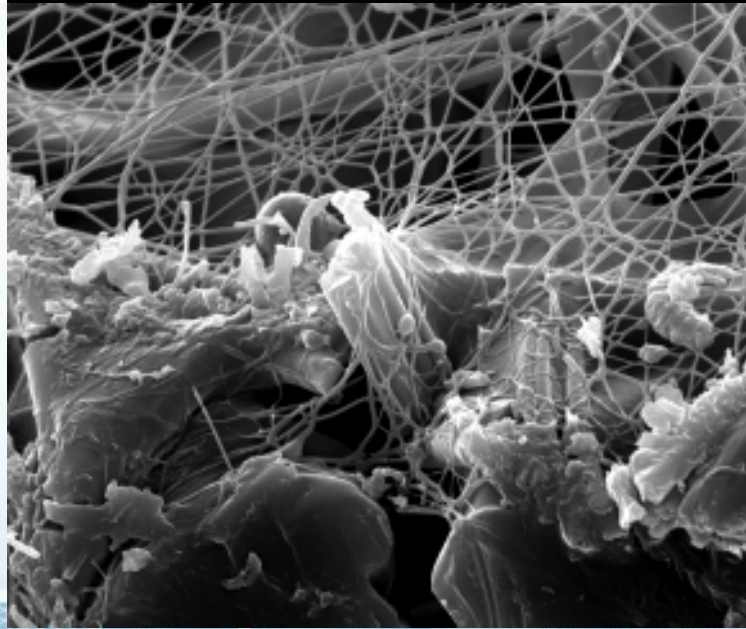




Donaldson[®]
Filtration Solutions

Filter Media Technology

*Specially Formulated to Protect
Gas Turbines, Compressors and Generators*



- ☑ **Media Choices: Purely synthetic or Duratek™, our blend of synthetic and natural fibers**
- ☑ **Our exclusive Spider-Web® Nanofiber Technology is available on either media**
- ☑ **Choose Media to Conquer Your Challenging Environment**
- ☑ **Learn why Lowest ΔP is Important!**

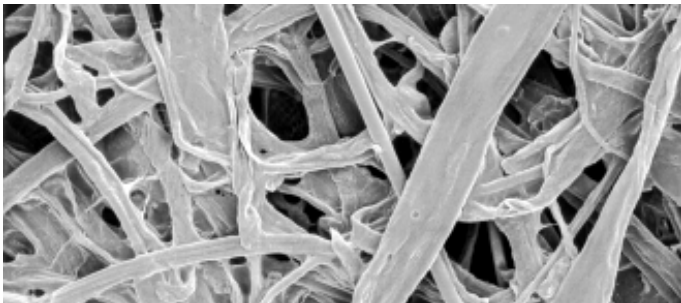
GTS-200
rev 7/05

Take a Close Look at Donaldson Filter Media

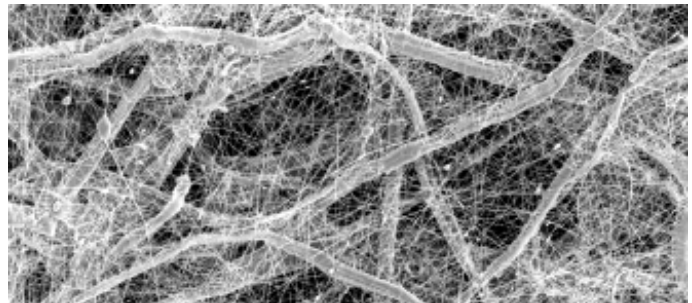
Examine the heart of the filter system -- the filter media.

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.)

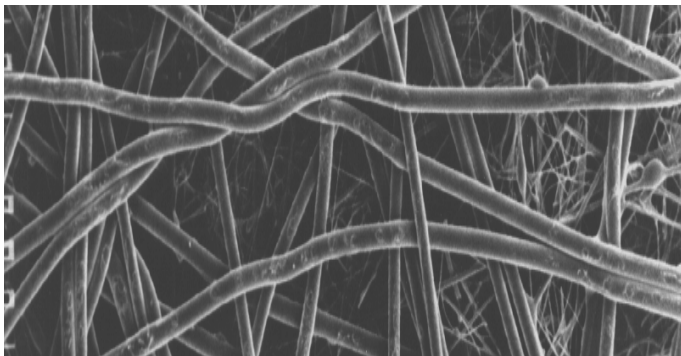
Duratek™ (Donaldson's proprietary blend of natural & synthetic fibers) -- Synthetic fibers mixed in add strength and moisture resistance.



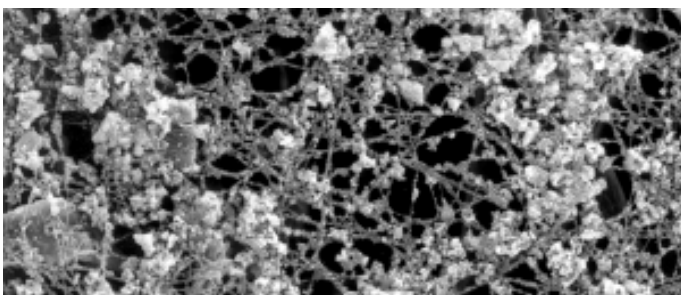
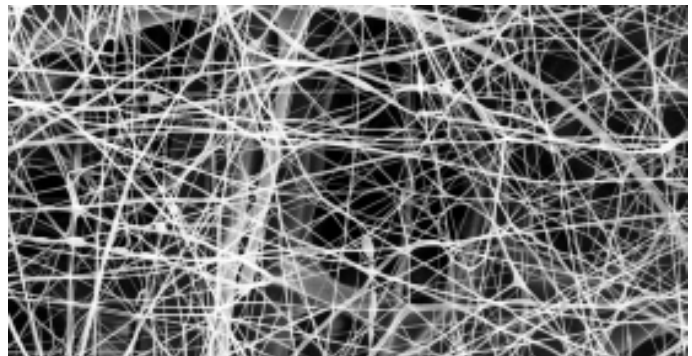
Duratek™ with Spider-Web® -- Adding Donaldson Spider-Web®, our patented layer of nanofibers, over the Duratek™ substrate creates very small pore sizes, enabling entrapment of very small (even sub-micron!) particulate.



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 low impedance to airflow -- helping to maintain low ΔP for the entire life of the filter.



Synthetic with Spider-Web® -- Note the 'web' of our patented nanofiber technology 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 Now It's Dirty -- Spider-Web® catches most of the very fine particulate, allowing two major benefits: (a) very fine particles that cause fouling (those less than $5\mu m$ in size) are more effectively captured, 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®.)

Donaldson Offers a Wide Choice of Media

So That You Can Choose the Best Filter for Your Particular Environment!

Premium Protection: Synthetic Media

Our man-made fibers, with their controlled fiber diameter and pore size, result in superior dust-holding capacity and low impedance to airflow. It helps keep ΔP low throughout the entire life of the filter, which typically ranges from 2 to 4 years depending on the harshness of the environment. Synthetic media is sturdy and durable, even under normal-filter-killing conditions such as consistent or prolonged moisture, sticky/wet hydrocarbons, salt, or very dusty/sandy.

Synthetic media is the basis for the best filtration performance in most cases.

Outstanding Protection: Duratek™ Media

Our special blend of synthetic and natural fibers, which we call Duratek™, is designed to resist the intermittent moisture that power plants and oil/gas field operations so often deal with, such as morning dew and coastal storms. Because of the synthetic fibers and the addition of certain resins, Duratek™ withstands harsh conditions, including high humidity and wet tropical environments. This cost-effective blend offers low ΔP , little or no media swelling/bunching, and high dust holding capacity.

Increase Media Power by Adding Spider-Web®

Spider-Web® is Donaldson's proprietary & patented nanofiber technology that catches very fine (even sub-micron!) particulate before it reaches the media substrate. Spider-Web® is a treatment that is bonded to a substrate -- either synthetic or Duratek™ filter media.

As you can see in the photos of media (magnified 100's of times) on the previous page, the Spider-Web® layer is made of fibers so fine that they don't impede airflow, yet are strong enough to capture very small particles. This is important for most turbine installations because the particles smaller than 5μ are the ones that cause fouling of the compressor blades. Spider-Web® protects your turbine from excessive and premature fouling.

And now, even higher performance is available in our Spider-Web® XP option. Learn more about it on page 5 of this document.

What can better air filtration mean to your operation?

- Better turbine protection
- Less blade fouling
- Higher turbine output
- Less maintenance cost
- Improved turbine availability

Matching Filter Media to Your Environmental Challenge

Donaldson Media Choices:	Synthetic/Spider-WebXP	Synthetic/Spider-Web	Synthetic	Duratek/Spider-Web	Duratek	
Desert: Arid; frequently heavy windblown dust concentration.	Superior	Satisfactory	Satisfactory	Recommended	Adequate	Superior - Recommended when highest filtration efficiency is needed.
Arid/Semi-Arid with frequent seasonal ground fog.	Superior	Recommended	Satisfactory	Satisfactory	Adequate	Satisfactory - Reasonable or good filter life with better than adequate filtration efficiency, but may not offer the best operating characteristics and economic value for this environment.
Arctic: very cold, dry air; snow and frost frequently build up on filters.	Superior	Satisfactory	Satisfactory	Recommended	Adequate	Recommended - Good filter life, good filtration efficiency, and best operating characteristics and economic value for this environment.
Urban/industrial: Variety of contaminants, including moderate amounts of hydrocarbons.	Superior	Satisfactory	Satisfactory	Recommended	Adequate	Recommended - Good filter life, good filtration efficiency, and best operating characteristics and economic value for this environment.
Marine, coastal, tropical and semi-tropical (i.e., hot, humid, moisture-laden) environments	Superior	Recommended	Satisfactory	Satisfactory	Adequate	Adequate - Reasonable filter life and adequate filtration efficiency.

Donaldson Spider-Web is the first filter media to effectively combine very high filter efficiency with low airflow restriction both initially and throughout the life of the filter.

The result is better turbine protection, lower overall turbine operating costs and higher turbine availability.

Spider-Web Advantages

Surface-Loading

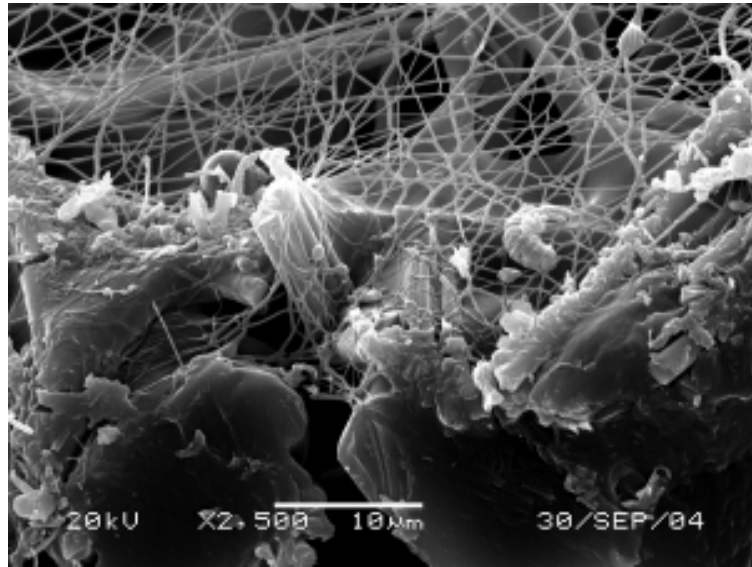
Donaldson's patented Spider-Web media technology consists of a "web" of sub-micron diameter fibers bonded to a substrate of Donaldson cellulose or synthetic filter media. The nanofiber web significantly improves the media's ability to collect dust particles on its surface, and minimizes the number of particles that penetrate into its depth. In traditional filter media without Spider-Web, particle ingress shortens filter service life.

Durability

The patented nanofiber web is extremely durable, as well as resistant to moisture and high temperature. This robust nanofiber layer protects the turbine and delivers superior self-cleaning performance throughout the life of the filter.

Low Pressure Drop

Incoming air passes through the Spider-Web layer without increasing filter pressure drop. Spider-Web fibers are very small compared to the airflow passages between media fibers. Particles collect on the Spider-Web layer, keeping the media pores open. In traditional filter media, dust particles lodge in the pores between fibers and become imbedded in the media depth. Eventually pores plug, causing filter pressure drop to increase.



This photo from our Scanning Electron Microscope shows Spider-Web media magnified 2500 times! Note the nanofiber 'web' over the filter media substrate.

High Efficiency

Initially

Traditional filters have an initial period during which filter efficiency must build up to peak levels, but Spider-Web filters are highly efficient from the time they are installed. Spider-Web media accelerates the forming of a dust cake on the media surface, bringing the efficiency to nearly 100% very quickly.

Because its fibers are less than 0.3µm in size, Spider-Web minimizes the number of fine particles that pass through the media during seasoning.

Throughout filter service life Spider-Web's unique surface loading capabilities cause incoming dust particles to continuously build up on the media's surface rather than its depth, thereby maintaining high efficiency and extending filter service life.

On Sub-Micron Particles

Another advantage of Spider-Web is its ability to capture sub-micron size particles. Because Spider-Web is made up of a tight 'web' of sub-micron diameter fibers, it is much more efficient than traditional filter media at collecting dust particles less than one micron in diameter.

Performance Improvements for Pulse-Cleaned Filters

Better Dust Particle Release

Dust particles are more easily dislodged during pulse cleaning, because they load on the surface of Spider-Web filter media rather than in its depth. In traditional filter media, dust particles become lodged in media pores, making it difficult to remove them during the pulse-cleaning process.

Improved Turbine Availability

The improved pulse cleaning performance of Spider-Web filters results in fewer planned and unplanned maintenance outages for filter replacement. This extended filter life, and the reduction in the amount and frequency of turbine cleaning provides improved turbine availability.

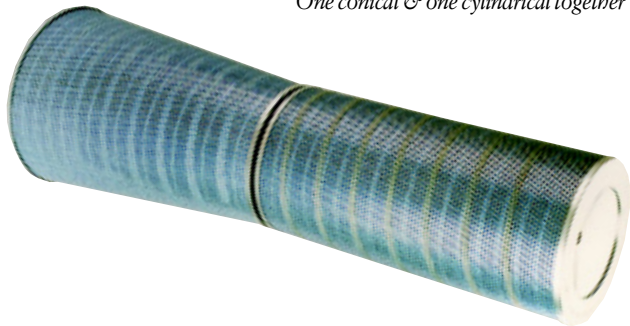
Lower, Stabilized Pressure Drop

Spider-Web's improved dust particle release capabilities result in a lower, stabilized filter pressure drop. The pressure drop of a pulse-clean filter system with Spider-Web filters stabilizes at a lower level than the same filter system with traditional filters, because the media's surface loading properties greatly improve dust particle release during the pulse-cleaning operation.



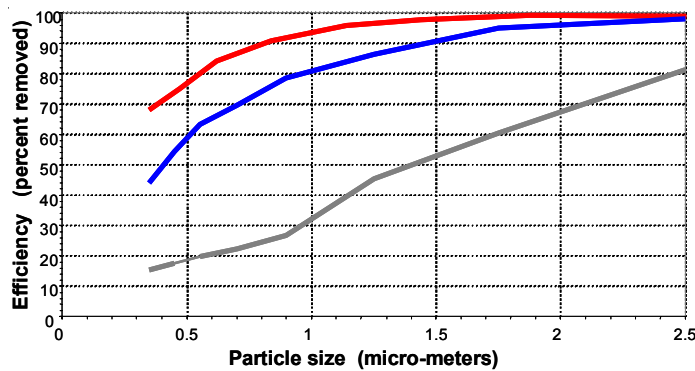
GDX Element Pair* Tested at 1630 cubic feet per minute (cfm), or 0.77 cubic metres per second (cms)

*One conical & one cylindrical together

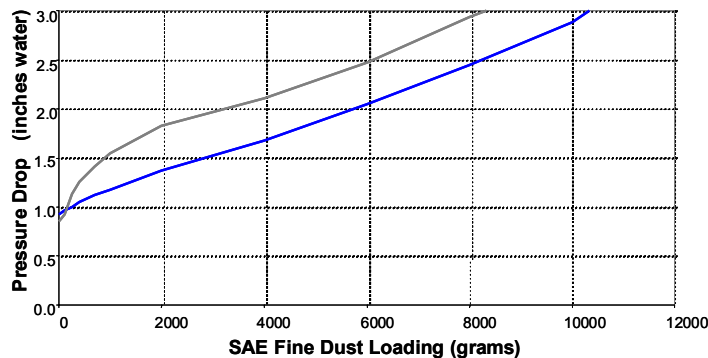


- Donaldson Spider-Web XP media
- Donaldson Duratek Spider-Web media
- Donaldson Duratek media (no Spider-Web)

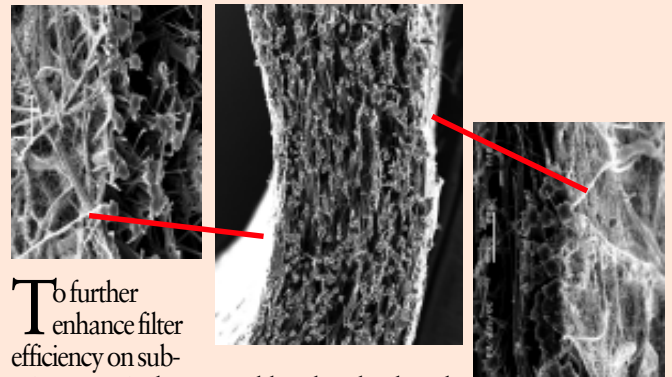
Initial Efficiency by Particle Size



ΔP with SAE Fine Test Dust Load



Choose Spider-Web XP for Premium Performance



To further enhance filter efficiency on sub-micron particulate, Donaldson has developed and patented Spider-Web XP.

Spider-Web XP features the web of sub-micron diameter fibers on both sides of the filter media substrate. Thanks to this unique design, initial filter efficiency is improved. For urban and industrial locations with high concentration of particles below one micron in size, Spider-Web XP offers superior turbine protection against fouling.

Spider-Web® XP reduces blade fouling significantly by capturing more particulate that is smaller than 2µm. Tests on Donaldson GDX filter pairs show (see graph below) that Donaldson Spider-Web XP reduces by about HALF the sub-micron particulate that penetrates through to reach the turbine blades compared to regular Spider-Web. And, Spider-Web XP captures FOUR TIMES as much sub-micron particulate as a standard "blended" media (such as our Duratek).

The secret to this extra performance is bonding our patented Spider-Web® nanofibers in very thin but robust layers on both sides of the substrate media.

The nanofibers are what enhance filter efficiency, especially on particles smaller than 1 µm, the ones that are primarily responsible for compressor fouling.

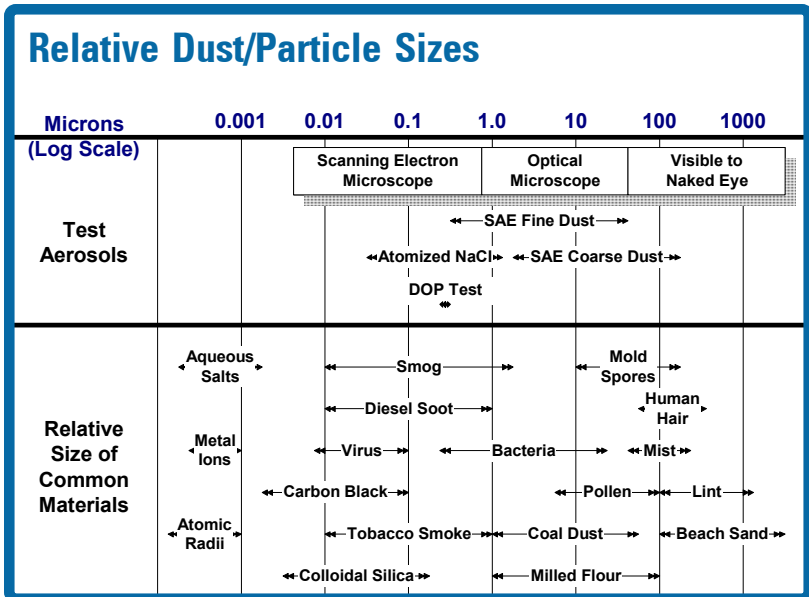
As shown in these photos of the media (taken with our scanning electron microscope at 500X magnification) the larger fibers are sandwiched between layers of very fine fibers. This triple-layer is what makes Donaldson Spider-Web® XP the most effective filter media for gas turbine protection!

Group	MERV Rating	(E ₁) Composite Avg. Particle Size Efficiency (PSE) 0.3 – 1.0 Microns	(E ₂) Composite Avg. Particle Size Efficiency (PSE) 1.0 – 3.0 Microns	(E ₃) Composite Avg. Particle Size Efficiency (PSE) 3.0 – 10.0 Microns	Average Arrestance by ASHRAE 52.1 Method
1	MERV 1	-	-	Less than 20%	<65%
	MERV 2	-	-	Less than 20%	65% – 69.9%
	MERV 3	-	-	Less than 20%	70% – 74.9%
	MERV 4	-	-	Less than 20%	≥75%
2	MERV 5	-	-	20% – 34.9%	-
	MERV 6	-	-	35% – 49.9%	-
	MERV 7	-	-	50% – 69.9%	-
	MERV 8	-	-	70% – 84.9%	-
3	MERV 9	-	Less than 50%	≥85%	-
	MERV 10	-	50% – 64.9%	≥85%	-
	MERV 11	-	65% – 79.9%	≥85%	-
	MERV 12	-	80% – 89.9%	≥90%	-
4	MERV 13	Less than 75%	≥90%	≥90%	-
	MERV 14	75% – 84.9%	≥90%	≥90%	-
	MERV 15	85% – 94.9%	≥90%	≥90%	-
	MERV 16	≥95%	≥95%	≥95%	-

MERV: Minimum Efficiency Reporting Values (ASHRAE Standard 52.2)

Air Filter Classification Equivalency Table
Meeting global standards: ASHRAE 52.1, EN 1779, Eurovent 4/5, BS 6540, DIN 24 185

Filter Type	Eurovent	EN779	ASHRAE 52.1 Efficiency	Measured By
for Coarse Dust	EU1	G1*	<65%	Synthetic Dust Weight Arrestance
	EU2	G2*	65<80%	
	EU3	G3*	80<90%	
	EU4	G4*	>90%	
for Fine Dust	EU5	F5**	40<60%	Atmospheric Dust Spot Efficiency
	EU6	F6**	60<80%	
	EU7	F7	80<90%	
	EU8	F8	90<95%	
	EU9	F9	>95%	
European HEPA Standards	EU10	H10	85%	Sodium Chloride or Liquid Aerosol
	EU11	H11	95%	
	EU12	H12	99.5%	
	EU13	H13	99.95%	
	EU14	H14	99.995%	
US HEPA Standard			99.97%	DOP test MIL Std 282



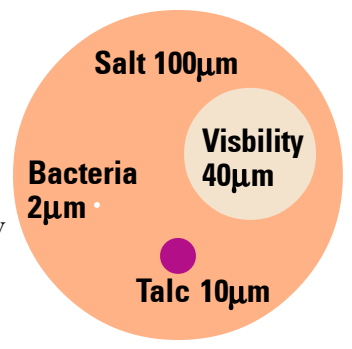
How Big is a Micron?

As a unit of measure, 1 micron also called micro meter) = 1 millionth of a meter or .000039 inch.

Symbol = μm

Size examples of familiar particles:

- 100μm = Grain of table salt (.004 inch)
- 40μm = Lower limit of visibility (.0015 inch)
- 10μm = Talcum powder (.0004 inch)
- 2μm = Bacteria (.00008 inch)



* Tested per EN 779 HEPA = High Efficiency Particulate Air Filter
** Efficiency @ 0.4 μm

Why Sub-Micron Size Dirt Can Hurt!

(a true story from one of our customers)

PROBLEM: One of our customers in Canada was seeing fast fouling of the compressor, which led to loss of turbine output. This meant loss of revenue!

ANALYSIS: Since they had two turbines running side-by-side, the customer decided to test Donaldson filters against the 'brand X' commodity filters they'd been using. They chose to install Donaldson filter cartridges made with Spider-Web® (our exclusive & proprietary fine fiber media technology) to capture the majority of the very fine dirt particles that they suspected had been fouling the compressor. Both the brand X and Donaldson filters were new & clean at the beginning of the test.

CONCLUSION: After 2360 operating hours, the stator blades on the turbine behind brand X were black with fouling, as shown in photo A. At the same time, the blades behind Spider-Web® were still clean & shiny! (photo B)

LONG-TERM BENEFIT: Customer measured their increased output from the turbine protected by Spider-Web® filters, as illustrated in the graph below. **Increased output value = OVER \$100,000 per year!** The extra \$6200 they paid for a full set of Spider-Web filters (over the price of the commodity filters) was an investment that paid for itself in the first 2 months of operation!

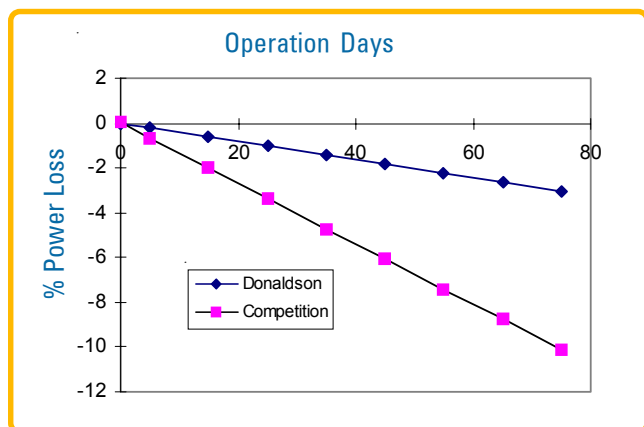
Actual photos taken by our customer of a section of blade from the 3rd stage of the stator



B) After 2360 operational hours, the blades behind the filters with Donaldson Spider-Web® are still clean -- and maintaining turbine output at optimal levels!



A) After 2360 operational hours, the blades behind 'brand X' are fouled -- and causing turbine output loss!



Pre-Filters

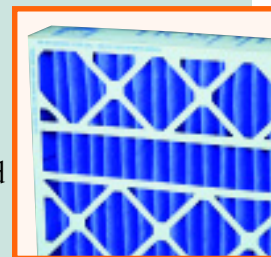
Pre-filters -- both wraps and panels -- have the job of extending the life of the primary filter by capturing larger particulate, such as seeds, leaves, airborne fibers, etc. They are made of low-cost, relatively low efficiency materials, and designed to be changed more often than primary filters, and thrown away. (Cleaning and reusing them is never recommended.)



The filter media Donaldson uses for our most popular pre-filters are made of polyester fibers, air laid (aka dry laid) in a randomly-oriented fashion to form a web.

Our pre-filter wrap is a "high loft" media, meaning it has quite a bit of air space between the fibers throughout the depth of the media mat, yet is visibly thicker & more robust than competitive offerings. This enables good airflow through the wrap even after it has captured much particulate.

Our pre-filter panel is made of longer, rather coarse fibers, packed more densely than the wrap media. The higher packing density enables good pleating, good efficiency on larger particulate, and strength. Choose either beverageboard or metal frame.



Improving on Already-Great Filtration: PowerCore

How can anyone improve on filter media that's as highly efficient as Spider-Web? One way we've found is to package it differently.

Traditionally, Donaldson filter media is dimpled and pleated to create more filter surface area in a relatively small space. Our newest media packaging technique, called PowerCore, uses layers of corrugated media (our normal synthetic or Duratek with Spider-Web) to create even more filtering surface -- which gives us flexibility relative to filter shape and size. PowerCore filters can offer same/similar filtering power in a smaller package, or more filtering power in the same/similar size package. PowerCore filters can be square, oval, or round.



This is a pair of panel filters used in the new Donaldson XLR inlet filtration system. Because of PowerCore technology, XLR provides high performance with only half as many filters as our GDX system.



Volvo FL6 medium duty trucks use this compact ob-round-shaped PowerCore filter to save space.

Where to Find Us:

www.donaldson.com

Corporate Headquarters

Serving the Americas

Donaldson Company, Inc.
PO Box 1299, 1400 W. 94th St.
Minneapolis MN 55440 USA

Phone: 1-952-887-3131

Fax: 1-952-887-3843

email: filterinfo@mail.donaldson.com

European Headquarters

Serving Europe, Africa, Middle East

Donaldson Europe, BVBA
Research Park Zone 1, Interleuvenlaan 1
B-3001 Leuven, Belgium

Phone: +32-16-38-3940

Fax: +32-16-38-3939

email: gts-europe@mail.donaldson.com

Donaldson Middle-East Office

Abu Dhabi, United Arab Emirates

Phone: 00 971-6 7 45-2238

Donaldson Gesellschaft m.b.H.

Dulmen, Germany

Phone: +49 25 94 78 10

Asia/Pacific Headquarters

Serving the Asia/Pacific Region

Donaldson Filtration Asia Pacific Pte Ltd
No. 3, Changi Business Park Vista #02-00
Singapore 486051

Phone: 65-6311-7373

Fax: 65-6311-7398

email: gts-asiapacific@donaldson.com.sg

Donaldson Australasia Pty. Ltd.

New South Wales, Australia

Phone: 61-02-4352-2022

DI Filter Systems Pvt. Ltd.

New Delhi, India

Phone 0091-124-229-0350

Donaldson Shanghai Office

Shanghai, Peoples Republic of China

Phone 86-21-5425-3508

Donaldson Far East Ltd.

Hong Kong

Phone 852-2402-2830

Nippon Donaldson, Ltd.

Tokyo, Japan

Phone: 81-42-540-4112

Donaldson Korea Company, Ltd

Seoul, Republic of Korea

Phone: 82-2-517-3333

