Filter Assemblies

Design Flexibility for a Wide Range of Applications

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Flow Range up to 6.62 lpm / 1.75 gpm @ 85 psi

Extend Maintenance Intervals

REDUCE OIL CONSUMPTION, INCREASE ENGINE PROTECTION

Donaldson Blue® premium lube filters remove more than 90% of contaminants that are 10 microns or larger, compared to 50% or less for typical cellulose filters.

Donaldson® BLUE®

Diesel Engine Lube Filtration Systems

The difference between the various lube filter configurations can be confusing. There are three common filtration approaches.

Full-Flow Filtration

Full flow-filters receive near 100% of the regulated flow in an engine lube system. Full-flow filters provide essential engine protection for maximum cold flow performance and filter life. Most lube filters available today are full flow.

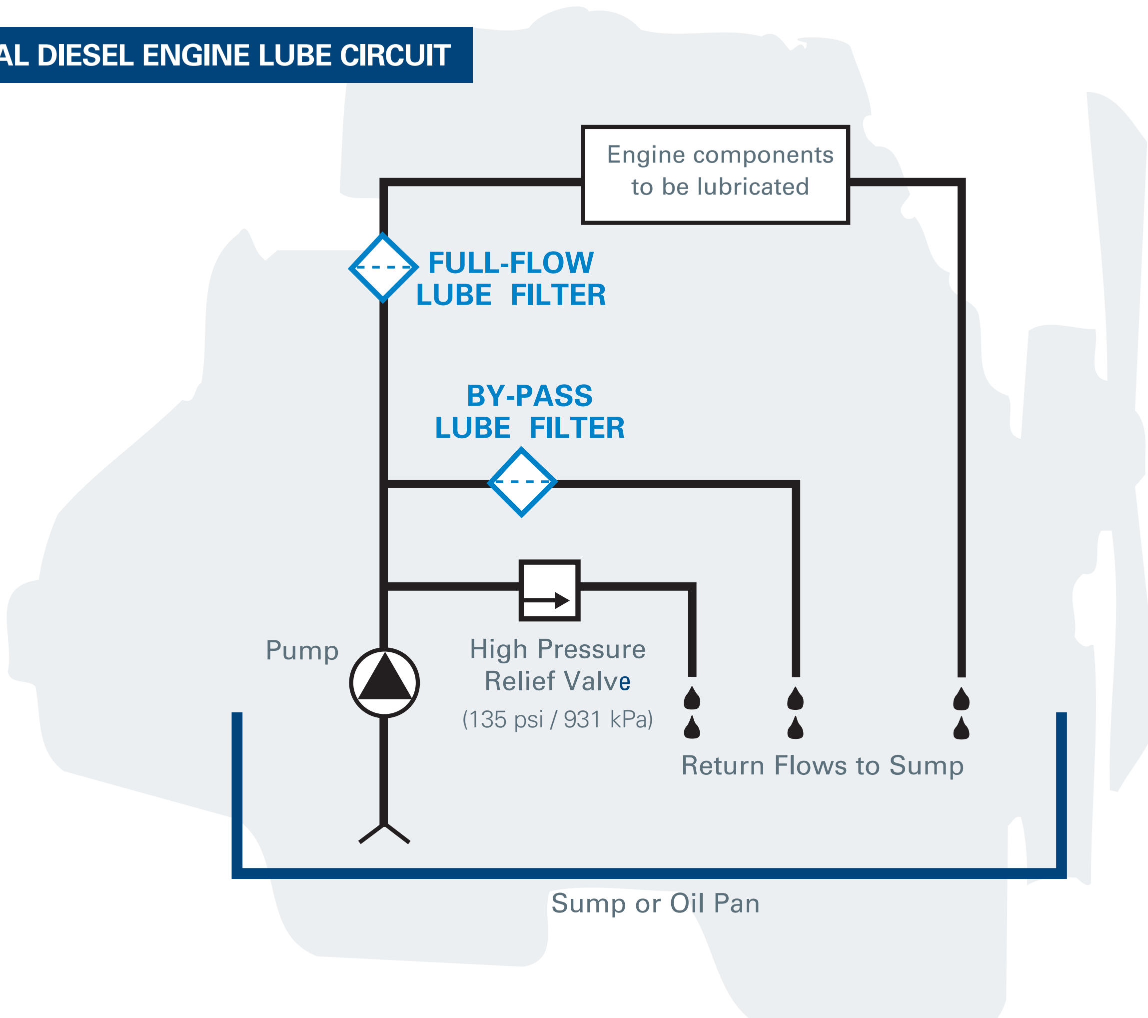
By-pass (Secondary) Filtration

By-pass filtration is when a small portion of the system's oil flow (usually 5-10%) is diverted back to the sump or oil pan before reaching the primary filter. A by-pass filter captures smaller particles than the full-flow filter. Because of the increased efficiency of a by-pass filter, they are more restrictive. To optimize restriction, a by-pass filter should be located in a separate flow path, as illustrated on the right.

Two-stage Filtration

A two-stage filter design attempts to combine the features of both a full-flow and by-pass filter. The two-in-one design significantly increases restriction, causing shorter filter life and decreased cold flow performance. Poor cold flow performance starves the engine of oil during start up, leaving the engine temporarily unprotected. This may lead to increased engine wear that could result in premature repairs or even engine replacement.

TYPICAL DIESEL ENGINE LUBE CIRCUIT



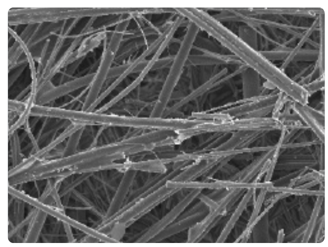
Filter Media

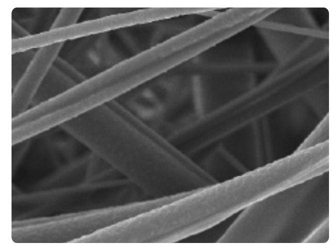
At Donaldson, we have a variety of lube filter medias available to meet the most stringent of engine lube system design requirements. Donaldson engineers have a history of developing media technology that exceeds application cleanliness and service life expectations. In fact, Donaldson was the first company to introduce fully synthetic media to the engine lube market in the early 1980's. This media is now commonly adopted for extended life or enhanced engine protection needs.

New lube media types are constantly under evaluation in our internal laboratories and in controlled field testing. If you have a specific application requirement, please contact Donaldson to see if there are additional media options to better suit your application.

Synteq™ Synthetic Media

Donaldson's fully synthetic lube filter media is constructed of layered, micro-fiberglass synthetic fibers. It provides enhanced durability for extended drain intervals while maintaining or improving efficiency and capacity. Synteq lube media offers lower restriction. Low restriction allows better flow which ensures component protection over a larger range of engine conditions.


SEM 100x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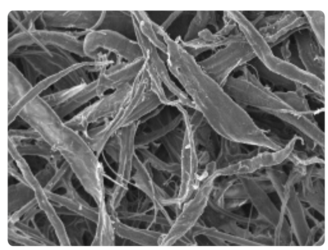
Synthetic Blend — Cellulose & Synteq™ Synthetic Media

This media is a blend of cellulose and synthetic media technologies. It utilizes the best attributes of both media fiber types to achieve an improved cost to performance ratio for more demanding applications than a cellulose only media can achieve.

This media provides the consistency of layered fibers to capture coarse contaminant coupled with the affordability of cellulose to deliver an efficient and effective performance alternative to traditional cellulose media.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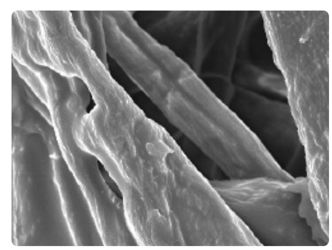
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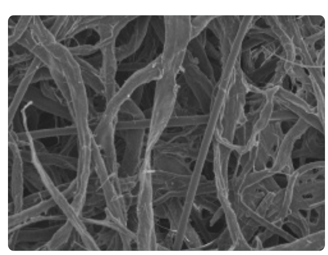
Cellulose Media

This traditional lube filter media is most commonly a pleated cellulose base material. This media effectively combines an application's efficiency and capacity requirements while maintaining cost effectiveness.

As oil flows through the media, large contaminants are captured on the surface of the filter while smaller contaminant becomes embedded in the underlying media layer.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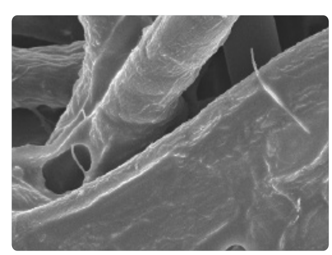
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Extended Oil Drain Intervals

Oil service intervals are pre-determined by engine manufacturers (OEM's) and are designed to provide maximum engine protection under a wide variety of conditions. While a majority of equipment owners follow these guidelines there is a growing trend to extend oil service intervals beyond the OEM recommendations. However, extended oil drain intervals are not for every application. Consider the following:

- Ensure oil meets the American Petroleum Institutes' (API) qualification criteria
- An extended oil drain schedule beyond the OEM's normal service interval should always be conducted in conjunction with a regular oil sampling and testing program
- Equipment operating extremes of heat, cold, idle time, airborne contaminants, and engine load negatively affect oil
- New engine designs today are cleaner burning with reduced emissions and make excellent candidates for extended oil drain intervals
- High-efficiency oil filters will help remove more contaminants, resulting in longer oil life

Donaldson Blue® Lube Filters

Donaldson Blue lube filters are designed specifically for extended maintenance programs. Donaldson Blue filters maintain oil health over the new drain interval and can last as long as the oil. All it takes is a simple cross reference of your current lube filter and you'll reduce oil consumption, increase engine protection and reduce operating costs.

Our Donaldson Blue lube filters use Synteq™ media, which is more effective than standard cellulose filter media at removing small contaminants. It improves lubricant flow and offers increased dirt holding capacity for extended oil drains. Donaldson Synteq™ media technology delivers the optimal balance of efficiency, capacity and restriction for lube systems.

Features

- Removes more than 90% of contaminants that are 10 microns or larger (cellulose filters typically remove 50% or less)
- Double the contaminant carrying capacity of standard cellulose filters – for much longer life
- Delivers lower restriction to provide maximum oil flow and lubrication.
- Heavy-duty, long life seals to support extended service life

Benefits

- Designed specifically to provide longer filter life
- Increase engine protection
- Reduce operating costs

Applications

- On- and off-road applications

Upgrade from Competitive Filters to Donaldson Blue®

Donaldson Blue filters are direct replacements to standard filters – no system modifications or special disposal requirements. Just a simple cross reference of your current lube filter and you'll reduce oil consumption, increase engine protection and reduce operating costs.

Lube Filtration Systems

The following pages present Donaldson's catalog lube oil product. Product offering includes both by-pass and full-flow filtration designs. Consult Donaldson for a custom solution.

Lube Filter Assembly Options

Reference the assembly options below to determine the filtration system that best matches up with the flow requirements and the key features for design and mounting on your engine.

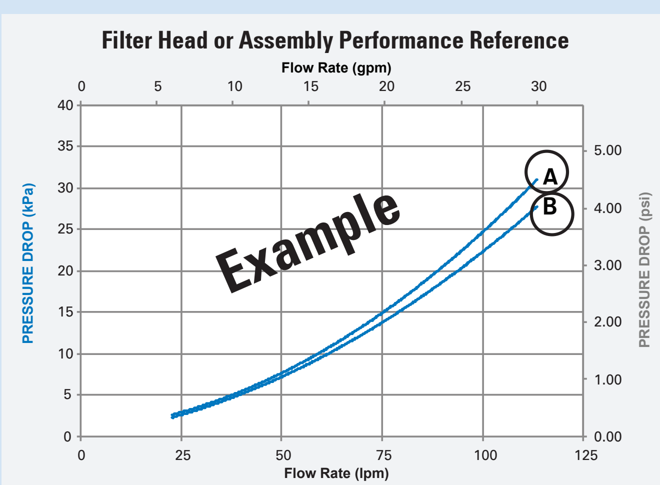
Filter Performance Choices

The filter selection charts list the separate filters that fit the same head assembly – these differ by length and filter performance. Choices are presented by maximum flow rate requirements and level of filtration efficiency.

Lube Filter Assembly Options

Families by Filter Diameter	Filter Design	Maximum Flow Range
93 mm / 3.66 in	Full-Flow	91 lpm / 24 gpm
118 mm / 4.65 in	Full-Flow	170 lpm / 45 gpm
	By-Pass (Secondary)	6.62 lpm / 1.75 gpm at 85 psi

How Donaldson Displays Filter Flow versus Pressure Loss Data



Performance Curve Notes

- Pressure loss was tested per the ISO 3968 standards.
- All flow measurements were made with Mobil DTE Light oil at 144°F / 62.2°C, 15 cSt.
- Test conducted with a sample size of three filters.
- Filter performance curves will list an alpha reference (see circled areas on chart). These labels correspond with the filter choice tables.

93 mm Full-Flow Filter Assembly

Max Flow Rate
91 lpm / 24 gpm
See table for filter flow rates

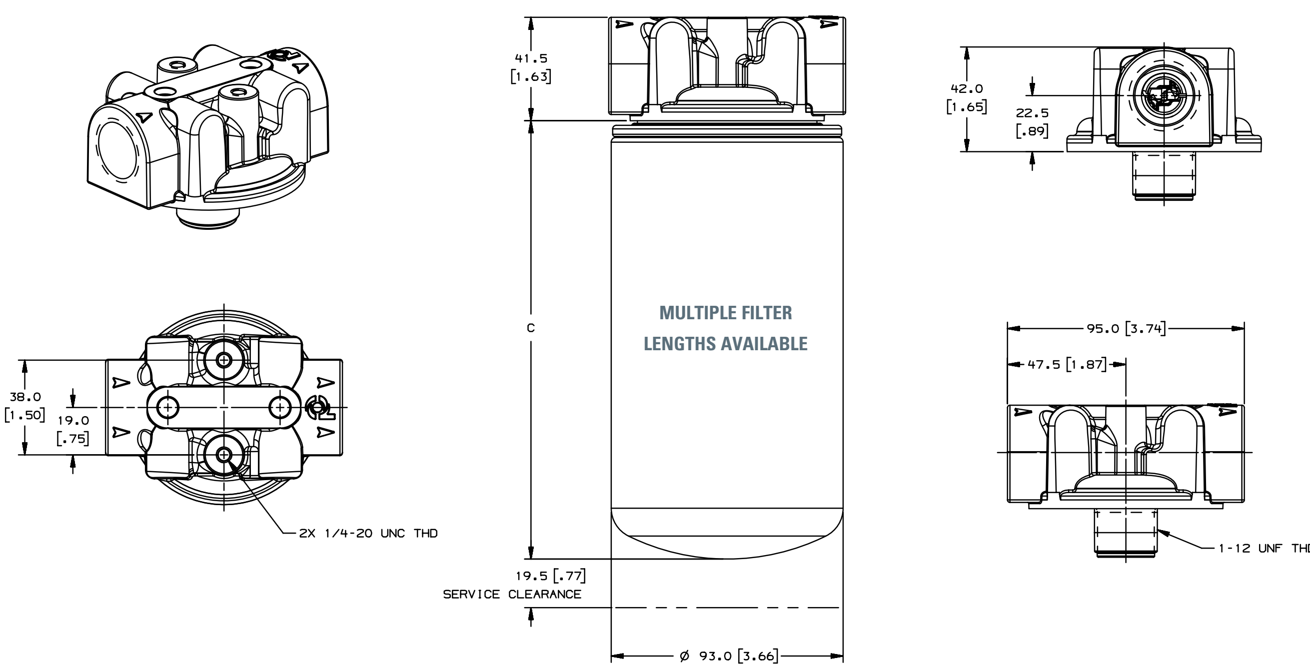
Operating Pressure
1034 kPa / 150 psi

Oil Compatibility
Compatible with petroleum based fluids (hydrocarbon)

Pressure Relief Valve
Head includes a 1.72 bar / 25 psi relief valve

Head
3/4" -14 NPTF Ports
PART NO. P561134

Specification Illustrations



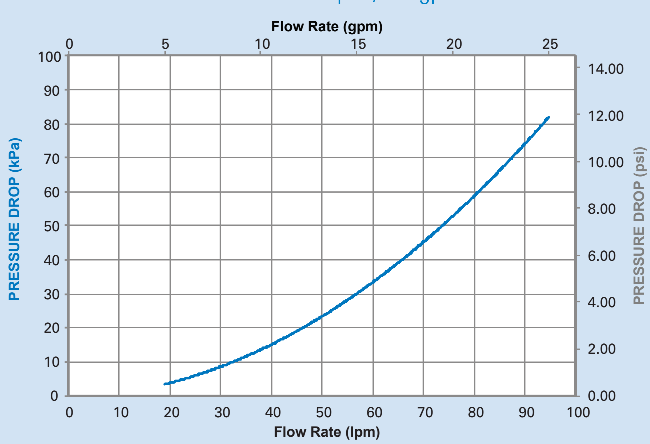
Full-Flow Lube Filtration
93 mm / 3.66" Filter Diameter

Filter Selection Chart

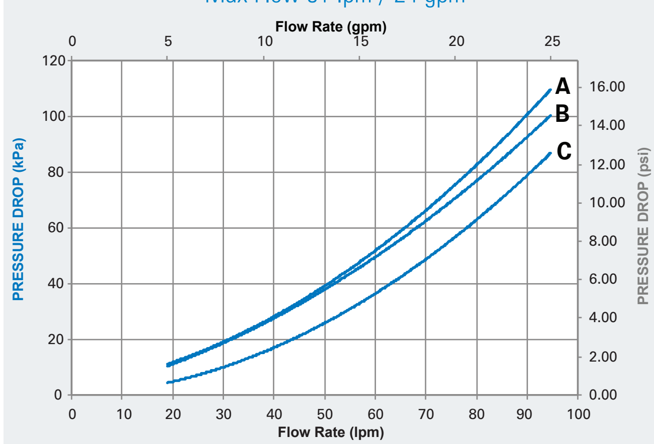
Maximum Recommended Flow Rate		(C) Filter Length		Media Type	Efficiency @ 99% per ISO 4548-12	Part Number	Performance Curve	Anti-Drain Back Valve	Filter Relief Valve Setting	
lpm	gpm	mm	in						bar	psi
57	15	135.9	5.35	Cellulose	40 µm	P552819	B	Yes	1.30-1.60	18-23
						P555680	C	--	1.30-1.60	18-23
						P559418	B	Yes	2.48	36
76	20	173.9	6.85			P553712	C	--	--	--
						P555616	A	Yes	--	--
						P557207	C	--	0.50-0.70	7-10
						P558250	B	Yes	0.80-1.00	11-17
91	24	209.9	7.87			P553771	A	Yes	2.41	35

Performance Curves

93 MM / 3.66" Head
Max Flow 91 lpm / 24 gpm



93 MM / 3.66" Filter Assembly
Max Flow 91 lpm / 24 gpm



118 mm Full-Flow Filter Assembly

Max Flow Rate
170 lpm / 45 gpm
See table for filter flow rates

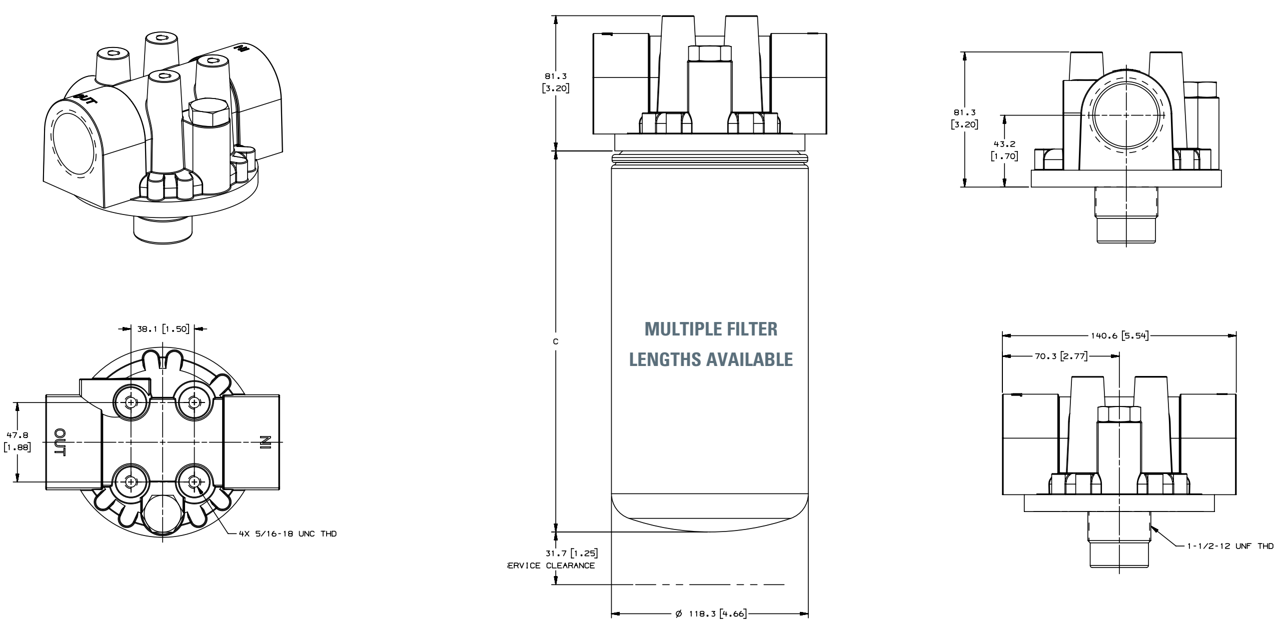
Operating Pressure
1034 kPa / 150 psi

Oil Compatibility
Compatible with petroleum based fluids (hydrocarbon)

Pressure Relief Valve
Head includes a 2.76 bar / 40 psi relief valve

Head
1 1/4" - 11 1/2" NPTF Ports
PART NO. P174780

Specification Illustrations



Full-Flow Lube Filtration
118 mm / 4.65" Filter Diameter

Donaldson. FILTRATION SOLUTIONS

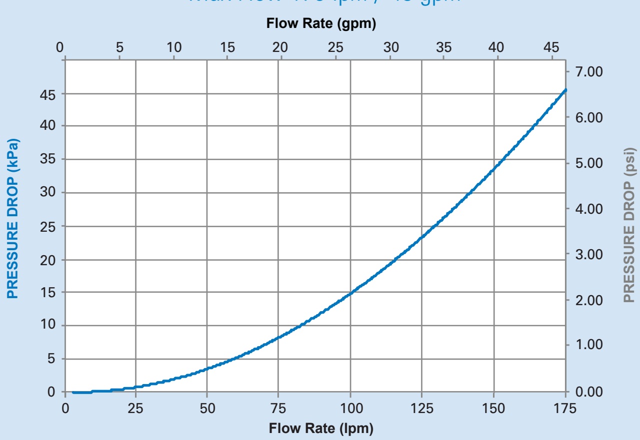
Filter Selection Chart

Maximum Recommended Flow Rate		(C) Filter Length		Media Type	Efficiency @ 99% per ISO 4548-12	Part Number	Performance Curve
lpm	gpm	mm	in				
95	25	157.9	6.22	Synteq Synthetic	16 µm	DBL7947	B
				Cellulose	23 µm	P550947	A
132	35	198.8	7.83		40 µm	P551381	C
		227.0	8.94		23 µm	P550671	D
170	45	260.0	10.24	Synteq Synthetic	16 µm	DBL7670	E
				Cellulose	23 µm	P551670	E

Performance Curves

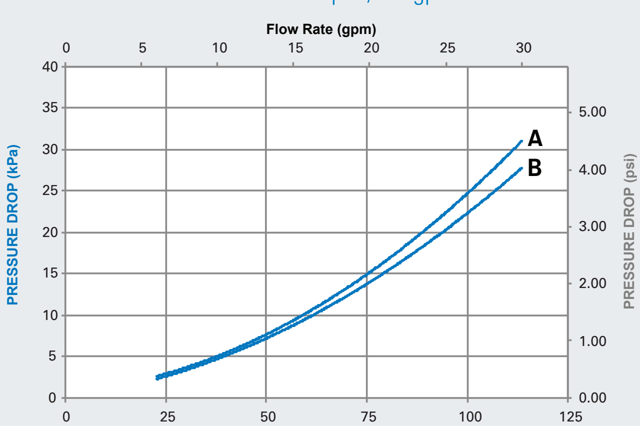
118 mm / 4.65" Head

Max Flow 170 lpm / 45 gpm



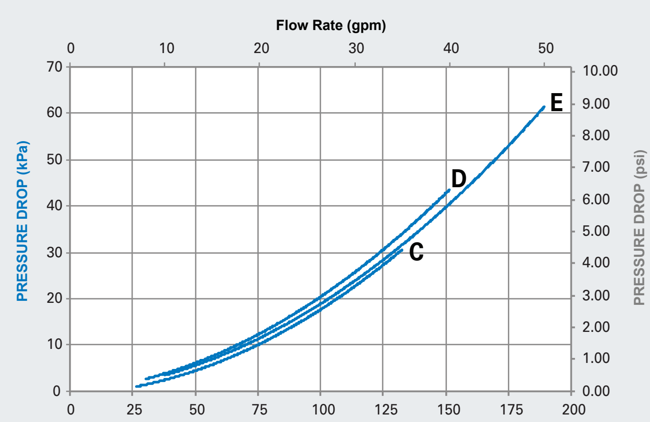
118 mm / 4.65" Filter Assembly

Max Flow 95 lpm / 25 gpm



118 mm / 4.65" Filter Assembly

Max Flow 132-170 lpm / 35-45 gpm



118 mm By-Pass Filter Assembly

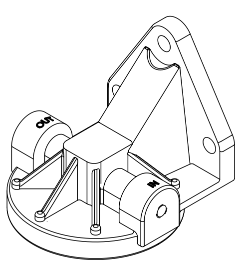
Max Flow Rate
6.62 lpm / 1.75 gpm @ 85 psi

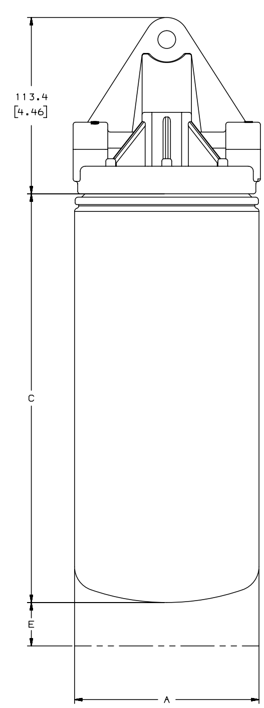
Operating Pressure
1034 kPa / 150 psi

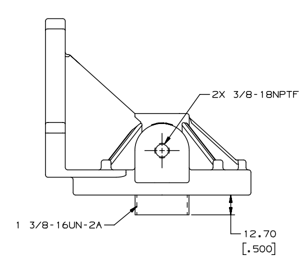
Oil Compatibility
Compatible with petroleum based fluids (hydrocarbon)

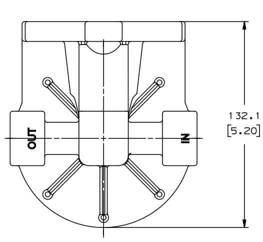
Head
3/8" -18 NPTF Ports
PART NO. P174777

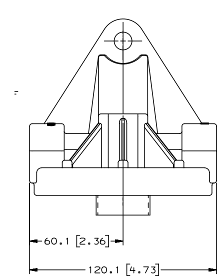
Specification Illustrations











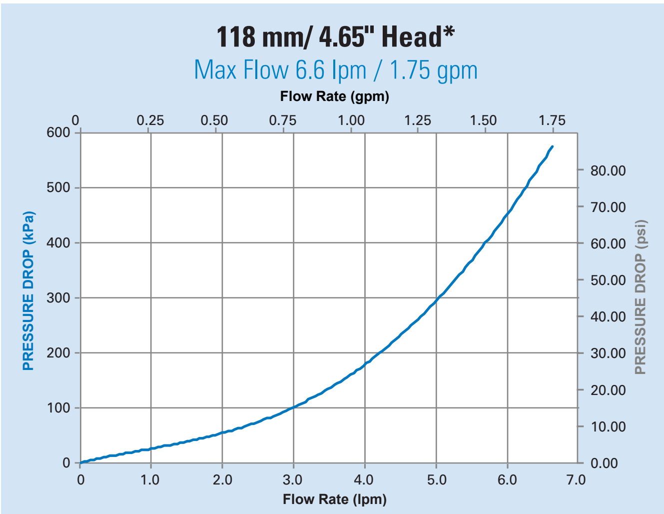
By-Pass Lube Filtration
118 mm / 4.65" Filter Diameter

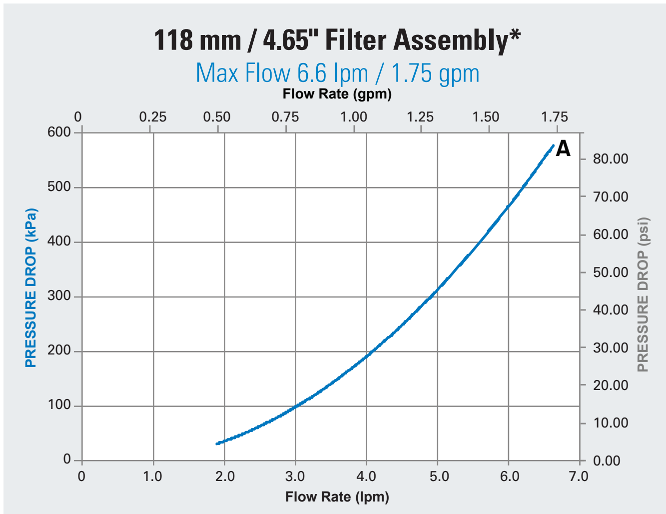
Donaldson. FILTRATION SOLUTIONS

Filter Selection Chart

Maximum Recommended Flow Rate		(C) Filter Length		Media Type	Efficiency @ 99% per ISO 4548-12	Part Number	Performance Curve
lpm	gpm	mm	in				
6.6	1.75	260	10.24	Cellulose	23 µm	P550777	A

Performance Curves





*These performance curves represent clean filter by-pass flow as a function of system pressure.

Filter Assemblies

Remote Mount Coolant Assemblies for Ease of Service

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Extend Coolant Maintenance Intervals

UP TO ONCE A YEAR OR 195,000 KM / 150,000 MI.

Donaldson Blue® premium coolant filters use Synteq™ media to remove fine contaminants from sensitive coolant systems.

Donaldson. BLUE®

Diesel Engine Coolant Filtration Systems

Coolant system filters are typically partial-flow (by-pass) filters, with less than 10% of the coolant flow circulating through the filter at any given time.

Donaldson's coolant filter offering allows you to choose the method that suits your maintenance practices and schedules.

Donaldson coolant filters are designed to work in a wide variety of operating environments and meet the service requirements of the majority of heavy-duty diesel engines.

Use of the correct filter is important to maintain the proper balance in the system to prevent over concentration (silicate drop out) or under concentration which leads to corrosion, liner pitting or other system problems.

There are multiple types of coolant filters:

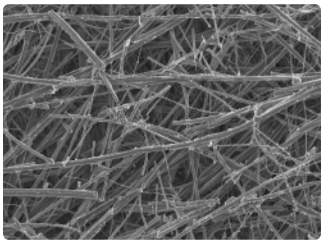
- The pre-charge filter which contains enough coolant additive to initially charge the cooling system and to allow for depletion to the first service interval.
- The standard charge spin-on filters which contain adequate chemical additive to maintain cooling systems between service intervals.
- Non-additive filters contain no chemical additives and can be used with cooling systems maintained by liquid additive, systems using long life coolants which require no additive, or on overcharged systems to bring the additive level back to a normal range. Non-additive filters are not intended to be used with water-only systems. Non-additive Donaldson Blue filters will go the distance of your coolant. These filters are intended for extended service coolant users.
- Donaldson Blue filters with additive replenishment technology contain small amounts of time-release additives to replenish coolant and maintain healthy coolant conditions. They are a direct replacement to standard filters.

Filter Media

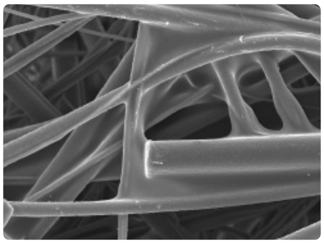
Coolant filter medias are available to meet the most stringent of engine system design challenges. Donaldson engineers have a history of development and application of media technology that exceeds application cleanliness and service life expectations.

Synteq™ Synthetic Media

Extended life intervals require micro-fiberglass synthetic media. Synteq media provides enhanced durability for extended drain intervals while maintaining or improving efficiency and capacity. This coolant media also offers lower restriction, ensuring component protection over a larger range of engine conditions.



SEM 100x



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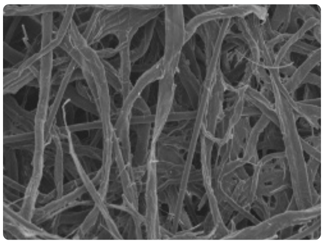
Cellulose Media

Engine coolant filter media is most commonly a pleated cellulose base material. This media effectively combines an application’s efficiency and capacity requirements while maintaining cost effectiveness.



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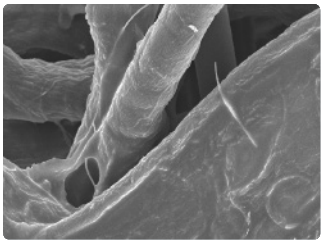

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Coolant Filtration

93 mm / 3.66" Filter Diameter

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FILTRATION SOLUTIONS

93 mm Filter Assembly

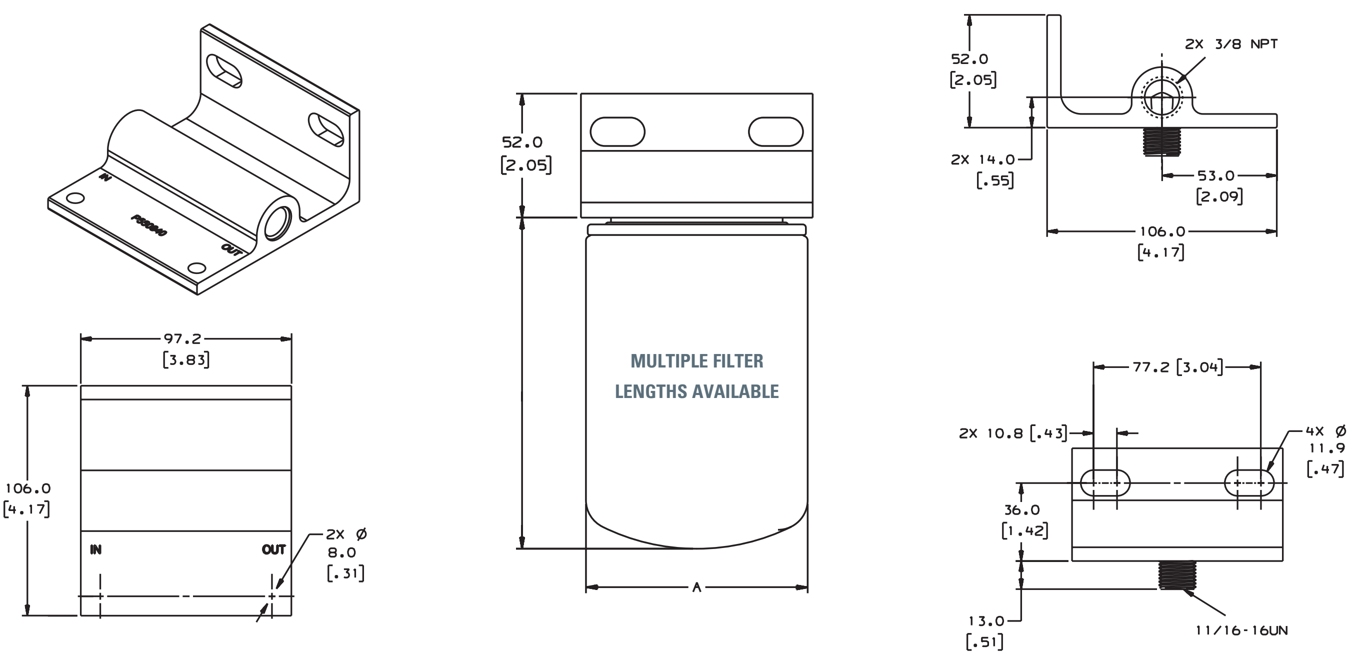
Coolant System
Up to 1500 lpm / 400 gpm

Operating Pressure
1034 kPa / 150 psi

Oil Compatibility
Compatible with petroleum based fluids (hydrocarbon)

Head
3/8" NPT Ports
PART NO. P550840

Specification Illustrations



Filter Selection Chart

(C) Filter Length		Media Type	Efficiency @ 99%	Additive Units	SCA Filter Part No.	SCA+ Filter Part No.
in	mm					
4.21	107	Cellulose	50 µm	2 Units	N/A	P552070
				4 Units	P554071	P552071
				6 Units	P554072	P552072
5.35	135	Synteq Synthetic	14 µm	Extended Service, No Additive	DBC4085	
				Extended Service, Additive Replenishment	DBC4088	N/A
		Cellulose	50 µm	8 Units	P554073	P552073
				12 Units	P554074	P552074
				15 Units	P554075	P552075
				Standard Service, No Additive	P554685	
7.87	200	Cellulose	50 µm	23 Units	N/A	P552076

Note
SCA may be substituted for DCA2 and BTE
SCA+ may be substituted for DCA4 and BTA Plus

SCA and SCA+ Chemical Differences

Donaldson SCAs combat a whole series of coolant system problems including, rust, scale from minerals, acidity from antifreeze, the intrusion of air, fuel and oil to coolant, pitting of engine parts from cavitation, foaming from coolant aeration and silicate drop-out from over-concentration.

Function	SCA Chemicals *Standard Protection*	SCA+ Chemicals *Improved Protection*
Provides protection against cavitation, erosion, and inhibits corrosion	Nitrite	Nitrite + Molybdate
Alkaline buffer to prevent acidity and control pH	Borate	Phosphate
Reduces corrosion of ferrous metals and aluminum	Silicate	Silicate
Creates a plating effect on copper and copper alloys, protecting them from direct contact with coolant and oxygen and subsequent corrosion	Benzotriazole	Tolyltriazole

Cooling System Service Guidelines

Below are recommended service intervals at flush and re-charge time.

Servicing up to 75.7 L / 20 gal

Install a new filter corresponding SCA/SCA+ units

Service Interval			0-5 gal	6-10 gal	11-15 gal	16-20 gal
@ Miles	@ KM	@ Hours	0-19 L	22.7-37.8L	41.6-46.7 L	60.6-75.7 L
5,000	8045	125 hrs	n/a	2 units	2 units	2 units
10,000	16,090	250 hrs	2 units	2 units	4 units	4 units
15,000	24,135	375 hrs	2 units	4 units	4 units	6 units
20,000	32,180	500 hrs	2 units	4 units	6 units	8 units
25,000	40225	625 hrs	2 units	4 units	8 units	12 units

*SCA or SCA+

Technical Reference

Donaldson provides this technical reference as a short course in "Engine Liquid Filtration 101"—for those who want to gain a better understanding of fluid filtration for engines. This guide is offered to aid in choosing the filter that will help you achieve the ideal cleanliness levels and longest life for your critical components.

In engine applications all over the world, we too often see engine systems that don't include proper fluid filtration, especially fuel. Good filtration needs to be an integral part of the circuit to ensure the long life and proper operation of the pumps, turbos, injectors and bearings. Today diesel engines are very sophisticated with many precision systems working together. These systems require optimum filtration to ensure their performance.

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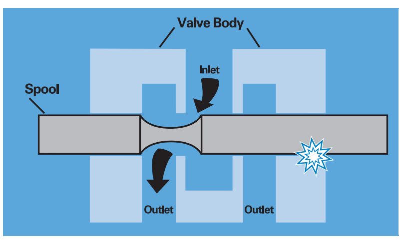
Symbols Used

ß	Beta Ratio
cSt	Centistokes
DP	Pressure Drop or Differential Pressure
ISO	International Standards Organization
µm	Micron or micrometer
ppm	Parts per million
SSU SUS	Saybolt Seconds Universal

Engine Components Need Protection

Engine liquid circuits (lube, fuel and coolant) are designed in all shapes and sizes, both simple and complex in design, and they all need protection from damaging contamination. Abrasive particles enter the system and, if unfiltered; damage sensitive components like pumps, bearings and injectors. It is the job of the filter to remove these particles from the fluid flow to help prevent premature component wear and system failure. As the sophistication of engine systems increases, the need for reliable filtration protection becomes ever more critical.

How Contamination Damages Precision Parts

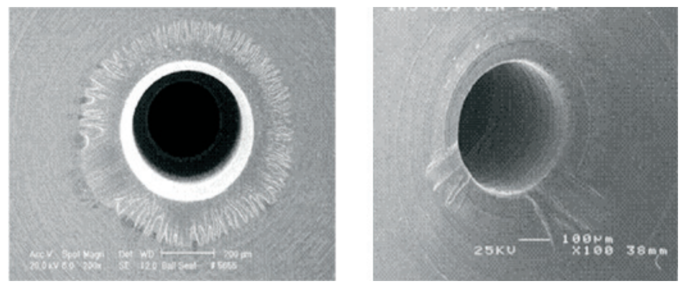


This cutaway view of a simple oil valve illustrates how particles damage components. In normal operation, the spool slides back and forth in the valve body, diverting oil to one side of the valve or the other. This type of valve is typical in engine oil control circuits. If a particle lodges between the spool and valve body, it will erode small flakes from the metal surfaces. As these flakes are moved back and forth by the action of the spool, they can roll into a burr that jams the spool and disables the valve.

In the pictures below, we see examples of how contamination can impact fuel injectors. Fuel injector nozzles are small passages that deliver an evenly distributed fine mist of fuel to the combustion chamber. These fine passages can become plugged with contamination.

Close up of new (left) and worn (right) fuel injector nozzles.

Another wear area can be the fuel injector needle seat. The needle mates to a seat which is the sealing surface to control the flow of fuel to the combustion chamber. If a particle becomes trapped between the needle and seat it can hold the needle open. In addition, this particle can wear the surface – causing it to become irregular and disable the sealing function of the needle. This can impact the fuel delivery performance of the injector.



Close-up of worn fuel injector needle seat.

Types of Contaminant

Many different types of contamination may be present in engine fluids, causing various problems. Some are:

- Particulate (dust, dirt, sand, rust, fibers, elastomers, paint chips)
- Wear metals, silicon, and excessive additives (aluminum, chromium copper, iron, lead, tin, silicon, sodium, zinc, barium, phosphorous)
- Water
- Sealant (Teflon®* tape, pastes)
- Sludge, oxidation, and other corrosion products
- Acids and other chemicals
- Biological, microbes

Where Contamination Comes From

New Fluids

Adding new fluid can be a source of contamination. Even though it's fresh from the drum, new engine oil isn't clean. (It may look clean, but, remember, the human eye can only see a particle the size of about 40 µm.) Also, diesel fuel cleanliness varies from pump to pump. Typical fuel cleanliness levels coming out of the pump are ISO rated at 22/21/18. (ISO cleanliness code of 22/21/18 translates to a particle count of 20,000 to 40,000 per milliliter for particles of 4 µm and greater; 10,000 to 20,000 per milliliter for particles of 6 µm and greater; and 1300 to 2500 per milliliter for particles of 14 µm and greater), and water content is typically 200 to 300 ppm. Never assume your fluid is clean until it has been filtered.

Built-In

Built-in contamination, also called primary contamination, is caused during the manufacture, assembly and testing of the engine and its components. Metal filings, small burrs, dirt or sand and other contaminants are routinely found in initial clean up filtration of newly manufactured engines.

Ingressed

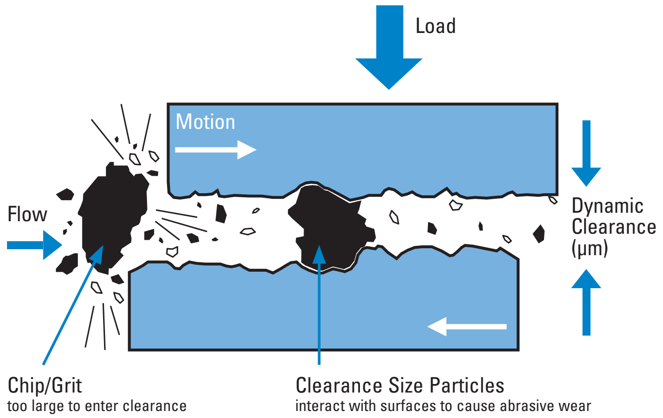
Ingressed or external contamination comes from the environment surrounding the engine or vehicle. Dirt can enter the engine liquid supply through crank case breathers or fuel tank breathers and vents and the air intake system. Ingressed moisture, particularly, can cause longer term problems. As a hot system cools at night, cool moisture-laden air can be drawn into the engine or fuel tank; as the air condenses, water is released into the engine or fuel tank. Water in excess of 0.5% by volume in a hydrocarbon-based fluid accelerates the formation of acids, sludge and oxidation that can attack internal components, cause rust, and adversely affect lubrication properties. The severity of ingression and type of contaminant are dictated by the applications and environment.

Induced

Maintenance procedures can introduce contamination into the engine. Opening the engine allows airborne particles to enter.
Removing air filters, opening oil caps, fuel tank caps and removal of oil and fuel filters are all possible sources for introducing contamination to an engine. Keep your system closed as much as possible and take care to be sure everything that goes into the engine is as clean as possible. One common example is very often funnels are used fill the engine with oil. The oily funnel will collect dirt between uses. The funnel should be properly cleaned before using it to fill the engine with oil.

In-Operation

The major sources of contamination in the engine are the combustion by-products (soot) and oxidation of the fluids in the engine due to the thermal stressing. Wear-generated contaminants are a hazard during engine operation.



The circuit actually generates additional particles as the fluid comes into contact with the precision machined surfaces of cylinder walls and pistons, injector needles and pistons and crankshaft bearings. Contaminant levels can keep doubling with every new particle generated. The result can be catastrophic if these contaminants are not properly filtered out of the system.

Rubber & Elastomers

Due to temperature, time, and high-velocity fluid streams, rubber compounds and elastomers degrade—thus releasing particulates into the fluid.

Biodiesel

Biodiesel can support biological growth and generate organic contamination and microbes.

Filter Design and Construction

There are two main differences in a filter. The first is the design of the filter itself, and the second is the type of media that is used in the filter.

Filter

Filters have some attributes that are immediately obvious to the casual observer, such as height, inside diameter, outside diameter, media concentration, type of liner, seal design, and the way the media and components are glued or potted together.

Center Tube Liner

Liners must be structurally sturdy to withstand pressure variance, yet open enough to allow good flow. Donaldson's spiral wound construction allows more flow area without compromising the collapse strength. Sharp edges on holes of competitive tubes can cause media to tear during pleat movement.

Donaldson's louver design has hundreds more flow openings than competitors. The louvers are pushed in towards the inner tube, the surface of which media come in contact with is smooth and pleat tip wear is eliminated.

Baffle Plate & Seam

Most heavy-duty liquid filters made by Donaldson have an identifiable baffle plate. They also have open ends that turn up for strength and durability. Competitive products have baffle plates that turn down and in.

Inner Seals

The top seal design must be leak-free, with a gasket or sealing device that ensures a good seal throughout the life of the filter. Standard seals are made of nitrile material, which is fine for most applications. However, if the filtered fluid is diesel or phosphate ester fluid, you'll need a seal made of a fluorocarbon.

Not all competitive filters have a seal between the baffle plate and end cap. Donaldson's seal is constructed of molded elastomer that is designed for extreme cold and heat. Some competitive brands use paper, cork and plastic spacer materials that do not last for the service life of the filter and may not be leak tight.

End Cap Sealing

A leak will occur in a filter when the end plate and filter do not seal completely. Donaldson filter media is embedded deeper in the sealing compound (plastisol, epoxy or urethane).

Media Potting

Media potting is key since it holds the media in place in between the end caps (not visible). Not only should the potting be fully around the ends of the media to prevent leaks, it should also be of a material that can withstand the application. For instance, epoxy potting should be used in filters that must perform in higher temperature environments, phosphate ester fluids and some high water based fluids.

Filter Media

Some of the most important characteristics of filter media (structure, fiber diameter, volume solidity, basis weight, thickness, layering) can only be detected under a microscope.

Curing is the process that adds strength to the filter media and ensures that filter by-pass does not occur. Donaldson cures filter media while it is in a flat, pleated state to ensure consistent and even curing. Uncured media has very low strength and can rupture easily when saturated with oil.

Media Pleating

Inside the filter, the media can vary in thickness, pleat depth and pleat concentration. Donaldson liquid filters are generally equipped with either white synthetic or yellow cellulose material media. It is important to note that media colors vary according to each manufacturer—it should not be assumed that any white-colored media is made of synthetic material.

Inner Spring or Grommet

These components keep the internal filter compressed against the baffle plate and seal. Donaldson spin-on filters use coil springs and grommets which compress and rebound under extreme pressure. Competitive brands use a leaf spring which, when compressed, will bend and deform, allowing unfiltered fluid to by-pass the filter.

Materials and Design Characteristics

Donaldson filters are designed for durability, reliable performance and consistent quality. The same filtration technology and expertise you've come to expect from Donaldson air filters is in every liquid filter we design and manufacture.

Baffle Plate

- Tapered profile makes installation easy, almost no chance of cross-threading

Seam

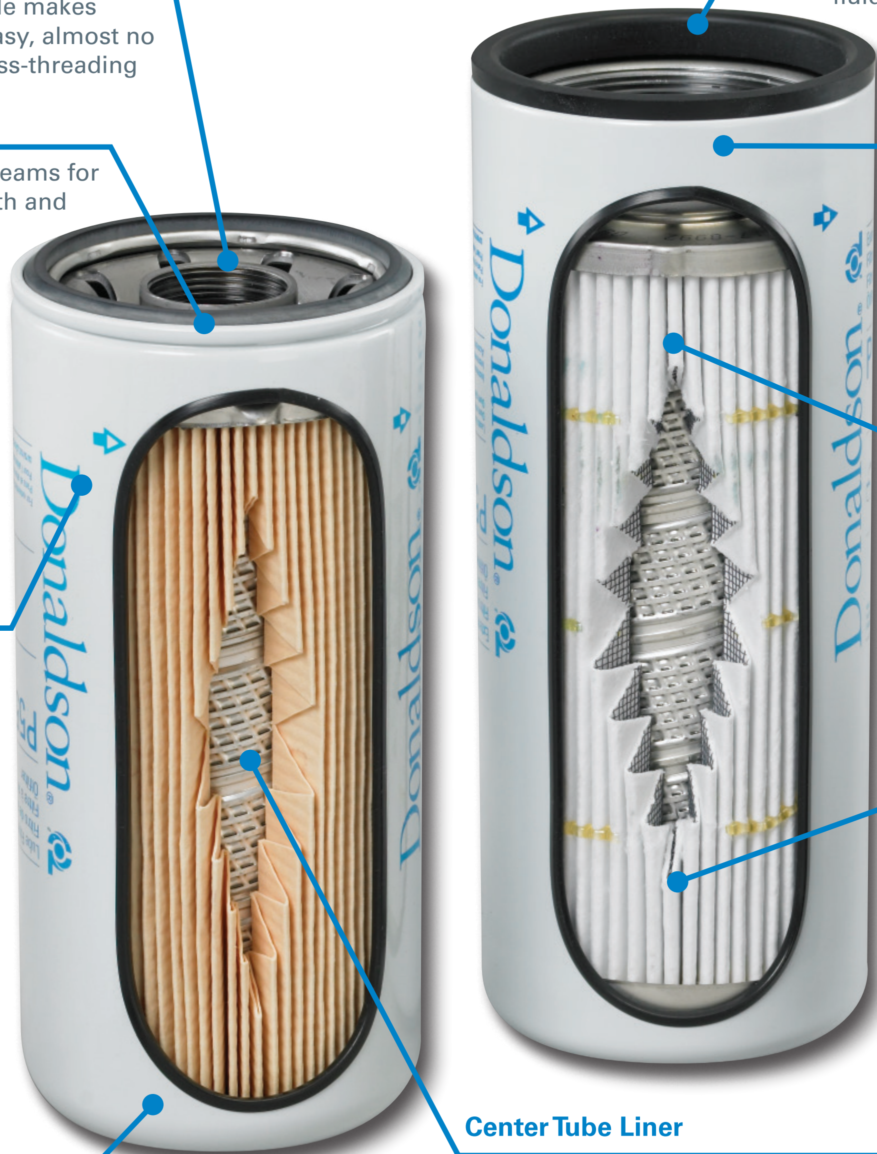
- Fully tucked seams for added strength and durability

Housing Can

- Heavy-duty coated shell, rounded dome and corner radius for superior fatigue performance

Inner Spring

- Our heavy duty coil spring seals the grommet between baffle plate and underside of the filter



Gaskets

- Designed to withstand the unique chemical properties of fuel, lube oil and coolant fluids

Inner Seals

- Critical seal between thread plate and filter cartridge
- Donaldson filters use a molded elastomer seal

Filter Cartridge

- Donaldson has design and manufacturing experience with both metal (traditional) and metal-free cartridge filters

Filter Media

- Over 35 different media formulations designed to meet or exceed application requirements

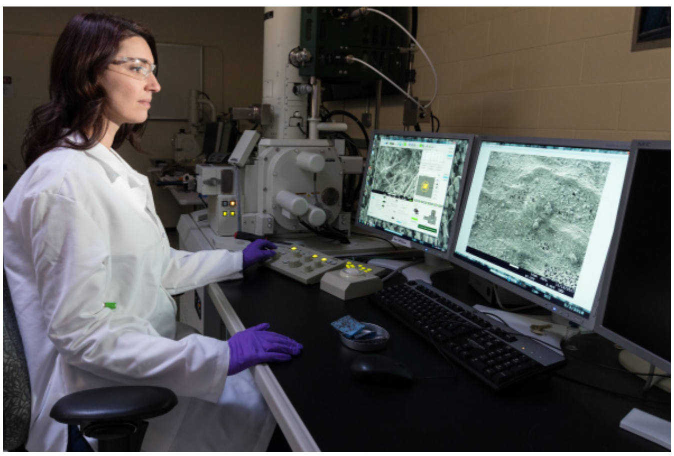
Center Tube Liner

- Louvered center tube and spiral lock seam design allows more flow area with greater collapse strength
- The louvers all face the center of the filter, keeping the media side surface smooth, which eliminates pleat tip wear

Filter Media Design and Development

Filter Media

Media is a term used to describe any material used to filter particles out of a fluid flow stream. From traditional cellulose to synthetic, the development of proprietary filtration substrates is at the heart of every Donaldson filtration system. If our existing media formulation doesn't meet our customer's specifications, our scientists use our in-house media development laboratory to design new formulations to meet those needs.



Donaldson has many internally developed proprietary computer models which enable us to predict media performance for a given fiber mixture, initial pressure loss for filter elements of various configurations, and filter loading with many different contaminants. This enables us to quickly work through many design concepts to optimize the filtration system for a unique application.

Synthetic media captures more and smaller contaminants than cellulose media. When an application requires higher efficiency filtration than cellulose filter media can deliver, Donaldson uses synthetic media technology.

Look for more information on filtration media available within the fuel, lube and coolant filtration sections.

Media Development

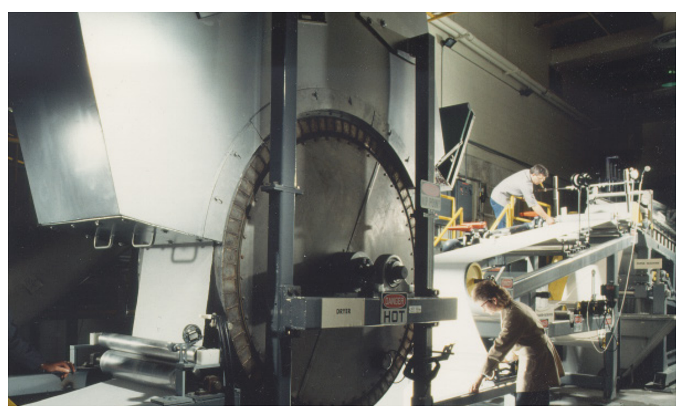
From traditional cellulose to nanofiber – the development of proprietary filtration substrates is at the heart of every Donaldson filtration system. If one of our existing media formulations does not meet our customer's specifications, our scientists use our in-house media development laboratory to develop new formulations that meet or exceed your requirements.

Media Characterization Testing

- Proprietary formulations
- Permeability
- Tensile strength
- Mullen burst
- Basis weight
- Pore size
- Thickness
- Gurley stiffness
- LEFS bench
- 3-Point bend

In-House Media Mill

- For application development
- Trial media production runs
- Development of proprietary formulations



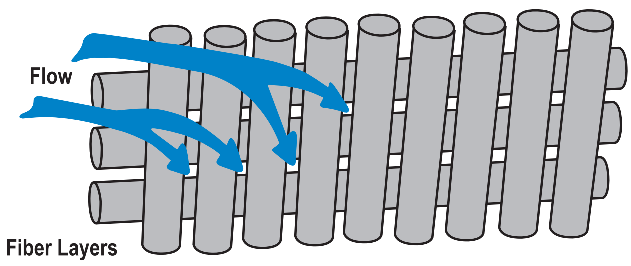
Filtration Performance Testing

- Particle counting
- Multi-pass testing
- Water removal efficiency

Basic Filtration Principles

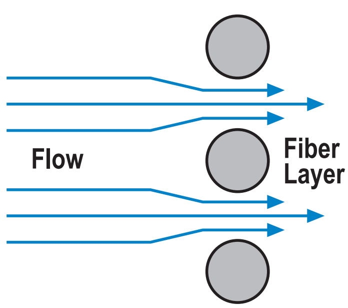
How Filter Media Functions In a Filtration System

The job of the media is to capture particles and allow the fluid to flow through. For fluid to pass through, the media must have holes or channels to direct the fluid flow and allow it to pass. That's why filter media is a porous mat of fibers that alters the fluid flow stream by causing fluid to twist, turn and accelerate during passage.



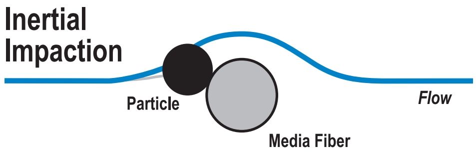
The fluid changes direction as it comes into contact with the media fibers, as illustrated above. As the fluid flows through the media, it changes direction continuously as it works its way through the maze of media fibers. As it works its way through the depths of the layers of fibers, the fluid becomes cleaner and cleaner. Generally, the thicker the media, the greater the dirt-holding capacity it has.

Looking at a cross section view of the fibers, we can see how the flow stream is accelerated as it flows into the spaces between the fibers.

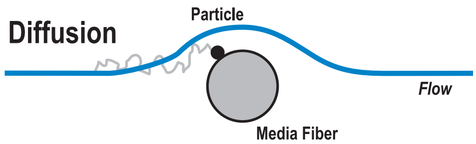


How Filter Media Collects Particles

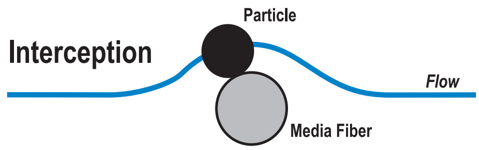
There are four basic ways media captures particles. The first, called **inertia**, works on large, heavy particles suspended in the flow stream. These particles are heavier than the fluid surrounding them. As the fluid changes direction to enter the fiber space, the particle continues in a straight line and collides with the media fibers where it is trapped and held.



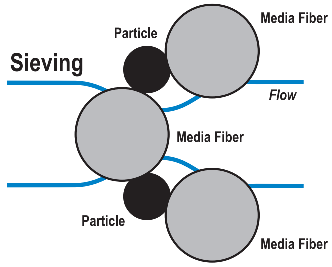
The second way media can capture particles is by **diffusion**. Diffusion works on the smallest particles. Small particles are not held in place by the viscous fluid and diffuse within the flow stream. As the particles traverse the flow stream, they collide with the fiber and are collected.



The third method of particle entrapment is call **interception**. Direct interception works on particles in the mid-range size that are not quite large enough to have inertia and not small enough to diffuse within the flow stream. These mid-sized particles follow the flow stream as it bends through the fiber spaces. Particles are intercepted or captured when they touch a fiber.



The fourth method of capture is called **sieving** and is the most common mechanism in liquid filtration. As shown below, this is when the particle is too large to fit between the fiber spaces.



ENGINE LIQUID FILTRATION TECHNICAL REFERENCE

Liquid Filtration Pressure Drop

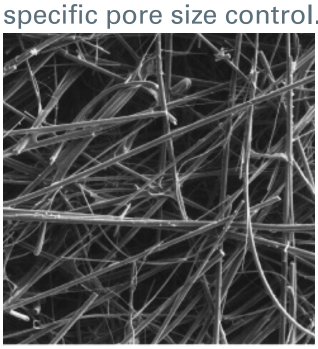
The difference between the inlet pressure and the outlet pressure is called pressure drop or differential pressure. It's symbolized by ΔP. ΔP is an irrecoverable loss of total pressure caused by the filter, and is mostly due to frictional drag on the fibers in the media. ΔP may increase as the particulate rating or efficiency of the filter gets better. ΔP also increases as the filter is being loaded with contaminant.

Major Factors Contribute to Pressure Drop

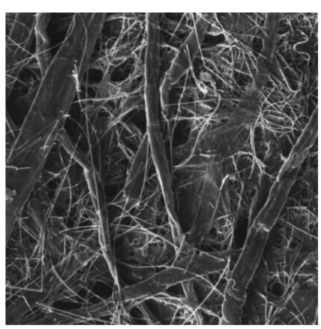
1. Filter Media

Media is the main factor influencing pressure drop; indeed, it causes pressure drop. That's why having a low-friction, high-flowing media is so important. The natural cellulose or paper fibers typically used in filtration are large, rough, and as irregular as nature made them.

Donaldson developed a synthetic media with smooth, rounded fibers, consistently shaped so that we can control the fiber size and distribution pattern throughout the media mat, and allow the smoothest, least inhibited fluid flow. Our synthetic media is named Synteq. Synteq fibers offer the least amount of resistance to fluid passing through the media. Consistency of fiber shape allows the maximum amount of contaminant catching surface area and specific pore size control.



Donaldson Synteq synthetic filter media is comprised of smooth rounded fibers provide low resistance to fluid flow.



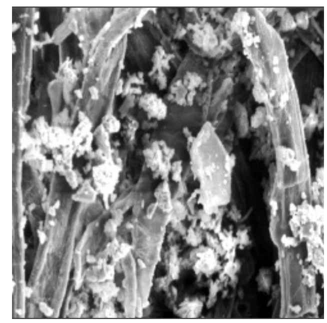
Cellulose filter media photo from scanning electron microscope magnified hundreds of times.

The result is media with predictable filtration efficiencies – removing specified contaminants and maximum dirt holding capacity. Natural cellulose fibers are larger than synthetic fibers and jagged in shape, so controlling size of the pores in the media mat is difficult and there is less open volume. In most applications this results in higher ΔP as compared to synthetic filters. Higher beta ratings mean there are smaller pores in the media; smaller media pores cause more flow resistance, in turn causing higher pressure drop.

2. Dirt, Contaminant

As dirt gets caught in the media, it eventually begins to build up and fill the pore openings.
As the pore openings shrink, the differential pressure, also referred to as pressure drop, increases. This is called restriction.

Typically there is a restriction limit for the system the filter has been applied to. The amount of restriction a filter can have before the system performance becomes affected is called the filter terminal pressure drop. This will usually be the point at which the filter capacity will be stated.



This photo from our scanning electron microscope shows actual dirt particles building up in the media pores.

3. Flow

Higher flows create higher pressure drop. With fast moving fluid, there will be more friction causing higher pressure drop across the media.

4. Fluid Viscosity

Measured in centistokes (cSt) or Saybolt Seconds Universal (SSU or SUS), fluid viscosity is the resistance of a fluid to flow. As fluid viscosity increases, the cSt rating increases. Higher fluid viscosities also mean higher pressure drop because the thicker oil has a tougher time passing through the layer of media fibers. Cold start fluid is a good example of highly viscous fluid.

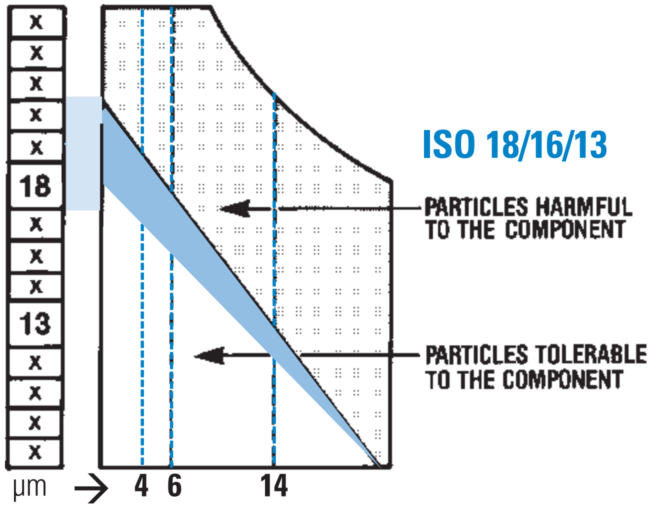
Filter media, amount of contamination, flow rate, and fluid viscosity are all factors in the importance of sizing the filter for the system requirements. Filters that are too small won't be able to handle the system flow rate and will create excessive pressure drop from the start. The results could be filter operation in the by-pass mode, filter failure, component malfunction, or catastrophic system failures. Filters that are too large for the system can be too costly. Oversized filters require more system fluid and higher cost replacement elements. Finding the optimal filter size is important.

Combining the ISO Rating and Filter Performance Ratings

Many of the components with filters have recommended or specified fluid cleanliness levels to ensure their performance and longevity. This is usually specified per ISO 4406 and with a three number rating expressed in x/y/z format. In this rating each number is a code representing the number of particles greater than a certain size. While filters, on the other hand, have a given efficiency performance based on the media used which is usually expressed in a beta rating or efficiency percentage. A direct connection between the beta rating scale and the ISO rating scale cannot be made.

Many application differences exist in engine liquid filters that need to be understood to begin to correctly apply a filtration media to obtain a desired fluid cleanliness. For example, is it a contained system like the lube oil system where the same fluid is re-circulated and the fluid will be put through the filter multiple times (multi-pass) or is it a fuel system where the fluid is consumed and needs to be cleaned in one time through the filter (single pass). What is the fluid cleanliness that is being started with and what are the application environmental conditions. These are just of few of the things to consider when choosing the correct media to apply.

The ultimate solution is monitoring filter media performance at removing particles in the 4 µm, 6 µm, and 14 µm ranges.



Fluid analysis and field monitoring are the only ways to get these measurements. Combine data from several tests to form a range of performance. Remember, actual filter performance will vary between applications.

ISO Rating System

The international rating system for fluid contamination levels is called the ISO contamination code and it is detailed in the ISO 4406 document. Many component manufacturers publish filtration level recommendations using the ISO code. Manufacturer's ISO contamination levels are based on controlling the particle counts of 4 µm, 6 µm and 14 µm particles in the system fluid. This level is identified by measuring the number of particles 4µm and greater, 6 µm and greater, and 14 µm and greater in one milliliter of the system fluid sample.

ISO 4406 Contamination Codes

Range of number of particles per milliliter

Code	More Than	Up to & Including
24	80,000	160,000
23	40,000	80,000
22	20,000	40,000
21	10,000	20,000
20	5,000	10,000
19	2,500	5,000
18	1,300	2,500
17	640	1,300
16	320	640
15	160	320
14	80	160
13	40	80
12	20	40
11	10	20
10	5	10
9	2.5	5
8	1.3	2.5
7	.64	1.3
6	.32	.64
5	.16	.32
4	.08	.16
3	.04	.08
2	.02	.04
1	.01	.02

Filter Efficiency Ratings

This information is provided as an aid to understanding fluid filter efficiency terminology based on current ISO and SAE test standards.
It is not proprietary and may be reproduced or distributed in any manner for educational purposes.

What is Beta Ratio?

Beta ratio (symbolized by ß) is a formula used to calculate the filtration efficiency of a particular fluid filter using base data obtained from multi-pass testing.

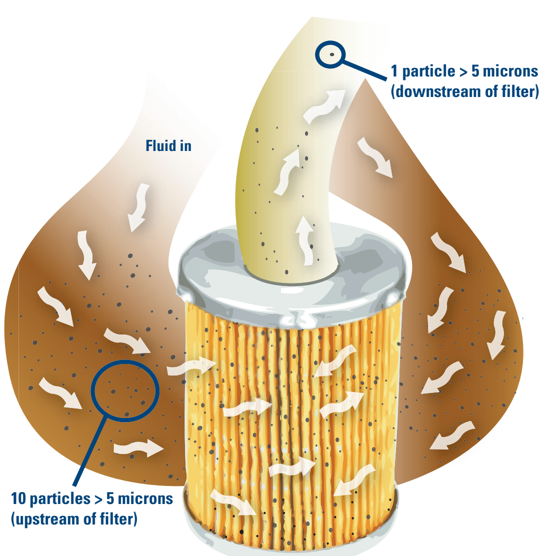
In a multi-pass test, fluid is continuously injected with a uniform amount of contaminant (i.e., ISO medium test dust), then pumped through the filter unit being tested. Filter efficiency is determined by monitoring oil contamination levels upstream and downstream of the test filter at specific times. An automatic particle counter is used to determine the contamination level. Through this process an upstream to downstream particle count ratio is developed, known as the beta ratio.

Beta Ratio Formula

$$\text{Beta ratio}_{(x)} = \frac{\text{particle count in upstream fluid}}{\text{particle count in downstream fluid}}$$

where (x) is a given particle size

$$ß_{(5)} = 75$$



Efficiency

The beta ratio is commonly used to calculate the filtration efficiency of a filter and can be converted into an percentage of efficiency at a give particle size.

Efficiency Performance Formula

$$\text{Efficiency}_{(x)} = \frac{ß - 1}{ß}$$

(x) is a given particle size

ß	Efficiency
2	50 %
5	80 %
10	90 %
20	95 %
75	98.7%
100	99 %
1000	99.9%

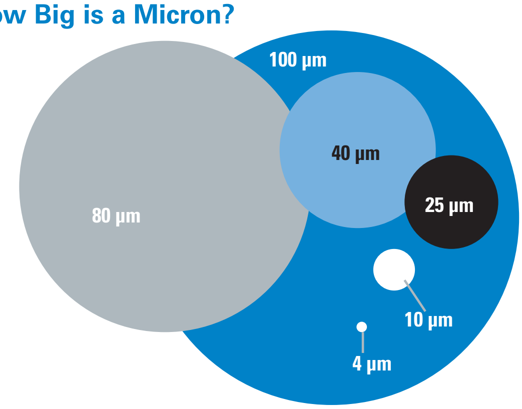
ß 75 is 98.7% for particles 5µm and greater

$ß_{(5)} = 75$ **is same as 98.7% @ 5µm**

What is a micron?

The common unit of measurement in the filtration industry is the micron or micrometer. One micron equals forty millionths of an inch (.00004). In comparison, a human hair is approximately 70 micrometers.

How Big is a Micron?



Micron Sizes of Familiar Particles

Grain of table salt	100 µm
Human hair	80 µm
Lower limit of visibility	40 µm
White blood cell	25 µm
Talcum powder	10 µm
Red blood cell	8 µm
Bacteria	2 µm
Silt	<5 µm

Frequently Asked Questions

FUEL FILTRATION

What is the meaning of efficiency in relation to a fuel filter?

Efficiency is the ability of the filter to remove particulate (% efficient) at a given micron (size). The type of media being used ultimately defines the filter's efficiency.

What is the capacity of a fuel filter and how is it measured?

Capacity is the measurement (in grams) of the total amount of containment a filter can retain at a rated flow and given end-point (restriction). The type of media (i.e. glass, cellulose, synthetic, etc.) and the amount (square inches) of media defines capacity.

What is restriction?

Restriction is the pressure drop across the filter at a given flow, temperature, and fluid viscosity. The type of media and general filter construction defines restriction.

What is hydrostatic burst pressure?

The hydrostatic burst pressure of a filter is its ability to withstand a deadhead pressure and is typically measured in kilopascal or pounds per square inch. The type of lock-seam, material thickness (bottom and body of filter), shape of tapping plate, and gasket contribute to hydro performance.

How can I estimate my engines total fuel flow rate?

If this information is not available from your engine or equipment manufacturer, use the following formulas for estimating purposes.

Diesel or kerosene fuel systems:

Gallons per Hour is Engine Horsepower (maximum) multiplied by 18% or

GPH = HP x 0.18 / LPH = HP x 0.681 / KW x 0.914

Gasoline fuel systems (carbureted):

Gallons per Hour is Engine Horsepower (maximum) multiplied by 10% or

GPH = HP X 0.1 / LPH = HP x 0.379 / KW x 0.508

Gasoline fuel systems (fuel injected):

Use a straight 40 GPH figure.

40 GPH / 151 LPH

How often should I change my fuel filter(s)?

Always follow the equipment or engine manufacturers recommendation on change intervals. The type of equipment and its usage will determine how often the filters need to be changed.

What is the difference between a primary and secondary diesel fuel filter?

The primary fuel filter must offer low restriction because it is mounted on the suction side of the fuel pump where normally a suction pressure of only 34474-41369 pascal / 5-6 pounds per square inch is available. This filter has the job of protecting the transfer pump and lightening the load of the secondary fuel filter (if installed). Primary fuel filters typically have a nominal rating of 10 - 30 microns.

Secondary fuel filters are mounted between the transfer pump and the injectors. The secondary fuel filter is designed to offer full protection to the fuel injectors. Since these filters are mounted after the transfer pump they tend to see much higher pressures than primary filters. Secondary fuel filters typically have a nominal rating of 4 - 10 microns.

What is the purpose a fuel/water separator?

Water flowing at high velocity between highly polished valve seats and through fine nozzle orifices causes a wearing action that approaches that of abrasion. The presence of water, especially with entrained air and various fuel components, causes rust and other chemical corrosion that eats away at the finely mated surfaces. Fuel/water separator filters use chemically treated paper to repel water which then settles by gravity to the bottom of the filter. Accumulated water can be drained from the filter during recommended service intervals if equipped with a drain valve or plug.

What is asphaltene?

All diesel fuels to a degree contain a substance known as asphaltene. Asphaltene is a by-product of fuel as it oxidizes. Asphaltene particles are generally thought to be in the half micron – 2 micron range and are harmless to the injection system, as they are soft and deformable. As these tiny particles pass through the filter media they tend to stick to the individual fibers. If you were to cut open a filter that had choked after a normal service interval you would see a black, tarry substance on the dirty side of the filter; this is asphaltene (oxidized fuel).

Frequently Asked Questions

LUBE FILTRATION

Can the filter cause low oil pressure?

While some pressure drop across the filter is normal, the oil filter is not capable of regulating the lube system pressure. Low oil pressure is generally the result of another malfunction in the engine such as the oil pump losing its prime or the pressure-regulating valve not functioning properly.

What causes a gasket to displace from the oil filter?

Gasket displacement is the result of insufficient gasket compression during installation, excessive lube system pressure or a combination of the two. Any deformation to the filter, from which the gasket was displaced, is a clear indicator that the filter was exposed to excessive lube system pressure. Excessive lube system pressure is most likely the result of a malfunctioning pressure regulating valve that is failing to open properly.

Is it better to use a filter with higher efficiency, regardless of the capacity of the filter?

The correct filter for an application will have a good balance between efficiency and capacity for the application that it is used in. Using a filter with very high efficiency may lower the dirt holding capacity of the filter enough to shorten the life of the filter on the application, increasing the risk of the system going into by-pass.

What is the difference between a by-pass lube filter and a full-flow lube filter?

The oil that goes through the full-flow lube filter goes on to lubricate the engine. The by-pass lube filter receives about 10% of the amount of oil that flows through the full-flow filters and filters that oil at a much higher efficiency. The oil that flows through the by-pass lube filter then returns to the sump. Due to the high efficiency of the by-pass lube filter, it cannot handle the same volume of flow as the full-flow filter. A metering orifice is commonly used to meter the flow of oil through the by-pass filter.

What is the purpose of a by-pass lube filter?

A by-pass lube filter is used to continually filter the oil in a system at a higher efficiency to remove contaminant that is not efficiently removed by the full-flow filter.

Can some filters be substituted for other filters?

This question is presented when customers are trying to consolidate some of the filters that they carry. The filter manufactures will not approve of such consolidation. While there are some filters that may work in the place of others, filter manufacturers recommend against consolidation, because each filter is designed after a specific OEM filter. Additionally, if changes are made to a specific filter to keep it up to date with the OEM filter that it replaces, it may no longer be an acceptable substitute for another filter that it could be used in place of, previously.

What is the micron rating and efficiency of the filter?

The micron rating of a filter represents the size of particle that the filter can remove from the fluid passing through it. The micron rating should be associated with an efficiency or beta value to indicate how efficient the filter is at removing that size of particle. Any given filter will remove various sizes of particles. The difference between filters is how efficient they are at removing certain sizes of particles.

What type of media does the filter use?

There are many different types of media that can be used in lube filters. Earlier filters used a depth type media, that type of media is still used in some filters today. Most lube filters now use pleated cellulose or cellulose blended media. Some lube filters in specialized applications use synthetic media (glass) or glass-blended media.

What are the advantages of glass media?

Glass media has more uniformity in the size of the opening in the media, which can provide for better flow performance. Glass media also has more dirt holding capacity per square inch of media than most cellulose media blends.

What is the service interval of the filter?

Aftermarket filter manufacturers design their filters to meet or exceed the performance requirements of the original equipment manufacturer, for which the filter is applied. Therefore, the use of an aftermarket filter will not affect the service interval recommendations of the original equipment manufacturer.

COOLANT FILTRATION

Do the liquid and solid additives last the same amount of time?
Yes, when equivalent amounts of supplemental coolant additives (SCA) are added.

How often should system maintenance be performed?
This is dependent on the type of SCA you have chosen to use. Refer to engine and additive manufacturer recommendations.

How can I obtain Safety Data Sheets (SDS) for coolant additives?
SDS information is available from the coolant additive manufacturer or your filter manufacturer.

Are there environmental hazards to not treating a coolant system properly?

There are no "environmental" hazards. There are definitely mechanical hazards related to incorrect coolant system maintenance procedures. (Water pump failures, wet sleeve cavitation erosion and pre-mature catastrophic engine failures.)

Why doesn't a coolant filter come factory installed on some engines?
Due to various engine designs, some engine and equipment manufacturers do not require coolant filtration. Coolant filtration can be added to these systems to prolong water life and/or aid with coolant maintenance.

Is regular tap water all right to use in coolant systems?
Most tap water does not meet engine manufacturer's specifications for use in coolant systems. Please refer to OEM guidelines and consider a coolant analysis program to determine suitability when in question.

I've never had cooling system problems. Why do I need coolant additives and filters?
It is very rare that a gasoline or diesel engine has "never" experienced a failure of a cooling system component, or a related part that couldn't have been prevented with the proper use of SCA's and a coolant filter. Both the short term and the long term economic benefits of properly utilizing SCA's and coolant filtration far out weigh the low initial investment for the appropriate coolant products and their installation.

How often do I need to monitor the system? How do I control monitoring when vehicles are traveling nationwide?
Monitoring, or testing, SCA levels are critical to the over all success of any coolant system maintenance program. SCA level monitoring can be done very easily by using coolant testing. Testing should be done at the maintenance interval for the type of SCA being used to determine if more additives are actually needed to accurately track SCA depletion rates. Testing can also be done at any time between maintenance intervals.

Can liquid SCA's and filters with SCA's be used together?
This depends on the total capacity of the cooling system. Most system capacities are of the size that either the liquid SCA or a filter with solid SCA is utilized. In larger capacity systems, however, both products are used for proper maintenance. Initial installation and maintenance instructions should always be consulted for proper product usage.

What is the difference between filters that are the same physical size and have the same thread size?
The differences in products that look alike are whether or not the filter contains SCA and, if it does, the type and the cooling system volume it will treat.

What is the difference between extended drain and extended service products?
If the SCA has the correct chemical formulation, the time required between total coolant system drain intervals can be extended beyond normal recommended intervals. The maintenance intervals to keep this product working effectively are not extended. Extended service interval products allow the service interval of the SCA to be extended beyond normal.

What is the correct water and antifreeze mixture to be used in coolant systems?
The ideal mixture is 50% water and 50% antifreeze. The coolant mixture should never contain less than 40% antifreeze or more than 60% antifreeze. The water used must meet engine manufacturer's guidelines for use in their coolant systems.

COOLANT FILTRATION, continued

Coolant seems to disappear from my system. Where does it go?

Coolant can seem to “disappear” from the system due to the lack of a coolant recovery system, evaporation, hose and clamp leakage or seepage, water pumps and/or thermostats not functioning properly, improperly sealed, cracked or broken head gaskets, cracked cylinder heads or engine blocks, and leaking or seeping radiators, heater cores or oil coolers. The consistent use of oil analysis can help pinpoint some of these problems and help avoid catastrophic failures.

Why does my coolant foam?

Foam in coolant is usually the sign of trapped air in the system, a leak on the suction side of the water pump, an improperly functioning water pump, low or no coolant in the coolant recovery tank, the lack of a coolant recovery system, the coolant system lack of appropriate SCA’s or the combining of incompatible chemicals in the coolant system.

What happens if the coolant system is overcharged with additives?

Over charging or over concentrating a coolant system with additives will result in the formation of solids. These solids will form deposits that drop out and clog passage ways in the system preventing proper heat transfer. These solids are also very abrasive and will permanently damage surfaces they come in contact with. If a coolant filter is in use, it will be quickly plugged up.

What is the best way to determine the freeze point of the coolant?

The most consistently accurate method to determine the freeze point of the coolant is the use of a refractometer. Alternative test methods can also provide an estimate of freeze point.

Can I use a liquid SCA in either a gasoline or diesel engine with no coolant filter?

Yes. However we do recommend the use of an additive free filter on all coolant systems to remove all solid and liquid contamination. Coolant system maintenance should always be done as a complete package to be most effective.

Will adding SCA’s to a coolant system postpone or cure existing corrosion problems?

No. If the system is already in poor physical condition, it should be thoroughly cleaned and flushed before the introduction of SCA’s. Once it is clean, the SCA’s will keep it that way provided proper maintenance intervals are followed.

Is it better to use a filter with coolant additive or a liquid SCA with an additive free filter?

Which coolant maintenance set-up to use is entirely determined by user preference. When properly installed, pre-charged and maintained, both filters with SCA’s and liquid SCA’s used with additive free filters will offer the coolant system identical levels of protection.

Why can’t I use a bigger filter with SCA’s?

Coolant filters with SCA’s are different physical sizes because they may contain different amounts of additives. The proper amount of SCA to be used to either pre-charge or maintain the additive level in the coolant is determined by the total capacity of the coolant system. Using the incorrect filter can result in an under-charged or an over-charged system. Both of these situations result in improper coolant system performance and could lead to pre-mature failures.

Do supplemental coolant products work with recycled antifreeze?

The vacuum distillation recycling method is the only method accepted by original equipment manufacturers. Some processes return the antifreeze to the customer with SCA’s already added. Before installing any products on the systems using recycled antifreeze, you must know whether it contains any SCA’s. If it does, an additive free filter is all that is needed until the first service interval is reached. At this point to properly treat the system, you must know what type of SCA was used by the recycler.

Do you really need to test between service intervals?

Yes. Leaks in the system could develop, other components that could allow contamination into the coolant system could fail, foreign substances or incompatible fluids could be introduced to the system or coolant system components such as the thermostat or water pump could fail. All of these situations will directly affect the ability of a properly treated coolant system to perform correctly. Periodic testing with test strips can help avoid the potentially catastrophic results of a system that is not protected.

What does the additive actually do while circulating in the coolant system?

In a clean, properly treated system, the additive physically coats the metal components and protects them from scale build up, corrosion and cavitation erosion (liner pitting).

Donaldson.

ENGINE FUEL FILTRATION SYSTEM

APPLICATION DESIGN WORKSHEET

This form is intended to be filled out by an engineer or buyer that interested in a custom fuel filtration design system.

For proper development/design engineering solution, we ask you to provide details about your engine, project due dates, fuel system and performance (mechanical and filtration), system mounting, service, final packaging and product markings.

When completed, please forward this worksheet to your Donaldson representative. Upon receipt, a Donaldson Engineer will assess your requirements and get back to you as soon as possible.

Company Name:		**Revision:**
Project Name:		
Contact Name:		**Title**
Phone:	**Fax:**	**Email:**

Current Donaldson Model Used: (if applicable)	**Your Part Number:**

Engine Information

Manufacturer ______________________________

Model______________________________

Displacement______________________________

Number of Cylinders ______________________________

Annual Volume ______________________________

Key Project Dates:

Design Proposal: ______________________________

Prototype Delivery: ______________________________

Design Freeze: ______________________________

PPAP: ______________________________

Start of Production: ______________________________

Fuel System Profile

☐ Primary Filtration ☐ Secondary Filtration

Fuel Type:

☐ Standard grade ______________________

☐ Biodiesel and max. content ________________

☐ Alternative: ______________________________

Fuel Delivery System Brand: ________________

Fuel Flow Rates: ☐ lpm or ☐ gpm

Minimum ______ Normal ______ Maximum ______

Fuel System Pressure (kPa):

Minimum ______ Normal ______ Maximum ______

Temperature: ☐ °C or ☐ °F

Fuel: Min ______ Normal _______ Max _______

Ambient: Min ______ Normal _______ Max ______

Fuel Heating ☐ Yes ☐ No

Watts __________ Voltage __________

Priming Pump ☐ Yes ☐ No

Air Relief Valve ☐ Yes ☐ No

Water Separation __________%

Volume (ml)_________

Water Collection ☐ Bowl ☐ No-bowl

Water Sensor ☐ Analog ☐ Digital

Mechanical Performance

Hydrostatic Pressure Resistance (Burst):

Test Method : ______________________________

Minimum Value: _________________kPA

Continued on next page

Mechanical Performance, continued

Collapse Pressure:

Test Method : ______________________________

Minimum Value: _________________kPA

Pressure Testing:

	Min. Cycles	Range (kPa)	Frequency (Hz)
Hydrodynamic		to	
Flow Fatigue		to	
Vibration		to	

Leak Testing:

Test Method : ______________________________

Minimum Value: _________________kPA

Filtration Performance

Test Conditions:

Method: _________________________________

Flow Rate __________________ (l/min)

Fluid Viscosity: __________________ cSt

Final Restriction:_________________ (kPa)

Max. Initial Restriction:

____________ kPa @ ________ cSt

Average Particle Efficiency

> ____ µm	> ____ µm	> ____ µm	> ___ µm

Min. Beta Ratio: β(x) =Y

X > ____________ Y>_________________

Minimum Capacity: ____________**gms**

Validation Tests For Special Fluids:

____

____

Mounting & Service

Assembly Mounting:

☐ Side ☐ Top ☐ Bottom

☐ Other: ______________________________

Filter Change Interval:

________________ ☐ km or ☐ miles or ☐ hours

Do you require installation, service or maintenance recommendations from Donaldson? ☐ Yes ☐ No

Inventory Managed by Donaldson? ☐ Yes ☐ No

Packaging

Do you have any special packaging requirements?

☐ Yes ☐ No If yes, please check all that apply:

Protective caps: ☐ on inlet ☐ on outlet ☐ on port

Final Assembly:

☐ Bulk / Bagged ☐ Bulk / Individual Boxes

☐ Other ________________________________

____

Product Markings

Do you have any product marking requirements?

Head Assembly? ☐ Yes ☐ No

Filters? ☐ Yes ☐ No

If yes, artwork it is assumed customer will provide artwork for filter markings. Donaldson can provide marking area for artwork design. Standard installation icons are available from Donaldson.

Special Requirements or Application Notes

Use this area to provide additional information that will assist Donaldson engineering.

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____

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For Donaldson USE ONLY

Date Received: ____________________________ **Request From:** ☐ Catalog ☐ Web Site ☐ Other ______________________

Assigned to:

Business Unit: ____________________________ Account Manager: ________________________

Product Manager: _________________________ Engineer: ________________________________

Donaldson Company, Inc.
Minneapolis, MN

Engine Liquid
Applications Engineering

Doc. No. F115345 ENG (4/21)

ENGINE LUBE FILTRATION SYSTEM
APPLICATION DESIGN WORKSHEET

This form is intended to be filled out by an engineer or buyer that interested in a custom fuel filtration design system.

For proper development/design engineering solution, we ask you to provide details about your engine, project due dates, lube system and performance (mechanical and filtration), system mounting, service, final packaging and product markings.

When completed, please forward this worksheet to your Donaldson representative. Upon receipt, a Donaldson Engineer will assess your requirements and get back to you as soon as possible.

Company Name:		**Revision:**
Project Name:		
Contact Name:		**Title**
Phone:	**Fax:**	**Email:**

Current Donaldson Model Used: (if applicable)	**Your Part Number:**

Engine Information

Manufacturer ______________________________

Model ______________________________

Displacement ______________________________

Number of Cylinders ______________________

Annual Volume ___________________________

Key Project Dates:

Design Proposal: ________________________

Prototype Delivery: ______________________

Design Freeze: __________________________

PPAP: _________________________________

Start of Production: ______________________

Lube System Profile

☐ Full Flow Filtration ☐ Bypass Filtration

Oil Type and Grade

Type: ____________ Grade: ______________

Oil Flow Rates: ☐ lpm or ☐ gpm

Min _______ Normal _______ Max _______

Oil System Pressure (kPa):

Minimum _____ Normal _____ Maximum _____

Temperature: ☐ °C or ☐ °F

Oil: Min _____ Normal _______ Max _______

Ambient: Min _____ Normal ______ Max _____

Oil Change Interval:

_______________ ☐ km or ☐ miles or ☐ hours

Pressure Relief Valve: ☐ In Engine ☐ In Filter

Setting: ________ kPa

Anti-drain Back Valve: ☐ Yes ☐ No

Setting: ______ kPa Max. leak at valve ______ kPa

By-pass Valve: ☐ In Engine ☐ In Filter

Setting: _________ kPa

Mechanical Performance

Hydrostatic Pressure Resistance (Burst):

Test Method : ___________________________

Minimum Value: ________________kPA

Collapse Pressure:

Test Method : ___________________________

Minimum Value: ________________kPA

Continued on next page

Mechanical Performance, continued

Pressure Testing:

	Min. Cycles	Range (kPa)	Frequency (Hz)
Hydrodynamic		to	
Flow Fatigue		to	
Vibration		to	

Leak Testing:

Test Method : ______________________________

Minimum Value: _________________kPA

Filtration Performance

Test Conditions:

Method: _________________________________

Flow Rate __________________ (l/min)

Fluid Viscosity: __________________ cSt

Final Restriction:_________________ (kPa)

Max. Initial Restriction:

____________ kPa @ ________ cSt

Avgerage Particle Efficiency (size & %)

> ____ µm	> ____ µm	> ____ µm	> ____ µm
%	%	%	%

Min. Beta Ratio: β(x) =Y

X > ____________ Y>_________________

Minimum Capacity: ____________**gms**

Validation Tests For Special Fluids:

____

____

Mounting & Service

Assembly Mounting:

☐ Side ☐ Top ☐ Bottom

☐ Other: ______________________________

Filter Change Interval:

________________ ☐ km or ☐ miles or ☐ hours

Do you require installation, service or maintenance recommendations from Donaldson? ☐ Yes ☐ No

Inventory Managed by Donaldson? ☐ Yes ☐ No

Packaging

Do you have any special packaging requirements?

☐ Yes ☐ No If yes, please check all that apply:

Protective caps: ☐ on inlet ☐ on outlet ☐ on port

Final Assembly:

☐ Bulk / Bagged ☐ Bulk / Individual Boxes

☐ Other ________________________________

____

Product Markings

Do you have any product marking requirements?

Head Assembly? ☐ Yes ☐ No

Filters? ☐ Yes ☐ No

If yes, artwork it is assumed customer will provide artwork for filter markings. Donaldson can provide marking area for artwork design. Standard installation icons are available from Donaldson.

Special Requirements or Application Notes

Use this area to provide additional information that will assist Donaldson engineering.

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For Donaldson USE ONLY

Date Received: ____________________________ **Request From:** ☐ Catalog ☐ Web Site ☐ Other ______________________

Assigned to:

Business Unit: ____________________________ Account Manager: ________________________

Product Manager: __________________________ Engineer: ________________________________

Doc. No. F115346 ENG (4/21)

Always Connected.

Supporting maximum uptime.

EASILY MONITOR YOUR WHOLE FLEET WITH A SINGLE DASHBOARD

On-road, off-road and everywhere in between, Donaldson Filter Minder™ Connect can help you maximize productivity and manage downtime no matter the industry, environment, or size of your fleet. Filter Minder Connect monitoring solutions are easy to install and use. Sensors integrate seamlessly into your current filtration systems.

- **Cloud-based technology is available for air, fuel, hydraulic, and lube oil filtration systems – and for real-time oil condition monitoring.**
- **Modular platform can expand to your fleet's requirement as needed.**
- **Monitor selected equipment in a single dashboard.**
- **Data is accessible to users via the MyGeotab Dashboard.**
- **No new websites, apps, or software are required.**
- **Receive customizable alerts by email or through the dashboard.**

Please contact your Donaldson representative for availability within your region.

Global Presence with a Local Touch

At Donaldson, we've built a strong, flexible and responsive network to serve our customers around the world. Support begins and ends with our people.

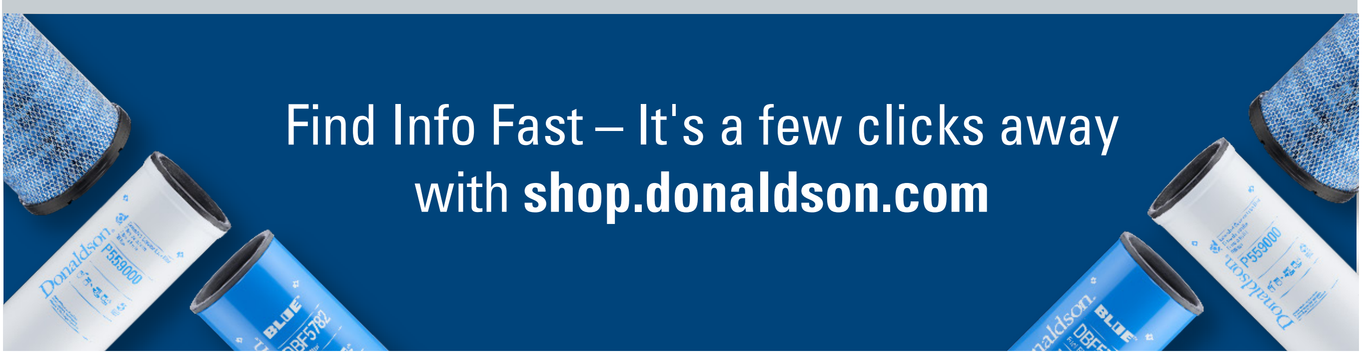
Reach Across Regions – With 11 regional headquarters, we have engineering, sales and customer service available to help whenever and wherever needed.

Localized Manufacturing – We have nearly 50 manufacturing locations around the world – producing most filters in the regions where they're used.

Distribution Centers – We then move filters and parts to our regional warehouses and distribution center hubs in over 25 countries, meaning the filters you need are never far away.

Logistics – We work with a network of transportation and logistics companies, consolidators and cross-docking facilities to deliver products to distribution partners quickly and efficiently.

Distribution Partners – We've built one of the largest, strongest and most responsive distributor networks in the filter industry. You can find the filters and support you need, nearly anywhere in the world.



Donaldson
FILTRATION SOLUTIONS

Donaldson Company, Inc.
Minneapolis, MN

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India 91-124-4807-400

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