Choosing the right cartridge filter: What you should know about media types and filter construction

Ensuring that your cartridge dust collector performs as expected begins with selecting the right media and construction for your pleated cartridge filters. After reviewing some filter media basics, this article compares performance characteristics and costs for common media types and describes filter construction options that allow you to customize the filters for your application.

By choosing the proper cartridge filter media and filter construction for your application, you can keep your dust collector running efficiently and energy-smart. Making the right filter choice can cut your dust collection system’s fan (or blower) energy consumption and filter-cleaning compressed-air usage, extend your filter life, and reduce the collector’s total ownership cost.

However, choosing a filter that can handle your operating conditions and dust characteristics is complicated not only by the many available media types and filter construction options, but by all the variables affecting your application. For instance, your process’s operating hours, the dust load volume entering the collector, your dust’s particle size and shape, and whether the dust is hygroscopic, sticky, fibrous, abrasive, corrosive, toxic, flammable, or explosive all will affect your filter choice.

Some filter media basics
Before we discuss common media types, let’s review some fundamentals that will help you compare media performance and costs.

How pressure drop affects media life and energy costs. Pressure drop (or pressure loss) is the resistance to airflow through the media (also considered the lost energy required to move air through the media). The higher the pressure drop across the media, the more energy (that is, fan horsepower) required to maintain the design airflow rate through the collector. To provide adequate air exhaust volume through the dust collection system’s capture hoods, the airflow through the collector must overcome the clean media’s initial pressure drop plus the additional pressure drop caused by the dust cake building up on the media. For this reason, lower pressure drop over the filter’s life cuts the energy cost of operating the overall dust collection system.

How a media handles dust loading. A filter media can be depth-loading or surface-loading. A depth-loading media has larger spaces (pores) that allow dust particles to penetrate deep into the media substrate. As particles build up within the substrate, the pressure drop across the media increases. To overcome this additional pressure drop and maintain the correct airflow volume through the dust collection system, the fan will require more horsepower, increasing energy use, and the collector’s filter-cleaning system will have to cycle more frequently. The cleaning cycles will also be less effective because the particles are lodged deep within the media substrate. Choosing a depth-loading media generally leads to a shorter filter life and higher collector operating costs.

A surface-loading media has a layer or barrier on its surface that prevents dust particles from penetrating into the media substrate. Because the particles are kept on the media surface, the media pores are open longer, resulting in lower pressure drop and lower energy consumption. Surface loading also allows the cleaning system to more effectively dislodge the collected particles from the media with fewer cleaning cycles and, thus, less compressed air. The lower pressure drop and improved cleaning properties

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of a surface-loading media lead to longer filter service life and lower filter replacement costs, with less collector downtime, than for depth-loading medias.

**How media efficiency is measured.** Filter media efficiency is a measure of how much dust the media removes as dust-laden air flows through it. This simple concept can be represented in many ways, most commonly as fractional efficiency, which is the number of dust particles removed, and mass efficiency, which is the total mass of dust particles removed. Both methods can be useful when considering media efficiency for your application.

Filter efficiency is sometimes misrepresented as being higher (such as “99.9+ percent”) than the media alone can achieve. But these higher numbers likely designate the filter’s mass efficiency while the collector is operating. This operational efficiency includes the efficiency benefit provided by dust particles building up on the media surface. Be aware that looking only at operational efficiency may not provide an accurate measure of how well the media matches your needs.

A better measure of media efficiency that isolates the media performance from operational efficiency is the Minimum Efficiency Reporting Value (MERV) rating system, derived from ASHRAE Standard 52.2-2007: Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.

A MERV rating measures the media’s fractional efficiency across three particle size ranges and then assigns the media a composite rating based on the total results. The higher the MERV rating, the more efficient the media is at removing particles in smaller size ranges. For instance, a media with a MERV rating of 9 is ineffective for particles from 0.3 to 1.0 micron, captures less than 50 percent of particles from 1 to 3 microns, and captures a minimum of 85 percent of particles between 3 and 10 microns, while a MERV 16 media collects a minimum of 95 percent of particles in all three size ranges.

**How a media is affected by operating conditions.** To select a media, consider its ability to withstand a wide range of operating conditions that may reduce filtering efficiency or shorten filter life. These operating conditions include a high airstream temperature, moisture or oil in the collected particles, condensation from a moisture-laden airstream, the impact of abrasive particles on the media surface, frequent filter-cleaning cycles, and others.

**How media costs can be evaluated.** Evaluate the media costs in terms of your filter lifecycle cost, which is a combination of the filter’s initial cost, the cost of maintenance labor and downtime for filter changeouts, and both fan energy and filter-cleaning compressed-air costs over the filter’s life. By looking at each of these component costs, you’ll have a more complete picture of the media’s true value.

**Common media types for pleated cartridge filters**

Use the following information about the most commonly used cartridge filter media types and their performance characteristics to help narrow your media options. Table I lists each type’s MERV rating, along with the media’s relative performance characteristics (including dust-release properties, durability, and pressure drop) and initial and lifecycle costs. Figure 1 provides a magnified view of each media.

**Cellulose and cellulose blend.** These depth-loading medias are available in 100 percent cellulose or a blend of cellulose with, most often, polyester (Figure 1a). They have a low efficiency rating (MERV 8 to 10). Both types — particularly the 100 percent cellulose media — have low resistance to abrasion and moisture. They’re typically used in low-cost commodity-grade filters with a short service life, which gives them a relatively high lifecycle cost.

**Spunbonded polyester.** This depth-loading all-synthetic media (Figure 1b) is 100 percent polyester. It has better dust-release properties than cellulose medias and an average MERV rating (from 10 to 11). While it has the same

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### Table I

<table>
<thead>
<tr>
<th>Media</th>
<th>MERV rating</th>
<th>Dust-release properties</th>
<th>Durability</th>
<th>Pressure drop</th>
<th>Relative costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cellulose blends</td>
<td>8 to 10</td>
<td>Poor</td>
<td>Poor</td>
<td>Very high</td>
<td>Low</td>
</tr>
<tr>
<td>Spunbonded polyester</td>
<td>10 to 11</td>
<td>Average</td>
<td>Good</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Nanofiber</td>
<td>13 to 15</td>
<td>Excellent</td>
<td>Good</td>
<td>Low</td>
<td>Moderate</td>
</tr>
<tr>
<td>ePTFE</td>
<td>16</td>
<td>Excellent</td>
<td>Good</td>
<td>Very high</td>
<td>Moderate</td>
</tr>
</tbody>
</table>

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shorter filter life as cellulose medias, spunbonded polyester is the most commonly used media in dust collectors because it’s strong and resists abrasion and moisture. The media has a relatively high initial cost but moderate lifecycle cost.

Nanofiber. This surface-loading media (Figure 1c) consists of an ultrathin (0.07- to 0.15-micron) layer of synthetic nanofibers applied to a substrate. The nanofiber layer works like a shield to prevent submicron particles from embedding within the substrate, giving this media excellent dust-release properties and a high MERV rating (from 13 to 15). The media’s durability depends on the substrate material, which can be either cellulose or polyester. The nanofiber media’s initial cost falls between that for cellulose and spunbonded polyester medias, but its better performance and moderate lifecycle cost provide a good performance-versus-cost balance.

ePTFE membrane. Another surface-loading media is expanded polytetrafluoroethylene (ePTFE) membrane media, which consists of an ePTFE membrane stretched over a spunbonded polyester substrate. (PTFE is also known as Teflon.) Like the nanofiber layer on a nanofiber media, the ePTFE membrane (Figure 1d) shields the substrate so particles can’t become embedded in it. This media has a very high efficiency rating (MERV 16) and strongly resists abrasion and moisture. Because ePTFE membrane filters have a higher initial cost than those made of other medias, an ePTFE membrane media is typically used only when an application requires it.

Common filter construction options

Once you’ve selected the media for your cartridge filters, you need to choose the filter construction options that will help your filters handle your dust and process conditions. The following information describes the most common construction options and how they impact filter performance.

Pleat spacing. The distance (or air gap) between adjacent filter pleats is called pleat spacing. Because synthetic medias are relatively rigid, they produce wider pleat spacing than more flexible cellulose-based medias. The tighter the pleat spacing, the harder it is to release the dust during filter cleaning, making wider pleat spacing good for handling irregularly shaped dust particles and agglomerative dusts. However, wider pleat spacing also reduces the total media surface area, limiting airflow through the filter and increasing the pressure drop.

Pleat depth. How deep a filter pleat is from its outer fold (the tip) to its inner fold is called pleat depth. All other filter properties being equal, a smaller pleat depth will release dust more effectively than a larger depth. However, the pleat depth must be balanced with pleat spacing because the deeper the pleat, the tighter the pleat spacing becomes.
As with wider pleat spacing, a smaller pleat depth reduces the total media surface area, reducing airflow through the filter and increasing the pressure drop.

**Outer liner.** Most cartridge filters come standard with an expanded metal (or perforated metal) outer liner to protect the pleated media from abrasion and other damage. For an application handling stringy, large dust particles or agglomerative dusts, choosing filters without this liner will provide more effective dust release during filter cleaning.

**Flame-retardant treatment.** For an application collecting combustible dust, the filter media can be treated with a flame-retardant chemical to inhibit combustion. While the dust cake on the filter will still be combustible, the flame-retardant treatment will assist in controlling a fire, should one occur.

**Hydro-oleophobic treatment.** The filter media can be treated with a hydro-oleophobic polymer for an application collecting dust from a moist or oily airstream. This treatment will inhibit the media’s absorption of moisture and oil.

**High-temperature construction.** For an application handling a high-temperature airstream, the filter’s construction materials may have to be upgraded. In this case, the filter may require not only heat-resistant media, but heat-resistant gaskets, liners, and glues or potting compounds.

**Antistatic options.** In an application handling statically charged dust particles, static forces can bond to the media fibers and inhibit dust release during filter cleaning. Using an antistatic grounded media (such as one impregnated with carbon or conductive fibers) or a filter cage with a grounding wire can help dissipate residual static charge from the filter to aid dust release.

**Working with the supplier**

Your filter or dust collector supplier can help you make sense of the wide array of available media types and construction options for your pleated cartridge filters. Work closely with the supplier to review the available choices in terms of your application requirements. Based on years of experience with hundreds of dust collection applications in bulk solids plants, the supplier can use your application information to ensure that the media and filter construction features you select will handle your process’s operating conditions and dust characteristics.

Most of all, the supplier can help you choose cartridge filters that meet your unique performance expectations, whether for a minimum filter life or a reduction in your dust collection system’s fan and compressed-air operating costs.

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**Reference**


**For further reading**

Find more information on cartridge filters and media types in articles listed under “Dust collection and dust control” in *Powder and Bulk Engineering*’s article index (in the December 2012 issue and at PBE’s website, www.powderbulk.com) and in books available on the website at the PBE Bookstore. You can also purchase copies of past PBE articles at www.powderbulk.com.

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