Donaldson

Tech Topics

7 Things to Know When Purchasing Air Filter Elements

High Performance Inlet Air Filters Can Aid Turbine Performance

Understanding & Comparing Performance Can Help You Find the Right Replacement Air Filter Elements

The price of replacement filters is, of course, of primary consideration, but the total 'cost' and, conversely, the value of the filters go deeper than that. **More efficient air filters can actually help reduce operating costs.**

Large particles (>10-20µ in size) cause blade erosion when present in sufficient quantities, while smaller particles (<5µ in size) result in compressor blade fouling. Less compressor fouling results in higher turbine output and improved heat rate (i.e., more efficient fuel consumption).

High efficiency air filters are able to capture most particulate larger than 10µ, but for reducing blade fouling, a high performance filter media is needed.

This guide will help you evaluate and compare, in a meaningful way, the data offered by filter manufacturers.

1. Turbine air filter performance is NOT best evaluated on mass efficiency — that is, efficiency by weight.
2. The key difference in air filters is found in the efficiency on particles smaller than 3µ.
3. Initial efficiency plus the rate at which efficiency improves are key in determining the overall efficiency of air filters.
4. To compare ASHRAE (or any) test results for two different filters, the tests must be performed at comparable airflow rates.
5. Pressure drop characteristics of different filter media or "similar" filters from different manufacturers can increase operating costs by more than the difference in the initial cost of replacement filters.
6. Despite generic filter media descriptions ("blended" or "synthetic"), filters from one filter manufacturer do NOT have the same operating characteristics as filters from another filter manufacturer.
7. Some 100% synthetic media filter elements may have performance characteristics that are "comparable" (but still not equivalent) in performance to filters with Donaldson Duratek® Spider-Web®.

For further discussion on each point, see next pages.

1 Why shouldn't filter performance be evaluated on mass efficiency (that is, efficiency by weight).

Because mass efficiency doesn't measure the effect of the smaller, atmospheric dust particles that cause compressor blade fouling.

Filter mass efficiency is based on the filter's ability to capture the dust used during testing, which typically has an average particle size of approxi-mately 5µ. There is widespread disagreement as to what the "typical" particle size make-up is for atmospheric dust; however, there is a general agreement that in North America the "average" atmospheric particulate concentration is 50-100 micrograms per cubic meter, with most of that particulate not being visible to the human eye (i.e., < 25µ in size). There is also agreement that 70-80% of that mass concentration is made up of particles ≤10µ in size, with as much as 30-40% of that (mass concentration) being made up of particles <5µ in size.

Any filter rating based on the mass efficiency of 5µ test dust provides little information about filtration efficiency on smaller atmospheric dust particles.

2 The key difference in air filters is found in the efficiency on particles smaller than 3µ.

While the turbine air filters offered by many manufacturers are adequately efficient on larger particles, there are significant differences in filter performance on particle sizes smaller than 3µ. Most filters using cellulose or blended media have poor initial efficiencies on sub-micron particulate, which is the primary cause of fouling.

To maximize efficiency on sub-micron particulate, replacement filters require a high performance media with performance characterisitics similar to those of Donaldson Duratek® with Spider-Web®.

3 Initial efficiency plus efficiency improvement rate (as the filter loads over time) are key in determining the overall efficiency of air filters.

ASHRAE test standards 52.1-1992 and 52.2-1999 describe the test procedures for evaluating and rating air filters based on Average Dust-Spot efficiency and Efficiency by particle size. Both of these test standards rely heavily on initial efficiency and filter loading charactistics in determining a filter's efficiency rating.

4 In order to compare ASHRAE (or any) test results for two different filters, the tests must be performed at comparable airflow rates.

Air filter elements used in turbine air inlet systems have been sized for a "design" airflow rate. Filter test results performed at a significantly different airflow will be of little value in predicting how well that air filter element will perform at that design airflow rate. For example, comparing results of an ASHRAE test for a filter tested at a 500 *cfm* airflow to results of an ASHRAE test for a similar filter tested at a 900 *cfm* airflow would provide very little meaningful information.

Donaldson has ASHRAE test results available for all of the filter elements used in Donaldson first-fit equipment. Those filter tests were performed by AFTL, an independent testing lab, at airflows appropriate for turbine installations. Donaldson also has ASHRAE test results for some competitive air filters that were performed (by AFTL) for direct comparison purposes.

Any filter manufacturer claiming to have "equivalent" or "comparable" replacement filter elements should be able to provide ASHRAE test results performed at appropriate airflows to support those claims.

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5 Filter pressure drop can impact your annual operating costs.

The pressure drop of an inlet air system can have a significant effect on turbine performance. In fact, turbine manufacturers say that 4.0" w.g. of inlet loss will reduce a turbine's output by 1.0-1.4%. The effect of inlet pressure drop is a straight-line function, which means that each 0.10" w.g. increase in (average) inlet pressure drop will decrease a turbine's output by 0.025%, or more.

In more specific terms:
The cost of operating a turbine with 0.10" w.g. of added inlet pressure drop over an 8000 hour operating year is equivalent to operating a turbine for two hours at full load without getting any of the revenue from the power generated. This is one of the hidden costs of using less efficient filters.

Lower ΔP filters yield increase turbine output!

6 Despite generic filter media descriptions ("blended" or "synthetic"), filters from one filter manufacter may not have the same operating charactistics as filters from another filter manufacturer.

It is easy to assume that "blended" and "synthetic" media are the same from different filter manufacturers because the media comes from the same mills. But it's NOT true, at least with regard to the filters manufactured by Donaldson.

Donaldson Company, Inc. is the leading manufacturer of air filter systems and replacement air filters for gas turbines and is one of only a few filter manufacturers that has its own media development capabilities. All of the air filter elements that Donaldson manufactures use proprietary media formulations that were developed in Donaldson labs. Each media has a specific formulation and engineering specification that differentiate it from media that other manufacturers try to claim as being "equivalent" or "comparable." By comparison, other filter manufacturers typically use one of several standard, non-proprietary media options available from the media mills.

7 Some 100% Synthetic media filter elements have performance charactistics that are comparable -- but are not equivalent -- to filters made with Donaldson Duratek® Spider-Web®.

Donaldson Spider-Web® is one of the proprietary filter products that was developed in the Donaldson corporate media development laboratory. It is not available to any other filter manufacturer or to any of the filter media mills. Donaldson originally developed the nanofiber technology for Spider-Web® in the early 1980s for use in Donaldson's industrial dust collection products for capturing sub-micron particulate on the surface of the media, which allowed the particulate to be easily pulsed off of the filters during pulse cleaning.

High Performance Filter Media: Synthetic & Duratek® Spider-Web®
ASHRAE test results of Donaldson filters with Duratek® Spider-Web® media are comparable (but not equivalent) to ASHRAE test results for Donaldson 100% synthetic media filters. The average pressure drop characteristics of the two media are similar; however, the Duratek® Spider-Web® media has slightly higher efficiencies and has significantly better self-cleaning performance charactistics.

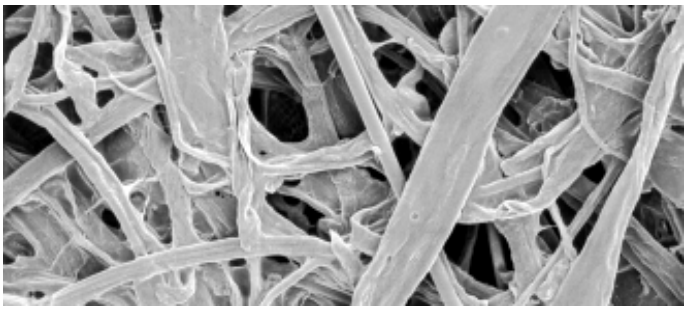
ASHRAE tests suggest similar performance characteristics for other filters with 100% synthetic media; however, NO filter manufacturer offering standard cellulose or blended media filter as being "similar" or "equivalent" to Donaldson Duratek Spider-Web has provided appropriate ASHRAE test reports to substantiate those claims.

Donaldson® Filtration Solutions

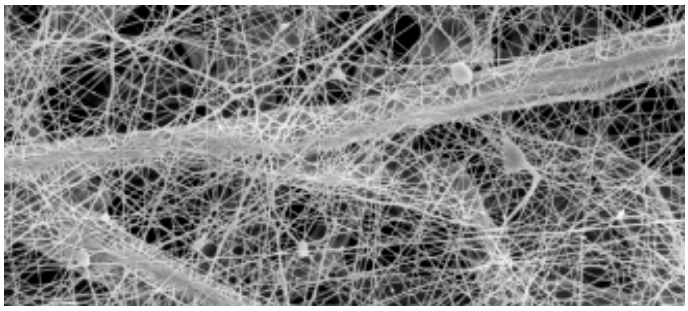
"Up Close and Personal!" ...The heart of the filter system: the filter media.

In these photos taken with our scanning electron microscope (SEM), you're seeing filter media magnified 200, 500, or 1000 times! Note the pore size (spaces between the fibers) and the construction of the fibers (smooth, rough, large, small.)

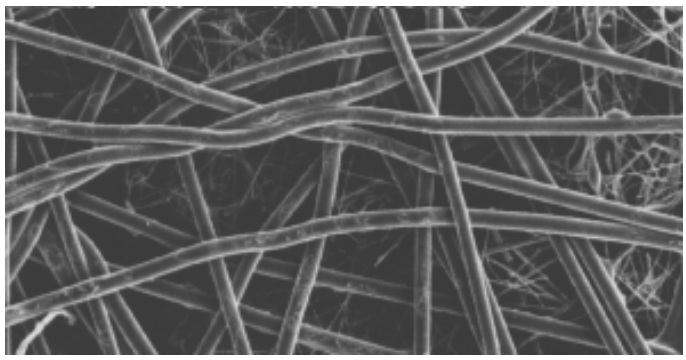
Duratek™ (Donaldson's proprietary blend of natural & synthetic fibers) -- Synthetic fibers mixed in add strength and moisture resistance.



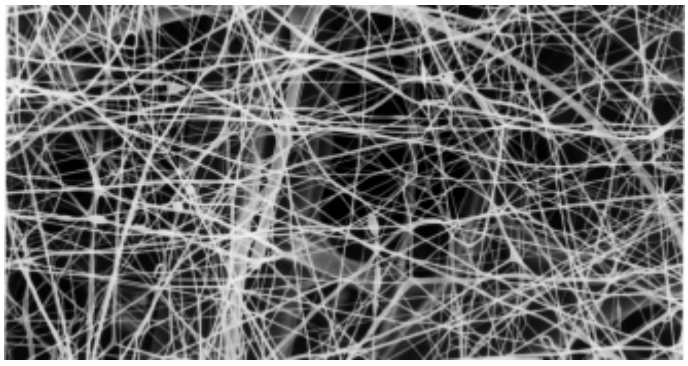
Duratek® with Spider-Web® -- You can see how adding the layer of nanofibers (Spider-Web®) over the Duratek® substrate creates very small pore sizes, enabling entrapment of sub-micron dust.

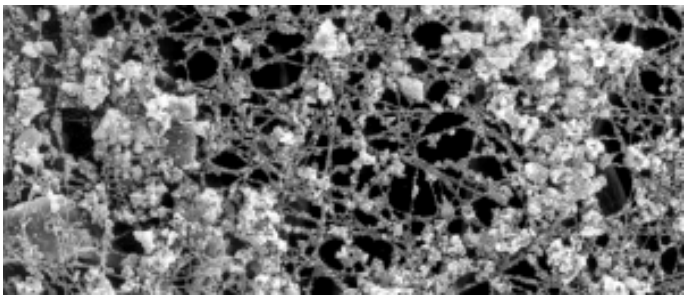


Synthetic (Donaldson's man-made filter media) -- By controlling the fiber diameter and the pore size, we can design filter media to be effective in various environments (desert, arctic/frost, urban, industrial, marine, etc.) The smooth fibers provide very low impedance to airflow -- helping to maintain low ΔP for the entire life of the filter.



Synthetic with Spider-Web® -- Note the 'web' of nanofibers bonded over the synthetic substrate. This media formulation has proven to be the most effective filter solution for gas turbine protection -- best filtering efficiency, best pulsing characteristics, best ΔP over the life of the filter, and longest filter service life.





And Now It's Dirty -- The 'web' catches most of the very fine particulate, allowing two major benefits: (a) very fine (<5μ) particles that cause fouling don't reach your turbine blades, and (b) pulse-cleaning is more effective due to the surface-loading characteristics of the Spider-Web® layer. (This photo shows Synthetic/Spider-Web®; the surface loading characteristics are the same for Duratek®/Spider-Web®.)

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