Companies expect higher efficiency, lower operational cost, and longer cartridge filter life from their dust collection systems. Nanofiber and expanded polytetrafluoroethylene (ePTFE) membrane are two surface-loading media technologies that are widely used in the industrial marketplace today. This article compares the two filter media technologies, reviews how each affects dust collector operation, and summarizes how each filter media technology should be applied.

Selecting the appropriate filter media technology for industrial air pollution control applications can often be a challenge. A stringent regulatory environment, combined with industries seeking operating expense reductions, has created a need for advanced filtration solutions capable of meeting these requirements. The two filter media technologies that are best equipped to meet advanced environmental regulatory requirements are nanofiber and ePTFE (expanded polytetrafluoroethylene) membrane technology. While sometimes presented or perceived as equivalent solutions, important differences exist between the performance characteristics and corresponding value that each offers.

Comparing nanofiber and ePTFE technologies

Nanofiber filter technology is an extremely fine, continuous filament of polymer fibers uniformly deposited and bonded to a filter media substrate through an electrospinning process. The applied layer thickness ranges between 0.1 and 0.5 microns (µm, 10^-6 m), with the diameter of the deposited fibers ranging between 50 and 300 nanometers (nm, 10^-9 m). These fibers, which are so small that they cannot be seen with the naked eye, are more than 1,000 times smaller in diameter than a human hair. For dust collection applications, cellulose or polyester-based materials are most commonly used as the substrate or base sheet.

ePTFE membrane technology is also a fine surface layer that features bonded PTFE fibers laminated onto a filter media substrate. The layer is created by stretching a PTFE membrane bi-directionally until an approximate thickness of 2.5–5.0 microns (µm) is achieved. The stretching process results in fiber diameters ranging between 50 and 500 nanometers (nm). This membrane is then laminated to the filter media substrate through the use of heat and pressure. ePTFE membranes are applied to polyester media substrates when used in dust collector applications.

Figure 1 shows scanning electronic microscope (SEM) images of each technology and illustrates the difference in fiber geometry and thickness of each surface layer. Notice how the nanofiber fibers are more consistent in diameter and more uniformly applied to the substrate. The images also illustrate the greater depth or thickness of the ePTFE layer.

How nanofiber and ePTFE achieve superior performance

Nanofiber and ePTFE membrane technology each provides a higher level of efficiency, reduced operating pressures, and extended filter life compared to commodity filter media. On its own, the pores of commodity filter media substrate are easily plugged, even under normal operating conditions. The surface layer with fine fiber deposition significantly reduces the pore size, capturing the particulate as it passes through the filter. This mechanical barrier also prevents particulate from embedding itself within the filter substrate depth, allowing the dust collection system to stabilize at a lower pressure drop. This drop in pressure results in less horsepower and lower energy costs.

Surface loading also allows the dust collector reverse pulse jet filter cleaning systems to work much more effectively. Because dust accumulates on the surface
of both nanofiber and ePFTE membrane filters, rather than within the media depth, less energy is required to dislodge the particulate from the media’s surface. This significantly reduces the number of cleaning cycles required to maintain a pressure drop, which translates to less compressed air usage, lower emissions, and extended filter life.

Both the fiber diameter and layer thickness affect the degree to which the above benefits are realized. Generally speaking, as fiber diameter decreases, increased levels of efficiency can be achieved with a minimal impact on media pressure loss. As layer thickness decreases, less energy is needed to move through the layer, resulting in lower pressure loss.

The difference between nanofiber and ePTFE

While nanofiber and ePTFE share several key performance benefits essential to optimal dust collector performance, the technologies differ in their performance and application. When these technologies are tested to ASHRAE 52.2 standards at equivalent conditions, the ePTFE cartridge has significantly higher pressure drop and lower dust-holding capacity, but it maintains a high level of efficiency. These results are due, in part, to the fact that industry standard dust collector cartridges using nanofiber typically contain up to 50 percent more filter area than the equivalently sized ePTFE versions. The following discussion focuses on how these results affect overall dust collector operation.

**Filter area.** The nanofiber layer is thinner and is applied to more flexible substrate allowing the filter media to be constructed in a manner that has additional filter area. In contrast, the reduced filter area means that ePTFE filters are often sized for more airflow per filter area (air-to-media ratio), resulting in higher operating pressures. If comparable air-to-media ratios were used, the system size or number of filters would be much larger than dust collection systems using nanofiber filters.

**Efficiency.** ePTFE membranes achieve a higher Minimum Efficiency Reporting Value (MERV) rating than nanofiber filters. This means that, once out of the box, ePTFE filters will be able to collect a higher percentage of submicron particulate. Higher MERV ratings would be beneficial in critical applications in which exceptionally high efficiency levels are required upon start-up. Once the initial dust cake develops on the filter surface, operational efficiencies in excess of 99.9 percent will be achieved by both technologies. It is important to note that the initial efficiency or MERV rating is not an accurate way to evaluate the overall potential for total system emissions, because operating pressure and pulse cleaning frequency both significantly influence total system emissions.

**Pressure drop.** The much thinner nanofiber layer leads to a higher permeability rating and results in a lower initial and operating pressure drop as compared to ePTFE. Lower operating pressures require less energy

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**Figure 1**

Surface layer images of each filter media shown at 600X and 20,000X magnification
to operate the blower of a dust collection system and improve the effectiveness of the reverse pulse cleaning system, thereby decreasing the cleaning frequency. Less frequent pulse cleaning saves compressed air, reduces system emissions, and minimizes nuisance noise and general wear and tear on your dust collection system.

**Dust-holding capacity.** Lower operating pressures allow the nanofiber filter media to hold a significantly larger amount of dust at the same pressure than ePTFE filters. The ASHRAE 52.2 testing showed that more than 7 times the amount of dust was collected at the same airflow and final pressure drop. Greater dust holding capacity means that more dust can be collected without requiring pulse cleaning cycles, leading to less compressed air usage as well as reduced system emissions and minimized system general wear and tear.

**Dust cake release.** Because of the surface loading properties of each media, both filter technologies effectively release the dust during pulse cleaning cycles. The ePTFE filter releases collected particulate well and typically has wider pleat spacing, leading to improved dust release characteristics on applications where dusts tend to be agglomerative or stringy.

**Dust characteristics.** The collected particulate characteristics are also an important consideration. Nanofiber filters are best suited for dry, fine, nonfibrous dusts (such as from welding, metalworking, and bulk powders) but they do have some limitations in applications with high moisture contents. ePTFE filters have wide pleat spacing, strong resistance to moisture, and good release characteristics, which make them a good choice for hygroscopic or agglomerative dusts, such as dusts produced during the processing of sugar, flour, and chemicals. Note that nanofiber filters can also be configured with wide pleat spacing to handle some fibrous or agglomerative dusts.

**Cost considerations.** When evaluating costs associated with each technology, consider not only the initial investment, but also the operational and replacement filter costs. Because ePTFE filters have significantly less media, the dust collection system may need to be larger. This translates to a higher initial investment. Higher operating pressures and increased pulse cleaning frequency will drive operational costs higher. For replacement filters, the price of ePTFE filters can be up to 3 times the price of comparable nanofiber cartridges.

**Points to consider when selecting your dust collection system filter**

Compared to traditional filter technologies, both nanofiber and ePTFE technologies offer improved filter and dust collector system performance, both of which are essential to meet the rigorous demands of today’s industrial applications.

When selecting the best filter solution for your company, keep the following points in mind:

- **Don’t base filter or equipment selection on efficiency or MERV rating alone.** It is important to select filter technology with the necessary minimum efficiency capable of capturing the particle size of your application, but it is equally important to select a filter technology that results in lower total emissions through reduced cleaning cycles.

- **Use ePTFE technology only when the dust characteristics warrant it.** The moisture resistance associated with ePTFE is a clear advantage over nanofiber solutions. However, to justify the higher filter costs and expenses associated with ePFTE filters, it is important to analyze your application and dust to determine whether moisture would be part of your process.

- **Understand how the technology affects the total cost of ownership.** Operating pressure drop affects the system operational costs through blower energy consumption and compressed air usage with filter pulse cleaning. Therefore, selecting filter technology that minimizes pressure drop results in lower operating costs. In addition to operating expenses, the cost and frequency of replacement filters should also be considered.

Both nanofiber and ePTFE membrane filters offer benefits that enhance key aspects of dust collector operation. For most applications, nanofiber technology provides better overall value by achieving these benefits at a more economical price. ePTFE solutions should be selected for special applications where moisture, agglomerative dusts, or exceptionally high levels of initial efficiency are required. Taking the initial time to review your application and the available technologies to find the best match for your application will be worth it in the long run.

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