cost to dispose of a filter?	$10
How much does a variable frequency drive (VFD) cost?	$2600
What is the current interest rate?	4.5%
How many minutes does it take to change Filter A?	10 minutes
How many minutes does it take to change Filter B?	5 minutes
Will there be a VFD operating the system?	Yes

4. Consider coated or treated media even if you don't have "difficult" dust.

When they were first introduced, coated media like nano and PTFE were regarded as high-end choices limited to exotic or demanding dust capture challenges. Though these media carry a cost premium, they are now more widely used. Today's plant managers and engineers better understand the advantages of coated media over standard media:

- Higher filtration efficiencies
- Better energy performance
- Superior cleanability
- Greater resistance to wear and tear from pulse-cleaning

As a rule of thumb, select nano fiber media if your application requires high initial filtration efficiency and better dust release through surface loading. Select PTFE-coated media for applications that require higher efficiency and improved dust release properties.

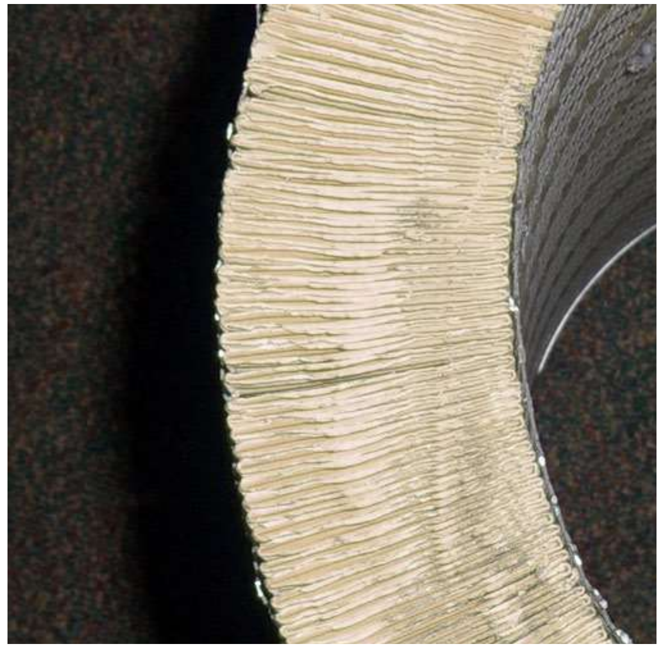
Beyond this, even for a "low-performance" application, a TCO analysis is useful to determine if the added cost of nano fiber media will be offset by savings in energy, filter change-out and disposal costs. For example, in a system operating at very high airflow, reducing pressure drop a half-inch using a coated media filter can make a huge difference in energy consumption.

5. Look for a uniform open pleat media design.

When it comes to media, more is not necessarily better. Many filter manufacturers add filter media to each cartridge so they can report a higher square footage of media. But often the pleats have to be tightly packed to fit more media in the same space. Many users don't realize that his configuration negatively effects dust collector performance. When dust gets between tightly-packed pleats, the reverse pulse cleaning system of the dust collector can't eject the dust. Air resistance increases, which reduces airflow through the fibers.

The key is to use an open pleat where 100 percent of the media is usable. An open-pleat filter allows the collected dust to release from the filter, keeping the resistance lower through the filter for a longer time. Some open-pleat filters use state-of-the-art technology that place synthetic bead pleat separators on the pleat tips to ensure they stay open for the best dust release possible. These separators prevent the media from folding over on itself, which could cause the filter to plug.

An open-pleat filter will often contain *less* total media area than a tightly pleated model, but this doesn't contribute to the filter effectiveness. The total square footage of the media is not what you want to look for. Instead look at the total *usable* media area that's really important.

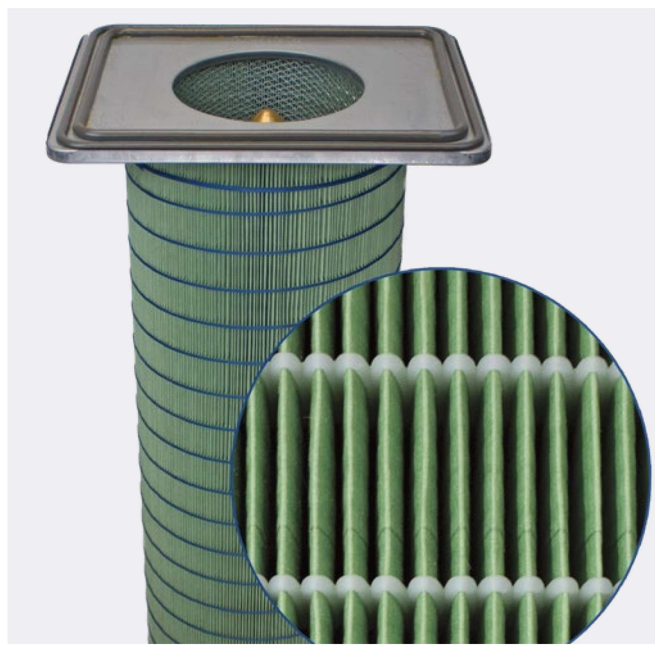


Tightly pleated filter tends to trap dust within the pleats.

About the author:

Randi Huckaby is Product Manager - Dry Filtration for Camfil APC Global. She has been with Camfil for more than five years, working in operations and R&D. She previously worked with Thomas & Betts/ABB. She has a BS in Mechanical Engineering & MBA from Arkansas State University.

Camfil APC (**www.camfilapc.com**) is a global manufacturer of dust, fume and mist collection equipment and is part of Camfil, the largest air filter manufacturer in the world. For further information, contact (800) 479-6801 or (870) 933-8048, e-mail **filterman@camfil.com**, or visit **www.camfilapc.com**.



Open-pleat media allows the collected dust to release from the filter, keeping the resistance lower through the filter and extending filter life. Exploded view shows internal pleat separation technique.