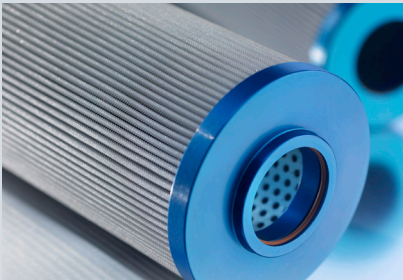
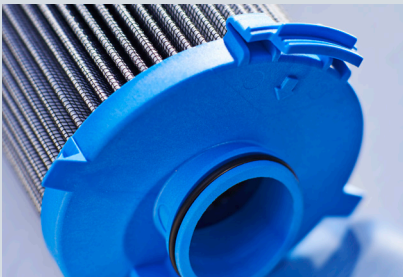




Hydraulic Filtration Product Guide

Spin-ons • Cartridges • In-tank • Low Pressure • Medium Pressure • High Pressure • Duplex • Accessories



Donaldson Delivers Performance Under Any Pressure!

Clean, dry oil is essential for your equipment. Donaldson Company, a leader in filtration for over 100 years, has proven performance in thousands of applications – offering the industry's largest selection of replacement hydraulic, lube and gear oil filtration products for contamination control.

Distributed by:

How Donaldson Displays Filter Flow versus Pressure Loss Data

Pressure Drop (ΔP) Correction Formulae

To properly calculate pressure loss for viscosity and/or specific gravity, use the filter and housing formulae below to determine the clean filter assembly pressure drop.

Filter Correction Calculation

$$\Delta P \text{ Filter} = \Delta P \text{ from graph} \times \frac{\text{New Saybolt Seconds Universal Viscosity (SSU)}}{150} \times \frac{\text{New Specific Gravity (S.G.)}}{.90}$$

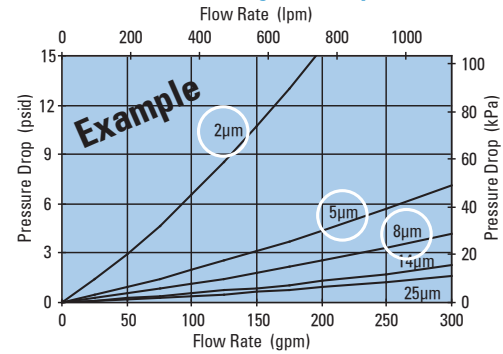
- or -

$$\Delta P \text{ Filter} = \Delta P \text{ from graph} \times \frac{\text{New Centistokes Viscosity (cSt)}}{32} \times \frac{\text{New Specific Gravity (S.G.)}}{.90}$$

Clean Filter Assembly Pressure Drop (ΔP) Calculation

$$\Delta P \text{ Clean Filter Assembly} = \Delta P \text{ head} + \Delta P \text{ filter}$$

Filter, Head or Housing/Assembly Reference



Performance Curve Notes

- All flow measurements were made with 32cSt [150 SSU] hydraulic oil at 100°F (37.7°C), fluid specific gravity of 0.9.
- The performance curves displayed are for the filter, head or housing assembly.
- Filter performance curves will either list media numbers or beta ratings (see circled areas on chart above). These labels correspond with the filter choice tables.

The Importance of Temperature in Determining Pressure Drop

Fluid viscosity plays an important role in restricting the flow through filters. It's crucial to select the proper filter to maintain adequate flow and avoid excessive pressure drops. Measured in centiStokes (cSt) or Saybolt Seconds Universal (SSU or SUS), fluid viscosity is the resistance of a fluid to flow (thickness of fluid). Low viscosity fluids pass through filters with less resistance than high viscosity fluids. Higher fluid viscosities have higher pressure drops due to higher resistance passing through the media. The colder the fluid, the higher the viscosity, so the lowest potential temperature of the fluid is the best measure for calculating pressure drop.

Use the chart below to determine the viscosity of the fluid to be filtered at its lowest potential temperature.

Oil Kinematic Viscosity Combined With Temperature in Centistokes cSt

SAE Gear Oil			75W			80W		85W	90			140	
SAE Engine Oil			5W	10W		20		30	40	50			
ISO Grade			15	22	32	46	68	100	150	220	320	460	680
°F	°C	Diesel											
248	120				4	4	6	7	9	12	13	18	23
230	110				4	6	7	9	12	15	19	24	30
212	100		1	5	5	7	9	11	15	19	25	32	41
194	90		3	5	7	9	11	15	20	26	34	44	58
176	80		5	7	9	11	15	20	27	36	48	63	85
158	70		6	9	11	15	20	28	39	52	71	95	130
140	60		8	12	15	21	29	40	57	80	110	151	211
122	50		11	15	22	30	43	62	99	128	181	254	365
104	40	1	15	22	32	46	68	100	150	220	320	460	680
86	30	2	21	32	51	76	116	175	271	409	613	907	1,380
68	20	3	33	51	87	135	214	334	536	838	1,290	1,980	3,130
50	10	4	52	87	162	264	438	711	1,190	1,920	3,070	4,870	8,020
32	0	5	85	180	340	585	1,020	1,720	2,990	5,060	8,400	13,900	23,900
14	-10	9	185	375	820	1,500	2,770	4,880	8,890	15,700	27,200	47,000	85,000
-4	-20	15	400	800	2,350	4,650	91,20	16,800	32,300	60,000			

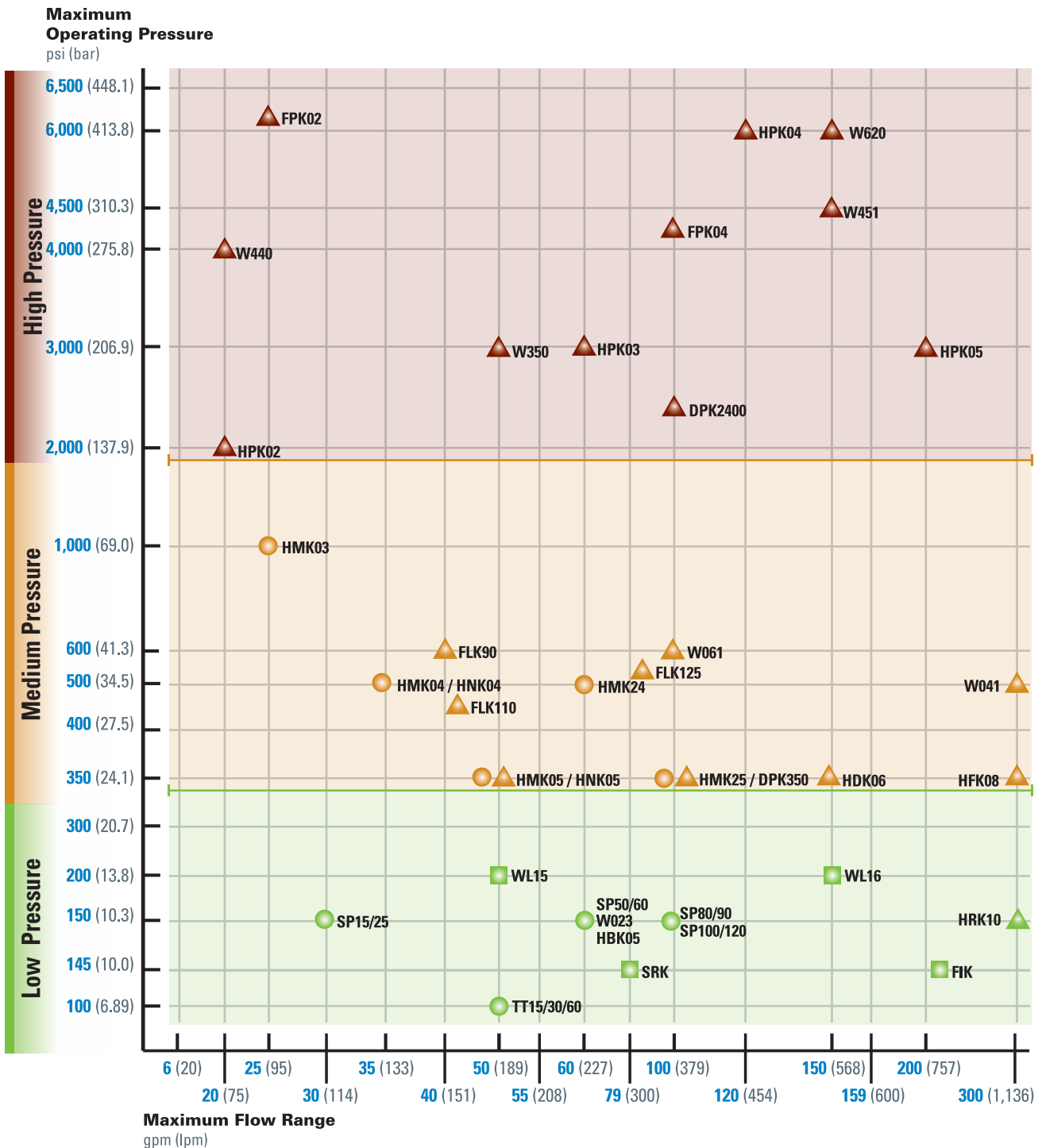
Hydraulic Filter Housing Selection Guide

Locate the Donaldson model closest to the intersection of the maximum operating pressure and maximum flow rate. If there is not a model at the exact intersection, select the nearest series to the right or above the intersection to ensure a filter that is adequate to handle the maximum operating pressure and flow rate has been selected.

Pressure families are color coded in the selection chart for low, medium and high model series. Filter housing styles are identified by their shape.

Filter Housing Style Code

● Spin-on
 ■ In-tank Housing / Cartridge
 ▲ In-line Housing / Cartridge



Selecting the Proper Hydraulic Filter

Sensitive hydraulic circuits are vulnerable to a variety of contaminants that result in inefficiency, downtime and excessive repair costs. It is important to remember that protecting and maintaining the most sensitive components within a circuit will result in effective contamination control.

With the broad range of housing styles and filters available from Donaldson, how do you choose the right filter to reliably protect your systems and equipment? Follow these recommended steps to identify the correct Donaldson filter and parts required for efficient contamination control.

1 Determine the system operating pressure and flow rate

Start by identifying two key factors in the hydraulic system operating environment for the most critical component being protected, such as pumps and motors.

- nominal and maximum operating pressure
- nominal and maximum flow rate

2 Select the filter housing model

Refer to the *Hydraulic Filter Model Series Selection Guide* on the left to select the filter housing that meets your requirements.

- Pressure families are color coded for low, medium and high models.
- Housing styles are identified by their shape code: spin-on, in-tank and in-line
- Porting type options – see page 3 for model series details.

3 Consider application factors when selecting the filter

After the appropriate housing is identified, other application factors must be considered when selecting the appropriate filter. Use the filter choice tables to determine a specific part number.

- components being protected
- ISO Code desired
- fluid type and material compatibility
- oil viscosity (SUS/cSt) & temperature
- vibration/cyclic flow surges
- media type
- flow rate (GPM/LPM)
- maximum allowable pressure drop
- efficiency / beta rating
- seal options
- standard vs. high-performance filters
- servicing and installation convenience

4 Choose the appropriate line and reservoir accessories

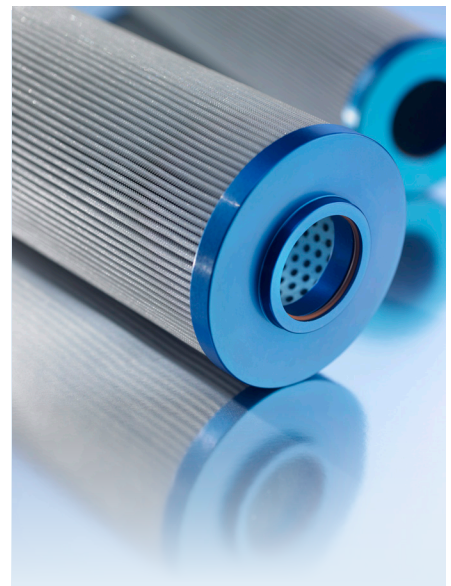
Items such as breathers, suction strainers, and gauges are important parts of an overall hydraulic system.

Refer to the Accessories Section for more information.

5 On-going contamination control practices

To optimize system performance and lengthen component life, new oil should be filtered before being transferred into a reservoir or gearbox. Monitor the condition of fluids and identify wear and contamination with regular fluid analysis.

Refer to the Off-Line Filtration and Fluid Analysis Sections for more information.



Looking for a replacement filter? Finding your Donaldson filter online has never been easier.

catalog.donaldson.com

Application/Cross-Reference/Attribute Search

You told us what you need – and we listened. We've built the ALL NEW **Donaldson DYNAMIC™ Search** to make finding your filter MUCH easier...faster...smarter... MORE flexible...powerful... DYNAMIC!



This publication contains a wide selection of standard and custom hydraulic filtration assemblies for equipment manufacturers – and replacement filters for both Donaldson housings and those produced by other manufacturers. Donaldson assemblies and filters can be used in both mobile and stationary equipment applications. For custom hydraulic filtration systems, please contact your Donaldson supplier.

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Product Line Overview

Comprehensive Hydraulic Filtration Solutions

Low Pressure Filtration

Max operating pressure < 350 psi (24 bar)



Low pressure filters are the most commonly used type of filter in hydraulic circuits, used most often in return line applications.

Donaldson low pressure filters are rated for working pressures up to 350 psi (2400 kPa). In-tank and in-line configurations are available to accommodate virtually any application.

Medium Pressure Filtration

Max operating pressure < 2,000 psi (138 bar)



Medium pressure filters can be used in applications up to 2000 psi (13790 kPa). Donaldson offers both spin-on and in-line cartridge-style filters.

Donaldson Duramax® filters are the highest rated medium pressure spin-on filters available. Duramax filters are proven, reliable, long-lived and easy to install.

High Pressure Filtration

Max operating pressure < 6,500 psi (450 bar)



High pressure filters are positioned between pumps and critical components such as cylinders, motors and valves. They help protect these critical components from catastrophic failure.

Donaldson heavy-duty high pressure filters are rated for working pressures up to 6500 psi (44818 kPa). Various porting sizes and types, including manifold style, are available for a wide range of applications.

	Model Series	Max Flow gpm (lpm)	Max Pressure psi (kPa) / bar	Porting Size Options	Page No.
Low Pressure Filtration Pages 29-80	Spin-on Filters				
	SP15/25	30 (114)	150 (1035) / 10.3	½", ¾" NPT, SAE-8, -12 O-ring	30
	W023	60 (227)	150 (1035) / 10.3	1¼" NPT, SAE-20 O-ring	34
	HBK05	60 (227)	150 (1035) / 10.3	1¼" NPT, SAE-20 O-ring	38
	SP50/60	60 (227)	150 (1035) / 10.3	1¼" NPT, SAE-20 O-ring	42
	SP80/90	100 (379)	150 (1035) / 10.3	1½" NPT, SAE-24 O-ring, 2" SAE 4-Bolt Flange Code 61	46
	SP100/120	100 (379)	150 (1035) / 10.3	1½" NPT	50
	TT15/30/60	50 (189)	100 (689) / 6.89	¾", 1½" NPT	54
	In-tank Filters				
	WL15	50 (189)	200 (1379) / 13.8	SAE-24 O-ring, 1½" SAE 4-Bolt Flange Code 61	56
	WL16	150 (568)	200 (1379) / 13.8	1½" NPT, SAE-24 O-ring, 1½" SAE 4-Bolt Flange Code 61	60
	FIK	170 (639)	145 (1000) / 10.0	½" NPT, ¾" NPT, 1" NPT, SAE-8,-12,-16,-20,-24 O-ring, 2" SAE 4-Bolt Flange Code 61	64
	SRK Combo	79 (300)	145 (1000) / 10.0	Inlet: SAE-16, -20 O-ring, Outlet: SAE-16 O-ring	74
	In-line Cartridge Filters				
	HRK10	300 (1136)	150 (1035) / 10.3	4" ANSI Flange, 8-bolt 150#	76
Medium Pressure Filtration Pages 81-124	Spin-on Filters				
	HMK03	25 (95)	1000 (6895) / 69.0	SAE-12 O-ring	82
	HMK04	35 (133)	500 (3450) / 34.5	¾", 1" NPT, SAE-12, -16 O-ring	86
	HNK04	35 (133)	500 (3450) / 34.5	SAE-12, -16 O-ring	94
	HMK05	50 (189)	350 (2415) / 24.2	1¼" NPT, SAE-20 O-ring	90
	HNK05	50 (189)	350 (2415) / 24.2	SAE-20 O-ring	94
	HMK24	60 (227)	500 (3450) / 34.5	SAE-20 O-ring, 1¼" SAE 4-Bolt Flange Code 61	86
	HMK25	100 (379)	350 (2415) / 24.2	1½" NPT, SAE-24 O-ring, 1½" SAE 4-Bolt Flange Code 61	90
	In-line Cartridge Filters				
	FLK90	40 (151)	580 (4002) / 40.0	SAE-12, -16 O-ring	99
	FLK110	42 (159)	435 (3001) / 30.0	SAE-20 O-ring	102
	FLK125	85 (320)	508 (3505) / 35.1	2" SAE 4-Bolt Flange Code 61	105
	DPK350	100 (379)	350 (2415) / 24.2	1½" SAE 4-Bolt Flange Code 61	108
	W061	100 (379)	600 (4140) / 41.4	SAE-12, -16, -20 O-ring	112
	HDK06	150 (568)	350 (2415) / 24.1	2½" NPT	116
W041	300 (1136)	500 (3450) / 34.5	SAE-24 O-ring, 2" or 2½" SAE 4-Bolt Flange Code 61	120	
HFK08	300 (1136)	350 (2415) / 24.1	3" NPT, SAE-20 O-ring	124	
High Pressure Filtration Pages 129-188	In-line Cartridge Filters				
	HPK02	20 (76)	2000 (13790) / 137.9	SAE-12 O-ring	130
	DPK2400	100 (379)	2400 (16547) / 165.4	1½" SAE 4-Bolt Flange Code 61	136
	W440	20 (76)	4000 (27580) / 275.8	SAE-12 O-ring or Manifold Mounting	140
	FPK02	25 (95)	6090 (42021) / 420.0	SAE-12 O-ring	144
	W350	50 (189)	3000 (20685) / 206.9	SAE-12, -16 O-ring	150
	HPK03	60 (227)	3000 (20685) / 206.9	SAE-12, -16 O-ring	154
	FPK04	100 (379)	4350 (30015) / 300.1	SAE-20 O-ring	160
	HPK04	120 (454)	6000 (41380) / 413.8	SAE-20 O-ring, 1¼" or 1½" SAE 4-Bolt Flange Code 61 or 62	166
	W451	150 (568)	4500 (31027) / 310.3	SAE-24 O-ring, 1½" SAE 4-Bolt Flange Code 61 or 62, Manifold Mounting	174
	W620	150 (568)	6000 (41380) / 413.8	SAE-16,-20, -24 O-ring, 1¼" SAE 4-Bolt Flange Code 62, 1½" SAE 4-Bolt Flange Code 61	178
	HPK05	200 (757)	3000 (20685) / 206.9	2" SAE 4-Bolt Flange Code 61	183

Product Line Overview

Comprehensive Hydraulic Filtration Solutions

Off-Line Filtration

The Donaldson Filter Cart, Filter Panel and Filter Buddy™ offer convenient off-line filtration, flushing and fluid transfer. Use them with your industrial and mobile equipment to achieve and maintain proper ISO cleanliness levels.

Filter Cart

Designed with performance, convenience and safety in mind. Includes value-added features to protect your machinery and equipment from breakdowns caused by contamination.

Filter Panel

Provides fixed/mounted offline filtration and a turn-key approach to supplemental filtration.

Filter Buddy™

This handheld portable system provides the capability to kidney loop reservoirs that you normally cannot reach with larger filter carts. Its small size and light weight allow for carrying up and down stairs and access into tight or confined spaces.



Replacement Filters

The Industry's Largest Selection of In-Stock Replacement Filters!

Donaldson offers a complete line of hydraulic filter heads and housings for low, medium, and high pressure applications. Spin-ons and cartridges are available in a wide range of filter medias.

When replacing another filter brand, our comprehensive and up-to-date cross-reference guide, available at catalog.donaldson.com, can guide you through performance improvement possibilities.

Our worldwide network of authorized distributors is ready to serve you with their extensive experience with hydraulic circuits and with Donaldson filters. Most distributors stock our filters and we have quick-ship programs so you can get the filter you need, when you need it.

To find a distributor near you, visit www.buydonaldson.com.



Product Line Overview

Comprehensive Hydraulic Filtration Solutions

Accessories

Accessories for hydraulic circuits, lines and reservoirs that will help you maintain proper ISO cleanliness levels.

Filter Service Indicators

- Service indicators to maximize filter life

Hydraulic Line Accessories

- Pressure gauges for monitoring system pressure
- Hoses and test points for sampling oil and determining ISO cleanliness levels
- Flanges to connect components
- Valves for system control

Reservoir Accessories

- Suction strainers help protect pumps from damage
- Diffusers for reducing aeration, foaming, turbulence and noise caused by return lines
- Sight and level gauges available, including plastic or steel screw-in styles for use in a variety of applications
- Plugs, caps and vents for small power units and gearboxes
- Filler breathers and caps come in chrome, zinc, epoxy-coated weatherproof finishes, and corrosion-resistance techno polymer – lockable, dipsticks and side-mount versions available



T.R.A.P.™ Breather Technology (Thermally Reactive Advanced Protection)

T.R.A.P. breathers provide fast-acting protection against airborne moisture and particulate contamination. They stop solid particulate down to 3 μm at 97% efficiency and prevent moisture from entering the reservoir. Water-holding capacity is regenerated with every oil return phase. This self-regenerating capability enables extended breather life.

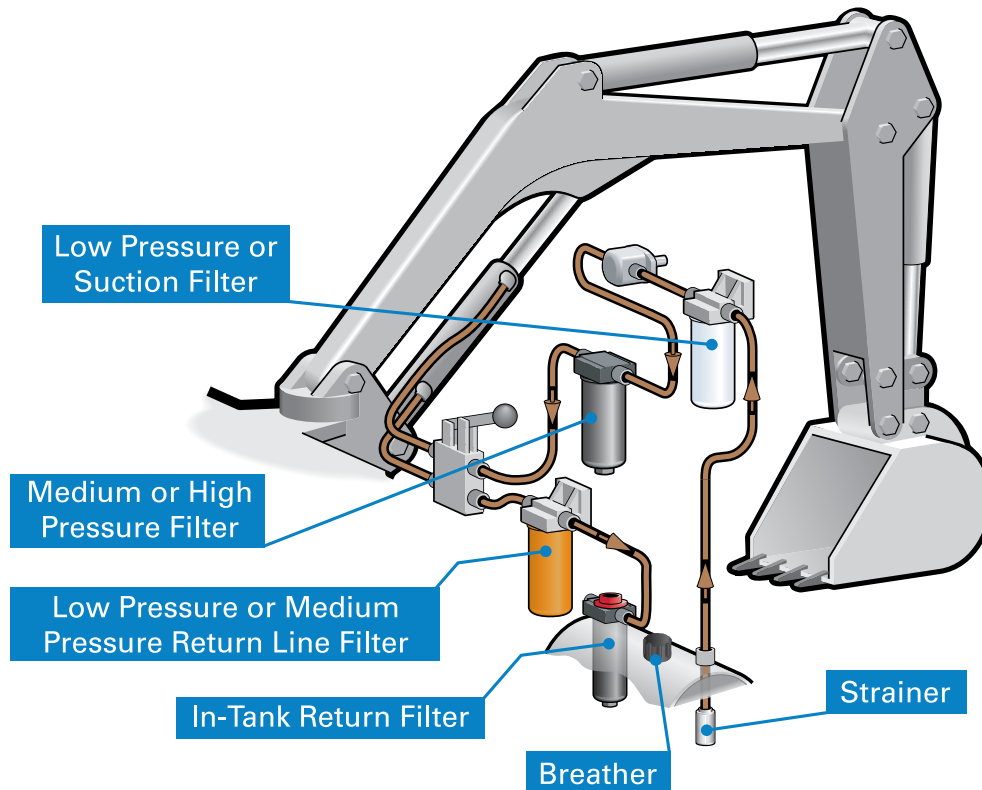
Hydraulic Filtration Solutions Engineered for Today's Industrial & Mobile Equipment



The best solutions for clean, dry oil.

Count on Donaldson to have the right filters, contamination control products and services to protect critical components in hundreds of applications – in the factory and on heavy-duty mobile equipment.

When you need hydraulic filtration, Donaldson delivers.



Full-Product Range

The industry's largest selection of in-stock filters and accessories – manufactured with consistent, high-quality performance.

Expert Technical Support

Prompt, accessible and knowledgeable customer service experts.

High-Performance Filtration

Increase dirt-holding capacity and lower pressure drop (ΔP) with Donaldson high-performance DT filters.

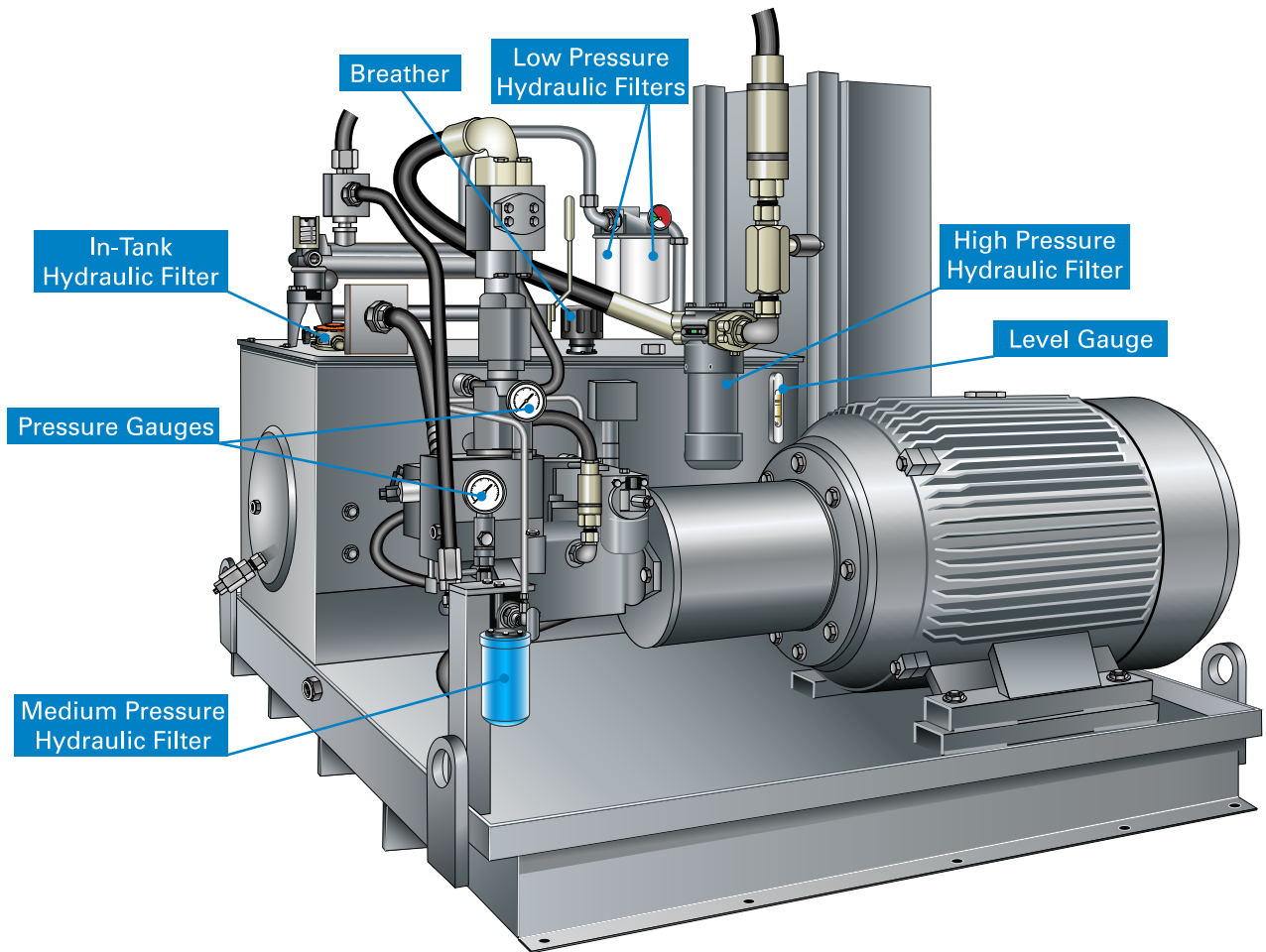
Hydraulic Filtration Solutions

Engineered for Today's Industrial & Mobile Equipment



any Performance Under Pressure

- Low, medium and high pressure filtration
- Spin-on, cartridge and in-tank style filters
- Hydraulic line and reservoir accessories
- T.R.A.P.™ reservoir breather technology



Off-Line Filtration

Filter carts, filter panels and Filter Buddy™ handheld filtration.

Water Removal

Systems and products designed to prevent water ingress and remove entrained water.


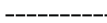
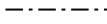

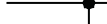
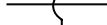
Vacuum Dehydrators & Coalescers

Quick removal of free water, dissolved water, particles and gases.




Common Fluid Power Symbols and Circuit Diagrams

Instrumentation and Pipeline Components

Lines

-  Continuous Line: Flow Line, Symbol Enclosure
-  Dashed Line: Pilot Line, Drain Line
-  System Enclosure: Long and Short Dashes around Two or More Component Symbols
-  Flexible Hose
-  Lines Connecting
-  Lines Crossing



Circular

-  Large Circle: Pump, Motor
-  Small Circle: Measuring Devices
-  Semi-Circle: Rotary Actuator



Square

-  One Square: Pressure Control Function
-  Two or Three Adjacent Squares: Directional Control







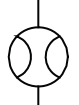
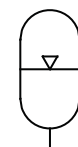
Diamond

-  Diamond: Fluid Conditioner (filter, separator, lubricator, heat exchanger)
-  Diamond with Dashed Line: Filter







Triangle

-  Solid: Direction of Hydraulic Fluid Flow
-  Open: Direction of Pneumatic Flow


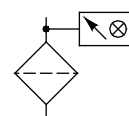
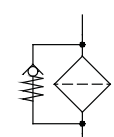
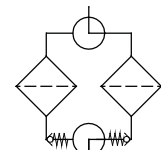
Miscellaneous Symbols

-  Spring
-  Flow Restriction
-  Connections to Tank
-  Temperature Gauge
-  Pressure Gauge
-  Test Point
-  Flow Meter
-  Gas Loaded Accumulator

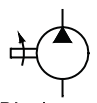

Isolation and Flow Control Valves

-  Isolator (Open)
-  Isolator (Closed)
-  Diverter Valve
-  Orifice (Jet)
-  Throttle Valve
-  Check Valve

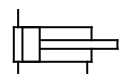

Filters

-  Basic Filter
-  Filter with Visual Clogging Indicator
-  Filter with Bypass Valve
-  Duplex Filter with Check Valve

Pumps and Motors

-  Fixed Displacement Pump
Uni-directional Flow
Anti-clockwise Rotation
-  Fixed Displacement Motor
Anti-clockwise Rotation

Cylinders and Semi-rotary Actuators

-  Double Acting Cylinder
-  Bi-directional
Semi-rotary Actuator

Hydraulic Filter Locations

Comprehensive Selection of Filtration Solutions

Typical Hydraulic Circuit and Filter Locations



Filter in a Circuit Symbol



Pressure Line Filter

Protects high-pressure side components. Helps prevent component wear or failure brought about by debris in the system.



In-Line Accessories

Pressure gauges for monitoring system pressure. Hoses and test points for sampling oil and determining ISO cleanliness levels. Flanges and valves for system control.



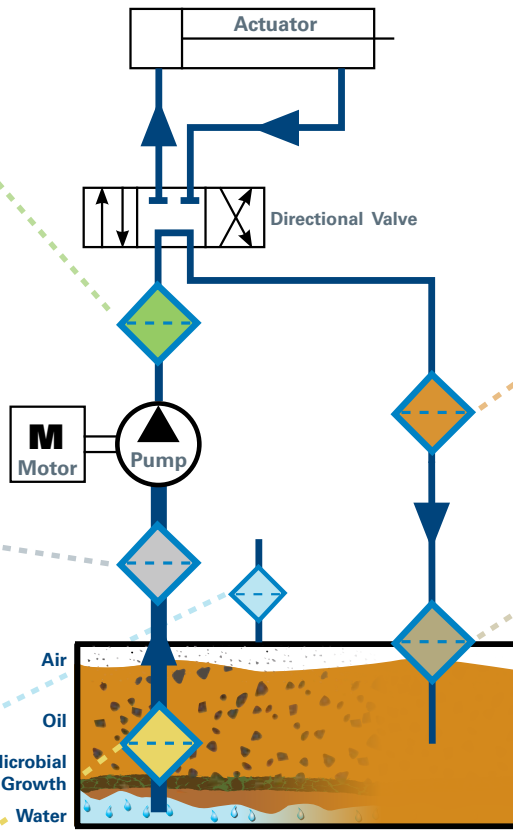
Suction Line Filter

Designed to remove particles in the 5 to 150 micron range. Easy to service and less expensive than other types of filters. Low by-pass valve use recommended to prevent pump starvation.



Return Line Filter

Captures debris from component wear or ingestion before it travels into the reservoir.



In-tank Return Line Filter

Space-saving in-tank return and suction line filters.



Reservoir Air Breather

Prevents ingress of airborne contaminants from entering the reservoir tank.

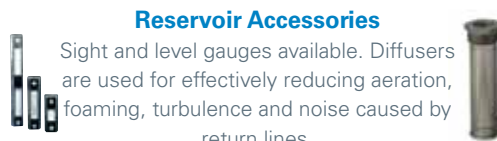
Reservoir Tank

Water in reservoir tanks is a serious threat to hydraulic systems. Dirt, particles and microbial growth are also common contaminants existing in tanks.



Suction Strainer

Removes large particles or objects built into the system during assembly or introduced during standard maintenance. Prevents catastrophic failure. Also known as a safety filter.



Reservoir Accessories

Sight and level gauges available. Diffusers are used for effectively reducing aeration, foaming, turbulence and noise caused by return lines.



Kidney Loop Filters

Off-line filtration supplements system cleanliness. Use with industrial and mobile equipment to achieve and maintain proper ISO cleanliness levels.

Industry Shaping Technology

Advanced Media Technology for Optimal Filtration Performance

Donaldson Media Formulations Set the Standard for Filtration Performance!

Donaldson offers extensive filter media technology choices for hydraulic filters – over 35 different formulations. These multiple formulations enable our engineers to develop filtration systems that meet or exceed a wide variety of customer specifications.



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

We use a variety of techniques to enhance filter media so it can withstand the high differential pressures found in typical hydraulic systems. Oven-curing, wire backing and multiple layers all contribute to our media integrity.

More detailed information on filtration media is available in the technical reference guide.

Synteq XP™ Filtration Technology

Synteq XP™ is a breakthrough in synthetic filter media technology that takes hydraulic filtration to the next level. It is the next generation of Donaldson Synteq media, designed to increase filter dirt holding capacity and reduce pressure drop.

Synteq XP is the first filter media that delivers high filtration efficiency, high dirt holding capacity and low pressure drop in a single filter for hydraulic filtration applications.

Synteq XP media technology uses a resin-free bonding technique to provide improved filtration characteristics, including:

- Enhanced hydraulic system component protection
- Lower operating pressure drop
- Longer filter life – 2 to 3 times that of traditional cellulose filter media
- Higher filtration efficiency
- Versatile packaging



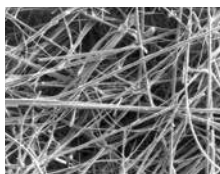
DT Synteq™ Synthetic Media (High-Performance)

DT grades of Synteq media utilize a blend of borosilicate glass fiber whose matrix is bonded together with an epoxy-based resin system. Donaldson filter media scientists found this to provide the best available chemical resistance for the broadest array of hydraulic applications. DT Synteq is ideal for use with phosphate ester and water glycol fluids.



Synteq™ Synthetic Media

This media's uniform synthetic fiber structure delivers higher filtration efficiency and longer filter life. Synteq filter media technology is ideal for synthetic fluids, water glycols, water/oil emulsions, HWCF (high water content fluids) and petroleum -based fluids. The smooth rounded fibers provide low resistance to fluid flow.



Cellulose Media

This media often has lower beta ratings, providing effective filtration for a wide variety of petroleum-based fluids. The smaller pores result in greater flow resistance, in turn causing higher pressure drop.

Water Absorbing Media

This media is formulated with absorbents and resins to remove moisture and condensation from petroleum-based fluids.

Wire Mesh Media

Wire mesh media consists of stainless steel, epoxy-coated wire mesh. This media is used to catch very large, harsh particulate that would rip up a normal filter. This media is also useful as a coarse filter in viscous fluid applications.

Filter Media Design & Development

From traditional cellulose to synthetic – 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

- 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

Industry Shaping Technology

Hydraulic Filtration Trends and Evolution

Hydraulic Filtration System Trends

Today's hydraulic systems are intolerant of corrosion, require higher cleanliness standards, and demand increased filtration performance. Hydraulic-powered vehicles and equipment owners desire the assumption of lower operation and ownership costs – a unique challenge that Donaldson understands.

Unique Filtration Systems

Donaldson continually strives to introduce new and effective filtration technologies that work within your engineering specifications and add customer value.

Low Pressure Systems

- Sensors, valves, and switches in a variety of styles and port sizes
- Unique filtration performance options
- Integrated mounting brackets
- Broad range of package sizes
- Custom design options

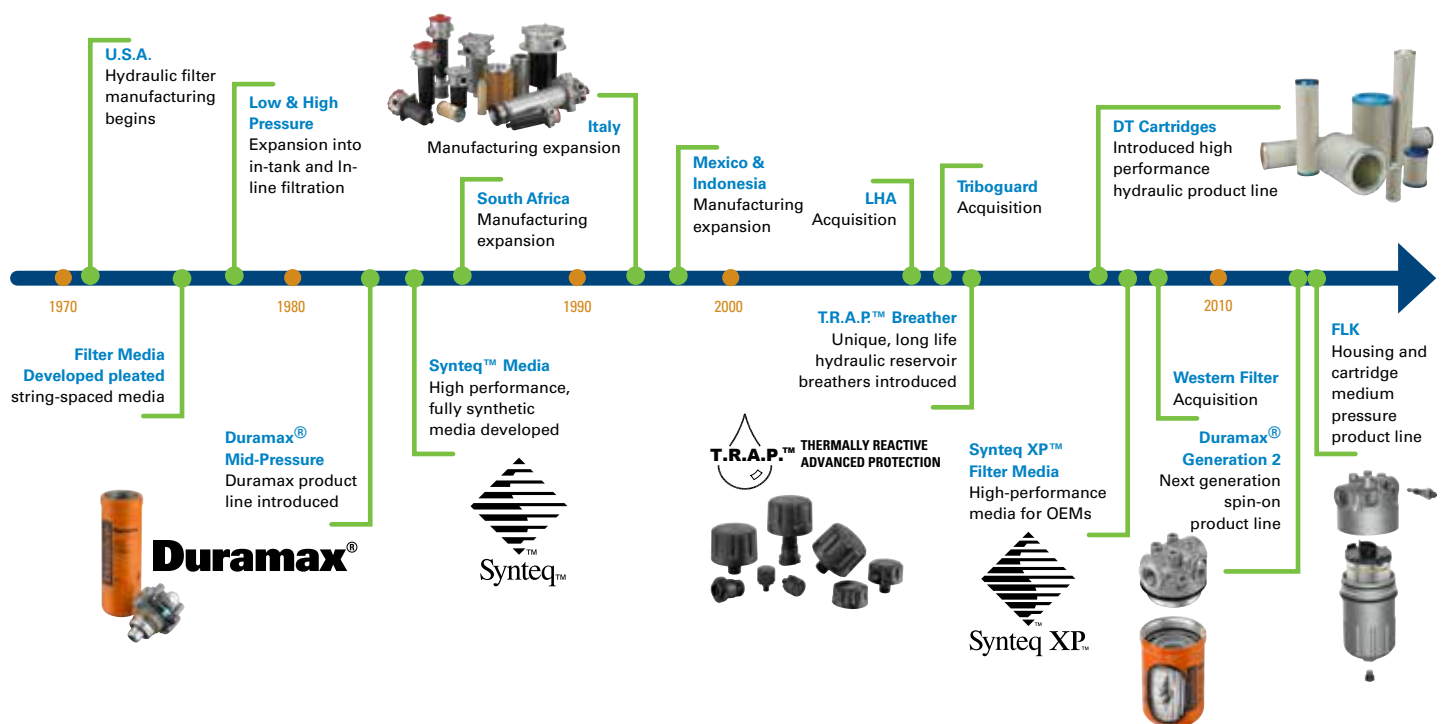
Medium Pressure Systems

- Die-cast and sand-cast custom head assemblies integrated into systems
- Enhanced system component protection
- Customized to existing filter interface – no system modification required

High Pressure Systems

- High-performance media options
- Synteq™ Filtration Media
- Material options - metal or plastic
- Multiple head interfaces

Hydraulic Filtration Design & Manufacturing Experience



Industry Shaping Technology Global Design & Logistic Capabilities

Donaldson has pioneered the use of a wide range of engineering, design and testing tools used during the product development and validation process.

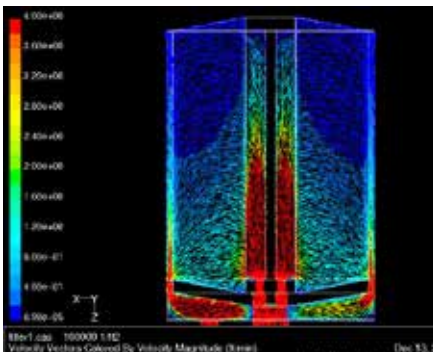
OVERVIEW

Engineering Capabilities Test & Evaluation Tools

- Design centers in three key regions – United States, Asia and Europe

Prediction and Simulation

- CAD
- Media modeling
- Fluid mechanics
- Structural analysis
- Thermal analysis



Structural Analysis

- Per SAE, ISO, and NFPA standards
- Burst
- Collapse
- Pressure impulse and fatigue

Tensile Compression

- Used to test material, component and assembly properties

Environmental Chambers

- Allows testing at hot or cold temperature, with humidity control

Flow Test Benches

- Allows measurement of static and dynamic flow and restriction for a device
- Allows calculation of device restriction at varying flows and temperatures
- System simulation

Filtration Performance Testing

- ISO, SAE, NFPA
- Customer standards
- Contaminant (particle or water) removal efficiency
- Contaminant capacity



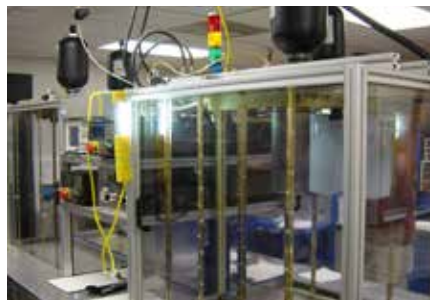
Development and Validation

Filter Durability

- Filtration performance testing per applicable SAE and ISO standards
- Fabrication integrity
- Environmental conditions
 - Salt spray and thermal cycling
- Pressure fatigue
- Flow fatigue
- Hydrostatic burst
- Flow benches
- Vibration benches
- Gravimetric analysis

Rapid Prototyping

- SLA, SLS
- Investment casting
- RTV molding



Analytical Chemistry Laboratory

- Optical microscopy
- Scanning electron microscopy (SEM)
- Chemical analysis
- Fourier transform infrared (FTIR)
- Gas chromatography (GC/MS)
- Thermal analysis (DSC, TGA)
- Liquid chromatography



Design Validation

- Test cell locations in three key regions
 - United States, Asia and Europe
- High viscosity ΔP (pressure drop)
- High temperature
- Flow fatigue
- Used oil analysis
- Component durability
- 24/7 durability testing
- Web-based test cell monitoring access
- Fluid compatibility



Vibration/Shaker

- Multiple benches
- Performance vibration with flow test
- Can apply random, shock or custom variable vibration profiles
- Capable of hot or cold tests

Field Testing

- On and off highway
- Heavy-duty
- Tests conducted on both end user and OEM applications

Field Data Acquisition

- Real time measurements
- Remote communications
- On-line collection tools
- Review daily, weekly and monthly reports to analyze operational trends

Quality Certified

- All facilities are ISO/TS certified

Quality Controls

- Consistent, reliable product
- On-site verification test units and equipment
- Part number specific PLC controls
- Manufacturing dates for tracking and warranty

Manufacturing

Locations for Liquid Filtration

- United States, Canada, Mexico, Europe and Asia-Pacific
- Located strategically with global partners



Base Component Materials

- Built for long-life, durability, corrosion resistance and liquid compatibility
- Metal and non-metal materials
- Methods to enhance media durability include oven-curing, wire backing and multiple layered media



Packaging Options

- Returnable packaging
- Heavy-duty packaging
- Pallets ISPM-15 compliant for international routing

Logistics / Distribution

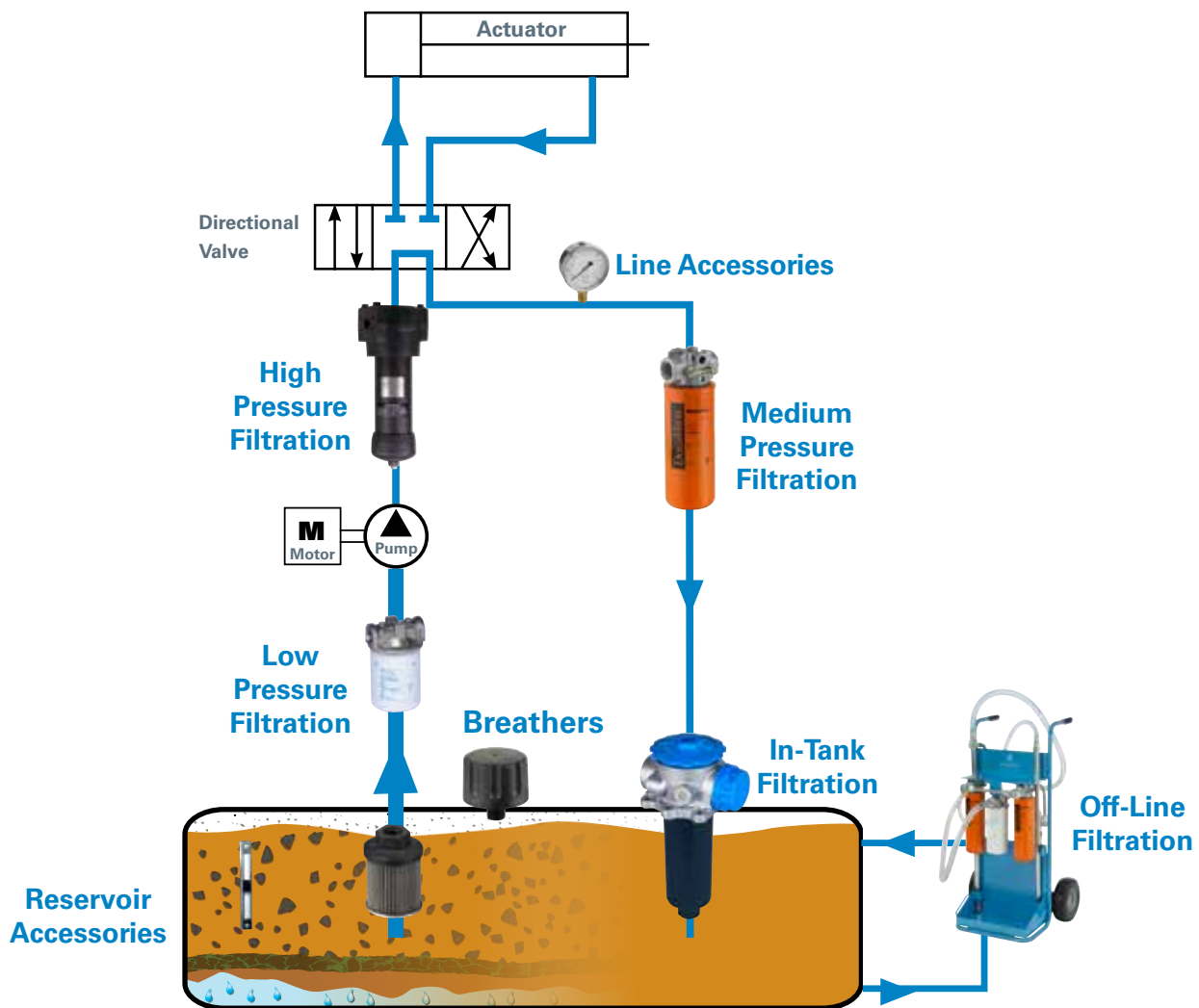
Donaldson has established a global distribution network to serve our customers locally and around the world. We operate as a global company with a network of primary distribution locations that support a mature hub of regional distribution centers and warehouses.

Donaldson distribution centers are strategically located around the globe to quickly and accurately deliver filtration and exhaust products wherever replacement products are needed. We work with a network of transportation, third party logistics companies, consolidators and cross-docking facilities to meet or exceed our customers' requirements.

Customers around the world benefit from our umbrella of distribution centers. We focus our efforts on local support and the capabilities of our staff. We continue to make significant investments in facilities, systems, supply chain relationships and staffing to offer the best order fulfillment options available.

Performance Under ^{any} Pressure

Donaldson hydraulic filters and accessories reduce a broad range of contaminants to keep sophisticated equipment running smoothly, resulting in efficient systems with superior performance. Whether it's located outdoors on equipment or inside a crowded manufacturing plant, hydraulic components need clean hydraulic and lubrication oil for maximum life and optimal productivity.



Tech-Tips for Hydraulic-Powered Vehicles and Equipment Owners

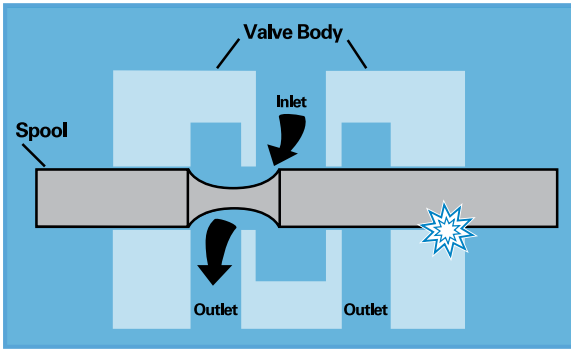
Catch-up on the latest information!

The Shoptalk section contains maintenance tips, cost reduction ideas, product features and benefits.



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Hydraulic Components Need Protection



This illustration of a simple hydraulic valve shows how particles damage components. 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.

Protect Precision Parts from Contamination Damage and Hydraulic Failures

Good filtration needs to be an integral part of the hydraulic circuit to ensure long life and the proper operation of pumps, valves and motors. Hydraulic circuits 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, valves and motors. It is the job of the hydraulic filter to remove these particles from the oil flow to help prevent premature component wear and system failure. As the sophistication of hydraulic systems increases, the need for reliable filtration protection becomes ever more critical.

Typical Factors in Component Life

Studies show that most (typically 70%) of hydraulic component replacement is necessary because of surface degradation, and most of that (50%) is due to mechanical wear.

Proper filtration of hydraulic fluids can lengthen component life. Don't cut costs by eliminating hydraulic filters. It could cost you more in the long run in major component repair!

70% Surface Degradation

- 50% mechanical wear from:
 - abrasion
 - fatigue
 - adhesion
- 20% corrosion

15% Accidents

15% Obsolescence

Ref: Shoptalk Card F115306

Where does Hydraulic System Contamination Come From?

Sources of Hydraulic System Contamination

New oil out of shipping containers is usually contaminated to a level above what is acceptable for most hydraulic systems. Never assume your oil is clean until it has been filtered. There are a surprising number of different sources of system contamination in hydraulic filtration.

New Fluid – most new fluid is not acceptable for use in hydraulic systems and must be filtered first. Learn how in the off-line filtration section-

Built-In – contamination introduced into the system during the manufacture, assembly and testing of components

Ingressed – external ingress of atmospheric contamination; air condenses and water is released into the reservoir

Induced – particles introduced during normal maintenance or system operation

In-Operation – wear generation contamination caused by the pump, actuators, cylinder or the hydraulic motor

Rubber and Elastomers – degradation of rubber compounds and elastomers products

High Water Based Fluids – supports biological growth

Replacement of Failed Components – failure to thoroughly clean conductor lines after replacing a failed pump

Types of Contaminant

Many different types of contamination may be present in hydraulic fluid. Contaminants grind and wear at the surface of moving parts, introducing even more particles into the system. These surface degradation contaminants cause more than 70% of all hydraulic system downtime.

- particulate – ingressed and built-in (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 (tape, pastes)
- sludge, oxidation, and other corrosion products
- acids and other chemicals
- biological and microbial



Scratches along the inside surface of a hydraulic cylinder reveal component damage caused by contaminants.

Ref: Shoptalk Card F115305

Understanding the Beta Rating System

This information is provided as an aid to understanding fluid filter efficiency terminology based on current ISO, ANSI and NFPA 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 β) 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 fluid 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.

The formula used to calculate the beta ratio is:

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

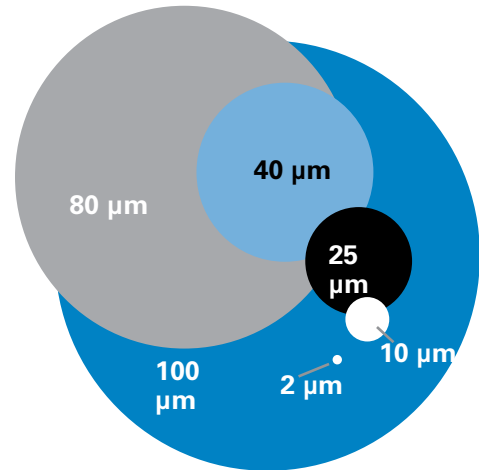
where (x) is a given particle size

Indicates that testing was done with APC's calibrated with NIST fluid

$$\beta_{10(c)} = 1000$$

1000 times more particles upstream than downstream that are 10 μm and larger

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

Hydraulic Oil Test Kits

The Advanced Fluid Analysis Kit is designed to monitor component wear, contamination and fluid condition.

Advanced Hydraulic Oil Test Kit

Kit X009330

24 Metals by ICP
Water by Karl Fischer, ppm
Viscosity at 40°C or 100°C
Oxidation/Nitration by FTIR
Total Acid Number
ISO Particle Count/Particle Quantifier
Sample Extraction Pump Part #P176431
Sample Extraction Tubing Part #P176433

Our basic hydraulic oil kit reports TAN (total acid number), water in PPM and ISO particle count.

Basic Hydraulic Oil Test Kits

- 1- Basic Use Kit X007374
- 2- Correct Drain and ISO use Kit X007377

	1	2
Metals, ppm by wt	◆	◆
Viscosity, cSt.	◆	◆
Water %	◆	
TAN (Total Acid #)		◆
Water, ppm		◆
ISO Particle Count		◆



Kit X007377 for basic hydraulic oil analysis

Recommended Sampling Interval

Industrial / Stationary

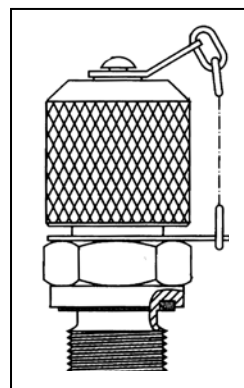
Transmissions	500 hours / monthly
Geared Drives	500 hours / monthly
Bearings	500 hours / monthly
Hydraulics	500 hours /monthly

Oil Sampling Accessories

These accessories can simplify your oil analysis during normal maintenance routines.



Sampling Pump (P176431) & Plastic Tubing (P176433) sold separately in 100 ft. rolls



Quick Sampling Metal Valve for test point. 1/8" NPT (P563212)
Working Pressure
5800 psi / 400 bar

Ref: Shoptalk Card F11523

Watch Out for Dents on Liquid Filters!



Dents in a steel filter canister create a concentration of stress—making the canister more susceptible to fatigue.

Dents May Cause Cracks

Cracked filters can be caused by dents made during improper installation. Filters that are dented prior to or during installation should not be used. Filters dented after installation should be replaced immediately. The cost of replacing a dented filter is much less than the cost of the damages that could result from a dented filter that fails during service.

Filter fatigue results from pressure pulses within the system. Pressure is regulated by a pressure regulating valve. This valve is spring operated and intermittently opens and closes to regulate pressure. Once pressure exceeds the setting of the spring in the regulating valve, the valve will open and relieve pressure until the spring can expand and close the valve. This function is repeated continuously during operation of the system, creating a pulsing effect. Filter canisters are subjected to the same pulsation. However, unlike the spring in the pressure regulating valve, canister material is susceptible to failure after such fatigue.

Filters are designed with a low carbon steel to resist fatigue and are formed so the stress created by the pulses in the system are equalized over the surface area of the canister. A dent provides an area of stress concentration where pressure pulses can greatly shorten the fatigue life of the canister.

If you receive filters that were dented prior to your receipt, you should contact Donaldson customer support for corrective action.

Ref: Shoptalk Card F115275

Watch Out for Old Compression Gaskets!



When changing any filter that has a gasket — use caution as old gaskets may stick!

A compression seal is a means of preventing migration of liquids, gases or solid contaminants across a joint or opening in an assembly or housing. A seal not only prevents the escape of fluid from inside and foreign material from entering the system from outside, but it must provide for easy installation and removal. A new gasket is critical for proper filter function.

Remember ...

- Remove used gaskets and clean the sealing area thoroughly
- Always use a new gasket with a replacement filter
- Over-tightening the filter may damage the head
- Dispose of used filters properly

Ref: Shoptalk Card F115233

How Clean is Your New Oil?

Amount of contaminant in 100 gallons hydraulic oil

Donaldson Hydraulic Filter
Synteq™ Media

Standard Hydraulic Filter
Cellulose Filter Media

New, Unfiltered Hydraulic Oil



ISO 14/9/3
.004 gram dust



ISO 19/17/14
.363 gram dust



ISO 22/21/18
4.73 grams dust

Contamination Levels of Different ISO 4406 Codes Vary Dramatically.*

New, unfiltered hydraulic oil can contain 1,000 times more contaminant than oil that has passed through filter media.

Protect your hydraulic system from costly repairs and downtime with Donaldson hydraulic products with Synteq™ filter media technology – designed to meet equipment filtration requirements and strength needs!

Prevent Catastrophic Damage to Your Expensive Equipment

Hydraulic Pump Exposure to Dirt

Synteq™ Media

Cellulose Media

New Hydraulic Oil

ISO 14/9/3

ISO 19/17/14

ISO 22/21/18

.03 lbs

2.5 lbs

32.5 lbs

12.5 grams

1,125 grams

4,750 grams

Amount of contaminant that passes through a 25 gallon hydraulic reservoir with a 25 gpm pump running for a period of 500 hours.

* Derived from the ISO 16889 test standard with NIST certified on-line automatic particle counters and ISO medium test dust (assumes spherical particle shape and lower bound diameter for test dust).

Achieved with $\beta_{4(c)} \mu m > 1000$ Synteq™ media. Actual results may vary.

Ref: Shoptalk Card F115284