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FILTRATION

FLUID CONTAMINATION SOLUTIONS CATALOG 1.0

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Fluid Contamination Under Control . . .

DFE Rated Filter Element Upgrades

Upgrade existing hydraulic and lube filter elements to Hy-Pro G7 Dualglass for cleaner fluid and improved reliability. Hy-Pro Elements are validated to achieve $\beta x_{[c]} > 1000$ beta ratios.

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Schroeder	MP Filtri	Internormen
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In-Tank Return Filters

Off-line Filter Units

High Flow Filter Assemblies & Duplexes

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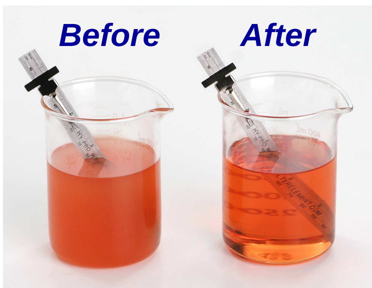
VAC-U-DRY Vacuum Dehydrators

75% of all hydraulic component failures are caused by surface degradation which is related to fluid contamination. The effects of moisture in oil systems can drastically reduce on stream plant availability. Bearing life and critical component life is greatly reduced by moisture levels above and within the saturation point. Continuous or periodic high water levels can result in damage such as:

- Metal Etching (corrosion)
- Abrasive wear in hydraulic components
- Dielectric Strength Loss
- Fluid Breakdown
- Additive precipitation and oil oxidation
- Reduction in lubricating properties

V10 Vac-U-Dry

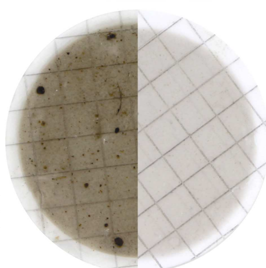
Vac-U-Dry removes water down to 50 ppm (0.005%), well below saturation, with greater efficiency than centrifuge, coalescing, or air stripping technologies



Filtering New Oil - Particulate and Water

New oil is typically dirty oil, and not suitable for use in hydraulic and lube systems.
New oil is one of the worst sources of particle contaminant ingression.

New oil ISO code can be 25/22/19 while servo system target is 16/14/11 or cleaner. Water must also be removed from new oil before adding new fluids to the system.



Mobile Filtration Systems - Filter Carts

The FCL series filter carts are ideal for both hydraulic and lube fluids (low and high viscosity).

Media options for fine particulate ($\beta 5_{[c]} > 1000$) & water removal capability. Flow rates 18 ~ 82 Lpm, 5 ~ 22 Gpm.

Optional particle monitor. Oil sampling ports standard.

Cleaner Fluid Improves Reliability & Uptime

Table 1 details extension of roller contact bearing component life as the ISO fluid cleanliness code improves.

Current ISO Code Start	Target ISO Code 2 x Life	Target ISO Code 4 x Life	Target ISO Code 5 x Life
25/22/19	20/18/15	16/14/11	15/13/10
23/21/18	19/17/14	15/13/10	14/12/9
22/20/17	18/16/13	15/13/10	13/11/8
21/19/16	17/15/12	13/11/8	-
20/18/15	16/14/11	-	-
19/17/14	15/13/10	-	-
18/16/13	14/12/9	-	-

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UNDERSTANDING ISO CODES

The ISO cleanliness code (per ISO4406-1999) is used to quantify particulate contamination levels per milliliter of fluid at 3 sizes $4\mu_{[c]}$, $6\mu_{[c]}$ and $14\mu_{[c]}$. The ISO code is expressed in 3 numbers (example: 19/17/14). Each number represents a contaminant level code for the correlating particle size. The code includes all particles of the specified size and larger. It is important to note that each time a code increases the quantity range of particles is doubling.

ISO 4406:1999 Code Chart

Range Code	Particles per milliliter: More than	Particles per milliliter: Up to/including
24	80000	160000
23	40000	80000
22	20000	40000
21	10000	20000
20	5000	10000
19	2500	5000
18	1300	2500
17	640	1300
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	0.64	1.3
6	0.32	0.64

Sample 1 (see photo 1)

Particle Size	Particles per milliliter	ISO 4406 Code range	ISO Code
$4\mu m_{[c]}$	**151773**	**80000~160000**	**24**
$6\mu m_{[c]}$	**38363**	**20000~40000**	**22**
$10\mu m_{[c]}$	8229		
$14\mu m_{[c]}$	**3339**	**2500~5000**	**19**
$21\mu m_{[c]}$	1048		
$38\mu m_{[c]}$	112		

Sample 2 (see photo 2)

Particle Size	Particles per milliliter	ISO 4406 Code range	ISO Code
$4\mu m_{[c]}$	**492**	**320 ~ 640**	**16**
$6\mu m_{[c]}$	**149**	**80 ~ 160**	**14**
$10\mu m_{[c]}$	41		
$14\mu m_{[c]}$	**15**	**10 ~ 20**	**11**
$21\mu m_{[c]}$	5		
$38\mu m_{[c]}$	1		

Photo 1: ISO code 24/22/19

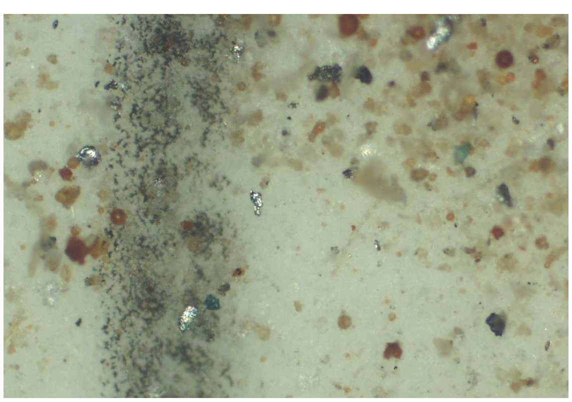


Photo 2: ISO code 16/14/11

HY-PRO FILTRATION

Selecting Target ISO Cleanliness Codes

When setting target ISO fluid cleanliness codes for hydraulic and lubrication systems it is important to keep in mind the objectives to be achieved. Maximizing equipment reliability and safety, minimizing repair and replacement costs, extending useful fluid life, satisfying warranty requirements, and minimizing production down-time are attainable goals. Once a target ISO cleanliness code is set following a progression of steps to achieve that target, monitor it, and maintain it will yield justifiable rewards for your efforts. Make an impact on reliability by controlling contamination.

Set the Target.
The first step in identifying a target ISO code for a system is to identify the most sensitive component on an individual system, or the most sensitive component supplied by a central reservoir. If a central reservoir supplies several systems the overall cleanliness must be maintained, or the most sensitive component must be protected by filtration that cleans the fluid to the target before reaching that component.

Other Considerations.
Table 1 recommends conservative target ISO cleanliness codes based on several component manufacturers guidelines and extensive field studies for standard industrial operating conditions in systems using petroleum based fluids. If a non-petroleum based fluid is used (i.e. water glycol) the target ISO code should be set one value lower for each size (4µ[c]/6µ[c]/14µ[c]). If a combination of the following conditions exists in the system the target ISO code should also be set one value lower:

- Component is critical to safety or overall system reliability.
- Frequent cold start.
- Excessive shock or vibration.
- Other Severe operation conditions.

Recommended* Target ISO Cleanliness Codes and media selection for systems using petroleum based fluids per ISO4406:1999 for particle sizes 4µ[c] / 6µ[c] / 14µ[c]

	Pressure < 140 bar < 2000 psi	Media βx[c] = 1000 (βx = 200)	Pressure 212 bar 3000 psi	Media βx[c] = 1000 (βx = 200)	Pressure > 212 bar > 3000 psi	Media βx[c] = 1000 (βx = 200)
Pumps						
Fixed Gear	20/18/15	22µ[c] (25µ)	19/17/15	12µ[c] (12µ)	-	-
Fixed Piston	19/17/14	12µ[c] (12µ)	18/16/13	12µ[c] (12µ)	17/15/12	7µ[c] (6µ)
Fixed Vane	20/18/15	22µ[c] (25µ)	19/17/14	12µ[c] (12µ)	18/16/13	12µ[c] (12µ)
Variable Piston	18/16/13	7µ[c] (6µ)	17/15/13	5µ[c] (3µ)	16/14/12	7µ[c] (6µ)
Variable Vane	18/16/13	7µ[c] (6µ)	17/15/12	5µ[c] (3µ)	-	-
Valves						
Cartridge	18/16/13	12µ[c] (12µ)	17/15/12	7µ[c] (6µ)	17/15/12	7µ[c] (6µ)
Check Valve	20/18/15	22µ[c] (25µ)	20/18/15	22µ[c] (25µ)	19/17/14	12µ[c] (12µ)
Directional (solenoid)	20/18/15	22µ[c] (25µ)	19/17/14	12µ[c] (12µ)	18/16/13	12µ[c] (12µ)
Flow Control	19/17/14	12µ[c] (12µ)	18/16/13	12µ[c] (12µ)	18/16/13	12µ[c] (12µ)
Pressure Control (modulating)	19/17/14	12µ[c] (12µ)	18/16/13	12µ[c] (12µ)	17/15/12	7µ[c] (6µ)
Proportional Cartridge Valve	17/15/12	7µ[c] (6µ)	17/15/12	7µ[c] (6µ)	16/14/11	5µ[c] (3µ)
Proportional Directional	17/15/12	7µ[c]] (6µ)	17/15/12	7µ[c] (6µ)	16/14/11	5µ[c] (3µ)
Proportional Flow Control	17/15/12	7µ[c] (6µ)	17/15/12	7µ[c] (6µ)	16/14/11	5µ[c] (3µ)
Proportional Pressure Control	17/15/12	7µ[c] (6µ)	17/15/12	7µ[c] (6µ)	16/14/11	5µ[c] (3µ)
Servo Valve	16/14/11	7µ[c] (6µ)	16/14/11	5µ[c] (3µ)	15/13/10	5µ[c] (3µ)
Bearings						
Ball Bearing	15/13/10	5µ[c] (3µ)	-	-	-	-
Gearbox (industrial)	17/16/13	12µ[c] (12µ)	-	-	-	-
Journal Bearing (high speed)	17/15/12	7µ[c] (6µ)	-	-	-	-
Journal Bearing (low speed)	17/15/12	7µ[c] (6µ)	-	-	-	-
Roller Bearing	16/14/11	7µ[c] (6µ)	-	-	-	-
Actuators						
Cylinders	17/15/12	7µ[c] (6µ)	16/14/11	5µ[c] (3µ)	15/13/10	5µ[c] (3µ)
Vane Motors	20/18/15	22µ[c] (25µ)	19/17/14	12µ[c] (12µ)	18/16/13	12µ[c] (12µ)
Axial Piston Motors	19/17/14	12µ[c] (12µ)	18/16/13	12µ[c] (12µ)	17/15/12	7µ[c] (6µ)
Gear Motors	20/18/14	22µ[c] (25µ)	19/17/13	12µ[c] (12µ)	18/16/13	12µ[c] (12µ)
Radial Piston Motors	20/18/15	22µ[c] (25µ)	19/17/14	12µ[c] (12µ)	18/16/13	12µ[c] (12µ)
Test Stands, Hydrostatic						
Test Stands	15/13/10	5µ[c] (3µ)	15/13/10	5µ[c] (3µ)	15/13/10	5µ[c] (3µ)
Hydrostatic Transmissions	17/15/13	7µ[c] (6µ)	16/14/11	5µ[c] (3µ)	16/14/11	5µ[c] (3µ)

*Depending upon system volume and severity of operating conditions a combination of filters with varying degrees of filtration efficiency might be required (I.e. pressure, return, and off-line filters) to achieve and maintain the desired fluid cleanliness.

Example		ISO Code	Comments
Operating Pressure	156 bar, 2200 psi		
Most Sensitive Component	Directional Solenoid	19/17/14	recommended baseline ISO Code
Fluid Type	Water Glycol	18/16/13	Adjust down one class
Operating Conditions	Remote location, repair difficult		Adjust down one class, combination
	High ingression rate	17/15/12	of critical nature, severe conditions

Extending Roller Bearing Life.
Improving fluid cleanliness in lubrication systems for roller bearings can exponentially increase component life. The table (right) describes attainable increases in life expectancy of roller bearings as improvements in ISO fluid cleanliness codes are made. Life extension for hydraulic components can be achieved by improving fluid cleanliness.

Current ISO Code	Target ISO Code	Target ISO Code	Target ISO Code	Target ISO Code
	2 x Life	3 x Life	4 x Life	5 x Life
28/26/23	25/22/19	22/20/17	20/18/15	19/17/14
27/25/22	23/21/18	21/19/16	19/17/14	17/15/12
25/23/20	21/19/16	19/17/14	17/15/12	16/14/11
15/22/19	20/18/15	18/16/13	16/14/11	15/13/10
23/21/18	19/17/14	17/15/12	15/13/10	14/12/9

Accurate oil analysis - Once the target ISO fluid cleanliness code is established it is critical to properly measure the actual cleanliness of the system. A well designed plan to achieve cleanliness can be undermined if steps are not taken to ensure accurate and repeatable oil analysis. When sampling the oil a wide range of variables can affect the outcome yielding inaccurate results. For more information see Accurate oil sampling and analysis article.

Oil sampling methods and practices - Bottle samples analyzed by independent laboratories is common and widely accepted as a method of quantifying fluid cleanliness. However, there are many variables associated with bottle sampling that can cause inaccurate readings.

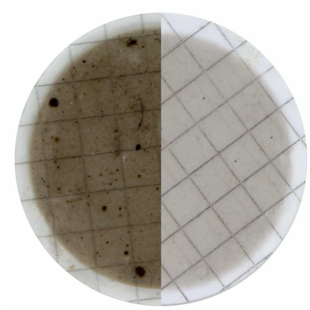
- Background contamination in “clean” sample bottles or vacuum tubes can increase ISO codes by 1~4 classes per size measured, 4μ[c]/6μ[c]/14μ[c].
- Inconsistent in-plant sampling practices (i.e. sample port flush time, bottle rinsed or not).
- Exposure of sample to airborne contaminate during sampling and analysis
- Analysis lab procedure repeatability by operator (i.e. agitation~count interval affect on suspension).
- Analysis lab calibration drift.
- Variability between oil analysis lab particle counting equipment.

On-line particle counting - Connecting an on-line particle counter directly to the hydraulic or lube system through sampling ports provides the most accurate snapshot of fluid cleanliness and eliminates many of the inherent variables associated with bottle sampling. Some particle counters can function with system pressure as low as 20 psi (1.42 bar) at certain viscosities for sampling pressure line, return line, or lubrication system. There are also particle counter options available to draw (Sip) the fluid from a reservoir, tote, or other container directly into the particle counter when system pressure is not available. Monitor sample port cleanliness in real time to know when the sample is truly representative of the system and not tainted with sample port contaminate buildup.

Maintaining control of the sampling and analysis procedures increases the accuracy of your results, eliminates the waiting game to get samples back from a lab, and allows quicker response to contamination related issues. Performing internal particle counts is a good complement to laboratory oil analysis for PPM, TAN, wear metals analysis, etc. No one knows your system better than you and once armed with the right oil analysis approach and diagnostic equipment you can make improvements in reliability.

Oil sampling port types and locations - Just as sampling technique and method can compromise results, sampling port and location can also be a challenge. Sampling ports are often contamination collection points and must be flushed for up to 6 minutes before a truly representative sample is captured. Without a proper port flush the results can be affected. Port location is also critical to obtaining a good sample. Locating a sampling where there is turbulent flow will provide more realistic results than a laminar area.

PTK-1 Oil Analysis Kit - Patch test kits are a good complement to on-line particle counters as they provide the capability to visually analyze contamination levels and types in the system. The kit includes a microscope, vacuum pump, test patches, and solvent dispenser integrated into a carrying case. The kit also features a reference manual to correlate visual patch appearance to approximate ISO code.



Machine Tool Contamination Field Study

Focus: Solving contamination issues resulting from insufficient filtration on power units and machine tools.

APPLICATIONS

- Pressure filters are ideal for protecting control valves and other sensitive components from internally generated contaminate and ingression.
- Machine tools without a pressure filter protecting valve manifolds after the pump.
- Power units on CNC lathes and milling equipment, plastics injection molding, mobile equipment, and other small industrial machines with sensitive control valves.

The Problem - Insufficient filtration

Machine tools and power units are frequently designed without the filtration necessary to maintain recommended fluid cleanliness levels for the system. A fluid cleanliness case study of three CNC lathes (A, B, C) raised some concern. The only filtration present was either a coarse suction strainer or coarse return-line screen. Baseline oil analysis (see fig 1) revealed that the fluid cleanliness levels of the hydraulic fluids (per ISO 4406 code chart) were higher than recommended levels for the system components (see fig 2).

fig. 1

Machine	ISO code*
A	22 / 20 / 14
B	23 / 20 / 14
C	23 / 21 / 16

fig 2.

Pumps		<2000 psi	2000~3000	>3000 psi
Fixed gear		20/18/15	19/17/15	
Fixed vane		20/18/15	19/17/14	18/16/13
Fixed piston		19/17/14	18/16/13	17/15/12
Variable vane		18/16/13	17/15/12	
Variable piston		18/16/13	17/15/13	16/14/12
Valves			**2000~3000**	**>3000 psi**
Directional	(solenoid)		20/18/15	19/17/14
Proportional			17/15/12	16/14/11
Servo Valve			16/14/11	15/13/10

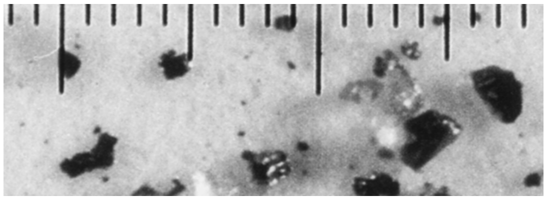
Contamination Basics & Sources

Particulate contamination is the number one cause of hydraulic component failure, and 70~75% of failures are related to surface degradation caused by mechanical wear.

Sources of particulate contamination

- Built-In contamination (assembly environment, dirty new components and hoses, metal fabrication)
- Ingested contamination (leaky reservoirs, no reservoir breather, worn rod wipers and bearing seals, dirty replacement components, system exposure during maintenance, new oil—see fig 3.)
- Internally generated contamination (abrasive wear, adhesive wear, stress related wear, corrosion, fluid breakdown)

Fig 3 (new oil typical ISO code 24/21/18).



Solution Part I - System Clean-up

The pressure filter assembly, including β12[c] = 1000 filter element and element condition indicator, was added to each of the three machines (see fig 4) after the pressure pump (piston type). After nine days of operation the indicators on machines A and C were signaling terminal pressure drop. At that time all three elements were serviced and the oil was analyzed (see fig 5). The ISO codes improved, but not to the level recommended for servo valves. The next step was to set target cleanliness codes and enhance the filtration efficiency to reach the target. The spent elements that were removed contained large particles including piping putty (from installation of new hoses) and other large debris that was not being removed by the suction strainer.

Fig 4.

fig. 5

Mach.	ISO code before Pressure filter	ISO code after 9 days (β12[c] = 1000)
A	22 / 20 / 14	19 / 18 / 12
B	23 / 20 / 14	21 /18 / 12
C	23 / 21 / 16	20 / 18 / 13

Solution Part II - Enhanced Filtration and Target Cleanliness Codes

A target ISO Cleanliness Code of 16 / 14 / 11 (measured at filter effluent) was established for all three machines to protect and maximize piston pump and solenoid valve life.

New filter elements were installed with a more efficient rating of $\beta5_{[c]}$ = 1000 (β3 = 200 according to old standards) to achieve the target. After 60 days of service the oil from all three machines was analyzed (see fig 7), even though none of the assemblies were indicating terminal pressure drop.

Machines B and C were able to attain the target while A did not, although adding the pressure filter made considerable improvement in cleanliness. The oil was sampled after 180 days using an on-line particle counter connected to the drain plug of the filter bowl. This location represents one of the dirtiest points on the system since the oil has been through the system and in the reservoir. Sampling with an on-line particle counter and proper flushing techniques eliminates variables associated with bottle sampling. Figure 8 illustrates increased life expectancy for hydraulic components that can be realized by reducing fluid cleanliness codes. The benefits of clean fluid justify the cost of filtration.

fig. 7

Mach.	ISO code before filter	ISO code after 60 days ($\beta5_{[c]}$ = 1000)	ISO code after 180 days ($\beta5_{[c]}$ = 1000)
A	22 / 20 / 14	17 / 15 / 11	‘11 / 9 / 7
B	23 / 20 / 14	15 / 13 / 8	13 / 11 / 9
C	23 / 21 / 16	16 / 12 / 10	14 / 11 / 9

fig. 8 Hydraulic Component

Current ISO Code	Target ISO Code	Target ISO Code	Target ISO Code	Target ISO Code
	2 x Life	3 x Life	4 x Life	5 x Life
28/26/23	25/22/19	22/20/17	20/18/15	19/17/14
27/25/22	23/21/18	21/19/16	19/17/14	18/16/13
26/24/21	22/20/17	20/18/15	19/17/14	17/15/12
25/23/20	21/19/16	19/17/14	17/15/12	16/14/11
25/22/19	20/18/15	18/16/13	16/14/11	15/13/10
23/21/18	19/17/14	17/15/12	15/13/10	14/12/9
22/20/17	18/16/13	16/14/11	15/13/10	13/11/8
21/19/16	17/15/12	15/13/10	13/11/8	-
20/18/15	16/14/11	14/12/9	-	-
19/17/14	15/13/10	13/11/8	-	-
18/16/13	14/12/9	-	-	-
17/15/12	13/11/8	-	-	-

Benefits of clean fluid

- Minimize unplanned equipment downtime.
- Reduce maintenance costs and labor.
- Reduce expensive component repair or replacement costs.
- Improve operating efficiency of equipment with sensitive components.
- Extend service life of fluids.

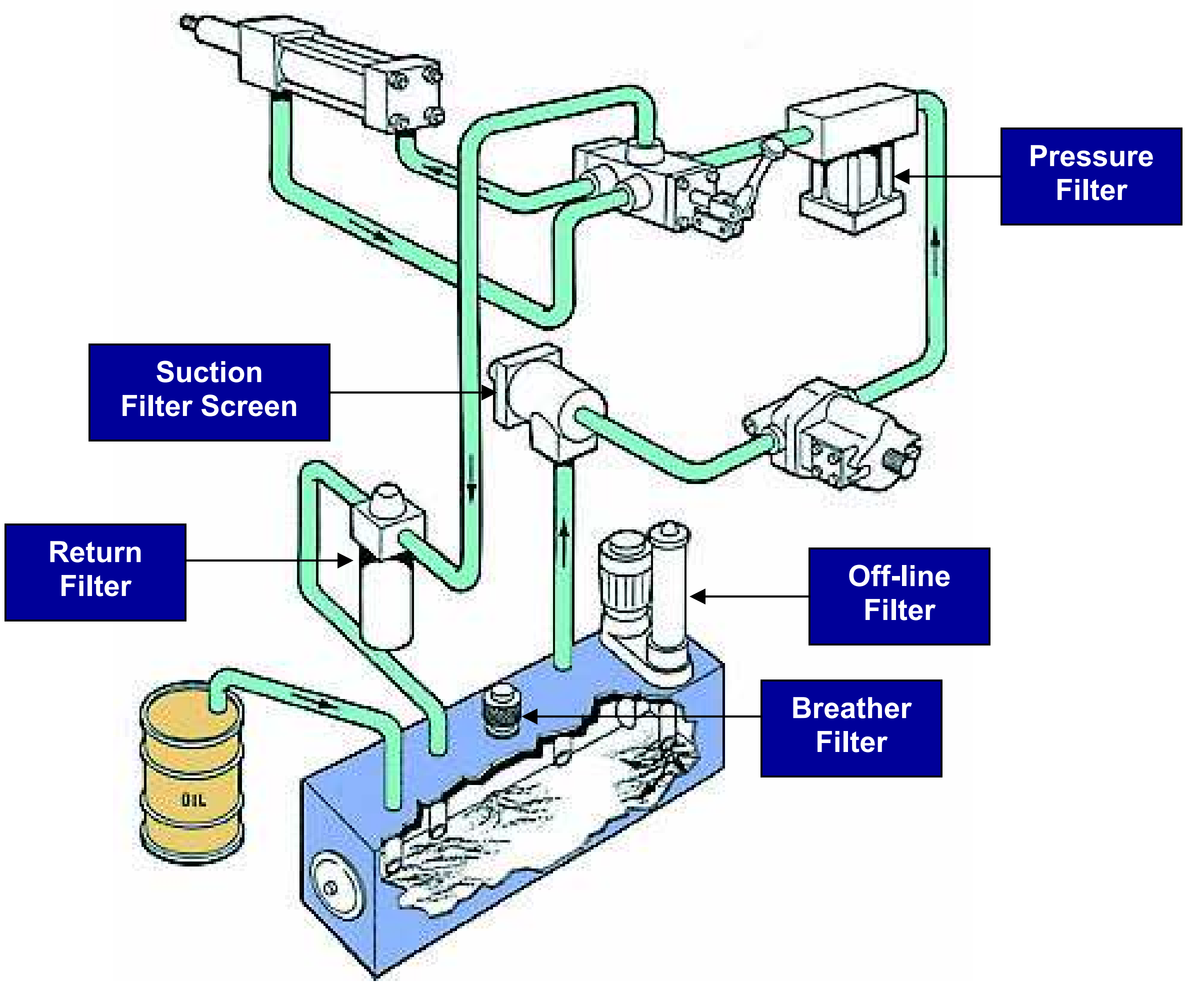
Adding a desiccant breather to the reservoir assures that the air ingested is dry and clean. Reducing water content reduces chemical compound formation, biological growth, oxidation and extends fluid life. Desiccant breathers also control particulate contaminate ingression down to 4µ[c] or 2µ with absolute efficiency. Filler-breather caps commonly found on reservoirs don’t properly control particulate contamination. Specific desiccant breathers also adsorb water and oil mist as the reservoir exhales. A full range of adapters is commonly available to retro-fit any reservoir.

Hydraulic & Lubrication Filters

Part I: Filter Types and Locations

It is very important to select a filter that will improve the reliability of a lube or hydraulic system so that the cause of any failure is not due to contamination.

Let us look at the various options for the location of a filter. There are no known mathematical models that will easily locate a filter in a given system. Even today, the location of filter remains subjective and it is up to the system designer to locate a filter to suit the system. However, there are a few locations that are predominantly used in a lube or a hydraulic system.



SUCTION FILTER OR SUCTION STRAINER

This filter is located on a suction port of the pump or submerged in the reservoir and attached to the suction line leading to the pump. The intention of a suction filter is to protect the pump from large particles found in the reservoir. This filter is usually a coarse mesh filter or even a magnetic separator. High efficiency filters are usually not placed on the suction side as high differential pressure can cause pump failure. A fine filter on a pump suction side would require the filter to be very large which will not only handle the flow but also have an extremely low pressure drop. Fine filters would also have a tendency to load quicker than coarse filters which allow the majority of small particles to pass. Improperly sized suction filters will cause the pump to fail due to cavitation rather than contamination.

Many pump OEMs discourage the use of suction filters and suction strainers because of the inherent risk of pump cavitation. Proper return filtration coupled with off-line filtration and proper control of particulate ingression with high efficiency breathers can often render suction filtration unnecessary.

PRESSURE FILTER

This filter is generally installed between the pump outlet and the rest of the components in a hydraulic system. The idea here is to protect all components in a given system. This filter must withstand full system pressure and must be capable of handling the max flow of the pump. For systems with a variable workload the filter must withstand fluctuating flow, pressure cycles and spikes. In most cases, this is usually the smallest filter but it is also the most expensive.

High Pressure filters may be installed with or without a bypass valve. The purpose of the integral bypass is to allow a portion of the flow to bypass the filter during cold start conditions or when the filter element is heavily loaded with contaminant. If a pressure filter with bypass is selected it is critical that the element is changed immediately after indication or on a regular preventive maintenance schedule. If the components in the system are very sensitive to contamination (servo valves) a pressure filter with no bypass may be selected to ensure that all of the fluid entering the sensitive components is filtered.

Filters with a bypass utilize elements that are classified as low collapse and can withstand differential pressures up to 450 psid, 30 bar. Filters with no bypass utilize elements that are classified as high collapse and can withstand differential pressures up to 3000 psid or 450 bar. The cost between bypass and non-bypass filter assemblies is minimal, however, high collapse replacement elements can cost up to 300% more than low collapse elements.

RETURN FILTER

Return filters may be installed either in-line or inside the reservoir (In-tank return filter). There are varieties of filters available for each style of filters. The designer of the system collects all flow from the system and directs it through the return line filter. Such an arrangement makes certain that the oil in the reservoir will be cleaned to desired ISO specification.

When a system contains several double acting cylinders it should be noted that the return flow from the blind end of a cylinder would usually be higher than the maximum flow of the pump. This filter must handle the maximum flow due to flow multiplication during cylinder discharge. (For more explanation of this contact Hy-Pro)

Return filters are fitted with internal or external bypass valves as a standard since they are subject to flow rates that may be higher than that of the maximum pump flow rate. The bypass valve protects the housing from bursting and the element from collapse failure.

Oversizing the return filter is a common practice. This allows the flexibility to enhance the degree of filtration without creating excessively high differential pressure. Normally this is the largest and least expensive filter and a common filter for a mobile hydraulic system.

PILOT LINE PRESSURE FILTER

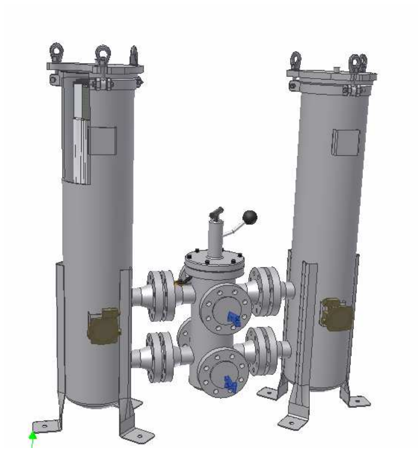
Some systems have a very sensitive components that see only a fraction of the flow. It is very easy to filter the entire system to the required cleanliness level, or as an alternate a smaller filter with a fine filter media can be installed in the critical leg of a system and the balance of the system can be fitted with an appropriately coarser filter. This might sound like an added expense but in the long run it is very economical for a system to have two filters rather than a large single filter with a fine filter media. The maintenance cost will be greater than initial cost of installing two filters in a system. In all of the above instances it should be noted that whenever the filter element requires servicing, the system must be shut down, element replaced and the system re-started. If such a condition is undesirable, such as in power plants, paper mills, etc. then it would be prudent to install a Duplex filter.

DUPLEX HIGH PRESSURE FILTER

When a single filter assembly is applied the system must be shut down or bypassed whenever the filter element requires servicing. If such a condition is undesirable (power plant) then it would be prudent to install a Duplex filter.

A duplex features at least two filter housings with a transfer valve separating the housings. The flow can be routed through one housing or both depending on the valve. When one of the filters is fully loaded the operator switches the valve to activate the standby filter and then services the dirty filter. This Duplex filter avoids shutting down of a system during a filter change.

DUPLEX LOW PRESSURE, HIGH FLOW FILTER



High flow, low pressure applications (lubrication, fuel oil) where shutting down the system to service a filter is not an option a duplex should be installed.

The Hy-Pro DLF and DLFM can handle high flows and high viscosity fluids typically used in lubrication applications. The DLFM may have up to 22 elements per vessel to yield extended element life .

The duplexes feature a true 6-way transfer valve to making switching between filter housings easy.

OFF-LINE FILTER (DEDICATED)

Some OEMS or the users of a hydraulic or lube system install an off line filter system. This system is a self-contained filter system. It includes a pump-motor combination as a power source and a range of filtration flexibility to accomplish many desired results. It can easily be connected to a system reservoir. This system can be run 24/7 or intermittently.

It can be fitted with very fine filter element to clean the oil several ISO classes below the required cleanliness, and can also be used to remove water. Multiple filters can be installed in series to remove water with one element and remove fine particulate with the next or extend element life with a “step down” approach to degree of filtration. When the filter element reaches its terminal drop, it is serviced without shutting down the main system.

OFF-LINE FILTER (MOBILE)

Mobile off-line filtration systems can offer the same impact and flexibility as dedicated off-line filters while performing multiple tasks. They include a pump-motor combination as a power source and filters that can be fitted with many different elements depending on the activity.

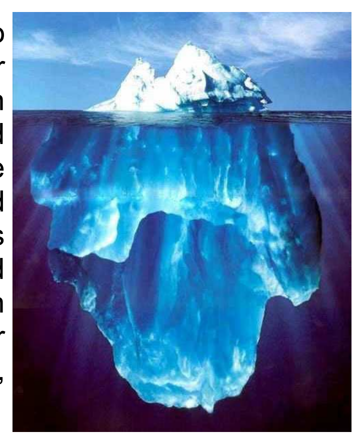
Commonly referred to as filter carts they can be fitted with quick disconnect fittings and connected to a reservoir or tote for conditioning, used to filter fluids during transfer, and used for filtering oil during recovery. A filter cart fitted with two filters in series can have a rapid impact on fluid cleanliness and water content with the appropriate filter elements are applied. They can also be fitted with online particle monitors that will alarm when the desired cleanliness is achieved during flushing applications. If a particle monitor is not specified oil sampling ports should be installed to measure cleanliness.

New oil is typically not suitable for any hydraulic or lubrication system so it is important to avoid contaminating a machine when adding fluids.

BREATHERS

High efficiency breathers are an essential component to proper contamination control. Pleated breathers with glass media can remove particulate down to 1 micrometer with absolute efficiency. Desiccant breathers control particles, adsorb water from the air, and can even control oil mist exhaust. High efficiency breathers can extend the life of all filter elements on hydraulic and lubrication systems by controlling airborne ingression, which is one of the major sources of particulate contamination. Spin-on and Desiccant breather suppliers offer a wide range of adaptors so that any reservoir or gearbox can be retrofitted.

Conclusion:



Filters are frequently considered as a necessary evil and are added to a system as an after thought instead of a valuable asset. Proper filter selection and sizing can provide years of reliable equipment operation and save money that is commonly lost battling contamination related failures. Approximately 75% of all hydraulic component failures are attributed to surface degradation caused by contamination and corrosion. The cost of installing and maintaining suitable filtration is estimated to be 3% of the cost associated with contamination related issues, the tip of the iceberg. Hidden costs of runaway contamination include; unplanned downtime, component replacement or repair expenses, fluid replacement, disposal, maintenance labor hours, troubleshooting time and energy, and waste.

Hydraulic & Lubrication Filters

Part II: Proper Filter Sizing

Every filter assembly has a minimum of two components, a filter housing and a filter element. Most filters include an integral bypass valve. This valve provides a parallel flow path to a filter element to protect it from collapsing, during cold start or once the element is heavily loaded with contaminant, by maintaining a desirable differential pressure across the element. Ideally, we want the flow to go through the filter element and thus the bypass valve is biased with a compression spring. The force of this spring keeps the bypass valve closed and for the most part fluid flows through the element. However, as the element gets dirty by collecting contaminants, the pressure drop across the element reaches the setting of the bypass valve at which time there are two paths for the fluid. At some point and time, the bypass valve may allow 95% of the fluid to go through it. Bypass valves have a cracking pressures typically range between 1,77 BAR (25 PSID) and 7 BAR (102 PSID) and It is dependent upon the location of a filter. Return line filters have a lower bypass setting than pressure line filters.

Generally, the sizing of a filter is very simple. This paper will make it even simpler for you. One must be careful as the filter will only perform adequately if it is maintained properly. It is a very good practice to change the filter element immediately when the differential pressure indicator signals the need for service. Differential pressure indicators should signal at 90% pressure drop of the bypass setting. An alternative to changing on indication is a preventive maintenance schedule. For example elements may be changed on a time interval regardless of element condition which will ensure that the filter will not consistently operate in a bypass condition.
The key parameters to consider for proper filter selection and sizing are as follows:

1. MAXIMUM FLOW RATE THROUGH A FILTER

Maximum flow through a filter may be larger than the maximum flow from the pump. This happens due to presence of double acting hydraulic cylinders in a system. If your system contains such cylinders, you must calculate the maximum flow rate from the blind end of the cylinder and size the filter accordingly. This applies to return line filters.

2. MAXIMUM SYSTEM PRESSURE

Generally this depends upon the location of the filter. Pressure line filters usually see the full pressure setting of the relief valve, whereas the return line filter may see no more than 100 PSI pressure. An appropriately rated filter will serve the purpose. Occasionally a filter will experience pressure fluctuations and in such cases, fatigue rating of the filter housing must be considered. It is wise to consult your filter supplier for guidance in such conditions as the rated fatigue pressure is typically lower than the maximum rated operating pressure of a given filter.

3. MINIMUM & OPERATING FLUID TEMPERATURE (VISCOSITY)

Viscosity of most hydraulic fluids varies inversely with the temperature. The lower the temperature the higher the viscosity and vice-versa. During “cold start up” the viscosity of the fluid may be high enough to cause a very high pressure drop through the element. It will open the bypass valve for a short period of time while the fluid is being warmed up. In most cases, this condition is acceptable. See **Footnote** at the end for an explanation.

The temperature of fluid also has an effect on seals. Select seals that will withstand extreme temperature without failure.

4. ACCEPTABLE PRESSURE DROP

Do not consider the pressure drop of the housing and clean element in your system design. It is the best condition that system will ever see. Always consider the worst case scenario which will occur when the entire flow goes over the bypass valve. It is imperative that you consider the maximum pressure drop across the bypass valve at the maximum flow. For example, if a filter has a 40 PSID bypass valve, then it is likely that at the maximum flow this valve may have a pressure drop of 5 BAR (70 PSID) or higher. Ask for this information from your filter supplier and use it in your calculations. If you locate a filter in a return line and the full flow bypass valve pressure drop were to be 5 BAR (70 PSID) or higher then you must make sure all the components upstream of filter will not be affected. Shaft seals of a hydraulic motor have been known to fail due to excessive back pressure caused by a filter.

5. FILTER ELEMENT SERVICE INTERVAL

This is one of the most difficult criteria for filter selection which in most cases is based upon the design engineer’s experience with a similar system. When an engineer selects a filter for a new machine or even an existing application, various manufacturers may give him data. Typical data should include; maximum flow rate, maximum pressure drop at a certain viscosity, Beta ratio (Filtration ratio) and dirt holding capacity. The last two values are obtained from the multi-pass test method per ISO 16889. The engineer must select an element with the highest capacity, all other things being equal. This will give him the maximum life between element changes in a given system.

Sometimes, an engineer may select a slightly larger filter to increase the filter element change interval. There is no right or wrong answer but under sizing a filter to save money is wrong in the long run. A smaller filter will be less expensive in the beginning, but the downtime it may cause due to frequent changes will reflect in poor productivity and throughput.

In a critical system, size a filter so that it gives you maximum life. A general rule of thumb is to change an element when the differential pressure indicates the need for a change or on a preventive maintenance schedule that can coincide with a planned shutdown regardless of the element condition.

FILTER ELEMENT SERVICE INTERVAL CONTINUED

For a simple calculation to determine element life in PSID, use the following formula:

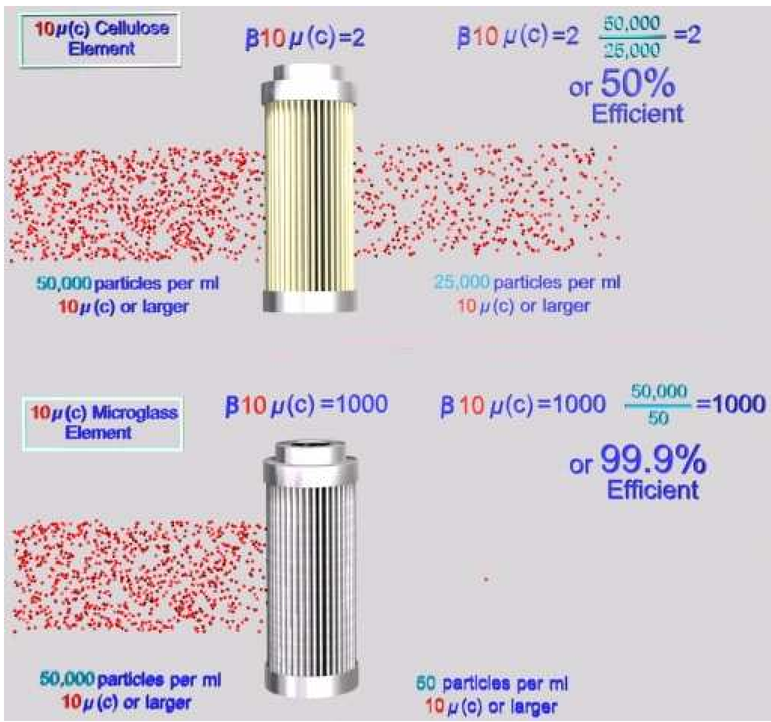
EL = BYPASS SETTING IN PSID – (H + E) where,

EL is element life in PSID
H is housing pressure drop in PSID
E is the clean element pressure drop at a flow and viscosity of interest.

A minimum rule of thumb is to allow 1 BAR (~15 PSID) life for a normal hydraulic system and for critical system, 1.7 BAR (~25 PSID). Selecting a larger filter will allow the element to last longer as the clean element pressure drop will be lower. Element life is defined by the amount of time, or contaminant the element will see before the indicator signals. Using a larger filter will yield a lower flow density through the element. Lower flow density means a lower flow rate per cm^2 (IN^2) which means that the element pressure drop will rise at a slower rate as it loads with contaminant.

6. FILTER MEDIA SELECTION

There are several distinct differences between available media options. Media selection should be based upon the required cleanliness and other unique needs of the system. Evaluate the Beta ratio (efficiency), dirt holding capacity, flow versus pressure drop characteristics, etc. A filter supplier should be able to supply more detailed test information in addition to what is supplied in their literature. Normally, wire mesh and cellulose media elements are nominally rated which means that they might be only 50% efficient at the rated micron size. Most glass media elements are considered to be "absolute" rated which means that they are 99.5% efficient at the rated micron size. Check the Beta ratio before selecting the media as all "10 micron" filter elements do not filter with the same efficiency. Absolute rated high efficiency glass media elements are the most suitable selection for achieving target ISO cleanliness codes on systems with components that are sensitive to contamination (servo valves, piston pumps, etc). Consult component manufacturers for required fluid cleanliness as this can be directly correlated to warranty requirements. Filter suppliers can also be a valuable resource for determining overall system cleanliness guidelines.



HY-PRO FILTRATION

FILTER MEDIA SELECTION CONTINUED

The majority of filter elements today are designed to be disposable, and utilize media constructed of synthetic or organic fibers. These elements are non cleanable and must be disposed off after their useful life. Some applications are fitted with stainless steel wire mesh media elements that yield a very low pressure drop and are somewhat cleanable. After they become loaded with contaminant they can be removed from the housing, cleaned and put back into the system. It is important to note that the cleaning process may be destructive which can compromise the element's efficiency and integrity (ultrasonic cleaning, high pressure steam cleaning). Size for size cleanable elements typically have a shorter life than their disposable counterparts made of glass or cellulose media. Wire mesh media elements are typically applied on systems with high viscosity fluids that do not require ultra clean fluid (gear box pressure line in steel mill).

7. FILTER ELEMENT COLLAPSE-BURST RATING

The full flow pressure drop through a bypass valve should be less than the collapse pressure (for outside to in flow) or burst pressure (for inside to outside flow) of the element. The element collapse/burst pressure should be at least 1.5 times the full flow pressure drop across the bypass valve. This will provide ample protection from collapse or burst even if there is a sudden increase in flow due to surge.

Applying an element with insufficient strength can result in a fully loaded element failing and releasing all of the previously captured contaminant along with filter element materials into the system. This sudden release of contaminant will cause catastrophic failure.

8. FLUID TYPE, PETROLEUM vs SYNTHETIC

Petroleum based fluids have a specific gravity of 0.86. Filters are generally sized for petroleum fluid in a hydraulic or lube system. Occasionally synthetic fluids are used in hydraulic systems, such as water glycol or high water based fluids. High water based fluids are constructed of 95% to 98% water with an additive package to provide lubricity, biocide, etc. Always consider the effect of specific gravity on pressure drop. Another issue with synthetic fluids is their compatibility with seals. Select the proper seal material as recommended by the fluid manufacturers.

Synthetic fluids can be highly corrosive (phosphate ester). Filter housings and element components may require special treatment or the use of stainless steel. It has also been proven that aggressive fluids can attack binding chemicals in non-woven filter media. Some synthetic fluids (fire resistant) can develop elevated acid levels (TAN) which can damage the filter media causing media migration and loss of efficiency. Communicating with your filter supplier when synthetic fluids are used is critical to proper material selection.

Certain high water based fluids have a very high pH value to keep growth of bacteria low. These fluids can react aggressively with aluminum parts in housings. For such applications, either avoid aluminum or anodize aluminum parts for added protection. Water glycol emulsions can fluctuate. It is wise to over size the filter assembly to avoid high differential pressure in the event that the emulsion yields higher than normal viscosity.

9. OVER SIZING FOR FUTURE FLEXIBILITY

Once a filter has been selected and sized based on fluid type, flow and desired cleanliness it is important to consider using a filter that is larger to allow for unforeseen system changes in the future. One of the key parameters mentioned earlier relates to fluid viscosity. If the selected filter is just large enough to handle the current system a change in fluid to a higher viscosity could result in unacceptable element life. Improving fluid cleanliness typically results in exponentially longer bearing and hydraulic component life. A common strategy for achieving lower ISO cleanliness codes ($4\mu_{[c]}/6\mu_{[c]}/14\mu_{[c]}$) is installing filter elements with a finer degree of filtration. If the filter housing is not large enough this might not be possible as the pressure drop can be prohibitive. Over-sizing the filter ahead of time will allow finer filter elements to be used in the future. The alternative is to install a new larger filter housing that might have a larger port to port dimension which will require additional pipe fitting.

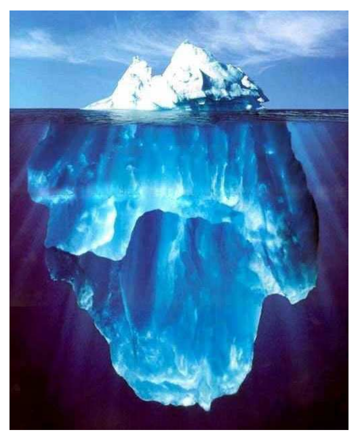
Footnote:

On occasion the fluid in the system will be very cold (high viscosity). Under such conditions the fluid may bypass the element until the fluid temperature rises. Typically downtime before start up is less than 24 to 48 hours. When the system is shut down due to end of a task or end of a shift, it is very likely that the oil in the system is clean to acceptable standards. Upon start up the oil is still clean and stays clean until it warms up.

We recommend that the filter be sized for normal operating conditions and not for cold start ups. However, there are applications where bypass is not acceptable. In this case the filter must be sized for the worst condition. Such a filter will generally be large and should be fitted with a high collapse element and no bypass.

Conclusion:

Filters are frequently considered as a necessary evil and are added to a system as an after thought instead of as a valuable asset. Proper filter selection and sizing can provide years of reliable equipment operation and save money that is commonly lost battling contamination related failures. Approximately 75% of all hydraulic component failures are attributed to surface degradation caused by contamination and corrosion. The cost of installing and maintaining suitable filtration is estimated to be 3% of the cost associated with contamination related issues, the tip of the iceberg. Hidden costs of runaway contamination include; unplanned downtime, component replacement or repair expenses, fluid replacement, disposal, maintenance labor hours, troubleshooting time and energy, and waste.



STAINLESS FIBER

Filter elements for power generation and other fire resistant applications

High Performance protection against corrosive fluids & high temperatures. S FIBER upgrades from glass media

Performance

Temperature: -20f to 250f, -29c to 120c (viton), Element collapse up to 3000 psid (210 bar)

Media Description

EHC systems commonly use phosphate ester which can develop high TAN (total acid number) when exposed to water. The acid attacks the binding agent in glass fiber media. The result is lower efficiency and media migration, or fiber shedding, where the filter is generating contamination.
S FIBER media utilizes sintered stainless steel fibers which are impervious to the acidic compounds that form in EHC systems.

Non-compressible media yields long on-stream life in high differential pressure applications.

Not affected by water & gelatinous contamination.

Absolute ratings from $\beta 2 = 200$, $\beta 4.4[c]=1000$, and $\beta 4.4[c]D = 500$ (DFE efficiency rating)

Applications

Hydraulic applications where fire resistant fluids are utilized. Including EHC for power generation, jack-up/lift-up system for turbine start up, governor control circuit for turbine speed. Primary metals applications.

Upgrades from glass media available for the following manufacturers:

GE	**Westinghouse**	**ABB**
Pall	**Parker**	**Hilco**
Kaydon	**Indufil**	

Dynamic Filter Efficiency Testing

DFE rated elements perform true to rating even under demanding variable flow and vibration conditions.

Today's industrial and mobile hydraulic circuits require elements that deliver specified cleanliness under all circumstances. Wire mesh supports the media to ensure against cyclical flow fatigue, temperature, and chemical resistance failures possible in filters with synthetic support mesh.

Cross sectional view of -3SF code Dynafuzz media

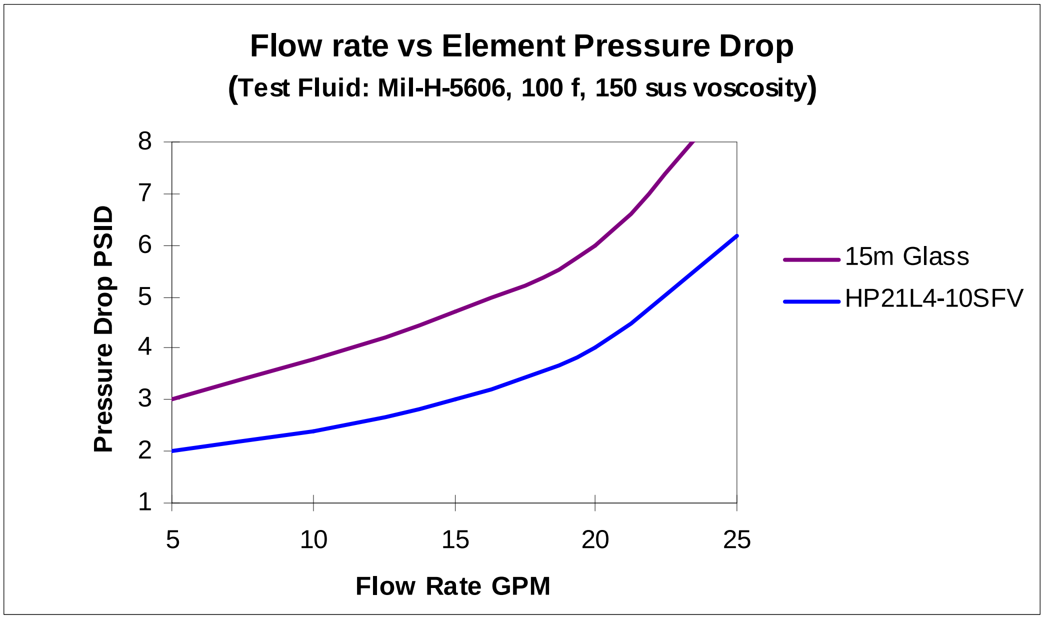
Typical Elements Upgraded to Stainless Fiber

Pall	Hy-Pro
HC9401FDP13Z	HP41L13-3SFV
HC9401FDP13ZYGE	HP41L13-3SFV
HC9401FDT13Z	HP41L13-10SFV
HC9401FDT13ZYGE	HP41L13-10SFV
HC9601FDP11Z	HP61L11-3SFV
HC9601FDP11ZYGE	HP61L11-3SFV
HC9601FDT11Z	HP61L11-10SFV
HC9601FDT11ZYGE	HP61L11-10SFV
HC9601FDP16Z	HP61L16-3SFV
HC9601FDT16Z	HP61L16-10SFV
HC9601FDP21ZYGE	HP61L21-3SFV
HC9601FDT21Z	HP61L21-10SFV
HC9601FDT21ZYGE	HP61L21-10SFV
HC9651FDP8Z	HP51L8-3SFV
HP9651FDT8Z	HP51L8-10SFV
HP9651FDP16Z	HP51L16-3SFV
HP9651FDT16Z	HP51L16-10SFV

Pall	Hy-Pro
HC9021FDP4Z	HP21L4-3SFV
HC9021FDP4ZYGE	HP21L4-3SFV
HC9021FDT4Z	HP21L4-10SFV
HC9021FDT4Z YGE	HP21L4-10SFV
HC9021FDP8Z	HP21L8-3SFV
HC9021FDP8ZYGE	HP21L8-3SFV
HC9021FDT8Z	HP21L8-10SFV
HC9021FDT8ZYGE	HP21L8-10SFV

General Electric	Hy-Pro
234A6578P0002	HPQ210128L13-3SFV
234A6579P0002	HPQ210129L13-3SFV
254A7229P0005	HPQ210130L13-3SFV
254A7729P0008	HPQ210131L13-3SFV
254A7220P0008	HPQ210132L13-3SFV
258A4860P002	HPQ210133L11-3SFV
258A4860P004	HPQ210134L21-3SFV
361A6256P010	HPQ210135L18-3SFV
B984C302P012	HP21L4-10SFV

Typical Pressure Drop Performance vs Glass



Hy-Pro filters are tested to the latest industry standard ISO16889 (replacing ISO4572) resulting in A new scale for defining particle sizes and determining filtration ratio (formerly known as beta ratio)

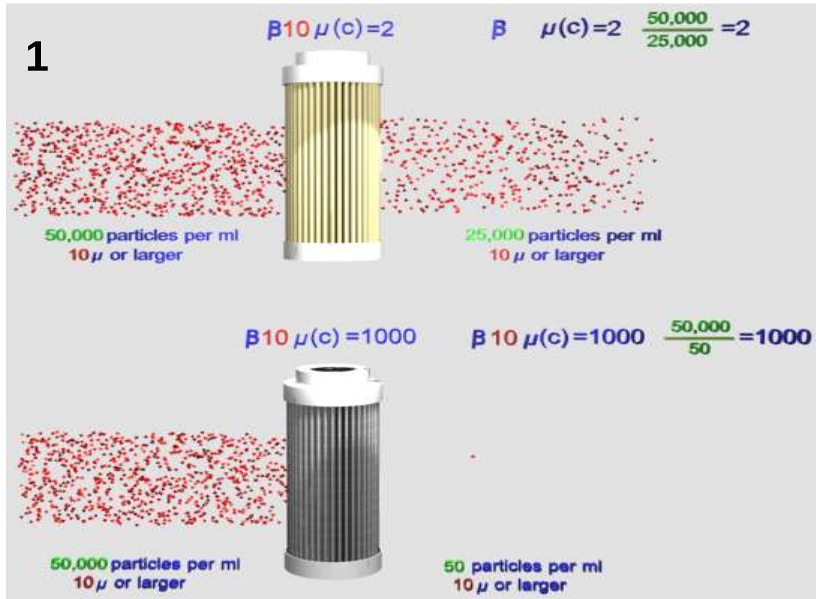
New (ISO16889) vs Old (ISO4572) size comparison

Bx(c)=1000 (ISO16889)	2.5	5	7	12	22
Bx=200 (ISO4572)	<1	3	6	12	25

HY-PRO FILTRATION

Evolution of Media: Hy-Pro G7 Dualglass Upgrade from Cellulose Media

Glass media has superior fluid compatibility versus cellulose with hydraulic fluids, synthetics, solvents, and high water based fluids. Glass media also has a significant filtration efficiency advantage over cellulose, and is classified as "absolute" where cellulose media efficiency is classified as "nominal".

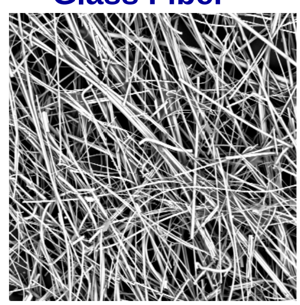


Elements of different media with the same "micron rating" can have substantially different filtration efficiency. Figure 1 provides a visual representation of the difference between absolute and nominal filter efficiency.

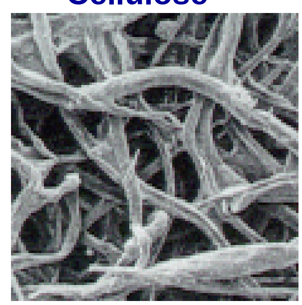
The illustrated glass element would typically deliver an ISO Fluid Cleanliness Code of 18/15/8 to 15/13/9 or better depending upon the system conditions and ingression rate. The cellulose element would typically achieve a code no better than 22/20/17.

Runaway contamination levels at $4\mu_{[c]}$ and $6\mu_{[c]}$ are very common when cellulose media is applied where a high population of fine particles exponentially generate more particles in a chain reaction of internally generated contaminate.

Glass Fiber



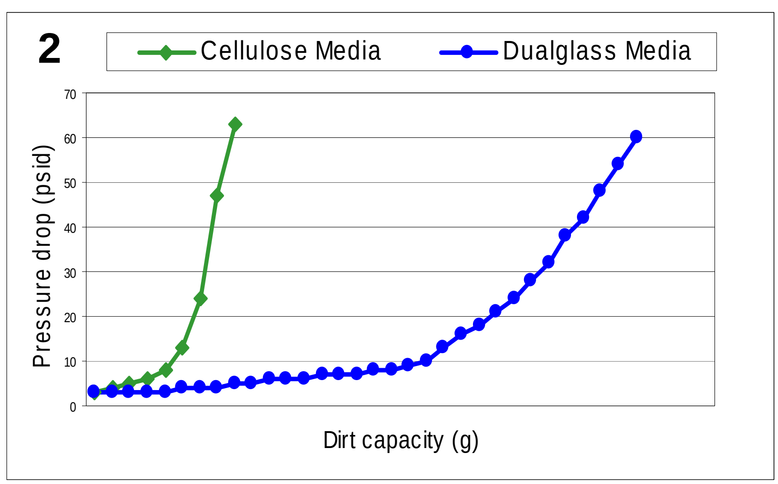
Cellulose



Inorganic glass fibers are much more uniform in diameter and are smaller than cellulose fibers. Organic cellulose fibers can be unpredictable in size and effective useful life. Smaller fiber size means more fibers and more void volume space to capture and retain contaminate.

Upgrading to Hy-Pro G7 Dualglass

Glass media has much better dirt holding capacity than cellulose. When upgrading to an absolute efficiency glass media element the system cleanliness must be stabilized. During this clean-up period the glass element halts the runaway contamination as the ISO cleanliness codes are brought into the target cleanliness range. As the glass element removes years of accumulated fine particles the element life might be temporarily short.



Once the system is clean the glass element can last up to 4~5 times longer than the cellulose element that was upgraded as shown in figure 2.

Cleaner Fluid . . . Longer Component & Fluid Life . . . More Uptime!

Roller Contact Bearing

Current ISO Code	Target ISO Code	Target ISO Code	Target ISO Code	Target ISO Code
	2 x Life	**3 x Life**	**4 x Life**	**5 x Life**
28/26/23	25/22/19	22/20/17	20/18/15	19/17/14
27/25/22	23/21/18	21/19/16	19/17/14	18/16/13
26/24/21	22/20/17	20/18/15	19/17/14	17/15/12
25/23/20	21/19/16	19/17/14	17/15/12	16/14/11
25/22/19	20/18/15	18/16/13	16/14/11	15/13/10
23/21/18	19/17/14	17/15/12	15/13/10	14/12/9
22/20/17	18/16/13	16/14/11	15/13/10	13/11/8
21/19/16	17/15/12	15/13/10	13/11/8	-
20/18/15	16/14/11	14/12/9	-	
19/17/14	15/13/10	13/11/8	-	
18/16/13	14/12/9	-	-	
17/15/12	13/11/8	-	-	
16/14/11	13/11/8	-	-	
15/13/10	13/11/8	-	-	
14/12/9	13/11/8	-	-	

Laboratory and field tests prove time and again that Hy-Pro filters consistently deliver lower ISO fluid cleanliness codes.

Improving fluid cleanliness means reduced downtime, more reliable equipment, longer fluid life, fewer maintenance hours, and reduces costly component replacement or repair expenses.

Hydraulic Component

Current ISO Code	Target ISO Code	Target ISO Code	Target ISO Code	Target ISO Code
	2 x Life	**3 x Life**	**4 x Life**	**5 x Life**
28/26/23	25/23/21	25/22/19	23/21/18	22/20/17
27/25/22	25/23/19	23/21/18	22/20/17	21/19/16
26/24/21	23/21/18	22/20/17	21/19/16	21/19/15
25/23/20	22/20/17	21/19/16	20/18/15	19/17/14
25/22/19	21/19/16	20/18/15	19/17/14	18/16/13
23/21/18	20/18/15	19/17/14	18/16/13	17/15/12
22/20/17	19/17/14	18/16/13	17/15/12	16/14/11
21/19/16	18/16/13	17/15/12	16/14/11	15/13/10
20/18/15	17/15/12	16/14/11	15/13/10	14/12/9
19/17/14	16/14/11	15/13/10	14/12/9	14/12/8
18/16/13	15/13/10	14/12/9	13/11/8	-
17/15/12	14/12/9	13/11/8	-	-
16/14/11	13/11/8	-	-	-
15/13/10	13/11/8	-	-	-
14/12/9	13/11/8	-	-	-

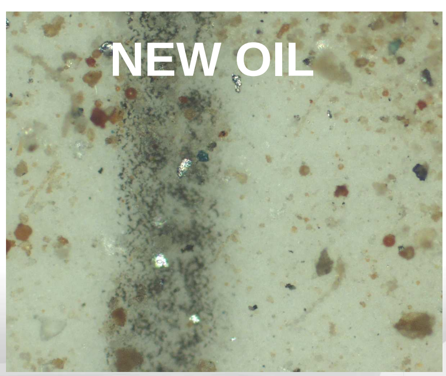
Develop a Fluid Cleanliness Target

Hy-Pro will help you develop a plan to achieve and maintain target fluid cleanliness. Arm yourself with the support, training, tools and practices to operate more efficiently, maximize uptime and save money.

New Oil is Typically Dirty Oil . .

New oil can be one of the worst sources of particulate and water contamination.

25/22/19 is a common ISO code for new oil which is not suitable for hydraulic or lubrication systems. A good target for new oil cleanliness is 16/14/11.



What is DFE (Dynamic Filter Efficiency)?

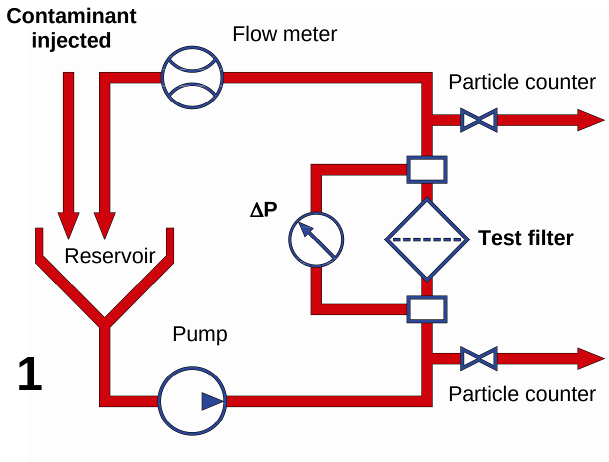
All hydraulic and lube systems have a critical contamination tolerance level that is often defined by, but not limited to, the most sensitive system component such as servo valves or high speed journal bearings. Component manufacturers provide fluid cleanliness levels, per ISO4406 or ISO4406:1999, required for optimum performance and predictable life. An operating system is at risk whenever the critical contamination level is exceeded. Contamination levels determine the individual component's wear rate (useful life) and ability to perform as intended (functionality).

System design, filter performance and maintenance practices largely determine the contamination level in a system. Filters are expected to maintain contamination below critical tolerance levels. Filter performance in a dynamic operating system is variable based upon flow rate and flow density, changes in flow rate (duty cycle), viscosity, fluid and structure borne vibration (Hz), contamination levels, ingression rate and several other conditions. All filters are subjected to some form of system dynamics. Hydraulic filters encounter frequent and rapid changes in flow rate accompanied by frequency changes. Lube filters typically experience dynamic conditions during start up and shut down. Two key characteristics of filter performance are capture efficiency and retention efficiency. Capture efficiency can be thought of simply as how effectively a filter captures particles while retention efficiency is a measure of how effectively that filter retains the particles it has captured. A filter is not a black hole, and its performance must not be based solely on how efficiently it captures particles. If not properly designed and applied, a filter can become one of the most damaging sources of contamination in a system.

The Dynamic Filter Efficiency Test (DFE) is the evolution of hydraulic and lube filter performance testing. The DFE test goes further than current industry standards to bridge the gap between lab and real world by inducing dynamic duty cycles and measuring real-time performance before, during and after the cycles. DFE testing quantifies both capture and retention efficiency in real time so that we may predict the worst case fluid cleanliness along with average fluid cleanliness. The DFE test method was pioneered in 1998 during a joint effort between Scientific Services Inc (SSI) and Hy-Pro Filtration.

Current Filter Performance Testing Methods

Manufacturers of filter assemblies and filter elements use an industry standard test to rate filter efficiency and dirt holding capacity of filter elements under ideal lab conditions. The test protocol is ISO standard ISO16889 multi-pass, and was updated from ISO 4572 in 1999. The standard provides a repeatable test method where identical filters should produce like results when tested on various test stands. Figure 1 depicts the test circuit where MIL-H-5606 hydraulic fluid is circulated at a constant flow rate in a closed loop system with the test filter and on-line particle counters before and after the filter. Contaminated fluid with a known quantity of contaminant is added to the system before the upstream particle counter, and at a constant rate. Small amounts of fluid are removed before and after the filter for particle counting to calculate the filter efficiency (capture). The capture efficiency is expressed as the Filtration Ratio (Beta) which is the relationship between the number of particles greater than and equal to a specified size ($x\mu_{[c]}$) counted before and after the filter.



Filtration Ratio (Beta) per ISO16889:

$$\beta_{x[c]} = \frac{\text{quantity particles} >= x\mu_{[c]} \text{ upstream of filter}}{\text{quantity particles} >= x\mu_{[c]} \text{ downstream of filter}}$$

Example: $\beta_{7[c]} = 600/4 = 150$, Filtration Ratio (Beta): $\beta_{7[c]} = 150$.

In the example, 600 particles greater than or equal to $7\mu_{[c]}$ were counted upstream of the filter and 4 were counted downstream. This Filtration Ratio is expressed as "Beta $7_{[c]} = 150$". The $_{[c]}$ is referred to as "sub c". The sub c is used to differentiate between multi-pass tests run per the current ISO16889 multi-pass test with new particle counter calibration per ISO11171 from ISO4572. Filtration Ratio expressed or written without the "sub c" refers to the antiquated ISO4572 multi-pass test superseded by ISO16889.

The efficiency may also be expressed as a percentage by converting the Filtration Ratio:

$\beta 7_{[c]} = 150 = (\beta-1)/\beta \times 100$, Efficiency percentage of $\beta 7_{[c]} = 150 = (150-1)/150 \times 100 = 99.33\%$. The test filter is 99.33% efficient at capturing particles $7\mu_{[c]}$ and larger.

The DFE Multi-pass Testing Method

DFE multi-pass enhances the industry standard by inducing dynamic conditions (duty cycle) and measuring the affects of the duty cycle in real time instead of looking at normalized numbers over a time weighted average. DFE also addresses the inherent problem of ISO16889 where fluid is added and removed throughout the test, thus creating a small mathematical error that must be corrected in final calculations. In addition to the capture efficiency, DFE also quantifies retention efficiency in real time. A filter that does not properly retain previously captured contaminant can be identified. The phenomenon of releasing captured contaminant is called unloading, and can result in temporary contamination levels that are well above the critical contamination tolerance level of a system.

The DFE test circuit also utilizes upstream and downstream particle counters, test filter and injection point before the upstream particle counter much like ISO16889. That is where the similarity to ISO16889 ends. The DFE flow rate is not constant like ISO16889, but rather hydrostatically controlled so flow changes can be made quickly while maintaining full system flow through the test filter. Particle counter sensor flows remain constant during all particle counts and no intermediate reservoirs are used to collect the particle counter flow before it is counted. This ensures that the fluid counted is representative of the system contamination level. Counts are taken before, during, and after each flow change. The total number of particle counts is determined by the duty cycle of the specific test. The efficiency results are reported in Filtration Ratio (Beta), efficiency percentage and actual particle levels per milliliter.

The raw data is digitally tagged so filter efficiency may be reported for various combinations of flow conditions as a time weighted average and specific ranges related to differential pressure across the filter element. Some typical combinations include all maximum flow counts, all low flow counts and all flow change counts (low to high or high to low). Rapid particle counting with proper timing is how DFE allows Hy-Pro to analyze and understand both capture efficiency and retention efficiency characteristics of each filter tested while contaminant is being introduced upstream of the filter or when there is no contaminant being injected.

The DFE Testing Method - Quantifying Contaminant Capture and Retention

Figure 2 compares the performance of two identical high efficiency glass media filter elements produced by the same manufacturer, one of which was tested per ISO16889 multi-pass and the other per the DFE multi-pass method. The graph expresses the actual number of particles 6$\mu_{[c]}$ and larger counted downstream of the filter element from several data points during the tests.

Filter Element	A1	A2
Element Rating	$\beta 7_{[c]} > 1000$	$\beta 7_{[c]} > 1000$
High Flow (lpm)	112	112
Low Flow (lpm)	56	-
Contaminant Injection Rate	3 mg/l	3 mg/l

Filter A2 was tested at a constant flow rate and maintained a steady efficiency throughout the test. Filter A1 was cycled between the max rated flow rate and half of rated flow with a duty cycle consistent with that of a hydraulic system. The downstream counts for Filter A1 varied and were highest during changes from low flow to high flow. The peaks represent counts taken during flow change and the valleys represent counts taken after each flow change. The alternating high peaks represent counts taken during changes from low flow to high flow. As the amount of contaminant captured by Filter A1 increased, the downstream counts increased most dramatically during the flow changes from low flow to high flow. Filter element A1, not properly designed to retain previously captured contaminant during dynamic system conditions, can become a dangerous source of contamination as it captures and then releases concentrated clouds of contaminated fluid.

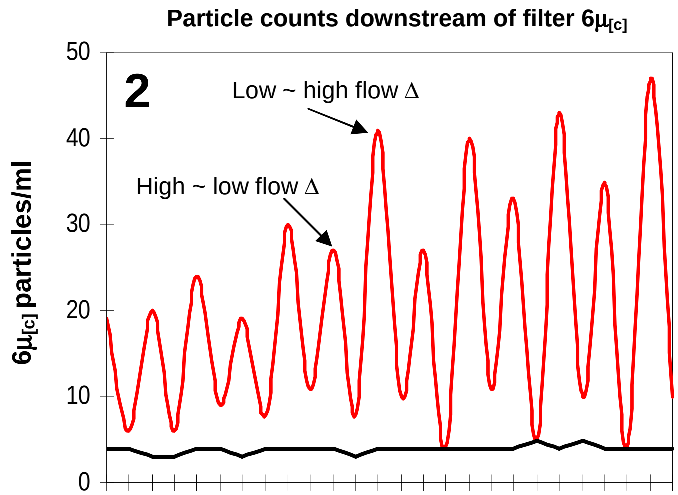
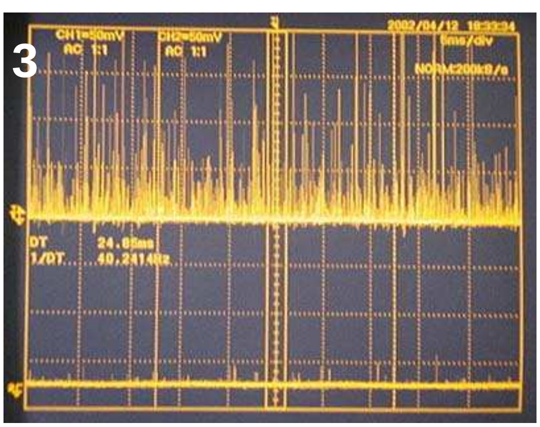
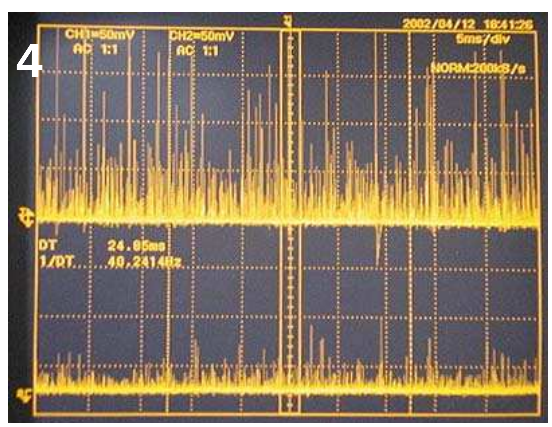


Figure 3 shows the particle counter raw data (top-upstream, bottom-downstream) for Element A1 before a change from low flow to high flow and Figure 4 shows the particle counter data for Element A1 during a change from low flow to high flow. The downstream particle count trace during the change reveals a much higher quantity of smaller particles and larger particles that did not pass the element before the dynamic system condition. This phenomenon can best be described as “contaminant unloading”. As the filter element captures more dirt, greater amounts may be released back into the system that it is installed to protect when the element is subjected to a dynamic flow condition and change in differential pressure across the element. Unloading may also occur when the flow rate changes from high flow to low flow, represented by the alternating smaller peaks in Figure 3. The filter element typically recovers shortly after the dynamic condition, but highly contaminated clouds of fluid from contaminant unloading can cause severe component damage and unreliable system performance.





The DFE Testing Method - Quantifying Contaminant Capture and Retention

Excessive unloading in the early stage of element life may be symptomatic of an element that will eventually fail and lose it's efficiency all together (media breakdown). Filter element B (graph 9) performed true to it's rating under the ISO16889 multi-pass and achieved a beta ratio in excess of $\beta7_{[c]}$ > 1000. However, when an identical element was tested per DFE multi-pass the beta ratio slipped well below the element rating during dynamic conditions (graph 11). Filter media selection is often based on the beta ratio rating published by filter manufacturers. The beta ratio is the product of the ISO16889 multi-pass test and does not account for the dynamic duty cycle of hydraulic systems since the flow rate condition remains constant throughout the test. A common result is a system that suffers from premature contamination related failures, even though it is protected by filters that in theory should prevent such failures, causing reduced uptime, unreliable equipment performance, and expensive component repair and replacement costs.

Figure 5 compares the performance of two identical Hy-Pro filter elements manufactured with G7 Dualglass media which have been designed and developed per the DFE multi-pass test method. All Hy-Pro elements that utilize the G7 or higher media carry the Hy-Pro DFE rating.

Filter Element	Hy-Pro 1	Hy-Pro 2
Element Rating	$\beta7_{[c]}$ > 1000	$\beta7_{[c]}$ > 1000
High Flow (lpm)	112	112
Low Flow (lpm)	56	-
Contaminant Injection Rate	3 mg/l	3 mg/l

Although the contaminant unloading effect is still evident, the unloading is insignificant as filter element Hy-Pro 1, tested per DFE, performed true to it's ISO16889 multi-pass rating of $\beta7_{[c]}$ > 1000 even during dynamic flow conditions.

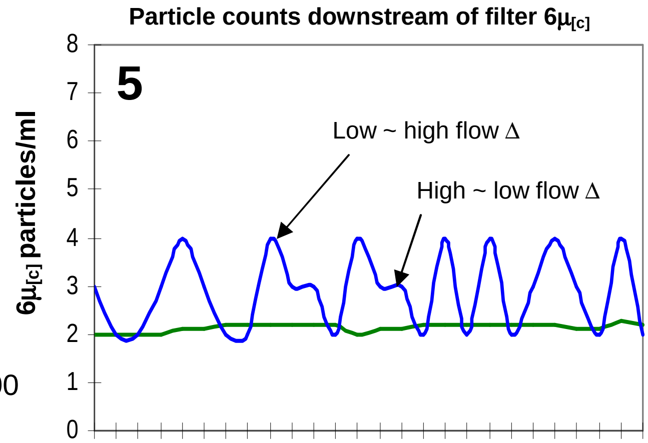
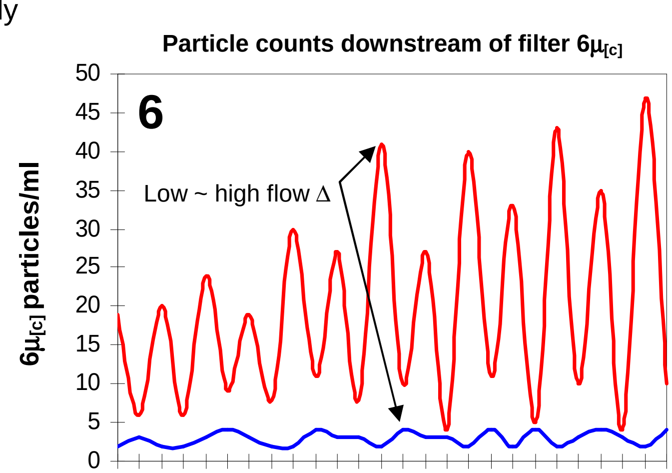


Figure 6 compares the performance of filter Element A1 and Hy-Pro 1 (DFE rated). Both elements demonstrated excellent particle capture performance during the ISO16889 and DFE testing. The DFE rated Hy-Pro element yielded much more stable particle counts downstream of the element and more consistent efficiency during the dynamic flow conditions. Improving particle retention results in more predictable fluid cleanliness levels and a system that can continually operate below the critical contamination tolerance level.



Filter Element	Element A1	Hy-Pro 1
Element Rating	$\beta7_{[c]}$ > 1000	$\beta7_{[c]}$ > 1000
High Flow (lpm)	112	112
Low Flow (lpm)	56	56
Contaminant Injection Rate	3 mg/l	3 mg/l

HY-PRO FILTRATION

The DFE Multi-pass Testing Method - Cold Start Contaminant Retention

Once the element has captured enough contaminant to reach approximately 90% of the terminal ΔP, dirty filter indicator setting, the main flow goes to zero and the injection system is turned off for a short dwell period. The main flow pump is turned on and rapidly achieves maximum element rated flow accompanied by real time particle count to measure retention efficiency of the contaminant loaded element.

After the start-up simulation the system continues to perform the test duty cycle to further monitor the retention efficiency of the filter element after a restart. The purpose of this portion of the DFE test is to quantify how well the filter element retains the contaminant it has previously captured when subjected to a start-up condition. The dwell before the restart may be a function of time or a function of system temperature to simulate cold restart with an element that has captured a substantial amount of contaminant.

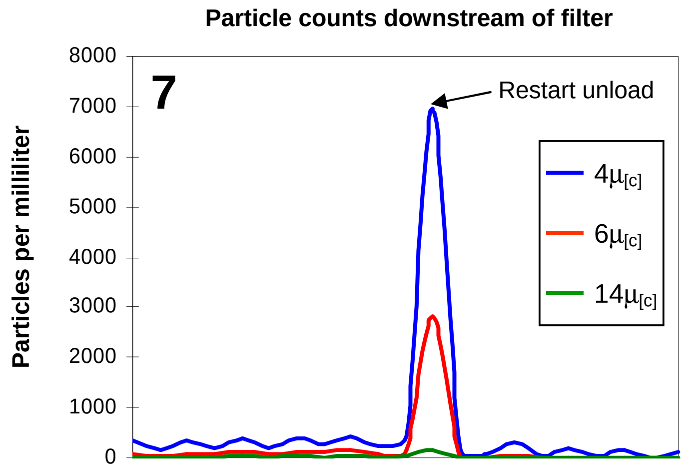
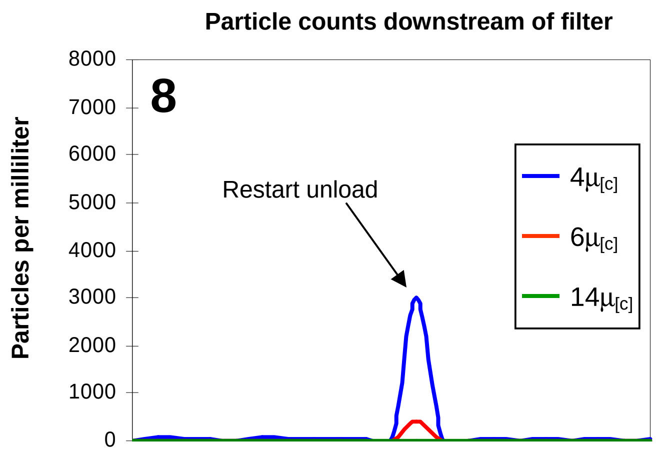


Figure 7 and the table below it show the performance of an element, from the same lot as filter elements A1 & A2 from figure 2, that was subjected to the DFE restart test. During the restart, particle counts after the filter increased by a factor of 20 on the $6\mu_{[c]}$ channel, and the ISO codes increased by 4 on the $4\mu_{[c]}$ and $6\mu_{[c]}$ channels. During the restart test there is no contaminant being injected so any particles measured were already in the system or were released by the element (unloading). The result is a temporary state of highly contaminated fluid that has resulted because the filter element did not properly retain the dirt.

Downstream Element A3	$4\mu_{[c]}$ particles/ml	$6\mu_{[c]}$ particles/ml	$14\mu_{[c]}$ particles/ml	ISO Code per ISO4406:1999
Before Restart	429	136	25	16/14/12
During Restart	6973	2802	139	20/18/14

Figure 8 and the table below it show the performance of Hy-Pro element 3, which is from the same lot as Hy-Pro 1 and 2 from figure 5. The unloading is evident in the DFE rated Hy-Pro 3 element, but the affect is greatly reduced. Element A3 (figure 7) unloaded 7 times more particles $6\mu_{[c]}$ and larger than did Hy-Pro 3, and 35 times more particles $14\mu_{[c]}$ and larger. The DFE rated Hy-Pro element had much higher retention efficiency than the filter designed and validated only to ISO16889 multi-pass.



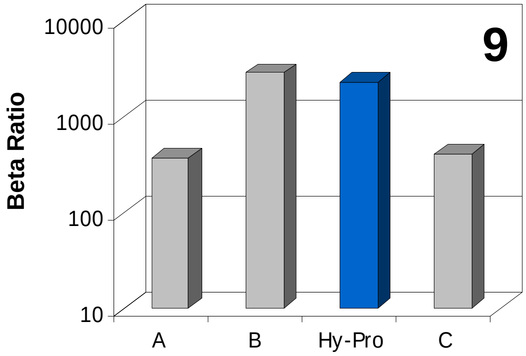
If we assume that a filter is like a black hole where all of the captured contaminant will remain trapped indefinitely we are operating with a false sense of security. If you are only discussing removal (capture) efficiency when it comes to filter elements you need to be looking at particle retention efficiency as well.

Downstream Element Hy-Pro 3	$4\mu_{[c]}$ particles/ml	$6\mu_{[c]}$ particles/ml	$14\mu_{[c]}$ particles/ml	ISO Code per ISO4406:1999
Before Restart	75	10	1	13/11/7
During Restart	2994	404	4	19/16/9

DFE - Comparison Between DFE and ISO 16889 Multi-Pass Test Results

Figure 9 shows the performance of like elements produced by three different manufacturers that were tested per ISO 16889 multi-pass. The results were expressed as a time weighted beta ratio. Element B had a better capture efficiency than the Hy-Pro element in the constant flow test environment of ISO 16889. All of the elements tested were true to their Beta Ratio of either $\beta 5_{[c]} > 200$ or 1000.

Time Weighted Beta Ratio Comparison per ISO16889 multi-pass for $\beta 5\mu_{[c]} > 200$ or 1000 filter element.



Time Weighted Beta Ratio Comparison per DFE multi-pass for $\beta 5\mu_{[c]} > 200$ or 1000 filter element.

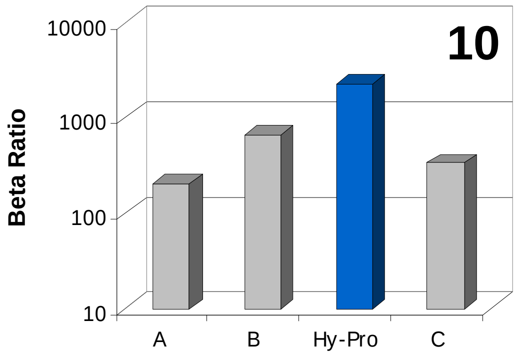
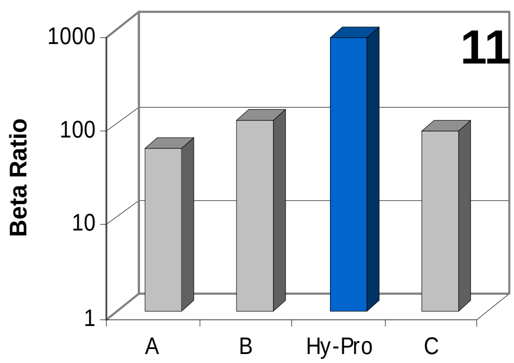


Figure 10 shows the time weighted performance of the like elements tested per DFE multi-pass. To illustrate the performance differences between DFE and ISO16889, the two tests were run similarly with the only difference being the DFE test flow rate. The flow through the element was cycled up and down the operating range to simulate a real world hydraulic system duty cycle. The time weighted beta ratio for elements A and B was below the rated beta ratio while elements Hy-Pro and C performed true to rating.

In figure 11 the particle counts taken during flow change have been isolated and then averaged to yield a beta ratio during transient flow. Since the DFE test has shown that filter element performance is at it's worst during flow changes isolating those sequences can help predict performance in dynamic flow systems. It is with this graph that we see how overall filter performance can be affected by systems with cyclic flow.

Real Time Flow Δ Beta Ratio Comparison per DFE multi-pass for $\beta 5\mu_{[c]} > 200$ or 1000 filter element.



Element B had a beta ratio in excess of $\beta 7_{[c]} > 2000$ when tested per ISO16889 (figure 9). However, figure 11 shows the average beta ratio of Element B during variable flow to be less than $\beta 7_{[c]} > 100$. The Hy-Pro element beta ratio was in excess of $\beta 7_{[c]} > 800$ and was the only one with a beta ratio greater than 100. The Hy-Pro performance in figure 11 illustrates why Hy-Pro is committed to the DFE test method for design and development.

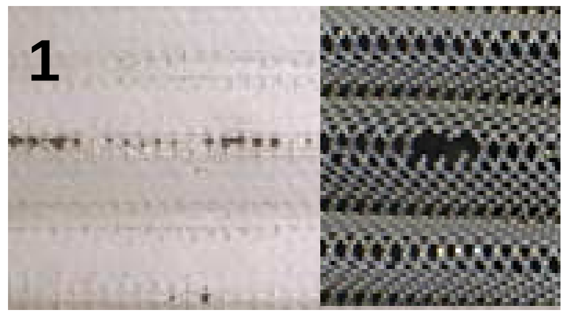
Relying solely on ISO16889 to predict how filter elements will perform in systems with dynamic flow conditions means that we are making decisions on filter performance without all of the available information. The current industry standard test for hydraulic and lube filter performance (ISO 16889) is a good tool for predicting performance of off-line filters and circulating systems, but does not accurately represent the stress of a hydraulic circuit with dynamic flow conditions or a lube system cold start condition. The first step to fixing a problem is acknowledging that a problem actually exists, and without DFE testing it is difficult to truly predict actual filter performance in a dynamic system.

Hy-Pro LSD Series

Low Spark Discharge Filter Elements for power generation high speed bearing lubrication & EHC hydraulic applications

Minimize turbine oil thermal degradation caused by filter element spark discharge.

Spark Discharge and Fluid Electrification



High flow main lube and high pressure last chance filter elements from large frame gas turbines that have been afflicted by varnish have shown evidence of high voltage sparking events that result in fluid degradation possibly caused by high temperature spark discharge. Figure 1 shows filter media and support mesh from a lube filter element with spark discharge burn damage.

The main lube bearing filter elements can also contribute to increased varnish potential by fluid electrification. As fluid passes through the typical tortuous filter media fiber matrix both fluid velocity and turbulence increase resulting in thermal events as the fluid layers shear creating static accumulation on elements can lead to spark discharge from media to support tube. Group I base stock oils could conduct low levels of static charge out of the system to ground. The changes in resistivity with Group II base stocks mean that static charges stay in the system and can yield higher levels of static charge on filter elements.

HY-PRO Low Spark Discharge Filter Elements

Hy-Pro has incorporated application specific filter media and element design modifications to reduce spark discharge and dissipate element static charges. Lower media flow density (reduced fluid velocity through media) and reduced friction conductive media minimize filter element spark discharge. Many factors contribute to varnish potential including:

- Increased oil stress from combined hydraulic & lube reservoir (GE F7).
- New oil formulations (Group I vs Group II base stock)
- Micro-Dieseling
- Increased output and flow rate yielding higher bearing temperatures.
- Auto-degradation

It is still unclear to what degree element spark discharge contributes to overall lube oil varnish problems, but any reduction in thermal sparking events and tribo-electric effect will have a positive impact on fluid condition.

HP-PRO LSD (Low Spark Discharge) Elements Upgrades

Original Part Number	Hy-Pro Part Number	Original Part Number	Hy-Pro Part Number
200EB10	HPQ20082S-12EV-LS	HC9021FAT8ZYGE	HP21L8-15EV-LS
234A6578P0002	HP41L13-3EV-LS	HC9021FDP4Z	HP21L4-2EV-LS
234A6579P0002	HP41L13-3EV-LS	HC9021FDP4ZYGE	HP21L4-2EV-LS
254A7220P0008	HP41L13-3EV-LS	HC9021FDP8Z	HP21L8-2EV-LS
254A7229P0005	HP41L13-3EV-LS	HC9021FDP8ZYGE	HP21L8-2EV-LS
258A4860P002	HP61L11-2EV-LS	HC9021FDT4Z	HP21L4-15EV-LS
258A4860P004	HP61L21-2EV-LS	HC9021FDT4ZYGE	HP21L4-15EV-LS
315A2600P003	HP21L4-15EV-LS	HC9021FDT8Z	HP21L8-15EV-LS
361A6256P010	HPK3L18-3EV-LS	HC9021FDT8ZYGE	HP21L8-15EV-LS
363A4378P003	HPQ20082S-17EV-LS	HC9601FAP11Z	HP61L11-2EV-LS
363A4378P004	HPQ20082S-12EV-LS	HC9601FAP11ZYGE	HP61L11-2EV-LS
363A7485P0001	HPQ20082S-12EV-LS	HC9601FAP16Z	HP61L16-2EV-LS
932683Q	HPK3L18-3EV-LS	HC9601FAP16ZYGE	HP61L16-2EV-LS
B984C302P012	HP21L4-15EV-LS	HC9601FAP21Z	HP61L21-2EV-LS
FQ19165	HPQ20082S-12EV-LS	HC9601FAP21ZYGE	HP61L21-2EV-LS
HC0101FAP18ZYGE	HP101L18-3EV-LS	HC9601FDP11Z	HP61L11-2EV-LS
HC0101FAS18Z	HP101L18-12EV-LS	HC9601FDP11ZYGE	HP61L11-2EV-LS
HC0101FAS18ZYGE	HP101L18-12EV-LS	HC9601FDP11ZYGE	HP61L11-2EV-LS
HC101FAP18Z	HP101L18-3EV-LS	HC9601FDP16Z	HP61L16-2EV-LS
HC2006FAS28Z	HPQ20082S-12EV-LS	HC9601FDP16ZYGE	HP61L16-2EV-LS
HC2006FAT28Z	HPQ20082S-25EV-LS	HC9601FDP21Z	HP61L21-2EV-LS
HC2006FKS28Z	HPQ20082S-12EV-LS	HC9601FDP21ZYGE	HP61L21-2EV-LS
HC2006FKT28Z	HPQ20082S-25EV-LS	HC9650FAP8Z	HP50L8-3EV-LS
HC2006FMS28Z	HPQ20082S-12EV-LS	HC9650FAP8ZYGE	HP50L8-3EV-LS
HC2006FMT28Z	HPQ20082S-25EV-LS	HC9650FKP16Z	HP50L16-3EV-LS
HC2618FAP18Z	HP102L18-3EV-LS	HC9650FKP16ZYGE	HP50L16-3EV-LS
HC2618FAP18ZYGE	HP102L18-3EV-LS	HC9650FKP8Z	HP50L8-3EV-LS
HC2618FKP18Z	HP102L18-3EV-LS	HC9650FKP8ZYGE	HP50L8-3EV-LS
HC2618FKP18ZYGE	HP102L18-3EV-LS	HC9651FAP16Z	HP51L16-2EV-LS
HC2618FAS18Z	HP102L18-12EV-LS	HC9651FAP16ZYGE	HP51L16-2EV-LS
HC2618FAS18ZYGE	HP102L18-12EV-LS	HC9651FAP8Z	HP51L8-2EV-LS
HC2618FKS18Z	HP102L18-12EV-LS	HC9651FAP8ZYGE	HP51L8-2EV-LS
HC2618FKS18ZYGE	HP102L18-12EV-LS	HC9651FAT8Z	HP51L8-15EV-LS
HC8900FMN26HY550	HPQ98320L26-6EB-LS	HC9651FAT8ZYGE	HP51L8-15EV-LS
HC8900FMN26ZY550	HPQ98320L26-6EV-LS	HC9651FDP8Z	HP51L8-2EV-LS
HC8900FMN39HY550	HPQ98320L39-6EB-LS	HC9651FDP8ZYGE	HP51L8-2EV-LS
HC8900FMN39ZY550	HPQ98320L39-6EV-LS	HC9651FDT8Z	HP51L8-15EV-LS
HC8900FMS26HY550	HPQ98320L26-12EB-LS	HC9651FDT8ZYGE	HP51L8-15EV-LS
HC8900FMS26ZY550	HPQ98320L26-12EV-LS	HC9701FAP18Z	HPK3L18-3EV-LS
HC8900FMS39HY550	HPQ98320L39-12EB-LS	HC9701FAP18ZYGE	HPK3L18-3EV-LS
HC8900FMS39ZY550	HPQ98320L39-12EV-LS	HC9701FDP18Z	HPK3L18-3EV-LS
HC9021FAP4Z	HP21L4-2EV-LS	HC9701FDP18ZYGE	HPK3L18-3EV-LS
HC9021FAP4ZYGE	HP21L4-2EV-LS	HP9560FAP16Z	HP50L16-3EV-LS
HC9021FAP8Z	HP21L8-2EV-LS	HP9560FAP16ZYGE	HP50L16-3EV-LS
HC9021FAP8ZYGE	HP21L8-2EV-LS	PH718-05CNVGE	**HP101L18-17EV-LS*
HC9021FAT4Z	HP21L4-15EV-LS	PMG528-10	HPQ20082S-17EV-LS
HC9021FAT4ZYGE	HP21L4-15EV-LS	PMG528-10B200-GE	HPQ20082S-12EV-LS
HC9021FAT8Z	HP21L8-15EV-LS	PMG528-10-GE	HPQ20082S-17EV-LS

**Recommendation of $\beta 17_{[c]} > 1000$ element per GE TIL1542-2*

HY-PRO FILTRATION

Water Removal

Available for all spin-on and cartridge filter elements.

Media code "A" specifies G7 Dualglass media co-pleated with water removal scrim to produce a filter that can remove water while maintaining $\beta x_{[c]} = 1000$ efficiency down to 1µ / 2.5µ$_{[c]}$.

WATER CONTAMINATION

Free and dissolved water in hydraulic and lube systems leads to bearing fatigue, accelerated abrasive wear, corrosion of metal surfaces, increased electrical conductivity, viscosity variance, loss of lubricity, and fluid additive breakdown. Sources include condensation, reservoir leakage, worn actuator seals, heat exchanger leakage, new oil and more.

Filter elements with water removal media can bring high water counts down. Most water removal elements utilize low efficiency (nominally rated) media. We combine the best of both worlds by removing the water while maintaining our $\beta x_{[c]} = 1000$ particulate removal efficiency and ensuring that none of the gel particles are released back into the system. Water removal is available with any of our glass media selections from 1µ to 40µ . There is a price adder to the glass element price so please consult the price list or call Hy-Pro before quoting.

CAPACITY BY COMMON SERIES

Hy-Pro Element	Capacity H_2O	
	Liters	Ounces
HP75L8-*AB	0.7	23
HP101L18-*AB	2.5	84
HP101L36-*AB	5.1	172
HP102L18-*AB	1.9	65
HP102L36-*AB	3.3	112
HP83L16-*AB	1.7	57
HP83L39-*AB	3.6	123
HP8314L39-*AB	5.9	200
HP8310L39-*AB	6.2	207
HPKL9-*AB	0.6	21
HP60L8-*AB	0.5	15
HP25L9-*AB	0.4	12

WATER REMOVAL APPLICATION - BULK OIL CONDITIONING

Fluid volume: 250 gallons, 1000 liters
Initial ppm H_2O: 12000 ppm, Final ppm H_2O: < 50 ppm

A power plant planned to use a vacuum dehydrator to remove the water from 1000 liters of hydraulic oil. Dehydrator rental was expensive and required one month minimum. As an alternative Hy-Pro element HP8314L39-6AB (A media code = G7 Dualglass + water removal) was applied. Hy-Pro estimated that 2 elements would bring the ppm levels below the target. After the second element was removed the ppm level was below 50 ppm H_2O. A third element was installed but did not reach terminal Δp before the fluid was determined to be free of water and ready for use.

Water PPM ~ Ounce conversion:
Moisture (PPM) X Fluid volume (Gallons) X .0001279 = Ounces of Water

HY-PRO

VAC-U-DRY

VACUUM DEHYDRATOR

- Remove Free & Dissolved Water down to 20 PPM (0.002%)
- Remove Free & Dissolved gasses
- Standard Flow range 5~60 gpm,19~225 lpm (larger units available)
- Visually Monitor Fluid and Process through Clear Chamber Covers
- High Water Removal Efficiency
- Adjustable vacuum setting valve
- High Efficiency Particulate Filtration
- Low Watt Density Heaters
- Dimensional and Arrangement Design Flexibility
- Condensate Water Holding Tank with Automatic Drain Standard
- Electrical Phase Reversal Standard
- Optional PLC or VFD Control

VAC-U-DRY has the ability to develop higher vacuum and flow for speed of dissolved water and gas removal, and the best negative head capability.

Operator Friendly Smart Relay - Smart relay enabled control panel performs controlled start-up & shut-down routines for ease of operation and keeps operators out of the control box. Includes machine drain sequence & automatic phase reversal (internally controlled, no guess work or switch to throw).

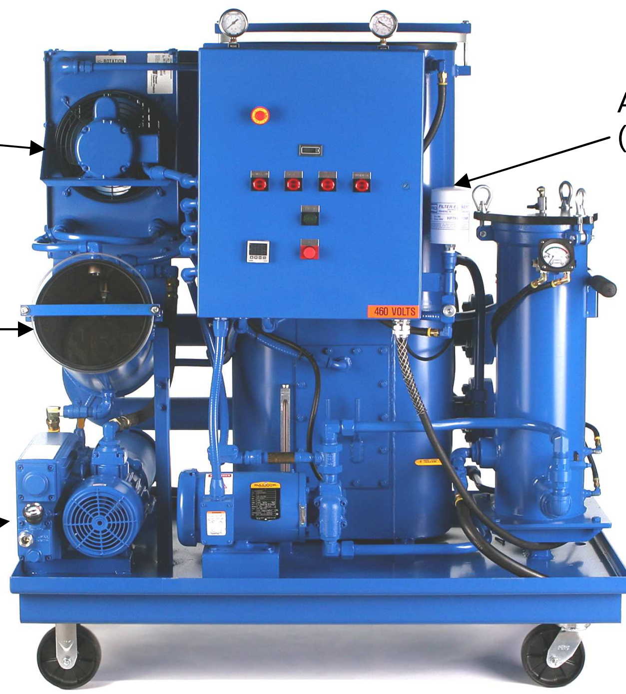
Programmable Thermostat - Programmable temperature controller for ease of operation and variable temp control with high limit safety setting.

Heater Selector Switch (keyed) - Optional keyed selector switch for all units above 12KW. Suitable with mobile unit when AMP circuit does not allow for AMP draw with heat > 12KW (Multiple heaters can be deselected)

Large air cooled condenser

Stainless steel condensate tank standard with clear cover (visual inspection)

High output vacuum pump



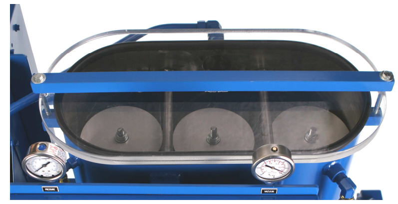
Air inlet breather. (particulate or desiccant)

Flexibility of design dimensions & process arrangement is an available option. We'll listen then customize a VAC-U-DRY for your specific application.

Model	Length Inch (mm)	Width Inch (mm)	Height Inch (mm)	Crated Weight Lbs (Kg)
V3	36 (914)	32 (813)	48 (1219)	1300 (590)
V5	48 (1219)	32 (813)	48 (1219)	1440 (654)
V10	56 (1422)	32 (813)	60 (1524)	1900 (863)
V15	56 (1422)	32 (813)	60 (1524)	1990 (904)

User friendly . . . Clear vacuum chamber and condensate tank covers allow you to see the performance (condensation and collected water).

Clear vacuum chamber and condensate tank covers for visual monitoring of dehydration process.



All condensate wetted parts are 304 stainless steel (standard)

V10 Model

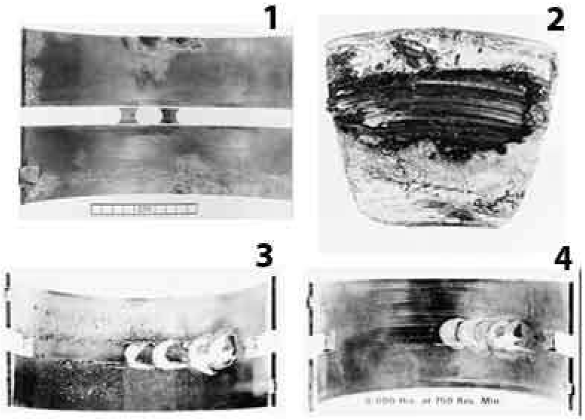
Top loading particle filter assembly with coreless filter element and true Δp gauge

Low watt density fin tube heaters prevent coking with no direct contact between heating element & fluid.

Standard Re-circulating line maximizes efficiency with cold start and allows adjustment system return flow rate.

Solid non-shedding wheels and forklift guides standard

Model	Length Inch (mm)	Width Inch (mm)	Height Inch (mm)	Crated Weight Lbs (Kg)
V20	72 (1829)	36 (914)	60 (1524)	2100 (954)
V30	84 (2134)	40 (1016)	60 (1524)	2500 (1136)
V45	84 (2134)	48 (1219)	60 (1524)	2840 (1290)
V60	84 (2134)	60 (1524)	60 (1524)	3210 (900)



The Harmful Affects of Water in Oil

Water is one of the most common and most damaging contaminants found in a lube or hydraulic system. Continuous or periodic high water levels can result in damage such as:

- Metal Etching (corrosion)
- Abrasive wear in hydraulic components
- Dielectric Strength Loss
- Fluid Breakdown
- Additive precipitation and oil oxidation
- Reduction in lubricating properties

75% of All Hydraulic Component failures are Caused by Fluid Contamination

The effects of moisture in your oil systems can drastically reduce on stream plant availability. Bearing life and critical component life is greatly reduced by moisture levels above and within the saturation point. Many systems run constantly above this point due to inefficient dehydration technologies and high ingression. This develops acidity and loss of lubrication properties. Free water occurs when oil becomes saturated and cannot dissolve any additional water. This water makes the oil appear cloudy and can even be seen in puddle form at the bottom of a reservoir. Water which is absorbed into the oil is called dissolved water. At elevated temperatures, oil has the ability to hold more water in the dissolved state due to the expansion of the oil molecules. As the oil cools, it loses its capacity to hold water and free water will appear where previously not visible. Fluid type also determines saturation point in addition to temperature changes.

Fluid	Saturation PPM	Saturation %
Hydraulic	300	0.03%
Lubrication	400	0.04%
Transformer	50	0.005%

New Moisture Level PPM (%)

Current Moisture Level (PPM)	1000 (0.1%)		500 (0.05%)		250 (0.025%)		100 (0.01%)		50 (0.005%)	
	Rolling Element	Journal Bearing	Rolling Element	Journal Bearing	Rolling Element	Journal Bearing	Rolling Element	Journal Bearing	Rolling Element	Journal Bearing
5000	2.3	1.6	3.3	1.9	4.8	2.3	7.8	2.9	11.2	3.5
2500	1.6	1.3	2.3	1.6	3.3	1.9	5.4	2.4	7.8	2.9
1000			1.4	1.2	2	1.5	3.3	1.9	4.8	2.3
500					1.4	1.2	2.3	1.6	3.3	1.9
250							1.5	1.3	2.3	1.6
100									1.4	1.2

Component Life Extension by Removing Water*

*courtesy of Noria

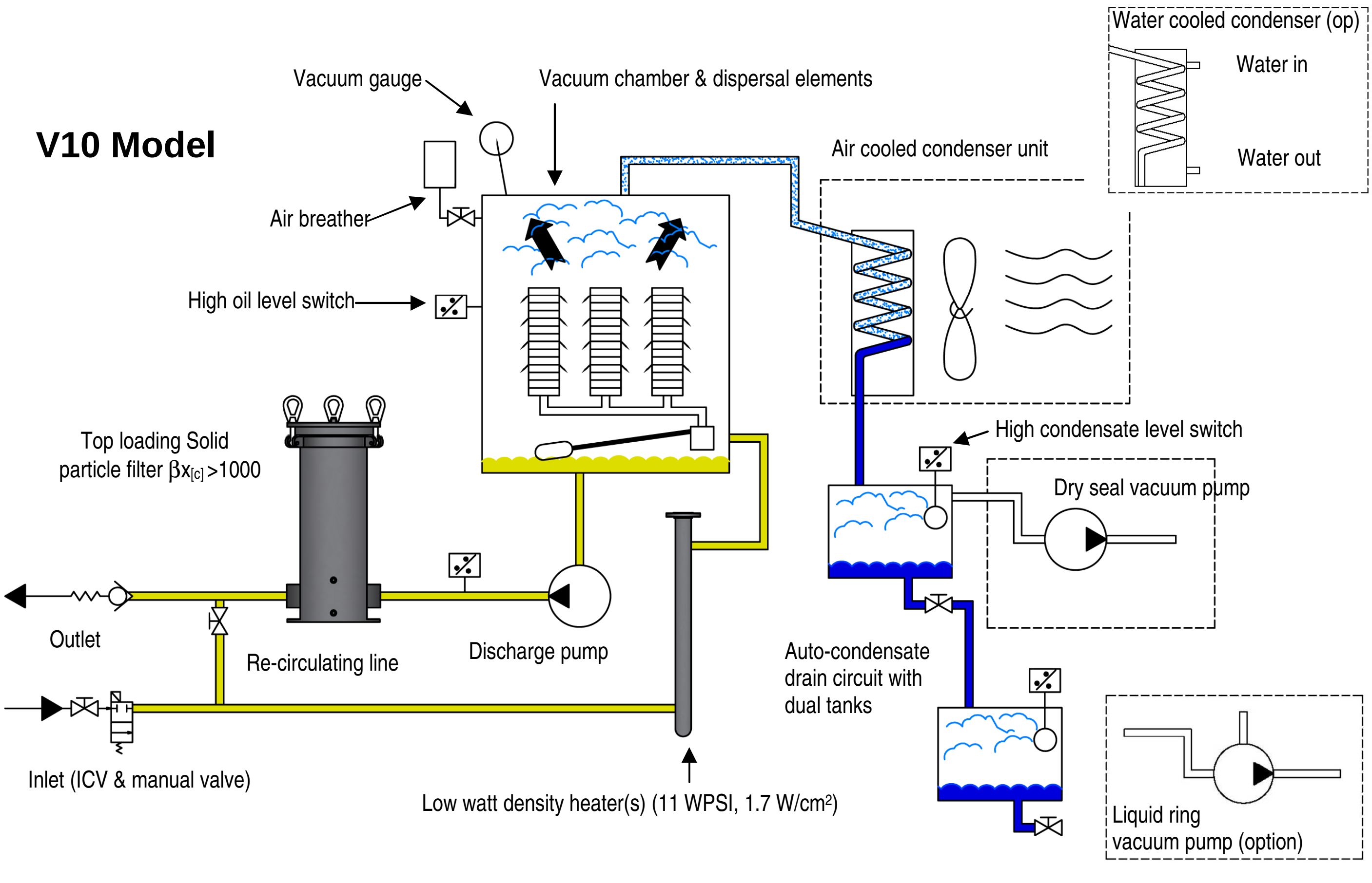
Increase "Must Have" Plant Reliability

Centrifuges only remove free water that is well above the saturation point leaving harmful quantities of free and dissolved water in the oil. Desorbers and coalescing filters can achieve water levels of 150 ppm, but the process can be much slower or impossible with the presence of surfactants and additives. VAC-U-DRY rapidly removes water (below 20 ppm (0.0020% with desiccant breather) with efficiency to control water levels under normal ingression and regain control of high ingression conditions in hours instead of weeks or months.

Contaminant Type	VAC-U-DRY Capability
Water	Remove 100% free water 90% + dissolved water
Particulate	ISO Cleanliness Code 13/11/8 per ISO4406:1999
Gases	Remove 100% free gases 90% + dissolved gases
Air	Remove 100% free air 90% + dissolved air

The VAC-U-DRY Purification Process and Flow Diagram

Contaminated oil is drawn into the VAC-U-DRY purifier by a high output vacuum pump. The oil passes through the low watt density heater where heated to optimum temperature for the dehydration process (150°F, 66°C). The oil enters the vacuum chamber passing through specially designed dispersal elements which create a thin film of oil that is exposed to the vacuum. The water is vaporized and then drawn into the condenser where it becomes liquid and drains into the condensate tank.

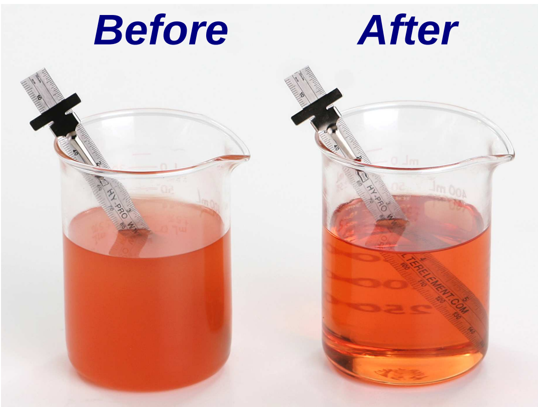


The dehydrated oil flows to the bottom of the vacuum chamber and is removed by the discharge pump. The oil is pumped through the high efficiency particulate filter assembly ($\beta x_{[c]}$ >1000) and returned to the system. The re-circulating line helps the VAC-U-DRY reach optimum temperature in cold start situations and can be used to throttle machine inlet and outlet flow.

HY-PRO FILTRATION

Feature	Description
Condensate wet parts stainless	Better fluid compatibility with no price adder (304 stainless standard)
Flexible design & dimensions	Flexible dimensions, process setup to suit your application (others won't)
Programmable thermostat	Precise temperature control, prevents overheating, unattended operation
Vacuum process	27" max Hg vacuum yields rapid water and gas removal. Operational up to 20 meter (60 ft) negative head
Visual access	Clear covers on vacuum chamber and condensate tank allow visual inspection of oil condition and process

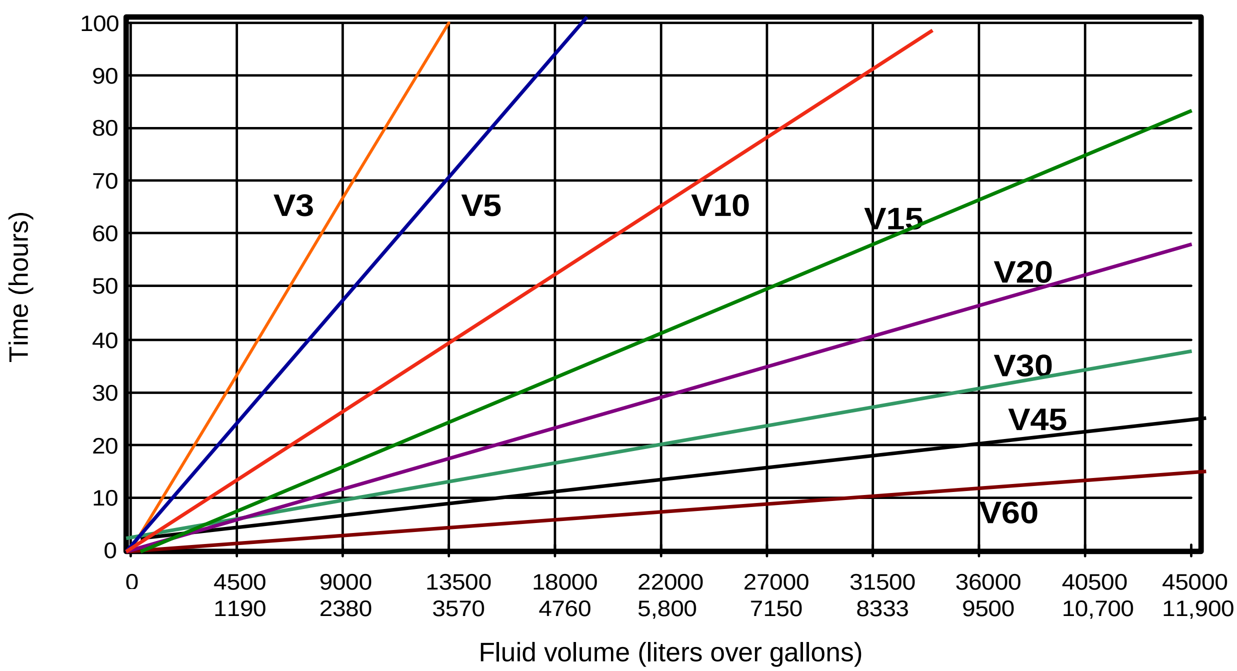
Feature	Description
Re-circulation line	Achieve optimum temp faster. Reduce flow rate for smaller systems. Maintain several systems with one VAC-U-DRY
Condensate collection	All water removed does not go through vacuum pump extends vac pump life.
Heater system	Low watt density heaters prevent coking No direct heat element contact with oil Heat applied only when necessary
Auto condensate drain	Automatic condensate drain standard Maximizes uptime (24/7 operation)
Electrical phase reversal standard	Electrical phase reversal automatically controlled in the control panel No guess work or switch to throw



Field Trial Results

Tank Volume	100 Gallons (375 litres)
Time Elapsed	95 Minutes
VAC-U-DRY Model	V10 (10 gpm, 37 litres)
Water content	Start: 10,000 PPM (1.0%) Stop: 50 PPM (0.005%)
ISO Cleanliness code	Start: ISO 21/18/16 Stop ISO 15/11/4

Estimated Water Removal Time - 5000 ppm (0.5%) to 150 ppm (0.015%)

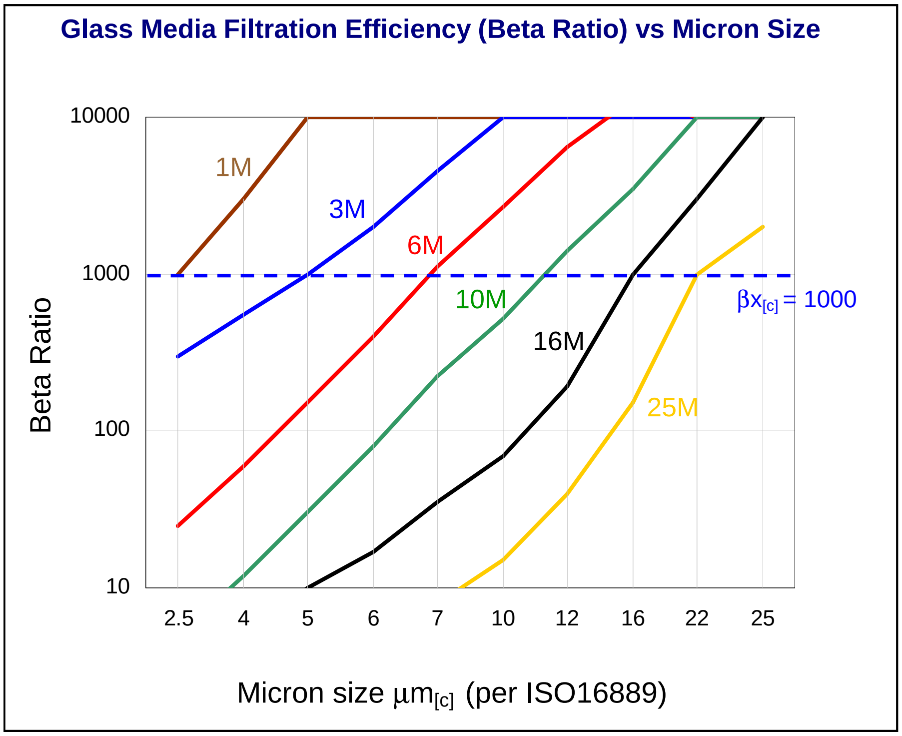


High Performance Particulate Filter Elements $\beta x_{[c]} > 1000$

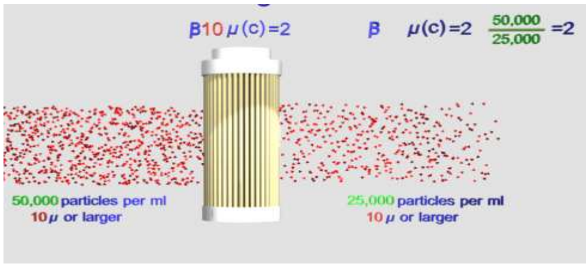
Dynamic Filter Efficiency (DFE) Testing - Revolutionary test methods assure that DFE rated elements perform true to rating even under demanding variable flow and vibration conditions. Today's industrial and mobile hydraulic circuits require elements that deliver specified cleanliness under ALL circumstances. Wire mesh supports the media to ensure against cyclical flow fatigue, temperature, and chemical resistance failures possible in filters with synthetic support mesh. Contact your distributor or Hy-Pro for more information and published articles on DFE testing and DFE rated filter elements.

Media Options - Through extensive testing we have developed media choices to handle any application. Media options include G7 Dualglass, and Stainless steel wire mesh.

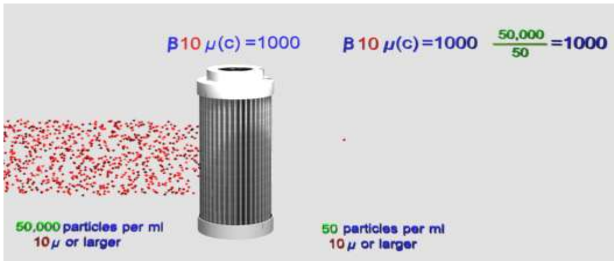
Fluid Compatibility - Petroleum based fluids, water glycol, polyol ester, phosphate ester, High water based fluids, Skydrol and many other synthetics. Contact us for material selection assistance and compatibility questions.



Typical cellulose media performance



Hy-Pro G7 Dualglass media performance



VAC-U-DRY PART NUMBER GUIDE

V	flow rate	pump seal	power	dispersal element	media	seal	heater	con-denser	special options

table 1 code	flow rate gpm (lpm)
3	3 (11)
5	5 (19)
10	10 (38)
15	15 (56)
20	20 (75)
30	30 (113)
45	45 (169)
60	60 (225)

table 2 code	vacuum pump
D	Dry seal
L	Liquid ring

table 3 code	power options
23	230 VAC, 3P, 60Hz
38	380 VAC, 3P, 50Hz
41	415 VAC, 3P, 50Hz
46	460 VAC, 3P, 60Hz
57	575 VAC, 3P, 60Hz

table 4 code	dispersal element
D	dispersal (υ < 500 cSt)
P	Packed (υ > 500 cSt)

table 5 code	Filtration rating
1M	$\beta2.5_{[c]}$ = 1000 ($\beta1$ = 200)
3M	$\beta5_{[c]}$ = 1000 ($\beta3$ = 200)
6M	$\beta7_{[c]}$ = 1000 ($\beta6$ = 200)
10M	$\beta12_{[c]}$ = 1000 ($\beta12$ = 200)
16M	$\beta17_{[c]}$ = 1000 ($\beta17$ = 200)
25M	$\beta22_{[c]}$ = 1000 (B25 = 200)
25W	25µ nominal wire mesh
40W	40µ nominal wire mesh
74W	74µ nominal wire mesh
149W	149µ nominal wire mesh
250W	250µ nominal wire mesh

table 6 code	seal material
V	Viton (standard)
E	EPR

table 7 code	heater (KW)
5	5 KW
10	10 KW
12	12 KW
24*	24 KW
36*	36 KW
48*	48 KW

*Possible high full Amp load (consider special option J)

table 8 code	condenser type
A	air cooled
L	liquid cooled
B	air & liquid cooled

table 9 Code	special options (add options to p/n in order they appear in table)
8	8" solid wheel upgrade
A*	Auto-condensate drain (supplied standard)
B	pre-filter Bag filter housing
C	CE mark (V5~V60) + International crating
D	dirty filter indicator alarm light
E	carbon vacuum pump exhaust filter
F	vacuum chamber foaming sensor
G	316 stainless condensate wet parts (304 standard)
H	manual reset hour meter (in addition to standard non-reset hour meter)
J	individual heater selector switches (24 KW and higher) for applications with limited amp circuit breakers
K	sight flow indicator (wheel type)
L	lifting eye kit
M	discharge line flow meter
P	water sensor + PLC control auto start/stop
Q*+	maintenance spares and repair kit
R*	electrical phase reversal switch (supplied standard)
T*	hose kit (suction & return hoses + wands)
U	electrical cord 50' without plug (13 meter)
V*	inlet control valve (for positive head inlet)
W	water sensor and indicator
X	explosion proof Class 1, Div 2, Group C/D with air purge (instrument quality air required). Consult factory for other explosion proof options.
Y	variable speed control (VFD drive)
Z*	on-site start up training (1 x 10 hour shift)

*recommended options (Auto-condensate drain & phase reversal standard)

+ Q option repair & spares kit includes several items such as fuses, common relay, vac pump oil/exhaust filters, vac pump coupling, vac pump oil, panel bulb, vac chamber & condensate chamber covers, flow switch, heat thermocouple, replacement element set for vacuum chamber and particulate housing.

FC Filter Cart

Flow rate up to 22 gpm (82 lpm)

Ideal for hydraulic fluids (ISO VG22 ~ ISO VG68)

Filter new fluids during transfer and replenishment (top-off)

Flush fluids already in service with high efficiency elements in addition to existing filtration.

Remove particulate and water.

Condition bulk oil before use.

Materials of Construction

Assembly Frame: Painted Steel
Tires: Rubber (foam filled, never flat)
Filter Assembly: Aluminum head, Steel canister
25 psid bypass valve
True differential pressure indicator
Hoses: Reinforced synthetic
Wands: Steel wands (zinc plated)

Operating Temperature

Nitrile (Buna)	-40°F to 150°F -40°C to 66°C
Fluorocarbon (Viton)*	-15°F to 200°F -26°C to 93°C

*High temperature / phosphate ester design

Fluid Compatibility

Petroleum and mineral based fluids (standard). For polyol ester, phosphate ester, and other specified synthetics use Viton seal option or contact factory.

Weight

FC1: 140 Lbs (63,6 kg) approximate
FC2: 145 Lbs (66 kg) approximate
FC3: 235 Lbs (106 kg) approximate

Explosion Proof Option

Class 1, Div 2 explosion option is available, or ask about our pneumatic powered cart.

Electrical Service

115VAC 60Hz 1P (standard) for FC1 & FC2
see options table for other selections

Electric Motor Specifications

TEFC or ODP, 56C frame
FC1: 1 HP, 1750 RPM, thermal overload reset
FC2: 1 HP, 1750 RPM, thermal overload reset
FC3*: 3 HP, 1750 RPM, thermal overload reset
*230VAC 1P or 440VAC 3P required for FC3

**No cord reel for FC3, any 3 phase or > 230 VAC

Recommended Viscosity Range

FC1*: 28 SSU ~ 2000 SSU, 6 cSt ~ 400 cSt
FC2*: 28 SSU ~ 1000 SSU, 6 cSt ~ 200 cSt
FC3*: 28 SSU ~ 1000 SSU, 6 cSt ~ 200 cSt

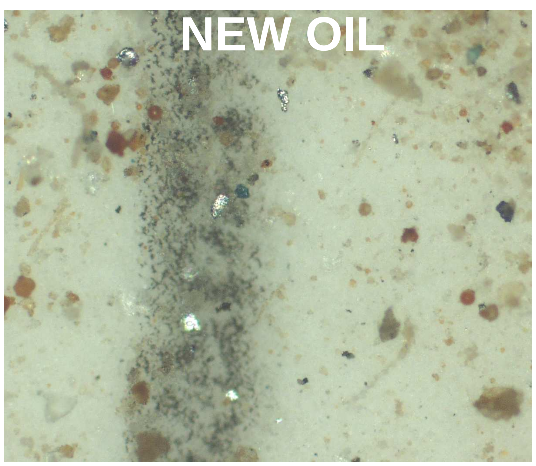
*At maximum viscosity clean element pressure drop with 3M media code < 12 psid/0.85 bar. Check maximum viscosity of oil in coldest condition. For high viscosity lubricating oils consider the FCL series or call Hy-Pro.

Pump Specifications

Gear pump
Internal relief full flow 100 psi, 6 bar standard

HY-PRO FILTRATION

****No cord reel for FC3, any 3 phase or > 230 VAC**



Filtering New Oil - Particulate and Water

New oil is typically not clean oil, and not suitable for use in hydraulic and lube systems. During the production and transportation process new oil collects high levels of solid contaminant and water.   A common ISO code for new oil is 24/22/19. New oil is one of the worst sources of particulate contaminant system ingression.

The FC with water removal element will effectively remove free water while capturing particulate with high efficiency. Free and dissolved water in hydraulic and lube systems leads to accelerated abrasive wear, corrosion of metal surfaces, increased electrical conductivity, viscosity variance, loss of lubricity, fluid additive breakdown, bearing fatigue and more.   The FC series filter cart includes a wide range of element combination options to tackle any challenge. The HP75L8-25AB water removal element holds 23 ounces of water while controlling particles with a beta ratio of $\beta25 = 200$, $\beta22[c] = 1000$.

Flush and Condition Existing Systems

The FC is also effective for condition fluids that are already in service. Equipping hose ends and reservoirs with quick disconnect fittings allows you to use the FC as a portable side loop system that can service several machines.

FC1, FC2, FC3 FILTER CART APPLICATION INFO

Cleaner Fluid, Greater Reliability

When establishing a target ISO cleanliness code first identify the most sensitive component. New oil added should be cleaner than the target ISO code for the system.

Figure 1 details the improvement in component life as the ISO cleanliness is improved for roller contact bearings. Improving and stabilizing fluid cleanliness codes can increase hydraulic component and bearing life exponentially.

Lab and field tests prove time and again that Hy-Pro filters deliver lower ISO cleanliness codes, and do it with greater consistency.

Figure 1

Current ISO Code	Target ISO Code	Target ISO Code	Target ISO Code	Target ISO Code
Start	**2 x Life**	**3 x Life**	**4 x Life**	**5 x Life**
28/26/23	25/22/19	22/20/17	20/18/15	19/17/14
27/25/22	23/21/18	21/19/16	19/17/14	18/16/13
26/24/21	22/20/17	20/18/15	19/17/14	17/15/12
25/23/20	21/19/16	19/17/14	17/15/12	16/14/11
25/22/19	20/18/15	18/16/13	16/14/11	15/13/10
23/21/18	19/17/14	17/15/12	15/13/10	14/12/9
22/20/17	18/16/13	16/14/11	15/13/10	13/11/8
21/19/16	17/15/12	15/13/10	13/11/8	-
20/18/15	16/14/11	14/12/9	-	-
19/17/14	15/13/10	13/11/8	-	-
18/16/13	14/12/9	-	-	-

The Right Element Combination

Figure 2 illustrates some possible combinations to use on the FC series cart. When water removal is desired use the 12A or 25A media code as a pre-filter. A finer media can be used on the main filter (second) to capture smaller particulate and reduce the ISO code. When conditioning a tote or flushing a fluid already in use the 1M media code will yield the quickest result on particulate.

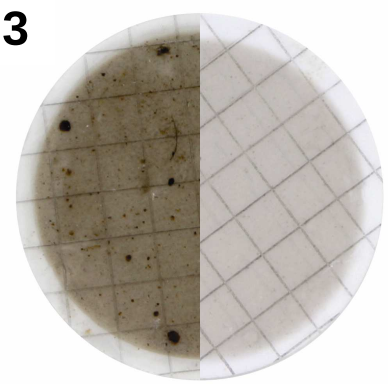
Figure 2

Current Condition	Pre-Filter	Main-Filter
ISO 25/24/22 (New oil) with High water content	HP75L8-25AB β22[c] = 1000 + water removal	HP75L8-3MB β5[c] = 1000
ISO 25/24/22 (New oil)	HP75L8-12MB β12[c] = 1000	HP75L8-1MB β2.5[c] = 1000
ISO 21/19/16	HP75L8-3MB β5[c] = 1000	HP75L8-1MB β2.5[c] = 1000

Don't Put Dirty Oil Into Your System

Figure 3 shows the difference in particulate contamination between unfiltered new fluid with an ISO Cod of 24/22/19 and fluid that has been conditioned to an ISO Code of 16/14/11.

3



Prepared using PTK1 patch test kit

HY-PRO FILTRATION

Dynamic Filter Efficiency (DFE) Testing

Revolutionary test methods assure that DFE rated elements perform true to rating even under demanding variable flow and vibration conditions. Today's industrial and mobile hydraulic circuits require elements that deliver specified cleanliness under ALL circumstances. Wire mesh supports the media to ensure against cyclical flow fatigue, temperature, and chemical resistance failures possible in filter elements with synthetic support mesh. Contact your distributor or Hy-Pro for more information and published articles on DFE testing.

Media Options

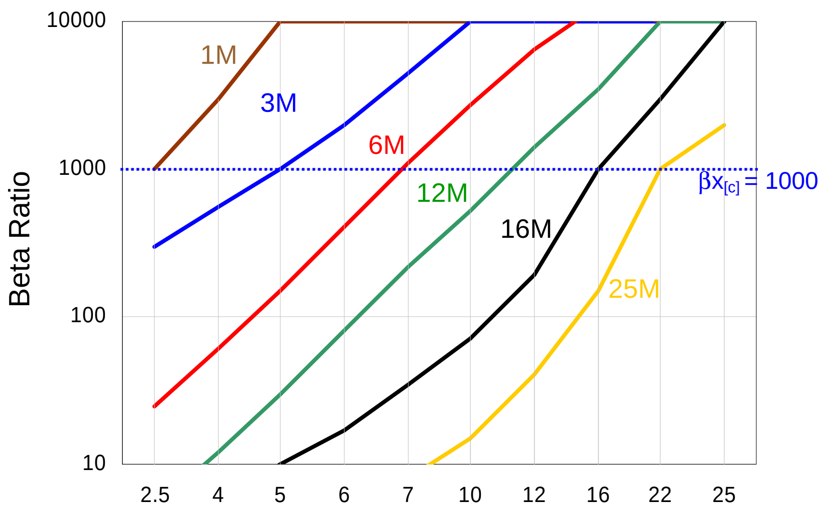
Through extensive testing we have developed media choices to handle any application. Options include G7 Dualglass, Dynafuzz (stainless fiber), and Wire mesh (stainless).

Fluid Compatibility

Petroleum based fluids, water glycol, polyol ester, phosphate ester, high water based fluids and many other synthetics. Contact us for seal material selection assistance.

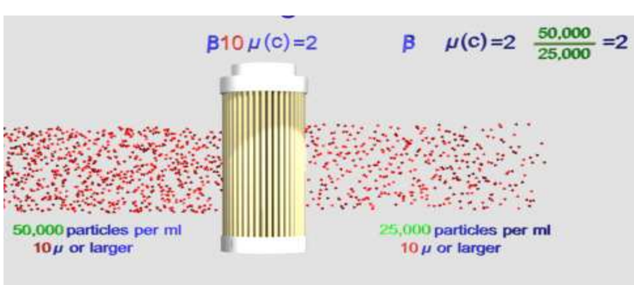
FILTER MEDIA SPECIFICATIONS

Glass Media Code Filtration Efficiency (Beta Ratio) vs Micron Size

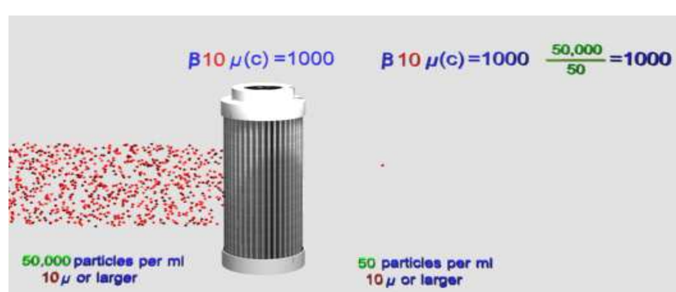


media code	media description
A	G7 Dualglass high performance media combined with water removal scrim. $\beta x_{[c]} = 1000$ ($\beta x = 200$)
M	G7 Dualglass our latest generation of DFE rated, high performance glass media for all hydraulic & lubrication fluids. $\beta x_{[c]} = 1000$ ($\beta x = 200$)
W	Stainless steel wire mesh media $\beta x_{[c]} = 2$ ($\beta x = 2$) nominally rated

Typical cellulose media performance



Hy-Pro G7 Dualglass media performance



FC1, FC2, FC3 FILTER CART PART NUMBER GUIDE

	table 1		table 2	table 2		table 3	table 4		table 5	table 6	
FC	Flow rate	-	Element 1 (Pre-filter)	Element 2 (Main-filter)	-	Seal	Hose	-	Power Option	Extra Option C1	Hy-Pro Mfg Code

REPLACEMENT FILTER ELEMENT PART NUMBER GUIDE

	table 2	table 3
HP75L8 -	Media	Seal

table 1 code	flow rate gpm (lpm)
1	5 gpm (18,7 lpm) 2 x S75, single element heads (in series)
2	10 gpm (37,5 lpm) 2 x S75, single element heads (in series)
3	22 gpm (82 lpm) 2 x S75D, dual element heads (in series)

table 2 code	filtration rating	media type
1M	$\beta 2.5_{[c]} = 1000$ ($\beta 1 = 200$)	G7 Dualglass
3M	$\beta 5_{[c]} = 1000$ ($\beta 3 = 200$)	G7 Dualglass
6M	$\beta 7_{[c]} = 1000$ ($\beta 6 = 200$)	G7 Dualglass
12A	$\beta 12_{[c]} = 1000$ ($\beta 12 = 200$)	G7 Dualglass + Water removal
12M	$\beta 12_{[c]} = 1000$ ($\beta 12 = 200$)	G7 Dualglass
25A	$\beta 22_{[c]} = 1000$ ($\beta 25 = 200$)	G7 Dualglass + Water removal
25M	$\beta 22_{[c]} = 1000$ ($\beta 25 = 200$)	G7 Dualglass
74W	74u nominal	wire mesh
149W	149u nominal	wire mesh

table 3 code	seal material
B	Nitrile (Buna)
V	*Specified synthetics or High Temperature (>150F). Viton seals, metal wands, lined hoses.

*Phosphate Ester, Water Glycol & other synthetics.

table 5 code	power options
*Omit (standard) *E1	115 VAC, 60Hz, 1P (1750 RPM motor) 120 VAC, 50Hz, 1P (1450 RPM motor)
E2 E3	230 VAC, 60Hz, 1P (1750 RPM motor) 230 VAC, 50Hz, 1P (1450 RPM motor)
E4	24 VDC (Consult factory for application)
E5	440-480 VAC, 60 Hz, 3P (1750 RPM motor)
E6	380-420 VAC, 50Hz, 3P (1450 RPM motor)
P	Pneumatic driven air motor (call factory)

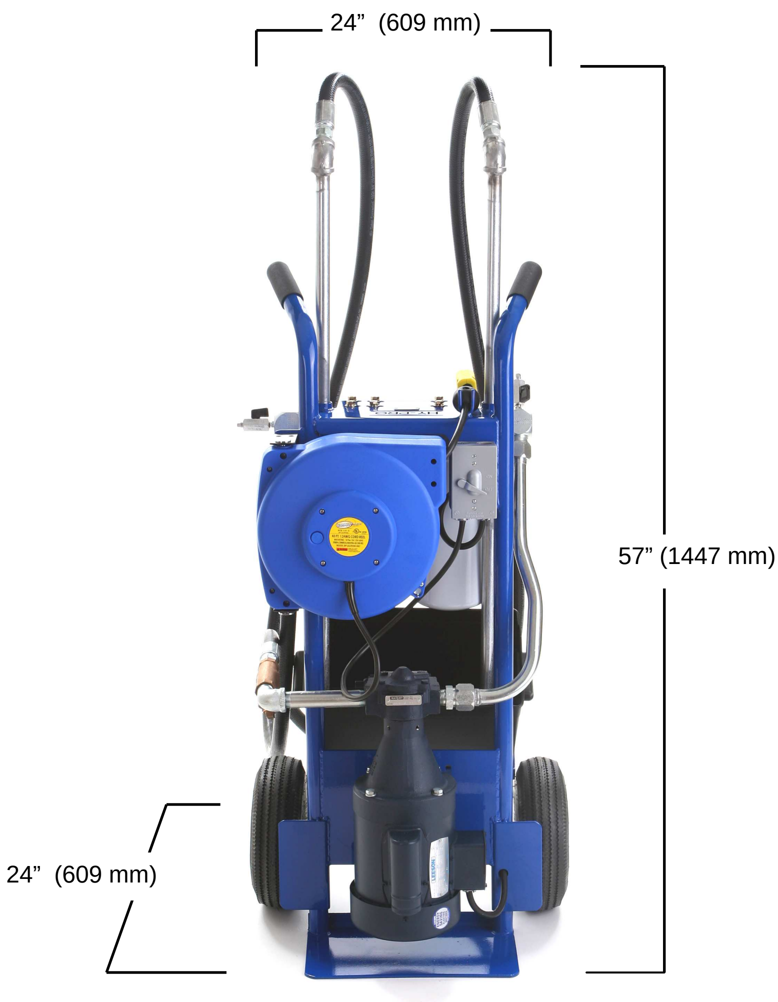
table 4 code	hose arrangement
W	Female 3/4" SAE/JIC swivel hose ends with steel wands
S	Female 3/4" SAE/JIC swivel hose ends (No Wands)
G	Female 3/4" BSPP swivel hose ends (No Wands)

*Extension hoses are available in 10' (254mm) lengths.

*Not available for FC3. 3 phase electrical option carts are supplied with terminated electrical cord only, and do not include electrical cord reel or electrical cord plug.

table 6 code	special options
C1	Explosion proof electrical (Class 1, Div 2)
H1	Suction & return hose extensions (10', 2,5 meter)
H2	Suction & return hose extensions (20', 5 meter)

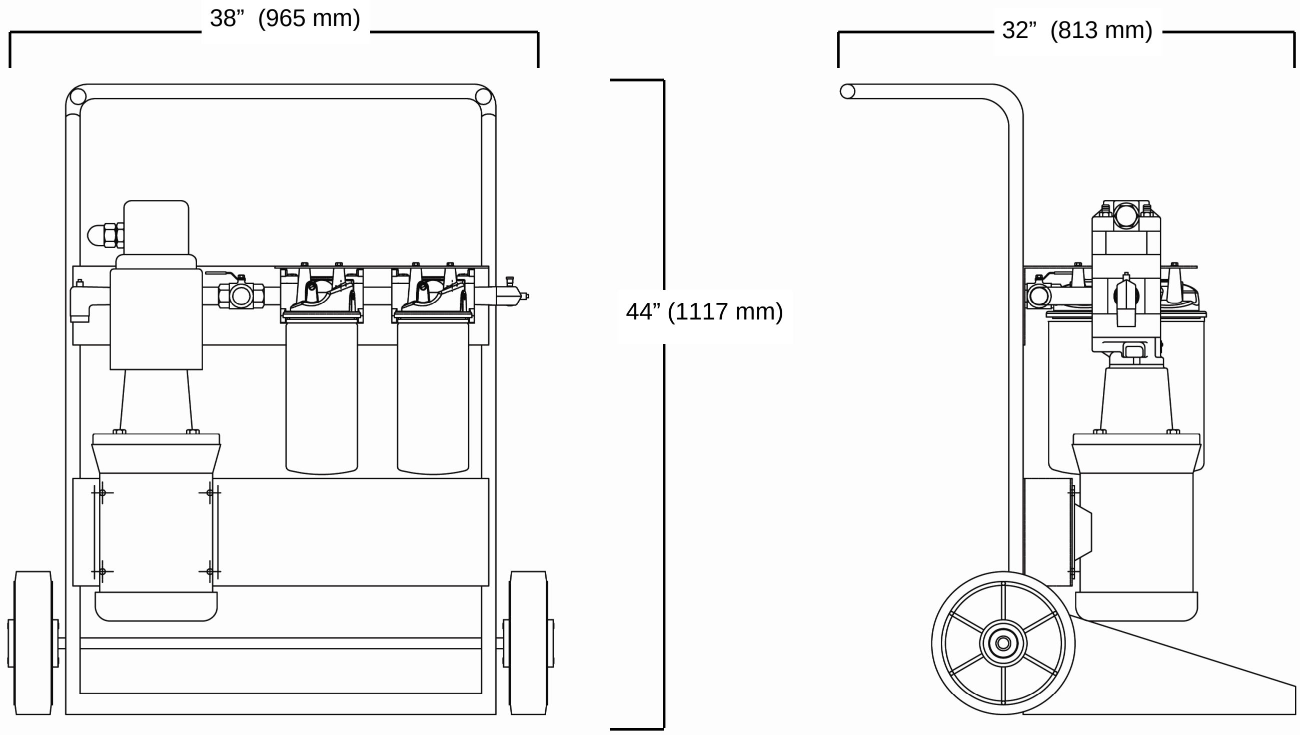
FC1, FC2 DIMENSIONS



FC1, FC2 SPARE PARTS

Part Number	Description
FCHOSE3/4SAE	3/4" SAE/JIC female swivel hose end, connects with Hy-Pro wands (sold individually)
FCHOSE3/4BSPP	3/4" BSPP female swivel hose end, Not compatible with wands (sold individually)
FCBATT	Removable drip pan
LFSV	Fluid sampling valve port
FCWANDST	Replacement wands steel
FCGRIPS	Cart handle grips (set of two)
FC1HPMTR	1 HP motor 115/230VAC 1P
FC1H1JIC	10 ft, 2,5 meter hose extension set JIC connections
FC1H1BSP	10 ft, 2,5 meter hose extension set BSP connections
FC1H2JIC	20 ft, 5 meter hose extension set JIC connections
FC1H2BSP	20 ft, 5 meter hose extension set BSP connections

FC3 DIMENSIONAL DRAWING



FC3 SPARE PARTS

Part Number	Description
FC3WANDST	Replacement wands steel
LFSV	Fluid sampling valve port
FC3H1JIC	10 ft, 2,5 meter hose extension set JIC connections
FC3H1BSP	10 ft, 2,5 meter hose extension set BSP connections
FC3H2JIC	20 ft, 5 meter hose extension set JIC connections
FC3H2BSP	20 ft, 5 meter hose extension set BSP connections

FCL Filter Cart

Flow rate up to 22 gpm (82 lpm)

Ideal for high viscosity Lubrication and hydraulic oils (ISOVG22 ~ ISOVG320)

Filter new fluids during transfer and replenishment (top-off)

Flush fluids already in service with high efficiency elements in addition to existing filtration (Reliability).

Remove particulate and water contaminant.

Condition bulk oil before use.

Large element yields extended life.

Materials of Construction

Assembly Frame: Painted Steel
Wheels: Rubber (solid, non-shredding)
Filter Assembly: Epoxy coated steel
25 or 50 psid bypass available
True differential pressure indicator
Hoses: Reinforced synthetic
Wands: Steel

Operating Temperature

Nitrile (Buna)	-40f to 150f
	-40c to 66c
Fluorocarbon (Viton)*	-15f to 200f
	-26c to 93c

*High temperature / phosphate ester design

Fluid Compatibility

Petroleum and mineral based fluids (standard). For polyol ester, phosphate ester, and other specified synthetics use Viton seal option or contact factory.

Weight

FCL1: 350 Lbs (159 kg) approximate
FCL2: 360Lbs (164 kg) approximate
FCL3: 430 Lbs (195 kg) approximate

Electric Motor Specifications

TEFC 56C frame
FCL1: 1 HP, 115VAC, 60Hz, 1P, 1750 RPM
FCL2: 1 1/2 HP, 115VAC (FLA 16 Amps)
230VAC, 60Hz, 1P, 1750 RPM
or 440VAC, 60Hz, 3P, 1750 RPM
FCL3: 3HP, 230VAC, 60Hz, 1P, 1750 RPM
220VAC, 50Hz 1P, 1425 RPM
or 440VAC, 60Hz, 3P, 1750 RPM

Recommended Viscosity Range*

FCL1*: 28 SSU ~ 4000 SSU, 6 cSt ~ 800 cSt
FCL2*: 28 SSU ~ 4000 SSU, 6 cSt ~ 800 cSt
FCL3*: 28 SSU ~ 2000 SSU, 6 cSt ~ 400 cSt

*At maximum viscosity clean element pressure drop on 6M media code < 10 psid. Please check maximum viscosity of oil in coldest condition.

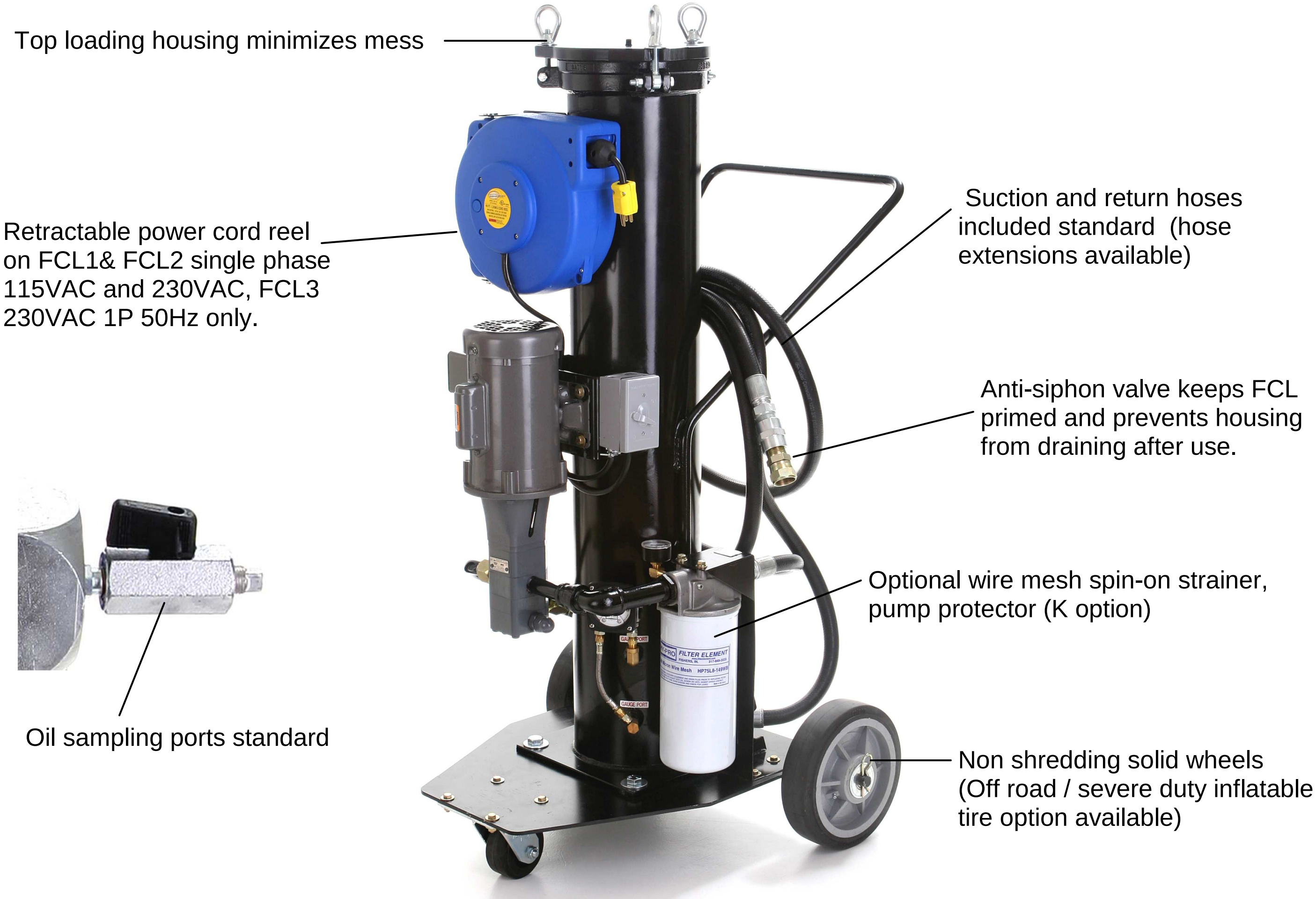
Pump Specifications

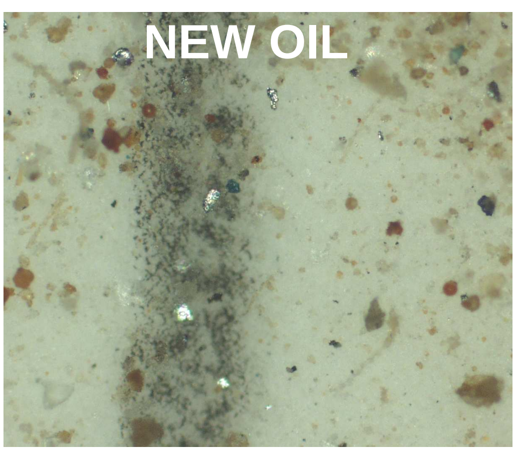
Gear pump
Internal relief full flow @ 100 psi standard.

Explosion Proof Option

Class 1, Div 2 explosion option is available. Ask About our pneumatic powered carts.

FCL1, FCL2, FCL3 FILTER CART APPLICATION INFO





Filtering New Oil - Particulate and Water

New oil is typically not clean oil, and might not be suitable for use in hydraulic and lube systems. During the production and transportation process new oil collects high levels of solid contaminant and water. A common ISO code for new oil is 24/22/19. New oil is one of the worst sources of particulate contaminant system ingression.

The FCL will effectively remove free water while capturing particulate with high efficiency. Free and dissolved water in hydraulic and lube systems leads to accelerated abrasive wear, corrosion of metal surfaces, increased electrical conductivity, viscosity variance, loss of lubricity, fluid additive breakdown, bearing fatigue, and more. The FCL series filter cart includes a wide range of element combination options to tackle any challenge. The “A” media adsorbs water while controlling particles with absolute efficiency (beta ratio of $\beta X = 200$, $\beta X_{[c]} = 1000$).

Flush and Condition Existing Systems

The FCL is also effective for conditioning fluids that are already in service. Equipping hose ends and reservoirs with quick disconnect fittings allows you to use the FCL as a portable side loop system that can service several machines.

Cleaner Fluid, Greater Reliability

When establishing a target ISO cleanliness code first identify the most sensitive component. New oil added should be cleaner than the target ISO code for the system.

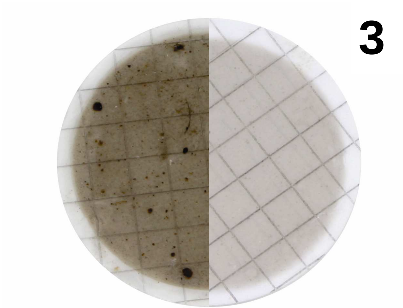
Figure 1 details the improvements in component life as the ISO cleanliness is improved for roller contact bearings. Improving and stabilizing fluid cleanliness codes can increase hydraulic component and bearing life exponentially.

Lab and field tests prove time and again that Hy-Pro filters deliver lower ISO cleanliness codes, and do it with greater consistency.

Figure 1

Current ISO Code	Target ISO Code	Target ISO Code	Target ISO Code	Target ISO Code
Start	**2 x Life**	**3 x Life**	**4 x Life**	**5 x Life**
28/26/23	25/22/19	22/20/17	20/18/15	19/17/14
27/25/22	23/21/18	21/19/16	19/17/14	18/16/13
26/24/21	22/20/17	20/18/15	19/17/14	17/15/12
25/23/20	21/19/16	19/17/14	17/15/12	16/14/11
25/22/19	20/18/15	18/16/13	16/14/11	15/13/10
23/21/18	19/17/14	17/15/12	15/13/10	14/12/9
22/20/17	18/16/13	16/14/11	15/13/10	13/11/8
21/19/16	17/15/12	15/13/10	13/11/8	-
20/18/15	16/14/11	14/12/9	-	-
19/17/14	15/13/10	13/11/8	-	-
18/16/13	14/12/9	-	-	-

3



Prepared using PTK1 patch test kit

Don't Put Dirty Oil Into Your System

Figure 3 shows the difference in particulate contamination between unfiltered new fluid with an ISO Cod of 24/22/19 and fluid that has been conditioned to an ISO Code of 16/14/11.

4

Coreless Filter Element Technology

Hy-Pro coreless elements are featured in the FCL series (see figure 4). The elements are oversized to yield extended element life and handle a wide variety of high viscosity oils. Hy-Pro coreless elements utilize wire mesh pleat support which ensures that the pleats won't collapse or lose integrity.

True Differential Pressure Gauges & Switches

Differential pressure gauges with green to red display ensures proper monitoring of filter element condition. DIN connector switch can be added to any pressure gauge (see figure 5).

5

HIGH PERFORMANCE FILTER ELEMENTS — THE HEART OF A FILTER

Dynamic Filter Efficiency (DFE) Testing

Revolutionary test methods assure that DFE rated elements perform true to rating even under demanding variable flow and vibration conditions. Today's industrial and mobile hydraulic circuits require elements that deliver specified cleanliness under ALL circumstances. Wire mesh supports the media to ensure against cyclical flow fatigue, temperature, and chemical resistance failures possible in filter elements with synthetic support mesh. Contact your distributor or Hy-Pro for more information and published articles on DFE testing.

Media Options

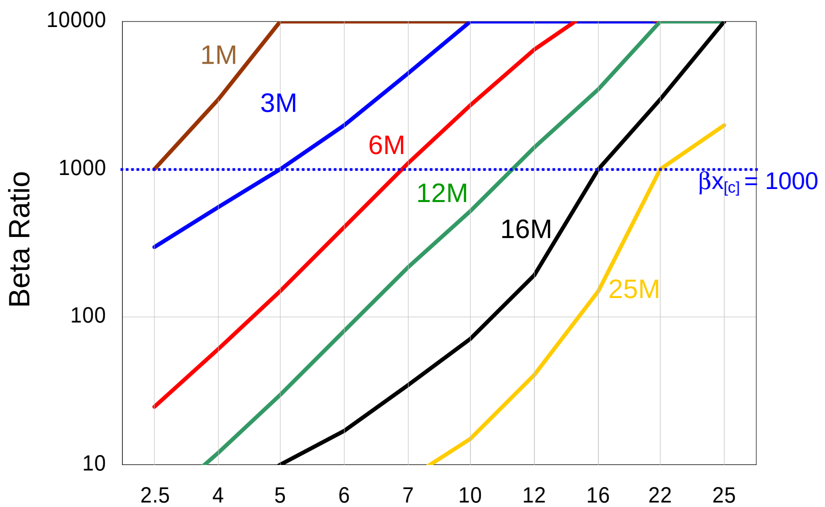
Through extensive testing we have developed media choices to handle any application. Options include G7 Dualglass, Dynafuzz (stainless fiber), and Wire mesh (stainless).

Fluid Compatibility

Petroleum based fluids, water glycol, polyol ester, phosphate ester, high water based fluids and many other synthetics. Contact us for seal material selection assistance.

FILTER MEDIA SPECIFICATIONS

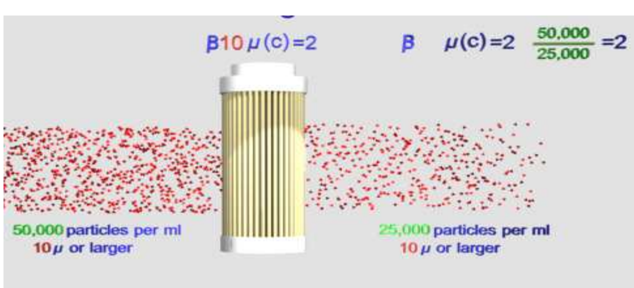
Glass Media Code Filtration Efficiency (Beta Ratio) vs Micron Size



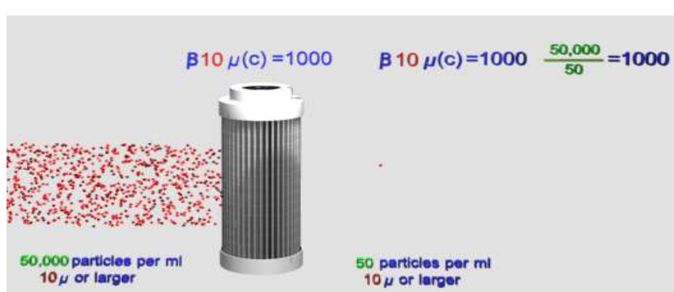
Micron size $\mu m_{[c]}$ (per ISO16889)

media code	media description
A	G7 Dualglass high performance media combined with water removal scrim. $\beta x_{[c]} = 1000$ ($\beta x = 200$)
M	G7 Dualglass our latest generation of DFE rated, high performance glass media for all hydraulic & lubrication fluids. $\beta x_{[c]} = 1000$ ($\beta x = 200$)
W	Stainless steel wire mesh media $\beta x_{[c]} = 2$ ($\beta x = 2$) nominally rated

Typical cellulose media performance



Hy-Pro G7 Dualglass media performance



FCL FILTER CART PART NUMBER GUIDE

	table 1		table 2	table 3		table 4	table 5		table 6	table 7	table 8	
FCL	Flow Rate	-	Element Type	Media Selection	-	Seals	Hose End	-	Δp Indictr	Power Option	Extra Option	Hy-Pro mfg code

REPLACEMENT FILTER ELEMENT PART NUMBER GUIDE

	table 2			table 3	table 4
HP10	☐	**L36***	**-**	☐	☐

*Use L39 length code for HP8314 element series.

table 1 code	flow rate gpm (lpm)
1	5 gpm (18,7 lpm)
2	10 gpm (37,5 lpm)
3	22 gpm (82 lpm)

table 4 code	seal material
B	Nitrile (Buna)
V	Specified synthetics or High Temperature (>150F). Viton seals, metal wands, Teflon lined hoses.

table 2 code	Element Configuration
5	HP105 coreless series, positive o-ring seals, **NO BYPASS,** max change-out 60 psid (4,2 bar)
6	HP106 element with bypass, 25 psid (1,8 bar) bypass, orings change-out 22 psid (1,5 bar)
7	HP107 element with bypass 50 psid (3,5 bar) bypass, orings change-out 45 psid (3,2 bar)
8	USE HP8314 for element P/N Interchanges with Pall HC8314, **NO BYPASS,** oring seals, max change-out 45 psid (3,2 bar)

table 3 code	filtration rating	media type
1M	$\beta 2.5_{[c]}$ = 1000 ($\beta 1$ = 200)	G7 Dualglass
3M	$\beta 5_{[c]}$ = 1000 ($\beta 3$ = 200)	G7 Dualglass
6M	$\beta 7_{[c]}$ = 1000 ($\beta 6$ = 200)	G7 Dualglass
10A	$\beta 12_{[c]}$ = 1000 ($\beta 12$ = 200)	Water removal +G7
10M	$\beta 12_{[c]}$ = 1000 ($\beta 12$ = 200)	G7 Dualglass
16A	$\beta 16_{[c]}$ = 1000 ($\beta 17$ = 200)	Water removal +G7
16M	$\beta 16_{[c]}$ = 1000 ($\beta 17$ = 200)	G7 Dualglass
25A	$\beta 22_{[c]}$ = 1000 ($\beta 25$ = 200)	Water removal +G7 Dualglass
25M	$\beta 22_{[c]}$ = 1000 ($\beta 25$ = 200)	
25W	25u nominal	wire mesh
40W	40u nominal	wire mesh
74W	74u nominal	wire mesh
149W	149u nominal	wire mesh

table 5 code	hose arrangement
W	Female SAE/JIC swivel hose end + wands
S	Female SAE/JIC swivel hose end, No wands
G	Female BSPP swivel hose end, No wands

*Extension hoses available 10' (254mm) lengths (see options)

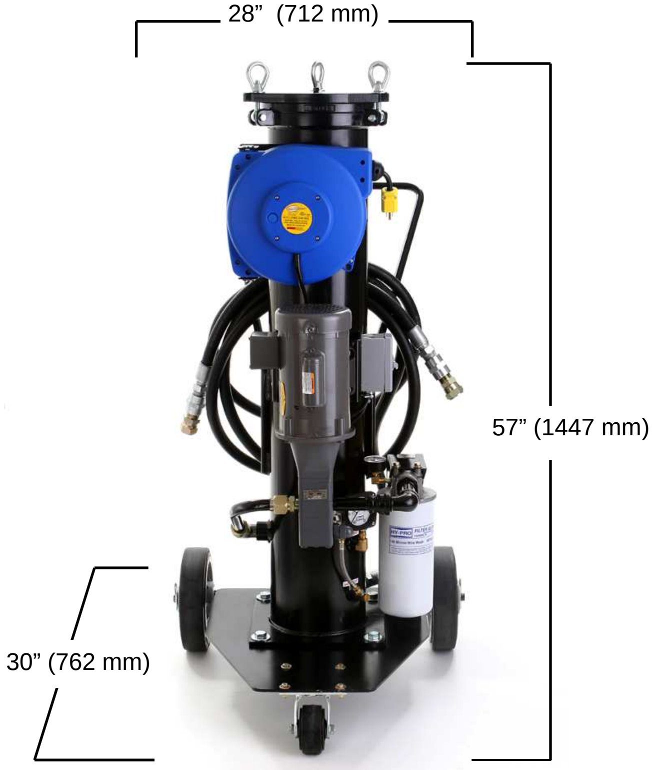
table 6 code	differential pressure indicator
X	None (ported, plugged)
D	22 psid visual Δp gage, + electric alarm (120V AC)
E	22 psid visual Δp gage
F	45 psid visual Δp gage, + electric alarm (120V AC)
G	45 psid visual Δp gage
H	65 psid visual Δp gage, + electric alarm (120V AC, element options 5 & 8 only)
J	65 psid visual Δp gage (element options 5 & 8 only)
P	Two pressure gages (industrial liquid filled)

table 5 code	power options
*Omit (standard) *E1	115 VAC, 60Hz, 1P (1750 RPM motor) 120 VAC, 50Hz, 1P (1450 RPM motor)
E2 E3	230 VAC, 60Hz, 1P (1750 RPM motor) 230 VAC, 50Hz, 1P (1450 RPM motor)
E4	24 VDC (Consult factory for application)
E5	440-480 VAC, 60 Hz, 3P (1750 RPM motor)
E6	380-420 VAC, 50Hz, 3P (1450 RPM motor)
P	Pneumatic driven air motor (call factory)

3 phase electrical option carts supplied with terminated cord only, cord reel, plug not included. FCL3 only includes cord reel if E3 (230VAC 1P 50Hz).

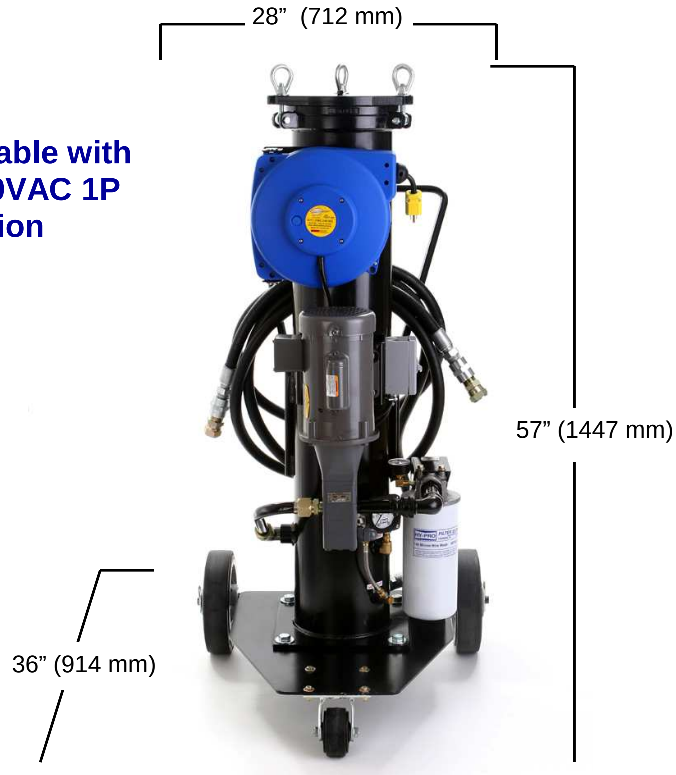
table 8 code	special options
18	L18 single length filter housing and element
C1	Explosion proof electrical (Class 1, Div 2)
H1	Suction & return hose extensions (10', 2,5 meter)
H2	Suction & return hose extensions (20', 5 meter)
K	149μ wire mesh spin-on pump suction strainer
P	On-board particle monitor (Hach PM4000-**)
T	Large inflatable tires (off-road, severe duty)

FCL1, FCL2 DIMENSIONS



FCL3 DIMENSIONS

FCL3 only available with cord reel on 230VAC 1P 50Hz power option



SPARE PARTS

Series	Part Number	Description
FCL1, FCL2, FCL3	Element	Check FCL cart ID tag for element part number
FCL1, FCL2, FCL3	FTHOSE1BSPP FTHOSE3BSPP	Hose with female swivel BSPP connection
FCL1, FCL2, FCL3	FTHOSE1SAE FTHOSE3SAE	Hose with female swivel SAE/JIC connection
FCL1, FCL2	FTHOSE1WD	Hose to accept steel wands (accepts wand FTWANDST)
FCL1, FCL2	FTWANDST	Steel wand set, connects with hose FTHOSE1WD only
FCL1	FT1HPMTR	Electric motor, 56C, TEFC or ODP, 1 HP, 115/230VAC, 1P
FCL2	FCL2MTR	Electric motor, 56C, TEFC or ODP, 1.5HP 230VAC 1P
FCL2	FCL2MTR3PH	Electric motor, 56C, TEFC or ODP, 1.5HP 440VAC 3P
FCL3	FCL3MTR	Electric motor, 56C, TEFC or ODP, 3HP 230VAC 1P
FCL3	FCL3MTR3PH	Electric motor, 56C, TEFC or ODP, 3HP 440VAC 3P
FCL1, FCL2, FCL3	LFSV	Oil sampling isolation valve
FCL1, FCL2, FCL3	SPLF107	HP106, HP107 Element hold down spring
FCL1, FCL2, FCL3	LFHD105KIT	HP105, HP8314 Element hold down plate with snap ring
FCL1, FCL2, FCL3	GLF	P option- liquid filled pressure gauge
FCL1, FCL2, FCL3	LFIND-D	22 psid green to red visual differential pressure gauge + electric alarm
FCL1, FCL2, FCL3	LFIND-E	22 psid green to red visual differential pressure gauge
FCL1, FCL2, FCL3	LFIND-F	45 psid green to red visual differential pressure gauge + electric alarm
FCL1, FCL2, FCL3	LFIND-G	45 psid green to red visual differential pressure gauge
FCL1, FCL2, FCL3	LFIND-H	65 psid green to red visual differential pressure gauge + electric alarm
FCL1, FCL2, FCL3	LFIND-J	65 psid green to red visual differential pressure gauge
FCL1, FCL2, FCL3	OVLFLID	Filter housing seal VITON
FCL1, FCL2, FCL3	LBLFLID	Filter housing seal BUNA
FCL1, FCL2, FCL3	LFLID	Filter housing cover
FCL1, FCL2, FCL3	LFLIDBLT	Filter housing cover bolts
FCL1, FCL2, FCL3	LFLIDNUT	Filter housing cover eye nuts
FCL1, FCL2, FCL3	LFDRPLUG	2" NPT filter housing drain plug
FCL1, FCL2, FCL3	LFVPLUG	1/4" NPT filter housing cover vent port plug
FCL1, FCL2	FC1H1JIC	10 ft, 2,5 meter hose extension set JIC connections
FCL1, FCL2	FC1H1BSP	10 ft, 2,5 meter hose extension set BSP connections
FCL1, FCL2	FC1H2JIC	20 ft, 5 meter hose extension set JIC connections
FCL1, FCL2	FC1H2BSP	20 ft, 5 meter hose extension set BSP connections
FCL3	FC3H1JIC	10 ft, 2,5 meter hose extension set JIC connections
FCL3	FC3H1BSP	10 ft, 2,5 meter hose extension set BSP connections
FCL3	FC3H2JIC	20 ft, 5 meter hose extension set JIC connections
FCL3	FC3H2BSP	20 ft, 5 meter hose extension set BSP connections

FSL Filter Unit

Flow rate up to 22 gpm (82 lpm)

Dedicated filtration skids for gearbox and side-loop reservoir conditioning.

Ideal for high viscosity Lube and hydraulic oils (ISOVG22~ISOVG460)

Filter new fluids during transfer and replenishment (top-off)

Remove particulate and water contamination.

Large element yields extended life.

Materials of Construction

Assembly Frame: Painted Steel
Drip Pan: Painted Steel
Filter Assembly: Epoxy coated steel
25 or 50 psid bypass available
True differential pressure indicator

Operating Temperature

Nitrile (Buna)	-40f to 150f
	-40c to 66c
Fluorocarbon (Viton)*	-15f to 200f
	-26c to 93c

*High temperature / phosphate ester design

Fluid Compatibility

Petroleum and mineral based fluids (standard). For polyol ester, phosphate ester, and other specified synthetics use Viton seal option or contact factory.

Weight

FSL1 (36 length): 260 Lbs (117 kg) approximate
FSL2 (36 length): 273 Lbs (124 kg) approximate
FSL3 (36 length): 292 Lbs (133 kg) approximate

Explosion Proof Option

Class 1, Div 2, Group C/D explosion optional.

Electrical Service

115VAC 60Hz 1P standard
(see options table for other selections)

Electric Motor Specifications

TEFC or ODP, 56C frame
FSL1: 1 HP, 115VAC, 60Hz, 1P, 1750 RPM
FSL2: 1 1/2 HP, 230VAC, 60Hz, 1P, 1750 RPM
or 440VAC, 60Hz, 3P, 1750 RPM
FSL3: 3HP, 230VAC, 60Hz, 1P, 1750 RPM
or 440VAC, 60Hz, 3P, 1750 RPM

Recommended Viscosity Range*

FSL1*: 28 SSU ~ 6000 SSU, 6 cSt ~ 1200 cSt
FSL2*: 28 SSU ~ 5000 SSU, 6 cSt ~ 1000 cSt
FSL3*: 28 SSU ~ 3000 SSU, 6 cSt ~ 600 cSt

*Please check maximum viscosity of oil in coldest condition and normal operating condition for sizing and selection. Do not rely solely on ISO VG viscosity rating of the fluid.

Pump Specifications

Gear pump
Internal relief full flow @ 100 psi standard.

Cleaner Fluid, Greater Reliability

When establishing a target ISO cleanliness code first identify the most sensitive component. New oil added should be cleaner than the target ISO code for the system.

Figure 1 details the improvements in component life as the ISO cleanliness is improved for roller contact bearings. Improving and stabilizing fluid cleanliness codes can increase hydraulic component and bearing life exponentially.

Lab and field tests prove time and again that Hy-Pro filters deliver lower ISO cleanliness codes, and do it with greater consistency.

Figure 1

Current ISO Code	Target ISO Code	Target ISO Code	Target ISO Code	Target ISO Code
Start	**2 x Life**	**3 x Life**	**4 x Life**	**5 x Life**
28/26/23	25/22/19	22/20/17	20/18/15	19/17/14
27/25/22	23/21/18	21/19/16	19/17/14	18/16/13
26/24/21	22/20/17	20/18/15	19/17/14	17/15/12
25/23/20	21/19/16	19/17/14	17/15/12	16/14/11
25/22/19	20/18/15	18/16/13	16/14/11	15/13/10
23/21/18	19/17/14	17/15/12	15/13/10	14/12/9
22/20/17	18/16/13	16/14/11	15/13/10	13/11/8
21/19/16	17/15/12	15/13/10	13/11/8	-
20/18/15	16/14/11	14/12/9	-	-
19/17/14	15/13/10	13/11/8	-	-
18/16/13	14/12/9	-	-	-


4

Coreless Filter Element Technology

Hy-Pro coreless elements are featured in the FSL series (see figure 4). The elements are oversized to yield extended element life and handle a wide variety of high viscosity oils. Hy-Pro coreless elements utilize wire mesh pleat support which ensures that the pleats won't collapse or lose Integrity.

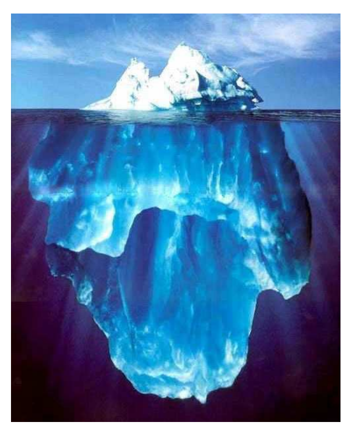

5

True Differential Pressure Gauges & Switches

Differential pressure gauges with green to red display ensures proper monitoring of filter element condition. DIN connector switch can be added to any pressure gauge (see figure 5).

Cost of Contamination Control - The Tip of the Iceberg

Filtration as a visible cost is less than 3% of the total costs associated with contamination and contamination related failures. Poorly managed fluid contamination can result in the following costly situations:

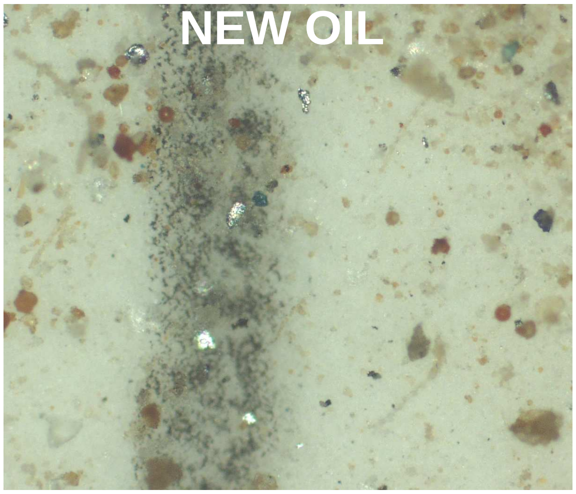


- **Lost production (downtime)**
- **Component repair, replacement**
- **Higher maintenance labor costs**
- **Unreliable machine performance**
- **Reduced fluid life**
- **Wasted time and energy**

FSL1, FSL2, FSL3 FILTER CART APPLICATION INFO

Filtering New Oil - Remove Particulate and Water

New oil is typically not clean oil, and not suitable for use in hydraulic and lube systems. During the production and transportation process new oil collects high levels of solid contaminant and water. A common ISO code for new oil is 24/22/19. New oil is one of the worst sources of particulate contaminant system ingression.



The FSL features a three-way valve on the inlet and may be used to draw new oil from a tote and pre-filter the new oil. Hy-Pro High efficiency media is your last line of defense against harmful particulate and water contamination. Free and dissolved water in hydraulic and lube systems leads to accelerated abrasive wear, corrosion of metal surfaces, increased electrical conductivity, viscosity variance, loss of lubricity, fluid additive breakdown, bearing fatigue, and more. The FSL features a wide range of options to tackle any challenge whether you are removing solid particles only or water and particles. The “A” media adsorbs water while controlling particles with absolute efficiency (beta ratio of $\beta X_{[c]} > 1000$).

Effective filter sizing requires consideration of flow rate, viscosity (operating and cold start), fluid type, degree of filtration. When properly sized bypass during cold start can be avoided/minimized and optimum element efficiency and life achieved. The filter assembly differential pressure values provided for sizing differ for each media code, and assume 150 SSU (32Cts) viscosity and 0.86 fluid specific gravity. Use the following steps to identify the correct high pressure filter assembly.

1. Calculate Δp coefficient at both operating and cold start viscosity:

$$\Delta p \text{ Coefficient} = \frac{\text{Actual Operating Viscosity (SSU)}}{150} \times \frac{\text{Actual S.G.}}{0.86}$$

2. Calculate actual clean filter assembly Δp at both operating and cold start viscosity:

Actual assembly clean Δp = Flow rate x Δp Coefficient x Assembly Δp factor (from sizing table)

3. Sizing Recommendations to optimize performance and permit future flexibility:

- To avoid or minimize bypass during cold start the actual assembly clean Δp calculation should be repeated for start-up conditions if cold starts are frequent.
- Actual assembly clean Δp should not exceed 5 psid at normal operating viscosity.
- If suitable assembly size is approaching the upper limit of the recommended flow rate at the desired degree of filtration consider increasing the assembly to the next larger size if a finer degree of filtration might be preferred in the future. This practice allows the future flexibility to enhance fluid cleanliness without compromising clean Δp or filter element life.
- Once a suitable filter assembly size is determined consider increasing the assembly to the next larger size to optimize filter element life and avoid bypass during cold start.
- When using water glycol or other specified synthetics we recommend increasing the filter assembly by 1~2 sizes.
- High viscosity fluid (ie gear lube ISO 220) will typically display very high viscosity as the temperature drops below 100f. For such applications avoiding bypass during start-up might not be possible.

FSL Filter Assembly (housing + element) Differential Pressure Factors

Media code	Length code	Δp factor* (psid/gpm)	Δp factor* (bar/lpm)	Length code	Δp factor* (psid/gpm)	Δp factor* (bar/lpm)
1M	16,18	0.059	0.00113	36,39	0.047	0.0009
3M		0.05	0.00096		0.042	0.00081
6M		0.048	0.00092		0.041	0.00079
10M		0.046	0.00087		0.04	0.00077
16M		0.043	0.00082		0.038	0.00073
25M		0.04	0.00077		0.037	0.00071
**W		0.037	0.00071		0.035	0.00067

FSL FILTER CART PART NUMBER GUIDE

	table 1		table 2	table 3		table 4	table 5		table 6	table 7	table 8	
FSL	Flow Rate	-	Element Type	Media Selection	-	Seals	Length	-	Δp Indictr	Power Option	Extra Option	Hy-Pro mfg code

REPLACEMENT FILTER ELEMENT PART NUMBER GUIDE

	table 2	table 5		table 3	table 4
HP10		***L__**	-		

*Use L16 or L39 length code for HP8314 single and double element lengths.

table 1 code	flow rate gpm (lpm)
1	5 gpm (18,7 lpm)
2	10 gpm (37,5 lpm)
3	22 gpm (82 lpm)

table 4 code	seal material
B	Nitrile (Buna)
V	Specified synthetics or High Temperature (>150F). Viton seals

table 2 code	Element Configuration
5	HP105 coreless series, positive o-ring seals, **NO BYPASS,** max change-out 60 psid (4,2 bar)
6	HP106 element with bypass, 25 psid (1,8 bar) bypass, orings change-out 22 psid (1,5 bar)
7	HP107 element with bypass 50 psid (3,5 bar) bypass, orings change-out 45 psid (3,2 bar)
8	USE HP8314 for element P/N Interchanges with Pall HC8314, **NO BYPASS,** oring seals, max change-out 45 psid (3,2 bar)

table 3 code	filtration rating	media type
1M	$\beta 2.5_{[c]}$ = 1000 (β1 = 200)	G7 Dualglass
3M	$\beta 5_{[c]}$ = 1000 (β3 = 200)	G7 Dualglass
6M	$\beta 7_{[c]}$ = 1000 (β6 = 200)	G7 Dualglass
10A	$\beta 12_{[c]}$ = 1000 (β12 = 200)	Water removal
10M	$\beta 12_{[c]}$ = 1000 (β12 = 200)	G7 Dualglass
16A	$\beta 16_{[c]}$ = 1000 (β17 = 200)	Water removal
16M	$\beta 16_{[c]}$ = 1000 (β17 = 200)	G7 Dualglass
25A	$\beta 22_{[c]}$ = 1000 (β25 = 200)	Water removal
25M	$\beta 22_{[c]}$ = 1000 (β25 = 200)	G7 Dualglass
25W	25u nominal	wire mesh
40W	40u nominal	wire mesh
74W	74u nominal	wire mesh
149W	149u nominal	wire mesh

table 5 code	element length
18	Single - 18" nominal (FSL1, FSL2 only)
36	Double - 36" nominal (FSL1, FSL2, FSL3)

table 6 code	differential pressure indicator
X	None (ported, plugged)
D	22 psid visual Δp gage, + electric alarm (120V AC)
E	22 psid visual Δp gage
F	45 psid visual Δp gage, + electric alarm (120V AC)
G	45 psid visual Δp gage
H	65 psid visual Δp gage, + electric alarm (120V AC, non-bypass element options 5 & 8 only)
J	65 psid visual Δp gage (non-bypass element options 5 & 8 only)
P	Two pressure gages (industrial liquid filled)

table 7 code	power options
*Omit (standard) *E1	115 VAC, 60Hz, 1P (1750 RPM motor) 120 VAC, 50Hz, 1P (1450 RPM motor)
E2 E3	230 VAC, 60Hz, 1P (1750 RPM motor) 230 VAC, 50Hz, 1P (1450 RPM motor)
E4	24 VDC (Consult factory for application)
E5	440-480 VAC, 60 Hz, 3P (1750 RPM motor)
E6	380-420 VAC, 50Hz, 3P (1450 RPM motor)
N	Pneumatic driven air motor (call factory)

*3 phase electrical option carts are supplied with terminated electrical cord only. Customer may provide a plug to be installed by Hy-Pro.

table 8 code	special options
C1	Explosion proof electrical (Class 1,Div 2, Grp C/D)
P	On-board particle monitor (call factory for info)
S	Stainless steel vessel, plumbing, element support
T	Drip Tray with for spill retention

HIGH PERFORMANCE FILTER ELEMENTS - THE HEART OF A FILTER

Dynamic Filter Efficiency (DFE) Testing

Revolutionary test methods assure that DFE rated elements perform true to rating even under demanding variable flow and vibration conditions. Today's industrial and mobile hydraulic circuits require elements that deliver specified cleanliness under ALL circumstances. Wire mesh supports the media to ensure against cyclical flow fatigue, temperature, and chemical resistance failures possible in filter elements with synthetic support mesh. Contact your distributor or Hy-Pro for more information and published articles on DFE testing.

Media Options

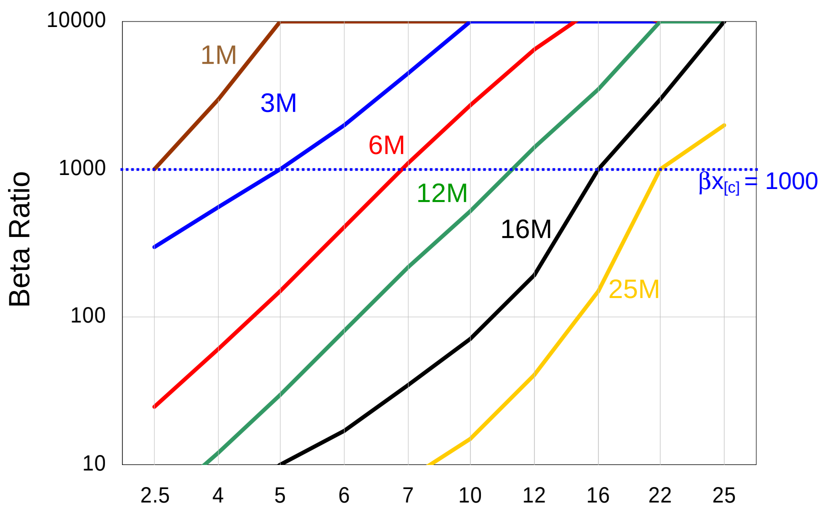
Through extensive testing we have developed media choices to handle any application. Options include G7 Dualglass, Dynafuzz (stainless fiber), and Wire mesh (stainless).

Fluid Compatibility

Petroleum based fluids, water glycol, polyol ester, phosphate ester, high water based fluids and many other synthetics. Contact us for seal material selection assistance.

FILTER MEDIA SPECIFICATIONS

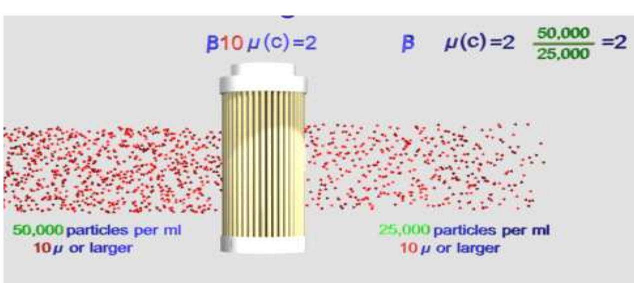
Glass Media Code Filtration Efficiency (Beta Ratio) vs Micron Size



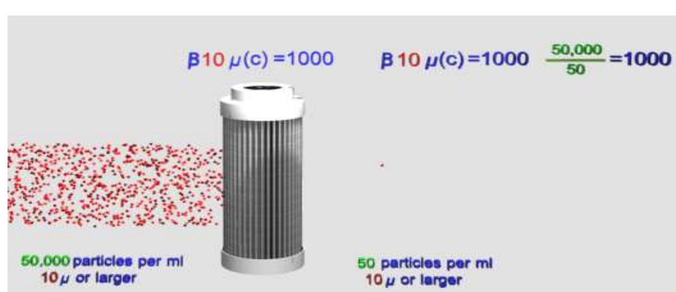
Micron size $\mu m_{[c]}$ (per ISO16889)

media code	media description
A	G7 Dualglass high performance media combined with water removal scrim. $\beta x_{[c]} = 1000$ ($\beta x = 200$)
M	G7 Dualglass our latest generation of DFE rated, high performance glass media for all hydraulic & lubrication fluids. $\beta x_{[c]} = 1000$ ($\beta x = 200$)
W	Stainless steel wire mesh media $\beta x_{[c]} = 2$ ($\beta x = 2$) nominally rated

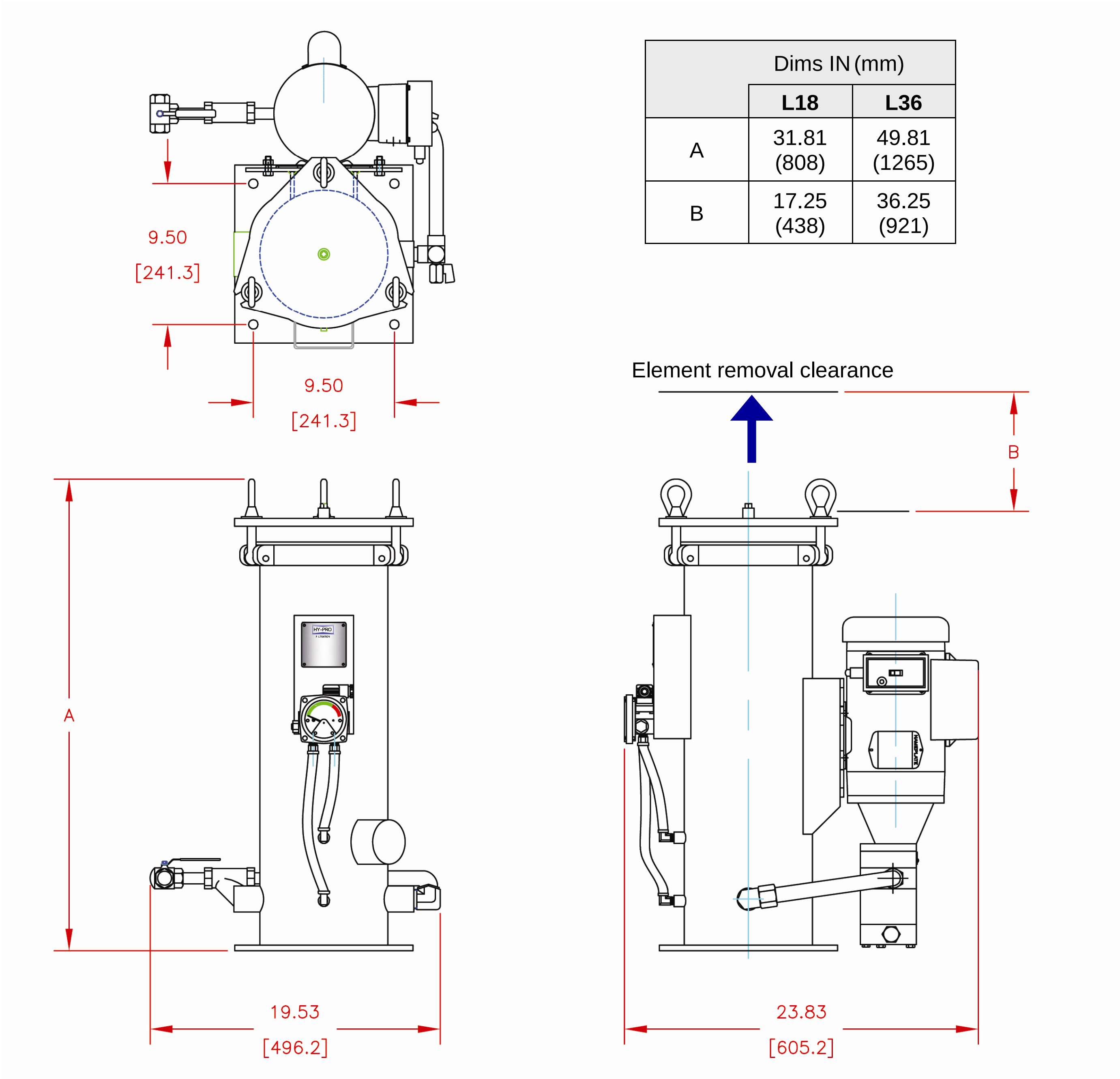
Typical cellulose media performance



Hy-Pro G7 Dualglass media performance



FSL1, FSL2 DIMENSIONS



Dims IN (mm)		
	L18	**L36**
A	31.81 (808)	49.81 (1265)
B	17.25 (438)	36.25 (921)

Series	Part Number	Description
FSL1, FSL2, FSL3	LFSV	Oil sampling isolation valve
FSL1, FSL2, FSL3	SPLF107	HP106, HP107 Element hold down spring
FSL1, FSL2, FSL3	LFHD105KIT	HP105, HP8314 Element hold down plate with snap ring
FSL1, FSL2, FSL3	GLF	P option- liquid filled pressure gauge
FSL1, FSL2, FSL3	LFIND-D	22 psid green to red visual differential pressure gauge + electric alarm
FSL1, FSL2, FSL3	LFIND-E	22 psid green to red visual differential pressure gauge
FSL1, FSL2, FSL3	LFIND-F	45 psid green to red visual differential pressure gauge + electric alarm
FSL1, FSL2, FSL3	LFIND-G	45 psid green to red visual differential pressure gauge
FSL1, FSL2, FSL3	LFIND-H	65 psid green to red visual differential pressure gauge + electric alarm
FSL1, FSL2, FSL3	LFIND-J	65 psid green to red visual differential pressure gauge
FSL1, FSL2, FSL3	OVLFLID	Filter housing seal VITON
FSL1, FSL2, FSL3	LBLFLID	Filter housing seal BUNA
FSL1, FSL2, FSL3	LFLID	Filter housing cover
FSL1, FSL2, FSL3	LFLIDBLT	Filter housing cover bolts
FSL1, FSL2, FSL3	LFLIDNUT	Filter housing cover eye nuts
FCL1, FCL2, FCL3	LFDRPLUG	2" NPT filter housing drain plug
FSL1, FSL2, FSL3	LFVPLUG	1/4" NPT filter housing cover vent port plug

FPL Spin-On Filter Panel

Flow rate up to 11 gpm (41 lpm), Max operating pressure 150 psi, 10 bar

Ideal for hydraulic fluids (ISO VG22 ~ ISO VG68)

Filter new fluids during replenishment (top-off)

Enhance existing filtration (high efficiency elements.)

Remove particle and water contaminant.

Materials of Construction

Assembly Frame: Painted Steel
Filter Assembly: Aluminum head, Steel canister
25 psid bypass valve
True differential pressure indicator

Operating Temperature

Nitrile (Buna)	-40°F to 150°F -40°C to 66°C
Fluorocarbon (Viton)*	-15°F to 200°F -26°C to 93°C

*High temperature / phosphate ester design

Fluid Compatibility

Petroleum and mineral based fluids (standard). For polyol ester, phosphate ester, and other specified synthetics use Viton seal option or contact factory.

Weight

FPL1: 110 Lbs (49.90 kg) approximate
FPL2: 120 Lbs (54.43 kg) approximate

Explosion Proof Option

Class 1, Div 2, Group C/D explosion optional.

Electrical Service

115VAC 60Hz 1P (standard)
see options table for other selections

Electric Motor Specifications

TEFC or ODP, 56C frame
FC1: 1 HP, 1750 RPM, thermal overload reset
FC2: 1 HP, 1750 RPM, thermal overload reset

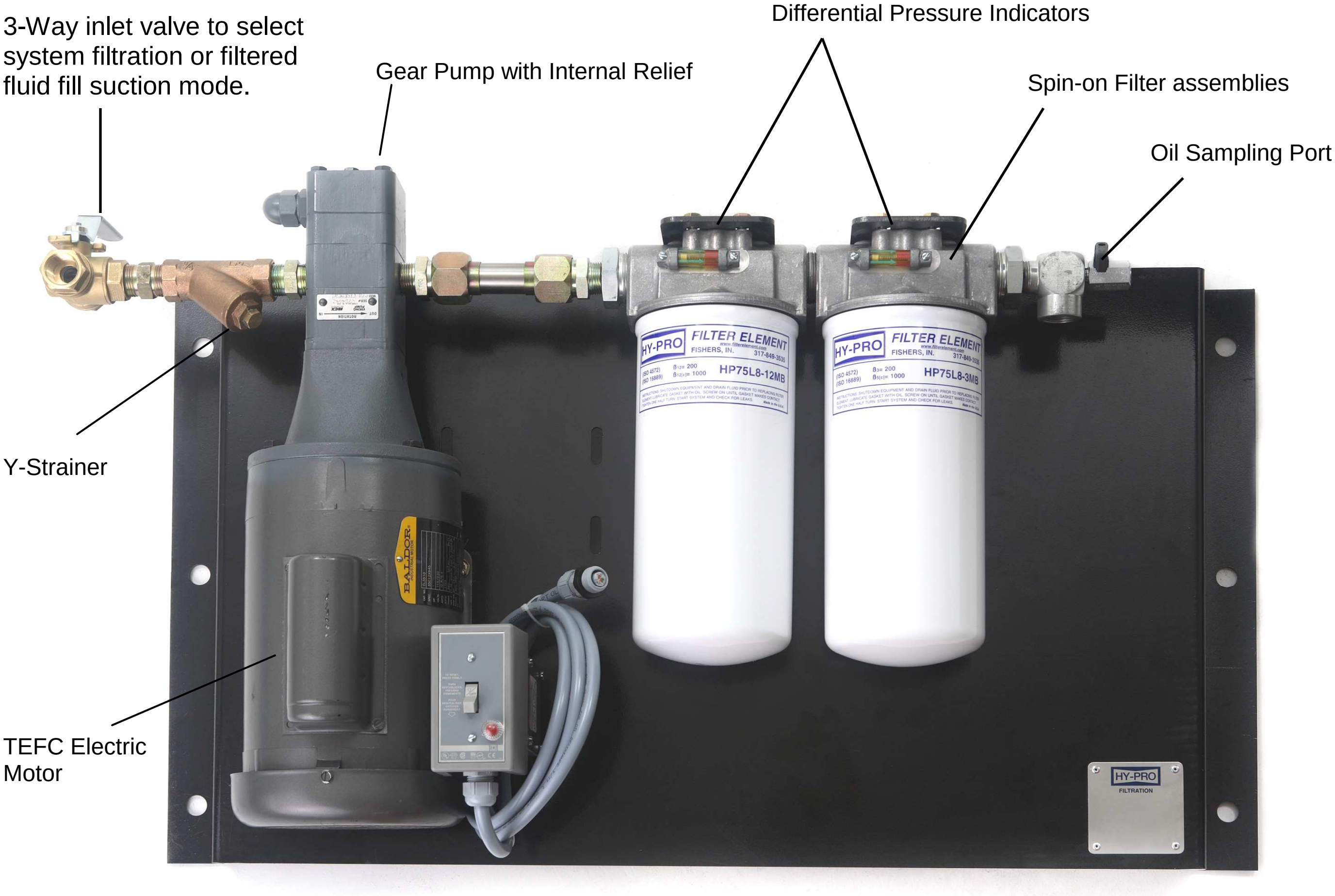
Recommended Viscosity Range

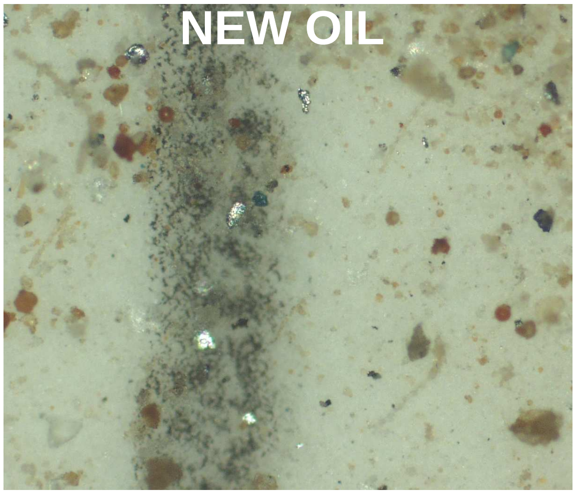
FC1*: 28 SSU ~ 2000 SSU, 6 cSt ~ 400 cSt
FC2*: 28 SSU ~ 1000 SSU, 6 cSt ~ 200 cSt

*At maximum viscosity clean element pressure drop with 3M media code < 12 psid/0.85 bar. Check maximum viscosity of oil in coldest condition. For high viscosity lubricating oils consider the FCL series or call Hy-Pro.

Pump Specifications

Gear pump
Internal relief full flow 100 psi, 6 bar standard





Filtering New Oil - Particulate and Water

New oil is typically not clean oil, and not suitable for use in hydraulic and lube systems. During the production and transportation process new oil collects high levels of solid contaminant and water. A common ISO code for new oil is 24/22/19. New oil is one of the worst sources of particulate contaminant system ingression.

The FPL will effectively remove free water while capturing particulate with high efficiency. Free and dissolved water in hydraulic and lube systems leads to accelerated abrasive wear, corrosion of metal surfaces, increased electrical conductivity, viscosity variance, loss of lubricity, fluid additive breakdown, bearing fatigue, and more. The FPL series filter panel includes a wide range of element combination options to tackle any challenge. The HP75L8-25AB water removal element holds 23 ounces of water while controlling particles with a beta ratio of $\beta 25 = 200$, $\beta 22[c] = 1000$.

Flush and Condition Existing Systems

The FPL is also effective for conditioning fluids that are already in service. Hy-Pro high efficiency elements can be used to enhance the filtration existing on the system without affecting system performance due to higher element differential pressures.

FPL1, FPL2 FILTER PANEL APPLICATION INFO

Cleaner Fluid, Greater Reliability

When establishing a target ISO cleanliness code first identify the most sensitive component. New oil added should be cleaner than the target ISO code for the system.

Figure 1 details the improvement in component life as the ISO cleanliness is improved for roller contact bearings. Improving and stabilizing fluid cleanliness codes can increase hydraulic component and bearing life exponentially.

Lab and field tests prove time and time again that Hy-Pro filters deliver lower ISO cleanliness codes, and do it with greater consistency.

Figure 1

Current ISO Code	Target ISO Code	Target ISO Code	Target ISO Code	Target ISO Code
Start	**2 x Life**	**3 x Life**	**4 x Life**	**5 x Life**
28/26/23	25/22/19	22/20/17	20/18/15	19/17/14
27/25/22	23/21/18	21/19/16	19/17/14	18/16/13
26/24/21	22/20/17	20/18/15	19/17/14	17/15/12
25/23/20	21/19/16	19/17/14	17/15/12	16/14/11
25/22/19	20/18/15	18/16/13	16/14/11	15/13/10
23/21/18	19/17/14	17/15/12	15/13/10	14/12/9
22/20/17	18/16/13	16/14/11	15/13/10	13/11/8
21/19/16	17/15/12	15/13/10	13/11/8	-
20/18/15	16/14/11	14/12/9	-	-
19/17/14	15/13/10	13/11/8	-	-
18/16/13	14/12/9	-	-	-

The Right Element Combination

Figure 2 illustrates some possible combinations to use on the FPL series panel. When water removal is desired use the 12A or 25A media code as a pre-filter. A finer media can be used on the second filter to capture smaller particulate and reduce the ISO code. When conditioning a tote or flushing a fluid already in use the 1M media code will yield the quickest result on particulate.

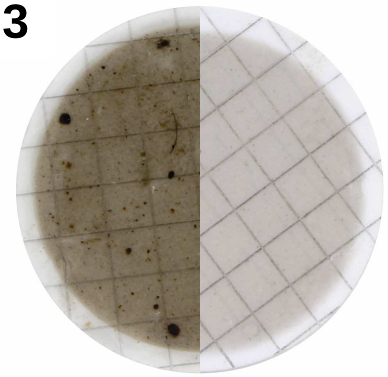
Figure 2

Current Condition	Pre-Filter	Main-Filter
ISO 25/24/22 (New oil) with High water content	HP75L8-25AB β22[c] = 1000 + water removal	HP75L8-3MB β5[c] = 1000
ISO 25/24/22 (New oil)	HP75L8-12MB β12[c] = 1000	HP75L8-1MB β2.5[c] = 1000
ISO 21/19/16	HP75L8-3MB β5[c] = 1000	HP75L8-1MB β2.5[c] = 1000

Don’t Put Dirty Oil Into Your System

Figure 3 shows the difference in particulate contamination between unfiltered new fluid with an ISO Code of 24/22/19 and fluid that has been conditioned to an ISO Code of 16/14/11.

3



Prepared using PTK1 patch test kit

Dynamic Filter Efficiency (DFE) Testing

Revolutionary test methods assure that DFE rated elements perform true to rating even under demanding variable flow and vibration conditions. Today's industrial and mobile hydraulic circuits require elements that deliver specified cleanliness under ALL circumstances. Wire mesh supports the media to ensure against cyclical flow fatigue, temperature, and chemical resistance failures possible in filter elements with synthetic support mesh. Contact your distributor or Hy-Pro for more information and published articles on DFE testing.

Media Options

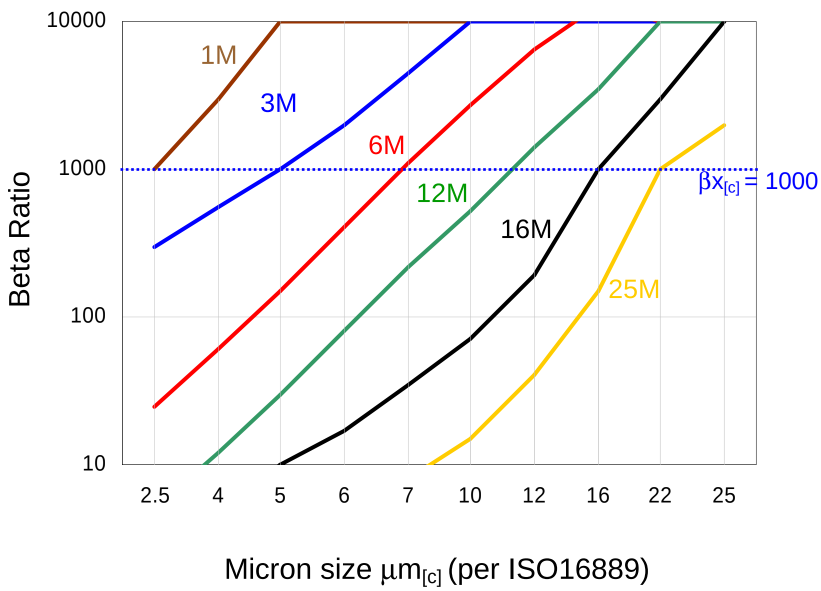
Through extensive testing we have developed media choices to handle any application. Options include G7 Dualglass, Dynafuzz (stainless fiber), and Wire mesh (stainless).

Fluid Compatibility

Petroleum based fluids, water glycol, polyol ester, phosphate ester, high water based fluids and many other synthetics. Contact us for seal material selection assistance.

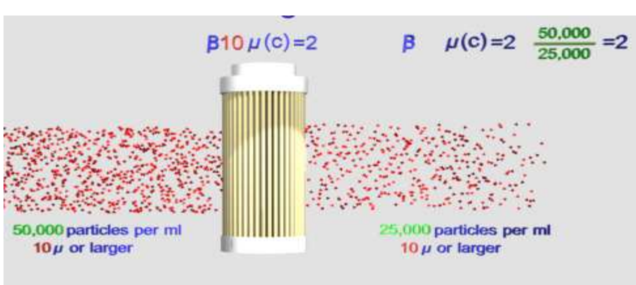
FILTER MEDIA SPECIFICATIONS

Glass Media Code Filtration Efficiency (Beta Ratio) vs Micron Size

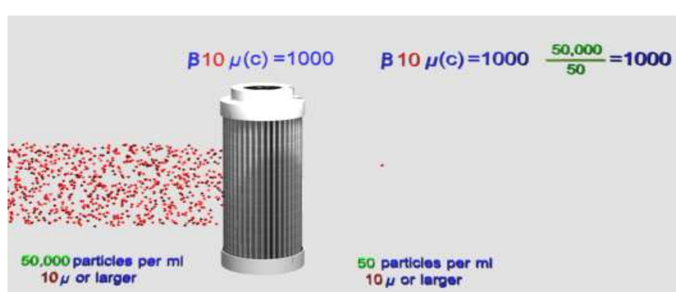


media code	media description
A	G7 Dualglass high performance media combined with water removal scrim. $\beta x_{[c]} = 1000$ ($\beta x = 200$)
M	G7 Dualglass our latest generation of DFE rated, high performance glass media for all hydraulic & lubrication fluids. $\beta x_{[c]} = 1000$ ($\beta x = 200$)
W	Stainless steel wire mesh media $\beta x_{[c]} = 2$ ($\beta x = 2$) nominally rated

Typical cellulose media performance



Hy-Pro G7 Dualglass media performance



FPL1, FPL2 FILTER PANEL PART NUMBER GUIDE

	table 1		table 2	table 2		table 3		table 4	table 5	
FPL	Flow rate	-	Element 1 (Pre-filter)	Element 2 (Main-filter)	-	Seal	-	Power Option	Extra Option	Hy-Pro Mfg Code

REPLACEMENT FILTER ELEMENT PART NUMBER GUIDE

	table 2	table 3
HP75L8 -	Media	Seal

table 1 code	flow rate gpm (lpm)
1	5 gpm (18,7 lpm) 2 x S75, single element heads (in series)
2	10 gpm (37,5 lpm) 2 x S75, single element heads (in series)

table 3 code	seal material
B	Nitrile (Buna)
V	*Specified synthetics or High Temperature (>150F). Viton seals

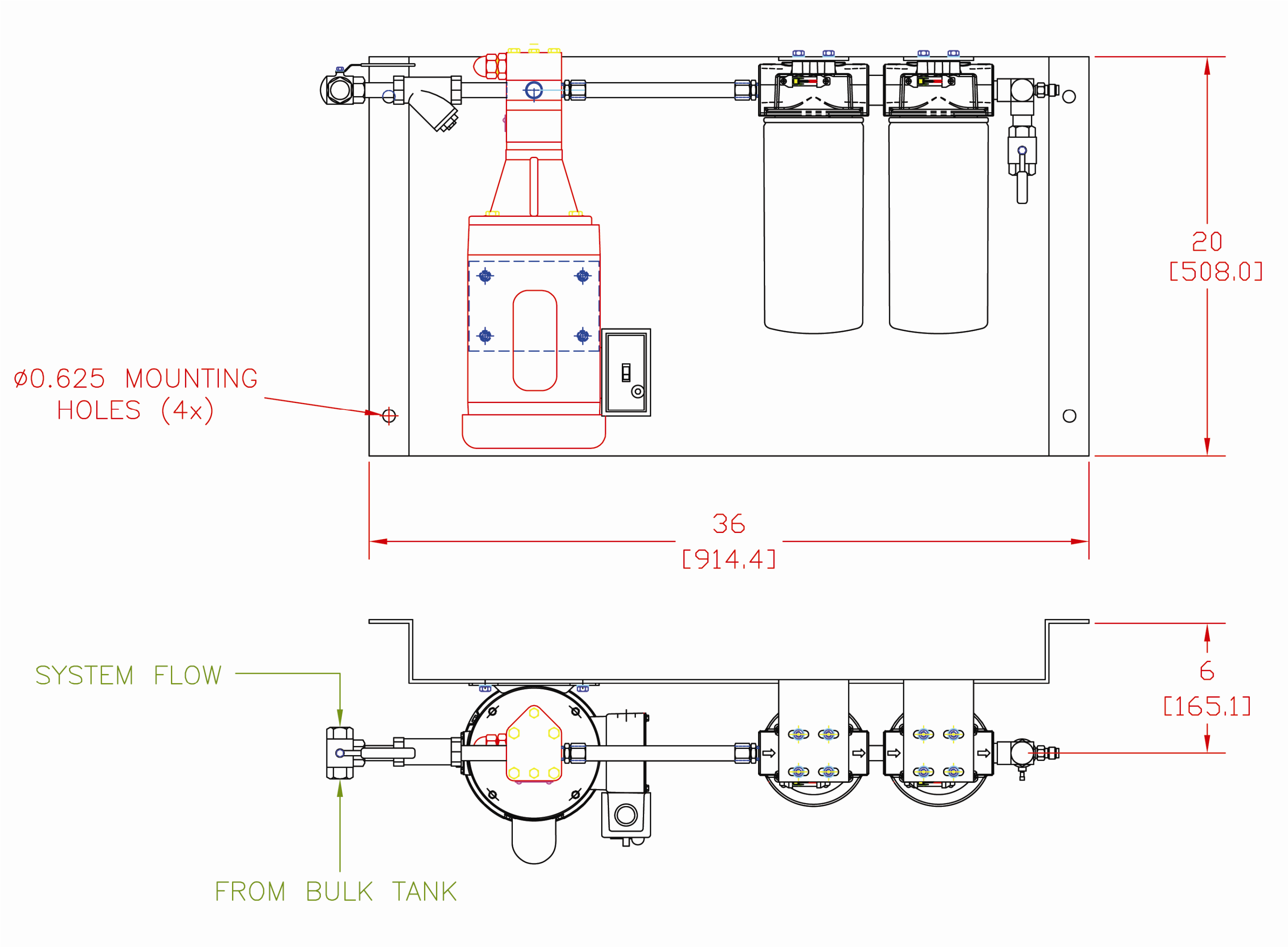
*Phosphate Ester, Water Glycol & other synthetics.

table 2 code	filtration rating	media type
1M	$\beta 2.5_{[c]} = 1000$ ($\beta 1 = 200$)	G7 Dualglass
3M	$\beta 5_{[c]} = 1000$ ($\beta 3 = 200$)	G7 Dualglass
6M	$\beta 7_{[c]} = 1000$ ($\beta 6 = 200$)	G7 Dualglass
12A	$\beta 12_{[c]} = 1000$ ($\beta 12 = 200$)	G7 Dualglass + Water removal
12M	$\beta 12_{[c]} = 1000$ ($\beta 12 = 200$)	G7 Dualglass
25A	$\beta 22_{[c]} = 1000$ ($\beta 25 = 200$)	G7 Dualglass + Water removal
25M	$\beta 22_{[c]} = 1000$ ($\beta 25 = 200$)	G7 Dualglass
74W	74u nominal	wire mesh
149W	149u nominal	wire mesh

table 4 code	power options
*Omit (standard) *E1	115 VAC, 60Hz, 1P (1750 RPM motor) 120 VAC, 50Hz, 1P (1450 RPM motor)
E2 E3	230 VAC, 60Hz, 1P (1750 RPM motor) 230 VAC, 50Hz, 1P (1450 RPM motor)
E4	24 VDC (Consult factory for application)
E5	440-480 VAC, 60 Hz, 3P (1750 RPM motor)
E6	380-420 VAC, 50Hz, 3P (1450 RPM motor)
P	Pneumatic driven air motor (call factory)

*3 phase electrical option carts are supplied with terminated electrical cord only, and do not include electrical cord reel or electrical cord plug.

table 5 code	special options
C1	Explosion proof electrical (Class 1, Div 2, Grp C/D)



ø0.625 MOUNTING HOLES (4x)
20 [508.0]
36 [914.4]
SYSTEM FLOW
6 [165.1]
FROM BULK TANK

TF4 In-Tank Filter Assembly

Featuring Hy-Pro G7 Dualglass high performance DFE rated filter element technology

APPLICATIONS

- Hy-Pro Low pressure TF4 series filters are ideal for installation on the return line to remove contaminant ingested or generated by the system.
- Power units
- Mobile equipment
- Compact alternative to spin-on filters (In-tank mount)

FEATURES, BENEFITS, ADVANTAGES

DFE rated elements	G7 Dualglass elements are DFE rated to assure performance even when exposed to the toughest conditions that hydraulic systems can generate (See DFE for details).
Low housing pressure drop	Unique internal flow paths provide low resistance to flow. (Low pressure drop)
Wire mesh media support	Ensures media integrity during dynamic flow. Don't sacrifice performance with plastic mesh.
Coreless element (4C element only)	Reduce disposal costs and reduce Environmental impact. Incinerates at 1100°F and weighs less.
Tank mounted	Most of the assembly is inside tank. Compact alternative to spin-ons
Single or Dual inlet ports	Available with one inlet port or two Inlet ports with 180° orientation Maximize flexibility of installation
Top loading	Minimal mess and oil loss. Clean and easy to service.
Universal mounting pattern	Accommodates North American and European mounting patterns.
Removable bowl	Dispose of all contaminated fluid and clean bowl during service.
Twist open bolt cover	Keyways on cover require only loosening cover bolts during service. No lost bolts.

PRODUCT SPECIFICATIONS

Operating Pressure	100 psi (6.85 bar) maximum
Maximum Flow rate	75 gpm, 281 lpm
Design safety factor	2.5:1
Element collapse	150 psid (10 bar)
Assembly material	Head: Cast aluminum (impregnated) Bowl: Conductive synthetic
Fluid compatibility (ISO 2948)	Compatible with petroleum based oils, specified water based, oil/water emulsion, and specified synthetic fluids with Flurocarbon or EPR seals (call for compatibility)
Bypass setting	25 psid (1.77 bar) standard
Weight (w/element)	With element 3.4 Lbs, 1.53 kg
Temperature rating	Buna: -40°F (-40°C) to 225°F (107°C) Viton: -15°F (-26°C) to 275°F (135°C)

Viton is a registered trademark of DuPont

HY-PRO FILTRATION

TF4 FILTER ASSEMBLY SELECTION AND SIZING GUIDELINES

Effective filter sizing requires consideration of flow rate, viscosity (operating and cold start), fluid type and degree of filtration. When properly sized, bypass during cold start can be avoided/minimized and optimum element efficiency and life achieved. The filter assembly differential pressure values provided for sizing differ for each media code, and assume 150 SSU (32cSt) viscosity and 0.86 fluid specific gravity. Use the following steps to identify the correct high pressure filter assembly.

1. Calculate Δp coefficient at both operating and cold start viscosity:

$$\Delta p \text{ Coefficient} = \frac{\text{Actual Operating Viscosity (SSU)}}{150} \times \frac{\text{Actual S.G.}}{0.86}$$

2. Calculate actual clean filter assembly Δp at both operating and cold start viscosity:

Actual assembly clean Δp = Flow rate x Δp Coefficient x Assembly Δp factor (from sizing table)

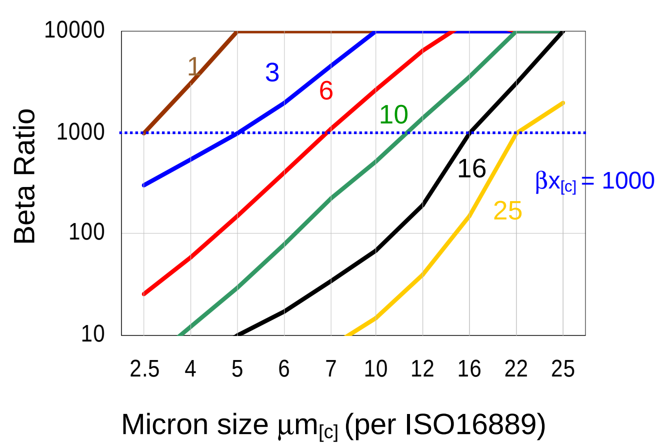
3. Sizing Recommendations to optimize performance and permit future flexibility:

- To avoid or minimize bypass during cold start the actual assembly clean Δp calculation should be repeated for start-up conditions if cold starts are frequent.
- Actual assembly clean Δp should not exceed 5 psid at normal operating viscosity.
- If suitable assembly size is approaching the upper limit of the recommended flow rate at the desired degree of filtration consider increasing the assembly to the next larger size if a finer degree of filtration might be preferred in the future. This practice allows the future flexibility to enhance fluid cleanliness without compromising clean Δp or filter element life.
- Once a suitable filter assembly size is determined consider increasing the assembly to the next larger size to optimize filter element life and avoid bypass during cold start.
- When using water glycol or other specified synthetics we recommend increasing the filter assembly by 1~2 sizes.
- High viscosity fluid (ie gear lube ISO 220) will typically display very high viscosity as the temperature drops below 100^{o}F. For such applications avoiding bypass during start-up might not be possible.

TF4** Assembly Differential Pressure Factors

Media code	Element code	Max flow gpm (lpm)	Port size	Δp factor* (psid/gpm)	Δp factor* (bar/lpm)
3M	4C, K	30 (112)	1 1/4" (B4, S4, N4)	0.285	0.0055
6M		42 (157)		0.189	0.0036
10M		50 (187)		0.147	0.0028
16M		55 (206)		0.115	0.0023
25M		65 (243)		0.098	0.0018
**W		75 (281)		0.011	0.0002

media code	media description
A	G7 Dualglass high performance media combined with water removal scrim. $\beta x_{[c]} = 1000$ ($\beta x = 200$)
M	G7 Dualglass our latest generation of DFE rated, high performance glass media for hydraulic & lubrication fluids. $\beta x_{[c]} = 1000$ ($\beta x = 200$)
W	Stainless steel wire mesh media $\beta x_{[c]} = 2$ ($\beta x = 2$) nominally rated



TF4 ASSEMBLY PART NUMBER GUIDE

	table 1	table 2	table 3	table 4	table 5		table 6
TF4						-	

TF4 ELEMENT PART NUMBER GUIDE

				table 2	table 4
HP	**4C**	**L9**	-		

BOLD text denotes standard options that are available for quick shipment.
Non-standard options are subject to longer lead times.

table 1

code	port configuration
Omit	Single inlet port
D	Double inlet port 180° orientation

table 2

code	filtration rating	media type
1M	β2.5[c] = 1000 (β1 = 200)	G7 Dualglass
3M	β5[c] = 1000 (β3 = 200)	G7 Dualglass
6M	β7[c] = 1000 (β6 = 200)	G7 Dualglass
10A	β12[c] = 1000 (β12 = 200)	Water removal
10M	β12[c] = 1000 (β12 = 200)	G7 Dualglass
16A	β16[c] = 1000 (β17 = 200)	Water removal
16M	β16[c] = 1000 (β17 = 200)	G7 Dualglass
25A	β22[c] = 1000 (β25 = 200)	Water removal
25M	β22[c] = 1000 (β25 = 200)	G7 Dualglass
25W	25u nominal	wire mesh
40W	40u nominal	wire mesh
74W	74u nominal	wire mesh
149W	149u nominal	wire mesh

table 3

code	porting options
B4	BSPT 1 1/4"
S4	SAE-20, 1 1/4"
N4	NPT 1 1/4"

table 4

code	seal material
B	Buna-Nitrile
V	Viton-Fluorocarbon

table 5

code	pressure indicator
M	Visual Pressure Gage
E	3-wire Electrical Pressure Switch
D	DIN Electrical Pressure Switch
X	No indicator (Pressure ports plugged)

table 6

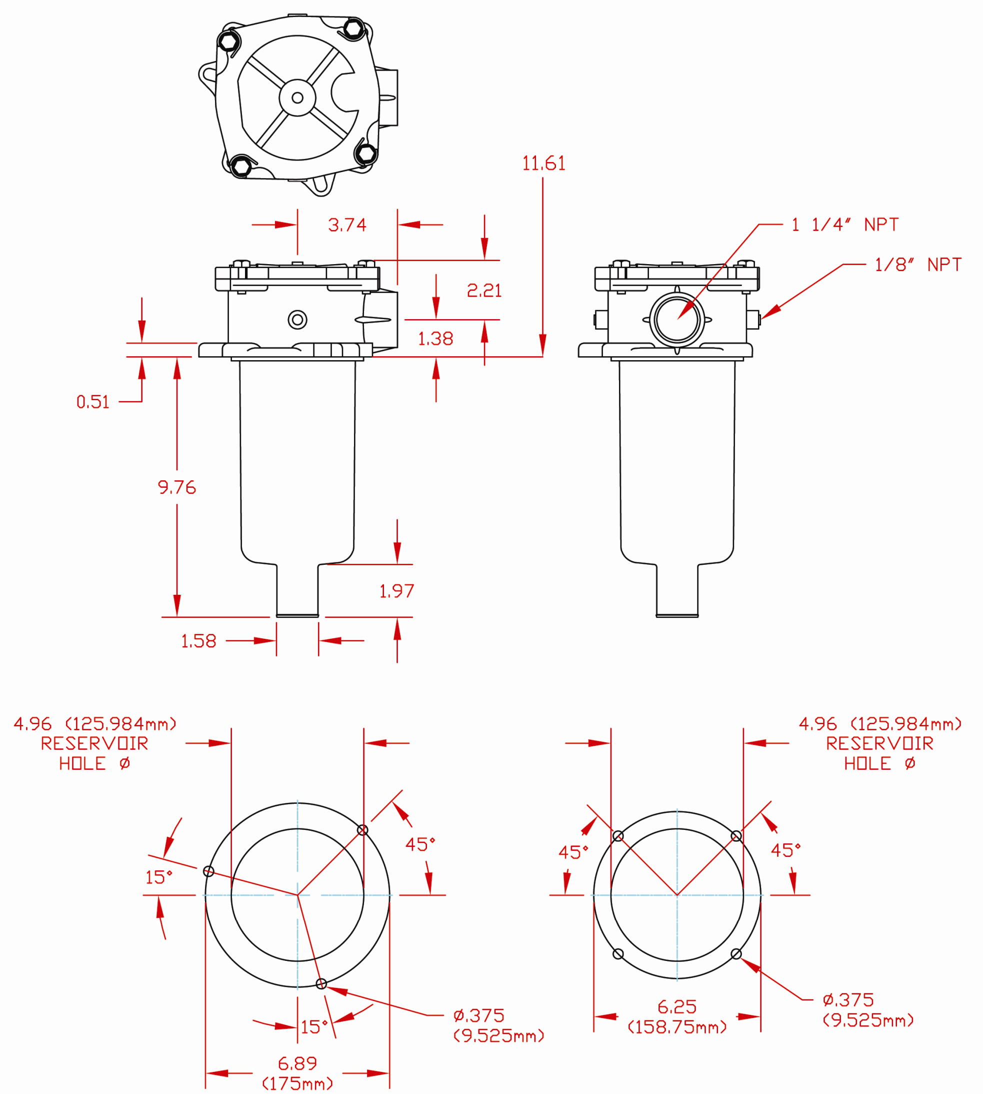
code	special options
H4	HPK series element instead of HP4C coreless. HPK conforms to AIAG HF4 automotive standard. **For element part number replace 4C with K**

Hy-Pro filters are tested to the latest industry standard ISO16889 (replacing ISO4572) resulting in a new scale for defining particle sizes and determining filtration ratio (formerly known as beta ratio)

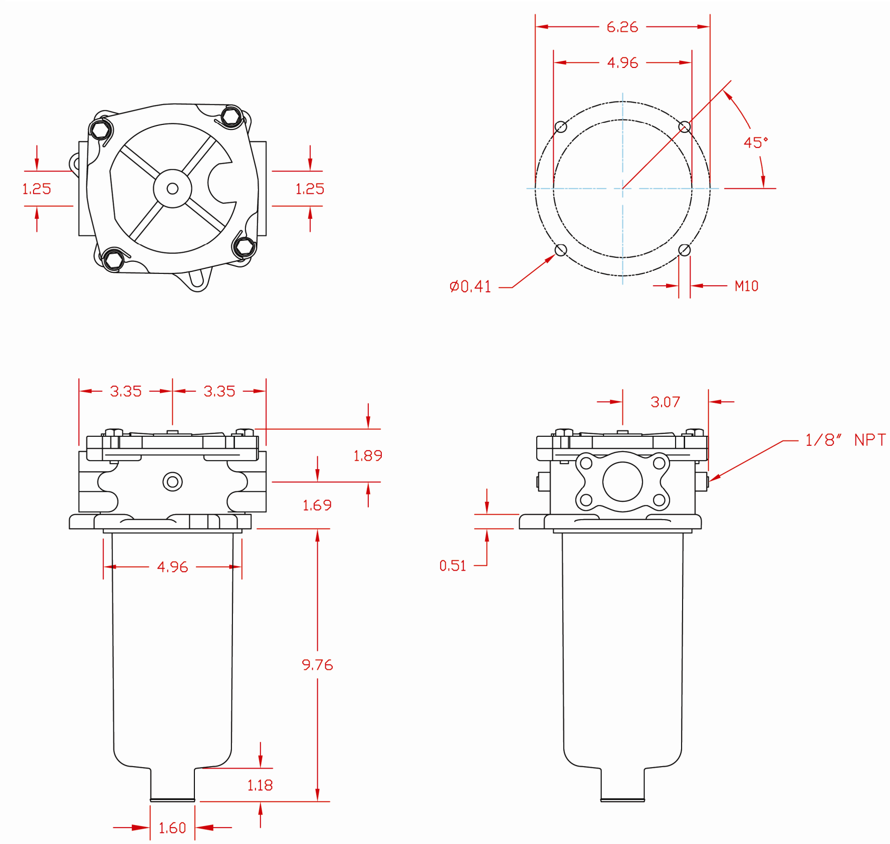
New (ISO16889) vs Old (ISO4572) size comparison

βx(c)=1000 (ISO16889)	2.5	5	7	12	22
βx=200 (ISO4572)	<1	3	6	12	25

HY-PRO FILTRATION



TF4 INSTALLATION DRAWING



TF4D INSTALLATION DRAWING

HY-PRO FILTRATION

TFR In-Tank Filter Assemblies

Featuring Hy-Pro G7 Dualglass high performance DFE rated filter element technology

APPLICATIONS

- Hy-Pro Low pressure TFR series filters are ideal for installation on the return line to remove contaminant ingested or generated by the system.
- Power units
- Mobile equipment
- Compact alternative to spin-on filters

FEATURES, BENEFITS, ADVANTAGES

DFE rated elements	G7 Dualglass elements are DFE rated to assure performance even when exposed to the toughest conditions that hydraulic systems can generate (See DFE for details).
Low housing pressure drop	Unique internal flow paths provide low resistance to flow. (Low pressure drop)
Inside~out flow	Dirty oil is trapped during element service. Avoid cross contamination common with outside~in flow filters.
Tank mounted	Most of the assembly is inside tank. Compact alternative to spin-ons
Integral element bypass valve	Valve is part of the element. New valve with every element. No risk of bypass valve spring fatigue failure.
Top loading	Minimize mess and oil loss. Clean and easy to service.
Universal mounting pattern	Accommodates North American and European mounting patterns
Optional fill port	Fill port option enables QD fluid fill without opening the housing
Twist open bolt cover	Keyways on cover require only loosening cover bolts during service. No lost bolts.

PRODUCT SPECIFICATIONS

Operating Pressure	150 psi, 10 bar max
Flow rate by series	TFR1 (L code 11) 35 gpm, 131 lpm TFR2 (L code 18) 120 gpm, 140 lpm TFR3 (L code 34) 200 gpm, 750 lpm
Design safety factor	2.5:1
Element collapse	100 psid (7 bar)
Assembly material	Head: Cast aluminum (impregnated) Diffuser: Plated steel
Fluid compatibility (ISO 2948)	Compatible with petroleum, based oils, specified water based, oil/water emulsion, and specified synthetic fluids with Flurocarbon or EPR seals (call for compatibility)
Bypass setting	25 psid (1.77 bar) standard see reverse for other options
Weight (w/element)	TFR1-6" 3.4 Lbs, 1.53 kg TFR1-8" 3.6 Lbs, 1.62 kg TFR1-11" 4.0 Lbs, 1.80 kg TFR2-8" 10.0 Lbs, 4.50 kg TFR2-11" 10.5 Lbs, 4.64 kg TFR2-18" 12.0 Lbs, 5.40 kg TFR3-15" 20.0 Lbs, 9.00 kg TFR3-19" 26.5 Lbs, 11.93 kg TFR3-34" 38.0 Lbs, 17.10 kg
Temperature rating	Buna: -40°F (-40°C) to 225°F (107°C) Viton: -15°F (-26°C) to 275°F (135°C)

HY-PRO FILTRATION

TFR FILTER ASSEMBLY SELECTION AND SIZING GUIDELINES

Effective filter sizing requires consideration of flow rate, viscosity (operating and cold start), fluid type and degree of filtration. When properly sized, bypass during cold start can be avoided/minimized and optimum element efficiency and life achieved. The filter assembly differential pressure values provided for sizing differ for each media code, and assume 150 SSU (32Cts) viscosity and 0.86 fluid specific gravity. Use the following steps to identify the correct high pressure filter assembly.

1. Calculate Δp coefficient at both operating and cold start viscosity:

$$\Delta p \text{ Coefficient} = \frac{\text{Actual Operating Viscosity (SSU)}}{150} \times \frac{\text{Actual S.G.}}{0.86}$$

2. Calculate actual clean filter assembly Δp at both operating and cold start viscosity:

Actual assembly clean Δp = Flow rate x Δp Coefficient x Assembly Δp factor (from sizing table)

3. Sizing Recommendations to optimize performance and permit future flexibility:

- To avoid or minimize bypass during cold start the actual assembly clean Δp calculation should be repeated for start-up conditions if cold starts are frequent.
- Actual assembly clean Δp should not exceed 5 psid at normal operating viscosity.
- If suitable assembly size is approaching the upper limit of the recommended flow rate at the desired degree of filtration consider increasing the assembly to the next larger size if a finer degree of filtration might be preferred in the future. This practice allows the future flexibility to enhance fluid cleanliness without compromising clean Δp or filter element life.
- Once a suitable filter assembly size is determined consider increasing the assembly to the next larger size to optimize filter element life and avoid bypass during cold start.
- When using water glycol or other specified synthetics we recommend increasing the filter assembly by 1~2 sizes.
- High viscosity fluid (ie gear lube ISO 220) will typically display very high viscosity as the temperature drops below 100f. For such applications avoiding bypass during start-up might not be possible.

TFR1** Assembly Differential Pressure Factors

Media code	Length code	Max flow gpm (lpm)	Port size	Δp factor* (psid/gpm)	Δp factor* (bar/lpm)
3M	L6	10 (37)	1" (B3, S3, N3)	0.717	0.0138
6M		14 (52)		0.597	0.0115
10M		19 (71)		0.420	0.0081
16M		23 (86)		0.285	0.0055
25M		27 (101)		0.198	0.0078
**W		36 (131)		0.065	0.0013
3M	L8	13 (49)	1" (B3, S3, N3)	0.514	0.0099
6M		18 (67)		0.420	0.0079
10M		23 (86)		0.337	0.0065
16M		28 (105)		0.242	0.0047
25M		33 (124)		0.169	0.0032
**W		42 (157)		0.052	0.001
3M	L11	21 (79)	1 1/4" (B4, S4)	0.326	0.0064
6M		28 (105)		0.261	0.0049
10M		33 (124)		0.223	0.0042
16M		42 (157)		0.181	0.0035
25M		48 (180)		0.134	0.0025
**W		57 (214)		0.039	0.0008

TFR FILTER ASSEMBLY SELECTION AND SIZING GUIDELINES

TFR2** Assembly Differential Pressure Factors

Media code	Length code	Max flow gpm (lpm)	Port size	Δp factor* (psid/gpm)	Δp factor* (bar/lpm)
3M	L8	30 (112)	1 1/2" (B5, S5, N5)	0.200	0.0038
6M		51 (190)		0.143	0.0028
10M		63 (236)		0.102	0.0020
16M		82 (307)		0.087	0.0017
25M		94 (352)		0.067	0.0013
**W		105 (393)		0.047	0.0009
3M	L11	38 (142)	1 1/2" (B5, S5, N5)	0.152	0.0030
6M		63 (236)		0.109	0.0021
10M		78 (292)		0.083	0.0016
16M		105 (394)		0.070	0.0013
25M		130 (490)		0.052	0.0010
**W		150 (562)		0.037	0.0007
3M	L18	70 (262)	1 1/2" (B5, S5, N5)	0.103	0.0020
6M		110 (412)		0.074	0.0014
10M		150 (562)		0.052	0.0010
16M		165 (618)		0.039	0.0008
25M		175 (656)		0.029	0.0006
**W		255 (956)		0.019	0.0004

TFR3** Assembly Differential Pressure Factors

Media code	Length code	Max flow gpm (lpm)	Port size	Δp factor* (psid/gpm)	Δp factor* (bar/lpm)
3M	L15	82 (307)	2 1/2" Flange SAE Code 61	0.093	0.0018
6M		118 (442)		0.066	0.0013
10M		165 (618)		0.047	0.0009
16M		200 (750)		0.042	0.0008
25M		236 (885)		0.033	0.0006
**W		285 (1068)		0.020	0.0004
3M	L19	105 (393)	2 1/2" Flange SAE Code 61	0.072	0.0014
6M		150 (562)		0.051	0.0010
10M		175 (656)		0.042	0.0008
16M		215 (806)		0.035	0.0007
25M		235 (881)		0.026	0.0005
**W		335 (1256)		0.018	0.0003
3M	L34	168 (630)	2 1/2" Flange SAE Code 61	0.044	0.0008
6M		240 (900)		0.031	0.0006
10M		280 (1050)		0.025	0.0005
16M		344 (1290)		0.021	0.0004
25M		376 (1410)		0.016	0.0003
**W		536 (2010)		0.011	0.0002

HIGH PERFORMANCE FILTER ELEMENTS - THE HEART OF A FILTER

Dynamic Filter Efficiency (DFE) Testing

Revolutionary test methods assure that DFE rated elements perform true to rating even under demanding variable flow and vibration conditions. Today's industrial and mobile hydraulic circuits require elements that deliver specified cleanliness under ALL circumstances. Wire mesh supports the media to ensure against cyclical flow fatigue, temperature, and chemical resistance failures possible in filter elements with synthetic support mesh. Contact your distributor or Hy-Pro for more information and published articles on DFE testing.

Media Options

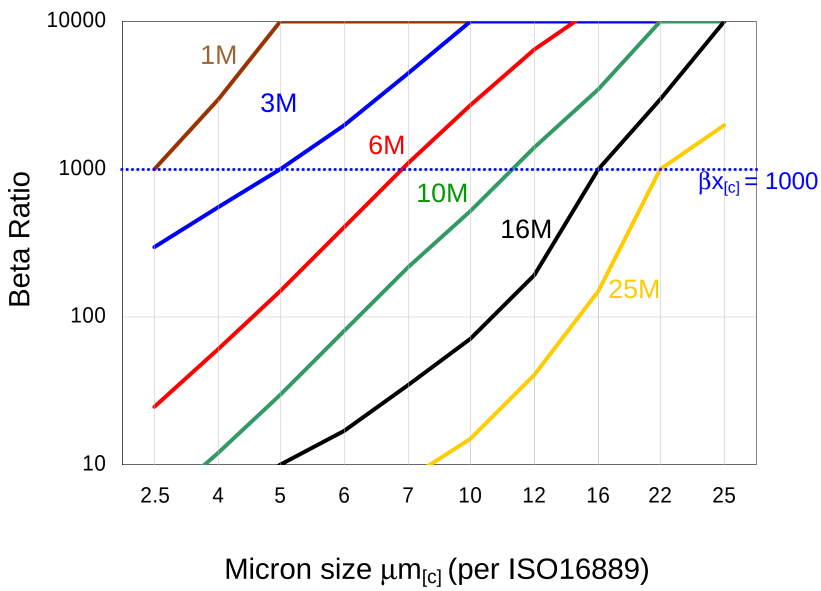
Through extensive testing we have developed media choices to handle any application. Options include G7 Dualglass, Dynafuzz (stainless fiber), and Wire mesh (stainless).

Fluid Compatibility

Petroleum based fluids, water glycol, polyol ester, phosphate ester, high water based fluids and many other synthetics. Contact us for seal material selection assistance.

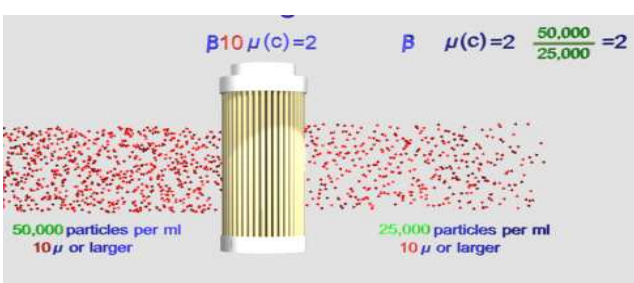
FILTER MEDIA SPECIFICATIONS

Glass Media Code Filtration Efficiency (Beta Ratio) vs Micron Size

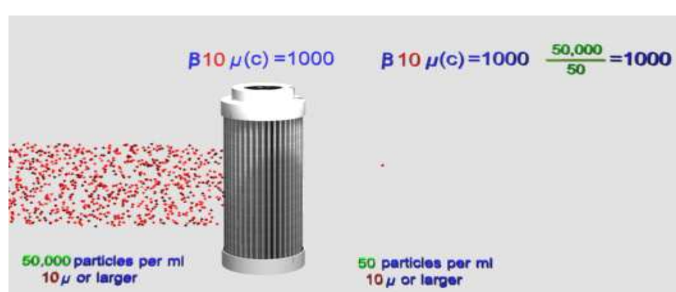


media code	media description
A	G7 Dualglass high performance media combined with water removal scrim. $\beta x_{[c]} = 1000$ ($\beta x = 200$)
M	G7 Dualglass our latest generation of DFE rated, high performance glass media for all hydraulic & lubrication fluids. $\beta x_{[c]} = 1000$ ($\beta x = 200$)
W	Stainless steel wire mesh media $\beta x_{[c]} = 2$ ($\beta x = 2$) nominally rated

Typical cellulose media performance



Hy-Pro G7 Dualglass media performance



TFR ASSEMBLY PART NUMBER GUIDE

	table 1	table 2	table 3	table 4	table 5	table 6	table 7
TFR							

TFR ELEMENT PART NUMBER GUIDE

	table 1		table 4		table 3	table 5		table 7
HPTFR		L		-			-	

BOLD text denotes standard options for each size (TFR1, TFR2, TFR3) that are available for quick shipment. Non-standard options are subject to longer lead times.

table 1 code	series
1	1 1/4" maximum inlet
2	1 1/2" maximum inlet
3	2 1/2" maximum inlet

table 4 code	element length* (series availability)
6	6" nominal (TFR1)
8	**8" nominal (TFR1, TFR2)**
11	**11" nominal (TFR1, TFR2)**
15	**15" nominal (TFR3)**
18	**18" nominal (TFR2)**
19	**19" nominal (TFR3)**
34	34" nominal (TFR3)

*Improper length selection could result in reservoir foaming. Consider diffuser and element length and anticipated reservoir fluid level when sizing. To protect against foaming using longer lengths is recommended.

table 2 code	porting options (series availability)
B3	**BSPT 1" (TFR1)**
B4	BSPT 1 1/4" (TFR1)
B5	**BSPT 1 1/2" (TFR2)**
F3	1 1/2" SAE Code 61 Flange (TFR2)
F4	**2 1/2" SAE Code 61 Flange (TFR3)**
S3	**SAE-16, 1" (TFR1)**
S4	SAE-20, 1 1/4" (TFR1, TFR2)
S5	**SAE-24, 1 1/2" (TFR2)**
N3	NPT 1" (TFR1)
N5	NPT 1 1/2" (TFR2)

table 5 code	seal material
B	Buna-Nitrile
V	Viton-Fluorocarbon

table 6 code	indicator
M	Visual Pressure Gage
E	Electrical Pressure Switch (3 wire)
D	Electrical Pressure Switch (DIN)
X	No indicator (pressure ports plugged)

table 3 code	filtration rating	media type
1M	β2.5[c] = 1000 (β1 = 200)	G7 Dualglass
3M	β5[c] = 1000 (β3 = 200)	G7 Dualglass
6M	β7[c] = 1000 (β6 = 200)	G7 Dualglass
10A	β12[c] = 1000 (β12 = 200)	Water removal
10M	β12[c] = 1000 (β12 = 200)	G7 Dualglass
16A	β16[c] = 1000 (β17 = 200)	Water removal
16M	β16[c] = 1000 (β17 = 200)	G7 Dualglass
25A	β22[c] = 1000 (β25 = 200)	Water removal
25M	β22[c] = 1000 (β25 = 200)	G7 Dualglass
25W	25u nominal	wire mesh
40W	40u nominal	wire mesh
74W	74u nominal	wire mesh
149W	149u nominal	wire mesh

table 7 code	bypass valve setting
Omit	25 psid, 1,77 bar (standard)
	consult Hy-Pro for alternate valve setting

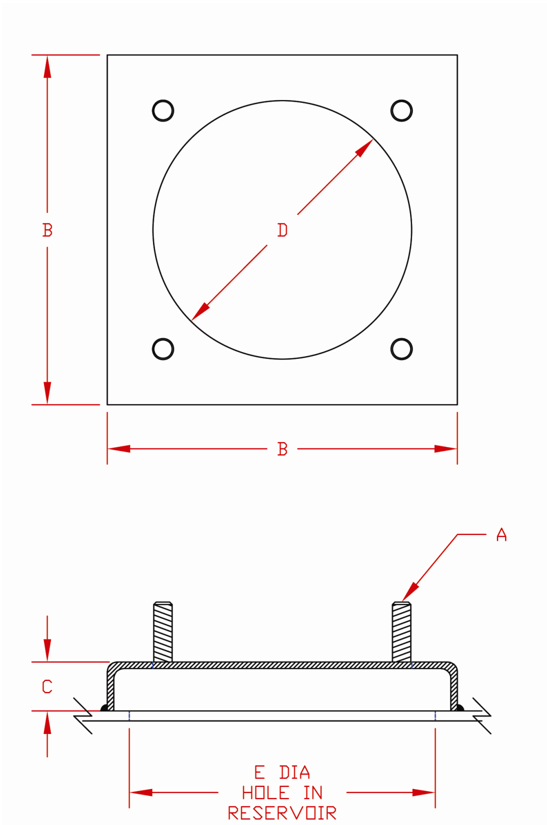
Hy-Pro filters are tested to the latest industry standard ISO16889 (replacing ISO4572) resulting in A new scale for defining particle sizes and determining filtration ratio (formerly known as beta ratio)

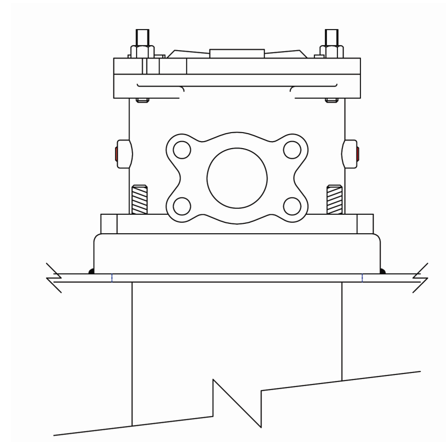
New (ISO16889) vs Old (ISO4572) size comparison

βx(c)=1000 (ISO16889)	2.5	5	7	12	22
βx=200 (ISO4572)	<1	3	6	12	25

HY-PRO FILTRATION

TFR MOUNTING FLANGES



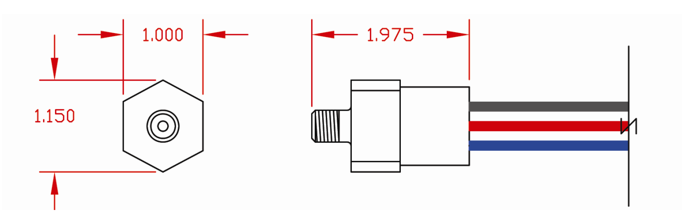


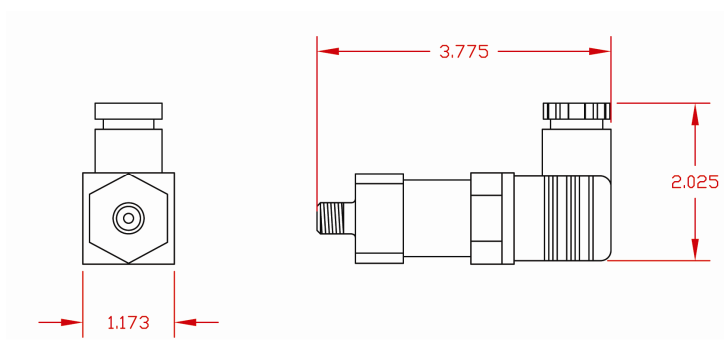
part num. (series)	A	B	C	D	E
	IN (mm)				
TFR-WF1 (TFR1)	5/16-18 UNC-2A	5.33 (135,4)	1.00 (25,4)	3.59 (91,2)	3.8 - 4.5 (96 - 114)
TFR-WF2 (TFR2)	3/8-16 UNC-2A	7.18 (182,4)	1.00 (25,4)	5.30 (134,5)	5.5 - 6.25 (140 - 158)
TFR-WF3 (TFR3)	3/8-16 UNC-2A	7.80 (194,7)	1.00 (25,4)	6.59 (167,5)	6.75 - 7.25 (171 - 184)

TFR PRESSURE GAGES & PRESSURE SWITCHES

Part Number	Connection Type	Wiring N. Closed	N. Open	Common	Set Point	Stud Connection
PS25E	3 Wire	Green	Red	Black	22 psi (rising)	1/8" NPT
PS25D	DIN 43650	Green: 2	Red: 3	Black : 1	22 psi (rising)	1/8" NPT

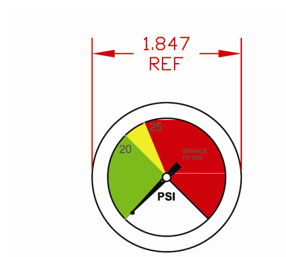
Voltage: 12VDC, 7.0 AMP
24VDC, 5.0 AMP
125/250VAC, 5.0 AMP Inductive



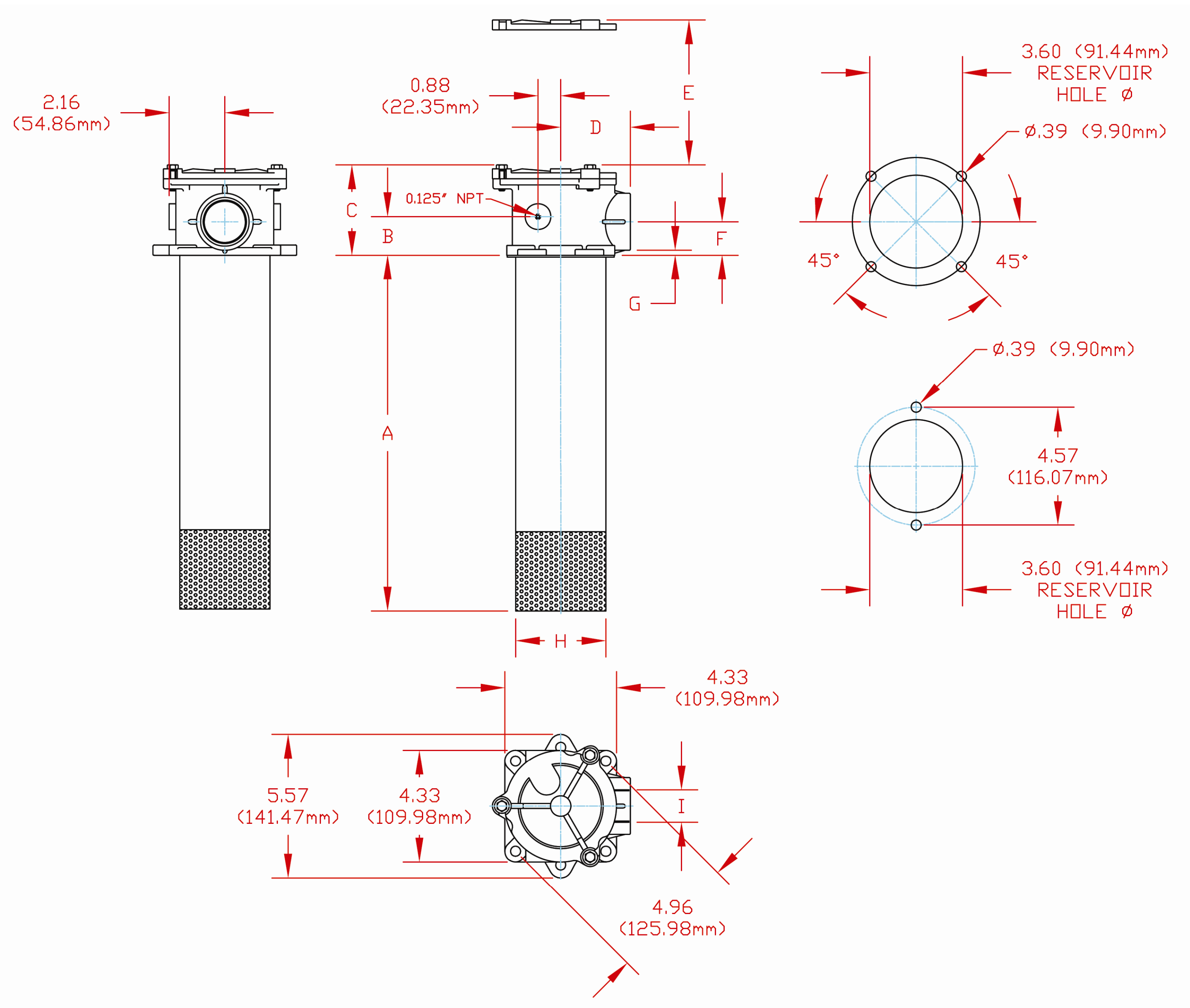


G25: Visual pressure gauge green to red at 25 psid to ensure service before Element operates in bypass.

Steel case, brass stem 1/8” NPT.



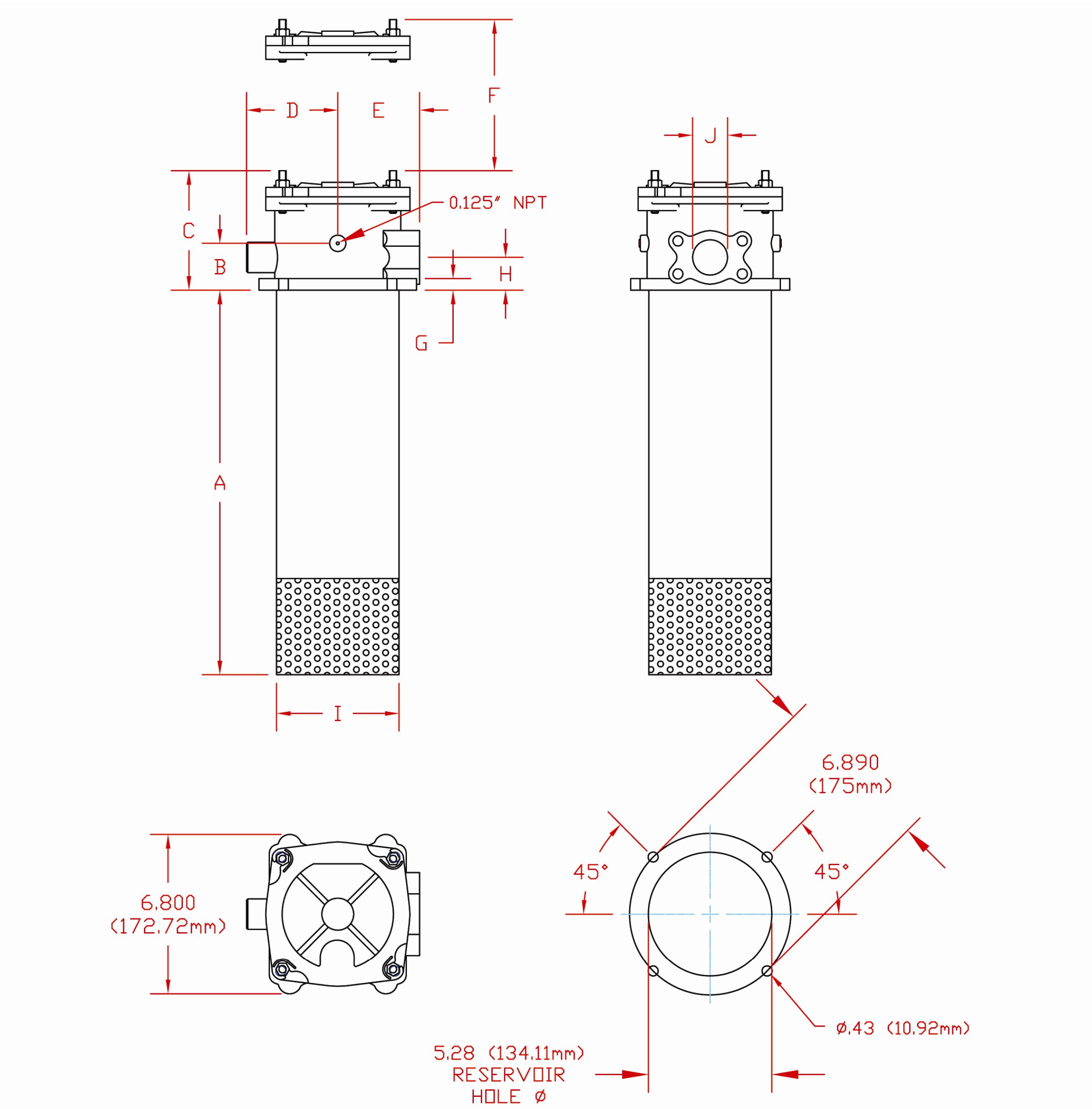
TFR1 INSTALLATION DRAWING



Length code (table 4)	Dimension IN (MM)									
	A	B	C	D	E	F	G	H	I	J
6	7.80 (198)	1.50 (38,1)	3.55 (90,2)	2.68 (68)	11.85 (301)	1.1 (28) or 1.26 (32)	0.24 (6)	3.50 (89)	1" or 1 1/4"	4.96 (126)
8	9.85 (250,2)	1.50 (38,1)	3.55 (90,2)	2.68 (68)	13.80 (350,5)	1.1 (28) ~ 1.26 (32)	0.24 (6)	3.50 (89)	1" or 1 1/4"	4.96 (126)
11	13.8 (350,5)	1.50 (38,1)	3.55 (90,2)	2.68 (68)	18.50 (470)	1.1 (28) ~ 1.26 (32)	0.24 (6)	3.50 (89)	1" or 1 1/4"	4.96 (126)

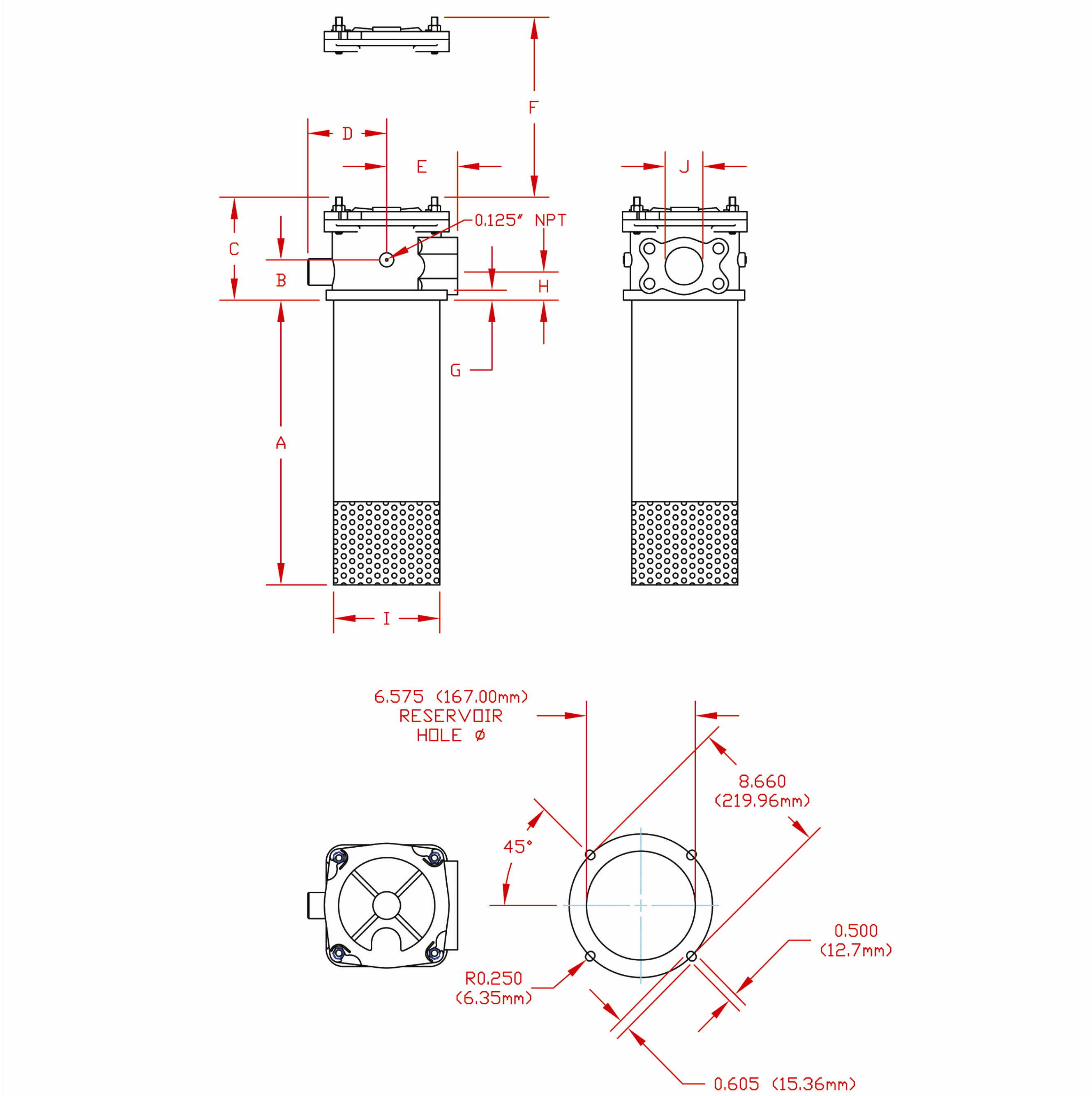
HY-PRO FILTRATION

TFR2 INSTALLATION DRAWING



Length code (table 4)	Dimension IN (MM)									
	A	B	C	D	E	F	G	H	I	J
8	9.85 (250)	1.97 (50)	5.20 (130)	3.94 (100)	3.54 (90)	9.25 (235) EL removal	0.47 (12)	1.42 (36)	5.24 (136)	1 1/2" port
11	12.6 (320)	1.97 (50)	5.20 (130)	3.94 (100)	3.54 (90)	12.0 (305) EL removal	0.47 (12)	1.42 (36)	5.24 (136)	1 1/2" port
18	20.7 (527)	1.97 (50)	5.20 (130)	3.94 (100)	3.54 (90)	18.7 (475) EL removal	0.47 (12)	1.42 (36)	5.24 (136)	1 1/2" port

TFR3 INSTALLATION DRAWING



Length code (table 4)	Dimension IN (MM)									
	A	B	C	D	E	F	G	H	I	J
15	18.5 (469)	2.16 (55)	6.10 (155)	4.50 (114)	4.33 (110)	17.19 (437)	0.55 (14)	2.16 (55)	6.52 (165,5)	2.5" Code 61
19	22.0 (560)	2.16 (55)	6.10 (155)	4.50 (114)	4.33 (110)	20.5 (520)	0.55 (14)	2.16 (55)	6.52 (165,5)	2.5" Code 61
34	37.0 (940)	2.16 (55)	6.10 (155)	4.50 (114)	4.33 (110)	35.5 (901)	0.55 (14)	2.16 (55)	6.52 (165,5)	2.5" Code 61

LF/LFM - Low Pressure High Flow Assemblies

LF flow rate to 560 lpm, 150 gpm / LFM flow rate to 16875 lpm, 4500 gpm

APPLICATIONS

- Hydraulic and Lubrication oil
- Fuel and Fuel oil
- Rolling mill oil
- Processing liquids
- Bulk oil handling - Transfer and clean up
- Off-line systems and flushing
- Power generation
- Primary metals
- Mobile flushing systems
- Particulate and water removal
- Transfer line machining coolants
- Large gearbox filtration
- High flow Return-line filtration

PRODUCT SPECIFICATIONS & FEATURES

Max Flow Rate Visc: 150 SUS, 32 cSt	**Recommended Series**
100 gpm (375 lpm)	LF Single length
150 gpm (560 lpm)	LF Double length
300 gpm (1125 lpm)	2 x LF Double parallel mount
4500 gpm (16875 lpm)	LFM multiple element series (call for sizing assistance)
Operating Pressure	**Standard 150 psi (10 bar)**
	Available up to 3000 psi (212 bar)
Pressure Indicators	
Up to 250 psi Operating	Two visual pressure gages or differential indicator available
450 psi and higher	Differential pressure Indicator required
Maximum Temperature	**Standard 250 F**
	Call for high temperature specs

- Carbon steel construction standard (304 & 316 stainless available).
- Duplexing option available for continuous filtration during filter element change-out.
- HP106 and HP107 element series have integral bypass valve (new bypass every time element is changed avoids bypass failure).
- Pressure gages are supplied standard for housings up to 250 psi operating (differential indicator is available). Differential pressure indicator is supplied standard for housings with operating pressure 450 psi and higher.
- Easy to service swing-lid design with eye nuts assures no lost hardware, hydraulic lift option available.
- Marine grade epoxy exterior finish for non-stainless steel assemblies
- Accepts coreless design with positive o-ring seals or industry standard 6 x 18 and 6 x 36 with gasket seals.
- Vent/bleed port standard in housing cover.
- 2” drain and cleanout port allows for quick draining and easy access for sump cleanout.
- Hy-Pro Dualglass filter element media technology validated per ISO16889 multipass and DFE (modified ISO16889) industry leading multipass testing.

ASME U & UM CODE REQUIREMENTS

Standard vessels are manufactured to ASME code standards, but not certified. ASME U and UM code certification is available as an option. See table 9 under the Filter Assembly part number guide on page 2 for ordering detail. Please call for price adders when specifying Code certification.

HIGH PERFORMANCE FILTER ELEMENTS - THE HEART OF A FILTER

Dynamic Filter Efficiency (DFE) Testing

Revolutionary test methods assure that DFE rated elements perform true to rating even under demanding variable flow and vibration conditions. Today's industrial and mobile hydraulic circuits require elements that deliver specified cleanliness under ALL circumstances. Wire mesh supports the media to ensure against cyclical flow fatigue, temperature, and chemical resistance failures possible in filter elements with synthetic support mesh. Contact your distributor or Hy-Pro for more information and published articles on DFE testing.

Media Options

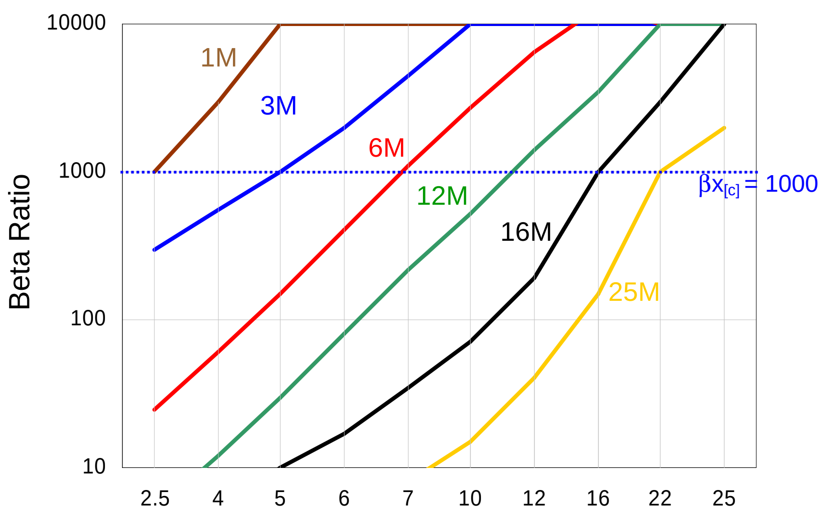
Through extensive testing we have developed media choices to handle any application. Options include G7 Dualglass, Dynafuzz (stainless fiber), and Wire mesh (stainless).

Fluid Compatibility

Petroleum based fluids, water glycol, polyol ester, phosphate ester, high water based fluids and many other synthetics. Contact us for seal material selection assistance.

FILTER MEDIA SPECIFICATIONS

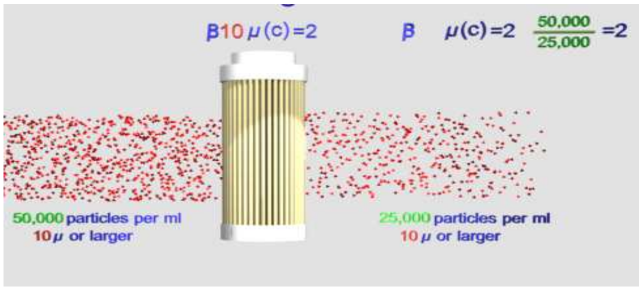
Glass Media Code Filtration Efficiency (Beta Ratio) vs Micron Size



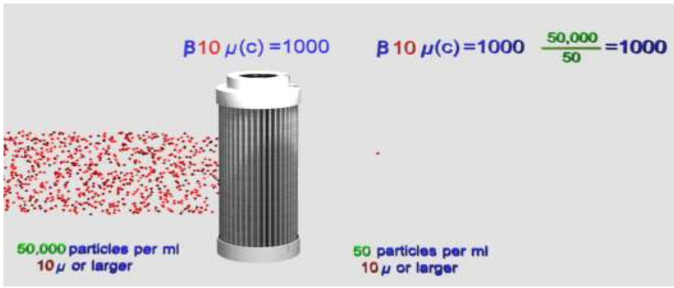
Micron size $\mu m_{[c]}$ (per ISO16889)

media code	media description
A	G7 Dualglass high performance media combined with water removal scrim. $\beta x_{[c]} = 1000$ ($\beta x = 200$)
M	G7 Dualglass our latest generation of DFE rated, high performance glass media for all hydraulic & lubrication fluids. $\beta x_{[c]} = 1000$ ($\beta x = 200$)
W	Stainless steel wire mesh media $\beta x_{[c]} = 2$ ($\beta x = 2$) nominally rated

Typical cellulose media performance



Hy-Pro G7 Dualglass media performance



FILTER ELEMENT PERFORMANCE DATA

Elements Tested to ISO quality standards

ISO 2941	Collapse and burst resistance
ISO 2942	Fabrication and Integrity test
ISO 2948	Material compatibility with fluids
ISO 3724	Flow fatigue characteristics
ISO 3968	Pressure drop vs. flow rate
ISO 16889	Multi-pass performance testing

Coreless Filter Element Technology

Hy-Pro coreless elements are featured in the FCL series. The elements are oversized to yield extended element life and handle a wide variety of high viscosity oils. Hy-Pro coreless elements utilize wire mesh pleat support which ensures that the pleats won't collapse or lose integrity.

DIFFERENTIAL PRESSURE GAGES

Differential Pressure Gauges + Switches

Differential pressure gauges with green to red display ensures proper monitoring of filter element condition. DIN connector switch can be added to any pressure gauge.

Available with terminal differential settings, visual green to red and alarm switch, at 22 psid (1.56 bar) and 45psid (3.19 bar).

Sampling Port Isolation Valves Standard

Sample port valves are located on inlet and outlet connections to which many different types of sampling connectors.

LF, LFM FILTER ASSEMBLY SELECTION AND SIZING GUIDELINES

Effective filter sizing requires consideration of flow rate, viscosity (operating and cold start), fluid type and degree of filtration. When properly sized, bypass during cold start can be avoided/minimized and optimum element efficiency and life achieved. The filter assembly differential pressure values provided for sizing differ for each media code, and assume 150 SSU (32Cts) viscosity and 0.86 fluid specific gravity. Use the following steps to identify the correct high pressure filter assembly.

1. Calculate Δp coefficient at both operating and cold start viscosity:

$$\Delta p \text{ Coefficient} = \frac{\text{Actual Operating Viscosity (SSU)}}{150} \times \frac{\text{Actual S.G.}}{0.86}$$

2. Calculate actual clean filter assembly Δp at both operating and cold start viscosity:

Actual assembly clean Δp = Flow rate x Δp Coefficient x Assembly Δp factor (from sizing table)

3. Sizing Recommendations to optimize performance and permit future flexibility:

- To avoid or minimize bypass during cold start the actual assembly clean Δp calculation should be repeated for start-up conditions if cold starts are frequent.
- Actual assembly clean Δp should not exceed 5 psid at normal operating viscosity.
- If suitable assembly size is approaching the upper limit of the recommended flow rate at the desired degree of filtration consider increasing the assembly to the next larger size if a finer degree of filtration might be preferred in the future. This practice allows the future flexibility to enhance fluid cleanliness without compromising clean Δp or filter element life.
- Once a suitable filter assembly size is determined consider increasing the assembly to the next larger size to optimize filter element life and avoid bypass during cold start.
- When using water glycol or other specified synthetics we recommend increasing the filter assembly by 1~2 sizes.
- High viscosity fluid (ie gear lube ISO 220) will typically display very high viscosity as the temperature drops below 100f. For such applications avoiding bypass during start-up might not be possible.

LF Single Element Assembly (housing + element) Differential Pressure Factors

Media code	Port size	L36, 39 Max flow gpm (lpm)	Length code	Δp factor* (psid/gpm)	Δp factor* (bar/lpm)	Length code	Δp factor* (psid/gpm)	Δp factor* (bar/lpm)
1M	2" Flange, NPT	100 (375)	16,18	0.059	0.00113	36,39	0.047	0.00090
3M		150 (560)		0.050	0.00096		0.042	0.00081
6M		150 (560)		0.048	0.00092		0.041	0.00079
10M		150 (560)		0.046	0.00087		0.040	0.00077
16M		200 (750)		0.043	0.00082		0.038	0.00073
25M		200 (750)		0.040	0.00077		0.037	0.00071
**W		300 (1125)		0.037	0.00071		0.035	0.00067
1M	3" Flange, NPT	150 (560)	16,18	0.047	0.00078	36,39	0.034	0.00065
3M		200 (750)		0.038	0.00073		0.030	0.00058
6M		200 (750)		0.036	0.00069		0.029	0.00055
10M		250 (935)		0.034	0.00066		0.028	0.00053
16M		300 (1125)		0.031	0.00060		0.026	0.00050
25M		300 (1125)		0.028	0.00054		0.024	0.00046
**W		300 (1125)		0.025	0.00048		0.022	0.00042

*Max flow rate and Δp factor assumes υ = 150 sus, 32 Centistokes. See Δp viscosity conversion formula for viscosity

HY-PRO FILTRATION

LFM3 Multi-Element Assembly (housing + element) Differential Pressure Factors

Media code	Length code	Max flow gpm (lpm)	Port size	Δp factor* (psid/gpm)	Δp factor* (bar/lpm)
1M	36, 39	600 (2250)	4" Flange	0.0081	0.000154
3M		800 (3000)		0.0055	0.000105
6M		900 (3375)		0.0051	0.000098
10M		1300 (4875)		0.0045	0.000087
16M		1300 (4875)		0.0041	0.000079
25M		1500 (5625)		0.0035	0.000067
**W		1500 (5625)		0.0027	0.000052
1M	36, 39	600 (2250)	6" Flange	0.0075	0.000144
3M		800 (3000)		0.005	0.000096
6M		900 (3375)		0.0045	0.000087
10M		1300 (4875)		0.0039	0.000058
16M		1300 (4875)		0.0035	0.000067
25M		1500 (5625)		0.0029	0.000059
**W		1500 (5625)		0.0021	0.000041

*Max flow rate and Δp factor assumes υ = 150 sus, 32 Centistokes. See Δp viscosity conversion formula for viscosity

LFM4 Multi-Element Assembly (housing + element) Differential Pressure Factors

Media code	Length code	Max flow gpm (lpm)	Port size	Δp factor* (psid/gpm)	Δp factor* (bar/lpm)
1M	36, 39	600 (2250)	4" Flange	0.0067	0.000129
3M		800 (3000)		0.0048	0.000092
6M		1000 (3750)		0.0044	0.000084
10M		1300 (4500)		0.0040	0.000077
16M		1400 (5250)		0.0037	0.000071
25M		1500 (6560)		0.0032	0.000061
**W		1500 (5625)		0.0025	0.000048
1M	36, 39	600 (2250)	6" Flange	0.0062	0.000119
3M		800 (3000)		0.0043	0.000083
6M		900 (3375)		0.0039	0.000075
10M		1300 (4875)		0.0034	0.000065
16M		1300 (4875)		0.0031	0.000059
25M		1500 (5625)		0.0026	0.000050
**W		1500 (5625)		0.00207	0.000038

*Max flow rate and Δp factor assumes υ = 150 sus, 32 Centistokes. See Δp viscosity conversion formula for viscosity

LF FILTER ASSEMBLY PART NUMBER GUIDE

	table 1	table 2	table 3		table 4		table 5		table 6	table 7	table 8	table 9	table 10
LF	☐	☐	☐	-	☐	-	☐	-	☐	☐	☐	☐	☐

FILTER ELEMENT PART NUMBER GUIDE

	table 4		table 5		table 6	table 7
HP10	☐	L	☐	-	☐	☐

table 1

code	Elements per vessel
omit	1 element
M3	3 elements
M4	4 elements
M9	9 elements
M14	14 elements
M22	22 elements

table 4

code	Element Configuration
1	HP101 series 6" OD x 2.6" ID, gasket seals. Recommended change-out 60 psid (4,2 bar)
5	HP105 coreless series, positive o-ring seals. Recommended change-out 60 psid (4,2 bar)
6	HP106 element with bypass, 25 psid (1,8 bar) bypass, orings change-out 22 psid (1,5 bar)
7	HP107 element with bypass 50 psid (3,5 bar) bypass, orings change-out 45 psid (3,2 bar)
8	USE HP8314 for element P/N Interchanges with Pall HC8314, **NO BYPASS,** oring seals, max change-out 45 psid (3,2 bar)

table 2

code	Materials
omit	Epoxy coated steel
S	304 Stainless steel

table 5

code	Element length
18	Single (LF single element vessel only), element codes 1,5,6,7 only
36	Double, element code 1,5,6,7
39	Double, element 8 (HP8314)

table 6

code	Filtration rating
1M	β2.5[c] = 1000 (B1 = 200)
3M	β5[c] = 1000 (B3 = 200)
6M 6A	β7[c] = 1000 (B6 = 200) β7[c] = 1000 + water removal
10M 10A	β12[c] = 1000 (B12 = 200) β12[c] = 1000 + water removal
16M 16A	β17[c] = 1000 (B17 = 200) β17[c] = 1000 + water removal
25M 25A 25W	β22[c] = 1000 (B25 = 200) β22[c] = 1000 + water removal 25u nominal wire mesh
40M,W	β35[c] = 1000 (B40 = 200) or 40u nominal wire mesh
74W	74u nominal wire mesh
149W	149u nominal wire mesh
250W	250u nominal wire mesh

table 3

code	Connections
B2*	2" BSPP
B3*	3" BSPP
B4*	4" BSPP
C2	2" SAE Code-61 Flange
C3	3" SAE Code-61 Flange
D2	DN50 DIN 2633 Flange
D3	DN65 DIN 2633 Flange
D4	DN100 DIN 2633 Flange
D5	DN125 DIN 2633 Flange
D6	DN150 DIN 2633 Flange
D8	DN200 DIN 2633 Flange
D10	DN250 DIN 2633 Flange
F2	2" ANSI Flange
F3	3" ANSI Flange
F4	4" ANSI Flange
F6	6" ANSI Flange
F8	8" ANSI Flange
F10	10" ANSI Flange
F12	12" ANSI Flange
N2	NPT 2"
N3	NPT 3"
N4	NPT 4"

*BSPP, DIN Flanges, and Vitolic connections options are subject to longer delivery time.

table 7

code	Seals
B	Buna (Nitrile)
E-WS	EPR (Skydrol fluid apps)
V	Viton (Fluoro)

table 8

code	Indicator
X	None (ported, plugged)
P	Two pressure gages
D	22 psid visual Δp gage, + electric alarm (120V AC)
E	22 psid visual Δp gage
F	45 psid visual Δp gage, + electric alarm (120V AC)
G	45 psid visual Δp gage

table 9

code	ASME code (Not required)
omit	No Code (Standard)
U	U code
M	UM code

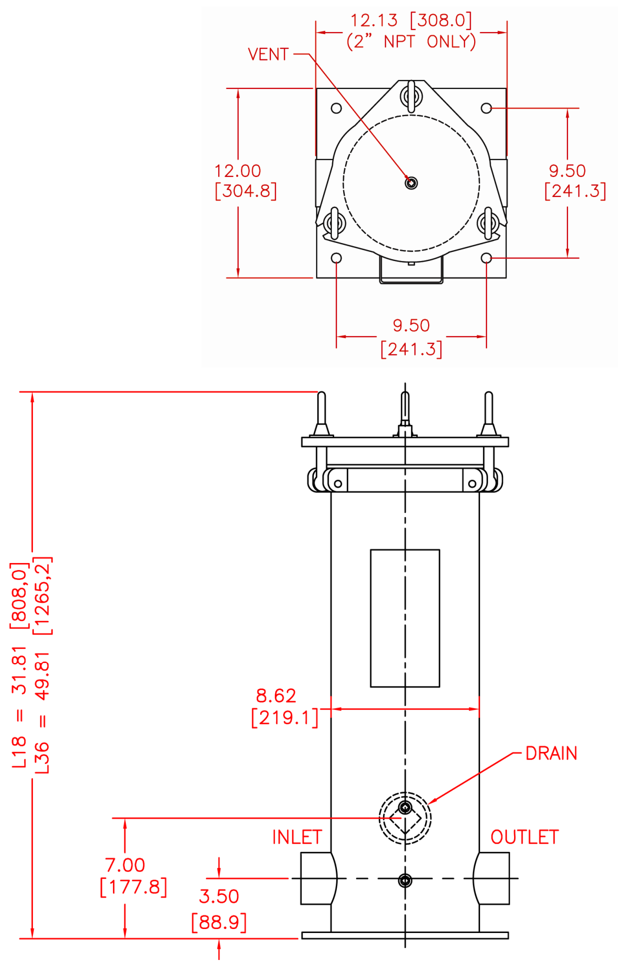
table 10

code	Max Operating Pressure
omit	150 psi (standard)
V	250 psi, 17 bar max
W*	450 psi, 30 bar max
X*	1000 psi, 66 bar max

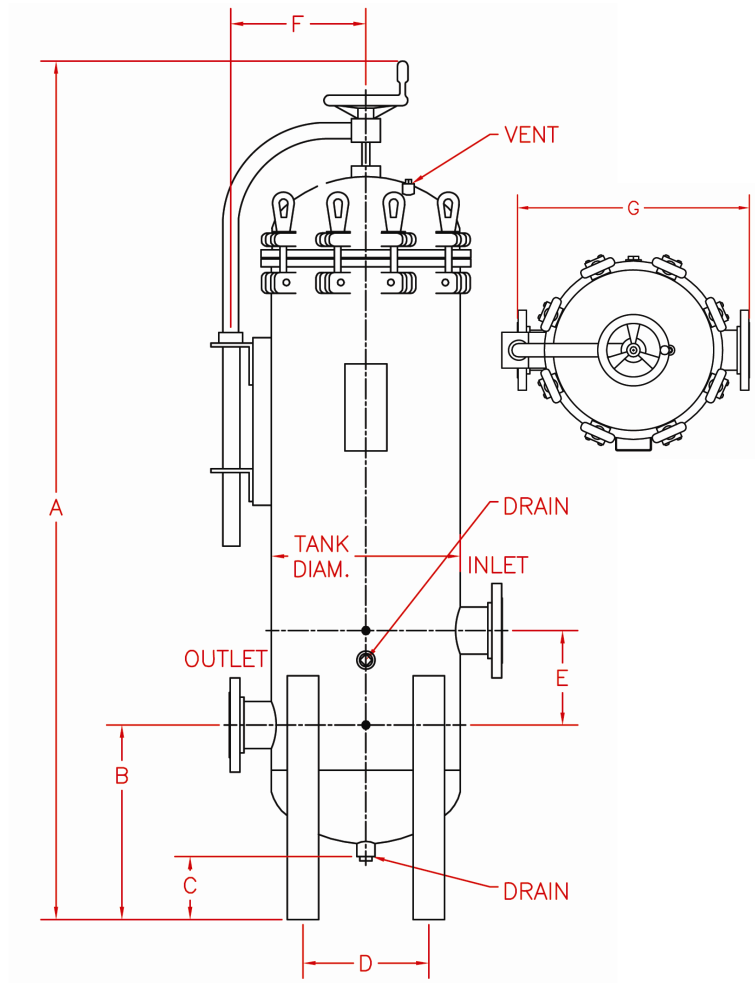
*Slip and blind flange bolt arrangement dimensions change from standard (9 bolts)

LF - 150 PSI (10 BAR) only

250 PSI (17 BAR), 450 PSI (30 BAR)
installation drawings next page

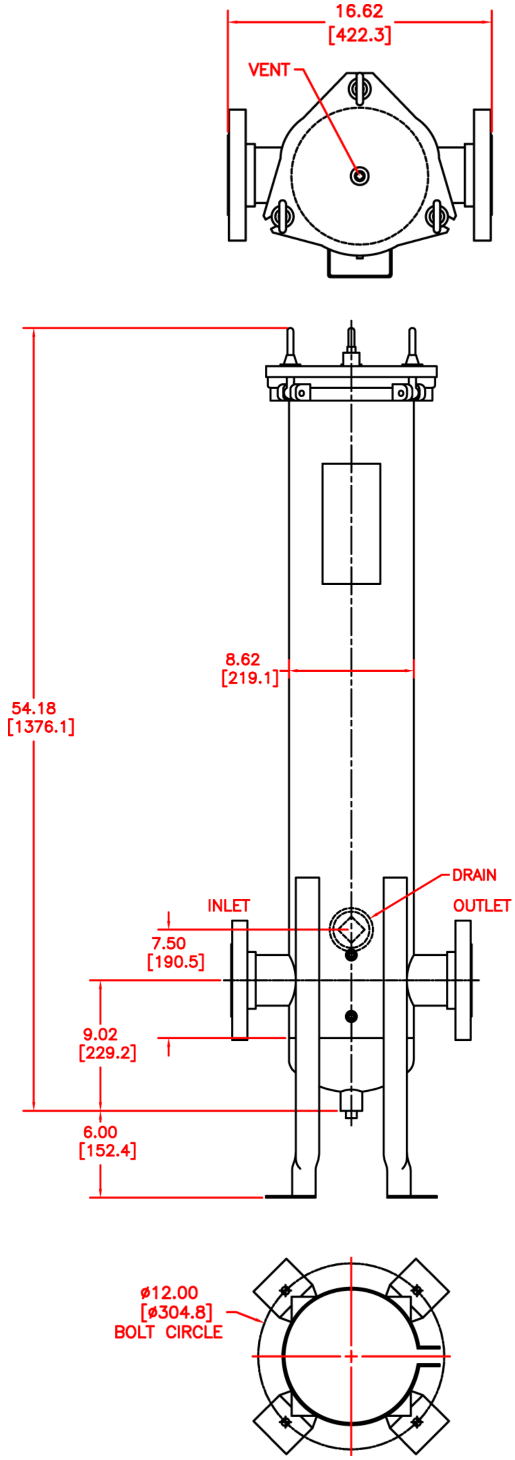


LFM* - up to 450 PSI (30 BAR)

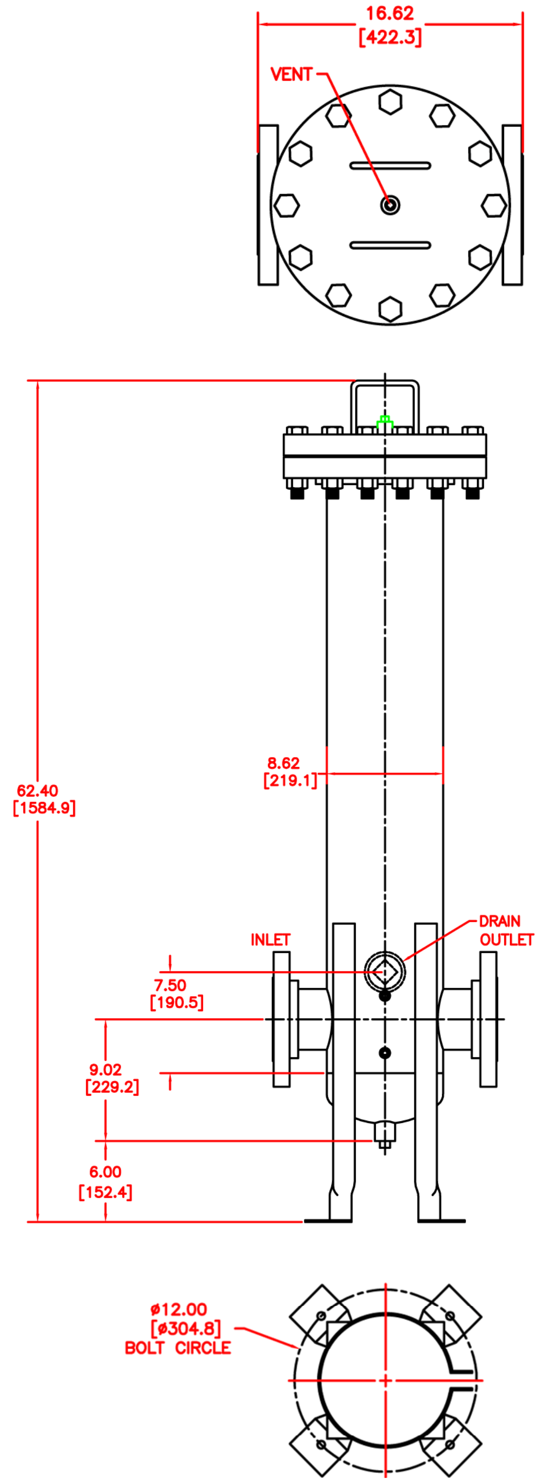


Series	Element Qty.	Tank Diam.	Port Sizes	Est. Weight	A	B	C	D*	E	F	G*
			2	485 Lbs	81.9 [2079,6]	18.5 [470,8]	6.0 [152,4]	10.0 [254,0]	9.0 [228,6]	11.9 [301,8]	24.0 [609,6]
LFM3	3	16	3	220 Kg	81.9 [2079,6]	18.5 [470,8]	6.0 [152,4]	10.0 [254,0]	9.0 [228,6]	11.9 [301,8]	24.0 [609,6]
		[406,4]	4		81.9 [2079,6]	18.5 [470,8]	6.0 [152,4]	10.0 [254,0]	9.0 [228,6]	11.9 [301,8]	24.0 [609,6]
			2	550 Lbs	81.9 [2079,6]	18.5 [470,8]	6.0 [152,4]	12.0 [304,8]	9.0 [228,6]	12.9 [327,2]	26.0 [660,4]
LFM4	4	18	3	250 Kg	81.9 [2079,6]	18.5 [470,8]	6.0 [152,4]	12.0 [304,8]	9.0 [228,6]	12.9 [327,2]	26.0 [660,4]
		[457,2]	4		81.9 [2079,6]	18.5 [470,8]	6.0 [152,4]	12.0 [304,8]	9.0 [228,6]	12.9 [327,2]	26.0 [660,4]
			3	645 Lbs	81.9 [2079,6]	18.5 [470,8]	6.0 [152,4]	18.0 [457,2]	9.0 [228,6]	15.9 [403,4]	32.0 [812,8]
LFM9	9	24	4	293 Kg	81.9 [2079,6]	18.5 [470,8]	6.0 [152,4]	18.0 [457,2]	9.0 [228,6]	15.9 [403,4]	32.0 [812,8]
		[609,6]	6		81.9 [2079,6]	18.5 [470,8]	6.0 [152,4]	18.0 [457,2]	9.0 [228,6]	15.9 [403,4]	32.0 [812,8]
			3	710 Lbs	81.9 [2079,6]	18.5 [470,8]	6.0 [152,4]	24.0 [609,6]	9.0 [228,6]	18.9 [479,6]	38.0 [965,2]
LFM14	14	30	4	323 Kg	81.9 [2079,6]	18.5 [470,8]	6.0 [152,4]	24.0 [609,6]	9.0 [228,6]	18.9 [479,6]	38.0 [965,2]
		[762]	6		81.9 [2079,6]	18.5 [470,8]	6.0 [152,4]	24.0 [609,6]	9.0 [228,6]	18.9 [479,6]	38.0 [965,2]
			4	900 Lbs	81.9 [2079,6]	24.5 [623,2]	6.0 [152,4]	30.0 [762,0]	15.0 [381,0]	21.9 [555,8]	44.0 [1117,6]
LFM22	22	36	6	410 Kg	81.9 [2079,6]	24.5 [623,2]	6.0 [152,4]	30.0 [762,0]	15.0 [381,0]	21.9 [555,8]	44.0 [1117,6]
		[914,4]	8		81.9 [2079,6]	24.5 [623,2]	6.0 [152,4]	30.0 [762,0]	15.0 [381,0]	21.9 [555,8]	44.0 [1117,6]
			6	2080 Lbs	81.9 [2079,6]	24.5 [623,2]	6.0 [152,4]	36.0 [914,4]	15.0 [381,0]	24.9 [632,0]	50.0 [1270,0]
LFM31	31	42	8	945 Kg	81.9 [2079,6]	24.5 [623,2]	6.0 [152,4]	36.0 [914,4]	15.0 [381,0]	24.9 [632,0]	50.0 [1270,0]
		[1067]	10		81.9 [2079,6]	24.5 [623,2]	6.0 [152,4]	36.0 [914,4]	15.0 [381,0]	24.9 [632,0]	50.0 [1270,0]
			8	2450 Lbs	81.9 [2079,6]	24.5 [623,2]	6.0 [152,4]	42.0 [1066,8]	15.0 [381,0]	27.9 [708,2]	56.0 [1422,4]
LFM38	38	48	10	1115 Kg	81.9 [2079,6]	24.5 [623,2]	6.0 [152,4]	42.0 [1066,8]	15.0 [381,0]	27.9 [708,2]	56.0 [1422,4]
		[1219]	12		81.9 [2079,6]	24.5 [623,2]	6.0 [152,4]	42.0 [1066,8]	15.0 [381,0]	27.9 [708,2]	56.0 [1422,4]

LF - 250 PSI (17 BAR)



LF - 450 PSI (30 BAR)



S series Low Pressure Spin-ons

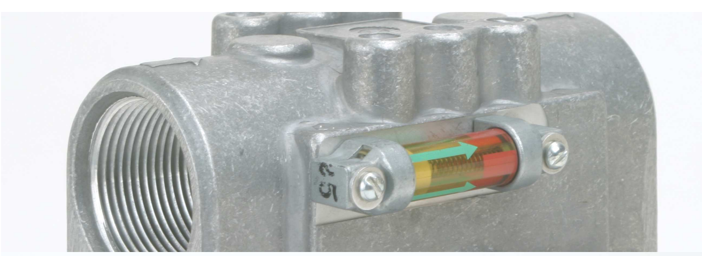
Featuring Hy-Pro G7 Dualglass high performance filter element technology

APPLICATIONS

- Hy-Pro Low pressure S series filters are ideal for installation on the return line to remove contaminate ingested or generated by the system. Functions include off-line filtration (kidney loop or filter cart) and some suction applications.
- Automotive manufacturing/assembly machine tools.
- Mobile applications such as waste haulers & transit .
- Filter carts and filter panels.
- Power unit return line/suction.

FEATURES, BENEFITS, ADVANTAGES

DFE rated elements	G7 Dualglass elements are DFE rated to assure performance even when exposed to the toughest conditions that hydraulic systems can generate (See DFE for details).
Low housing pressure drop	Unique internal flow paths provide low resistance to flow. (Low pressure drop)
True Differential Pressure gage	Visual differential bar gage makes element service decision easier than typical pressure gages.



PRODUCT SPECIFICATIONS

Operating Pressure	S75 200 psi (14 bar) max S75D 200 psi (14 bar) max S76 200 psi (14 bar) max
Flow rate	S75 50 gpm (186 lpm) S75D 100 gpm (373 lpm) S76 18 gpm (67 lpm)
Design safety factor	2.5:1
Element collapse	100 psid (7 bar)
Assembly material	Head: Aluminum Canister: Steel
Fluid compatibility (ISO 2948)	Compatible with all petroleum, based oils, High Water Based, oil/water emulsion, and specified synthetic fluids with Flurocarbon or EPR seals (call factory)
Bypass setting	25 psid (1.77 bar) standard see reverse for other options
Weight (w/element)	S75 single 5.5 lbs S75 double 12 lbs S76 single 2.3 lbs
Temperature rating	Nitrile -40°F(-40°C) ~ 225°F (107°C) Viton -15°F(-26°C) ~ 275°F(135°C)

SPIN-ON ASSEMBLY SELECTION AND SIZING GUIDELINES

Effective filter sizing requires consideration of flow rate, viscosity (operating and cold start), fluid type and degree of filtration. When properly sized, bypass during cold start can be avoided/minimized and optimum element efficiency and life achieved. The filter assembly differential pressure values provided for sizing differ for each media code, and assume 150 SSU (32Cts) viscosity and 0.86 fluid specific gravity. Use the following steps to identify the correct high pressure filter assembly.

1. Calculate Δp coefficient at both operating and cold start viscosity:

$$\Delta p \text{ Coefficient} = \frac{\text{Actual Operating Viscosity (SSU)}}{150} \times \frac{\text{Actual S.G.}}{0.86}$$

2. Calculate actual clean filter assembly Δp at both operating and cold start viscosity:

Actual assembly clean Δp = Flow rate x Δp Coefficient x Assembly Δp factor (from sizing table)

3. Sizing Recommendations to optimize performance and permit future flexibility:

- To avoid or minimize bypass during cold start the actual assembly clean Δp calculation should be repeated for start-up conditions if cold starts are frequent.
- Actual assembly clean Δp should not exceed 5 psid at normal operating viscosity.
- If suitable assembly size is approaching the upper limit of the recommended flow rate at the desired degree of filtration consider increasing the assembly to the next larger size if a finer degree of filtration might be preferred in the future. This practice allows the future flexibility to enhance fluid cleanliness without compromising clean Δp or filter element life.
- Once a suitable filter assembly size is determined consider increasing the assembly to the next larger size to optimize filter element life and avoid bypass during cold start.
- When using water glycol or other specified synthetics we recommend increasing the filter assembly by 1~2 sizes.
- High viscosity fluid (ie gear lube ISO 220) will typically display very high viscosity as the temperature drops below 100f. For such applications avoiding bypass during start-up might not be possible.

Differential Pressure Flow Factor - ΔP/GPM (ΔBar/lpm)

Media Code	S764 assembly (20 gpm max)	S768 assembly (30 gpm max)	S754 assembly (40 gpm max)	S758 assembly (60 gpm max)	S75D4 assembly (80 gpm max)	S75D8 assembly (120 gpm max)
1M	1.210 (0.0232)	0.726 (0.0139)	0.521 (0.0100)	0.313 (0.0060)	0.261 (0.0050)	0.156 (0.0030)
3C	0.773 (0.0148)	0.464 (0.0089)	0.429 (0.0082)	0.257 (0.0049)	0.214 (0.0041)	0.129 (0.0025)
3M	0.909 (0.0174)	0.545 (0.0104)	0.0367 (0.0070)	0.220 (0.0042)	0.183 (0.0035)	0.110 (0.0021)
6M	0.695 (0.0133)	0.417 (0.0080)	0.298 (0.0057)	0.179 (0.0034)	0.149 (0.0028)	0.089 (0.0017)
10C	0.500 (0.0096)	0.300 (0.0057)	0.182 (0.0035)	0.109 (0.0021)	0.091 (0.0018)	0.055 (0.0011)
12M	0.471 (0.0090)	0.283 (0.0054)	0.168 (0.0032)	0.101 (0.0019)	0.084 (0.0016)	0.050 (0.0009)
25A	0.479 (0.0092)	0.287 (0.0055)	0.178 (0.0034)	0.107 (0.0020)	0.089 (0.0017)	0.053 (0.0010)
25C	0.444 (0.0085)	0.266 (0.0051)	0.162 (0.0031)	0.097 (0.0018)	0.081 (0.0016)	0.049 (0.0009)
25M	0.43 (0.0082)	0.258 (0.0049)	0.158 (0.0030)	0.095 (0.0017)	0.079 (0.0015)	0.047 (0.0009)
74W	0.172 (0.0033)	0.103 (0.0019)	0.063 (0.0012)	0.038 (0.0007)	0.032 (0.0006)	0.019 (0.0003)
149W	0.129 (0.0024)	0.077 (0.0014)	0.047 (0.0009)	0.028 (0.0006)	0.024 (0.0005)	0.014 (0.0002)

HY-PRO FILTRATION

Dynamic Filter Efficiency (DFE) Testing

Revolutionary test methods assure that DFE rated elements perform true to rating even under demanding variable flow and vibration conditions. Today's industrial and mobile hydraulic circuits require elements that deliver specified cleanliness under ALL circumstances. Wire mesh supports the media to ensure against cyclical flow fatigue, temperature, and chemical resistance failures possible in filter elements with synthetic support mesh. Contact your distributor or Hy-Pro for more information and published articles on DFE testing.

Media Options

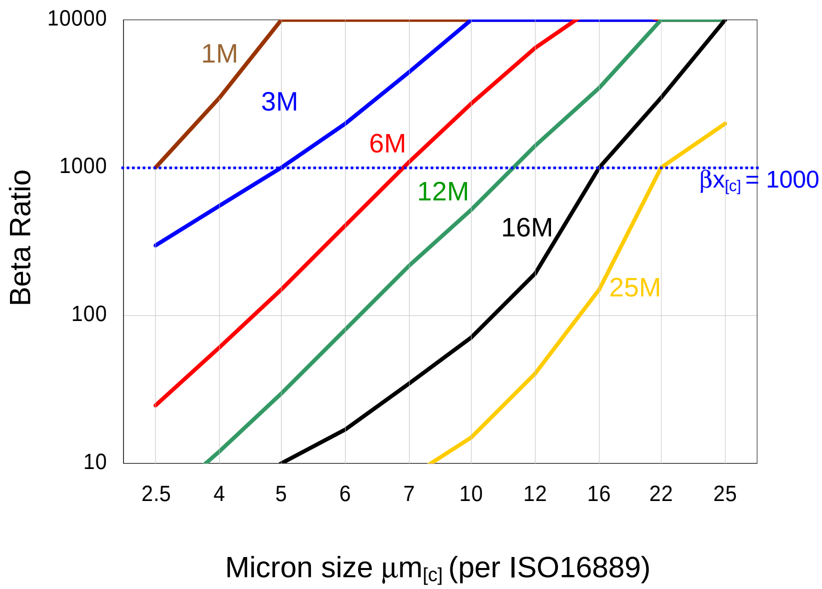
Through extensive testing we have developed media choices to handle any application. Options include G7 Dualglass, Dynafuzz (stainless fiber), and Wire mesh (stainless).

Fluid Compatibility

Petroleum based fluids, water glycol, polyol ester, phosphate ester, high water based fluids and many other synthetics. Contact us for seal material selection assistance.

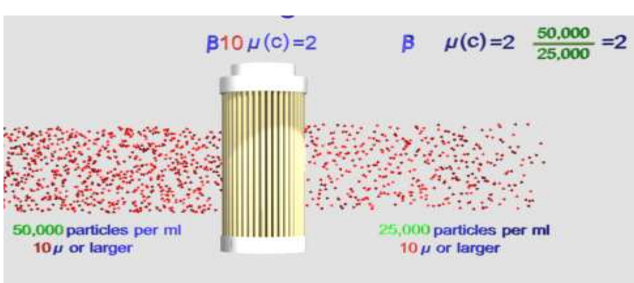
FILTER MEDIA SPECIFICATIONS

Glass Media Code Filtration Efficiency (Beta Ratio) vs Micron Size

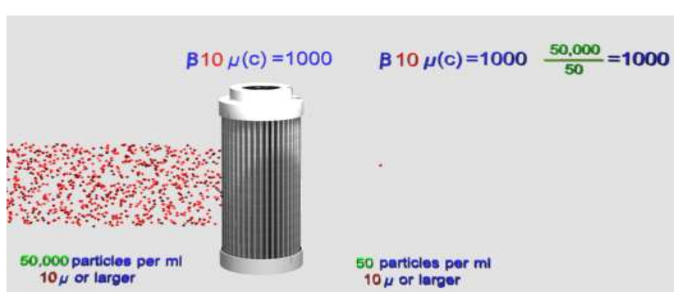


code	media description
A	"G7 Dualglass" high performance glass media combined with water removal scrim. βx[c] = 1000 (βx = 200)
C	Nominally rated "Cellulose" fiber media βx[c] = 2 (βx = 2)
M	"G7 Dualglass" is our latest generation of DFE rated, high performance glass media for use in all hydraulic fluids. βx[c] = 1000 (βx = 200)
W	Stainless steel "Wire mesh" media

Typical cellulose media performance



Hy-Pro G7 Dualglass media performance



SPIN-ON ASSEMBLY PART NUMBER GUIDE

	table 1	table 2	table 3	table 4	table 5	table 6	table 7
S							

SPIN-ON ELEMENT PART NUMBER GUIDE

	table 1		table 2		table 4	table 7
HP		**L**		**-**		

table 1	
code	**series**
75	Single head, 50 gpm, 186 lpm max
75D*	Double head, 100 gpm, 373 lpm max
76	Single head, 30 gpm, 111 lpm max

*For 75D element replacement series is HP75

table 2	
code	**length**
4	single
8	double

table 3	porting options
code	**(series availability)**
N1	BSPT 3/4" (76)
N2*	**NPT 3/4" (76)**
N3	NPT 1" (76)
N4*	**NPT 1 1/4" (75)**
N5*	NPT 1 1/2" threaded port + 2” SAE-32 Code 61 Flange (75D)
B5	1 1/4" BSP (75)
S1	SAE-8 (76)
S2	SAE-12 (76)
S4	SAE-20 (75)
S5*	SAE 1 1/2" threaded ORB port + 2” SAE-32 Code 61 Flange (75D)

Longer delivery and quantity requirements for non-standard ports

table 4		
code	**filtration rating**	**media type**
1M	$\beta 2.5_{[c]} = 1000$ ($\beta 1 = 200$)	G7 Dualglass
3M	$\beta 5_{[c]} = 1000$ ($\beta 3 = 200$)	G7 Dualglass
6M	$\beta 7_{[c]} = 1000$ ($\beta 6 = 200$)	G7 Dualglass
10C	$\beta 12_{[c]} = 2$ ($\beta 12 = 2$)	Cellulose
12A	$\beta 12_{[c]} = 1000$ ($\beta 12 = 200$)	G7+H_2O removal
12M	$\beta 12_{[c]} = 1000$ ($\beta 12 = 200$)	G7 Dualglass
25A	$\beta 22_{[c]} = 1000$ ($\beta 25 = 200$)	G7+H_2O removal
25C	$\beta 22_{[c]} = 2$ ($\beta 25 = 2$)	Cellulose
25M	$\beta 22_{[c]} = 1000$ ($\beta 25 = 200$)	G7 Dualglass
40W	40u nominal	wire mesh
74W	74u nominal	wire mesh
149W	149u nominal	wire mesh

table 5	
code	**indicator**
M	Visual Pressure Gage
E	Electrical Pressure Switch
D*	Visual Differential Indicator on right side (75,75D only)

table 6	
code	**bypass valve**
1	3 psid, 0,21 bar (suction)
2	5 psid 0,35 bar (suction)
3	15 psid, 1,06 bar
4	25 psid, 1,77 bar (standard)
5*	50 psid, 3,5 bar (S75D only)
x	No bypass

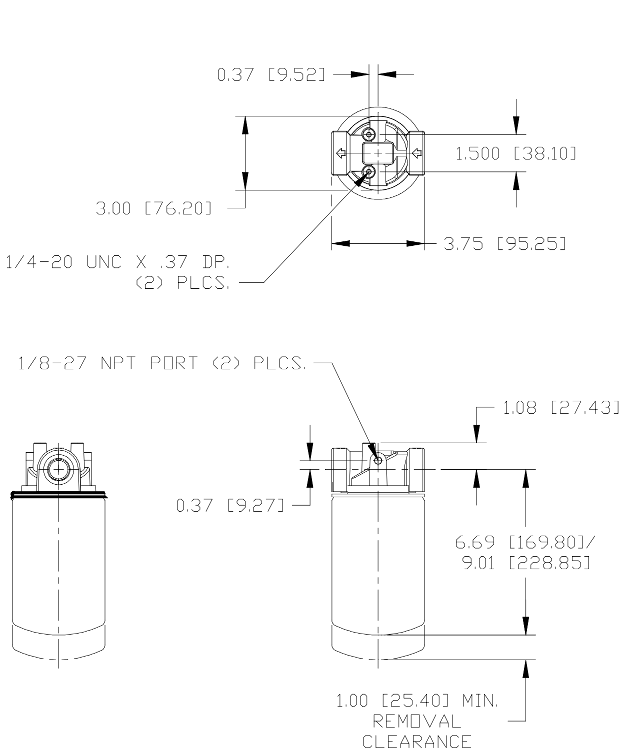
*ΔP indicators & pressure gauges are indicate at 25 psid & 25 psi respectively even if the bypass is set for 50 psid (3,5 bar) crack. S75D series only.

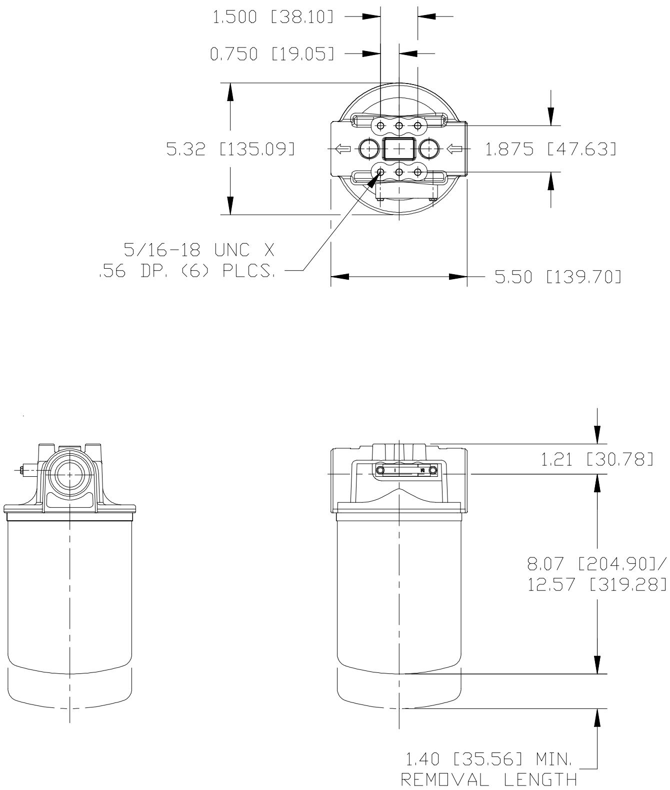
table 7	
code	**seal material**
B	Buna-Nitrile
V	Viton (75 only)

S76 INSTALLATION DRAWING

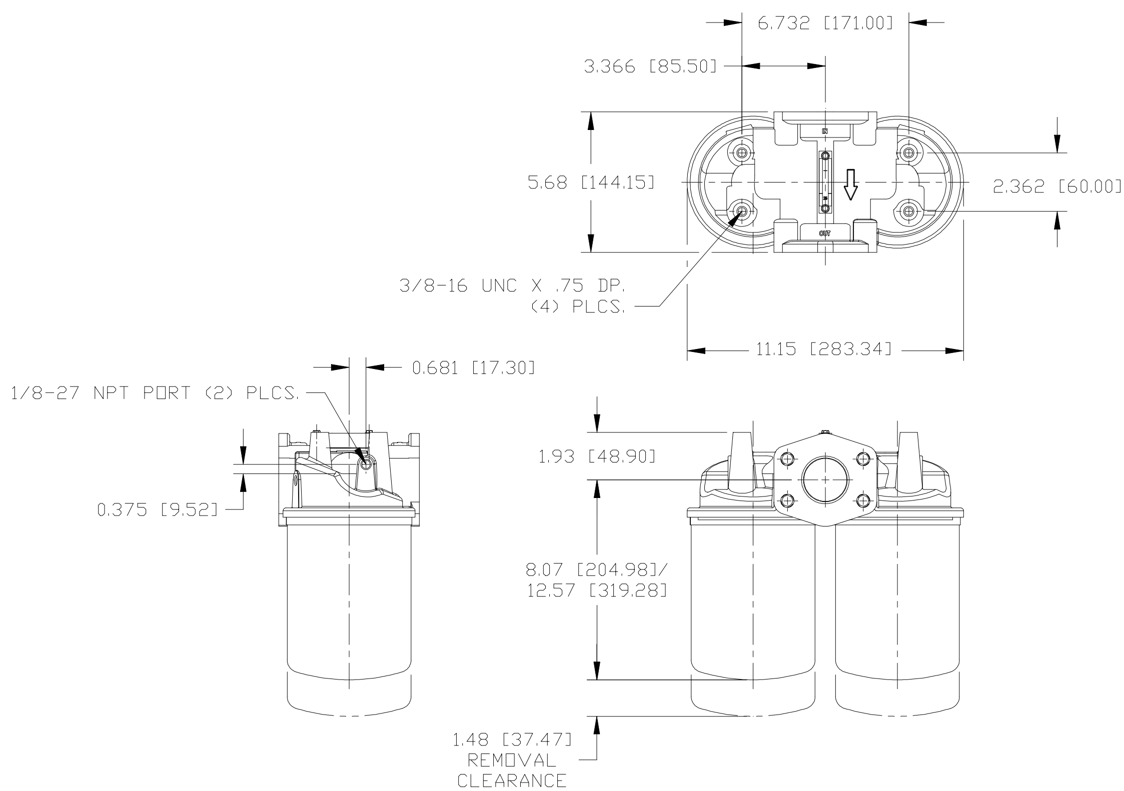
S75 INSTALLATION DRAWING

For more detailed or full-sized drawings contact Hy-Pro Filtration





S75D INSTALLATION DRAWING



HY-PRO
FILTRATION

PF2 High Pressure In-Line Filter

Featuring Hy-Pro G7 Dualglass Filter element technology

APPLICATIONS

- Hy-Pro PF2 pressure filters are ideal for protecting control valves and other sensitive components.
- Mobile applications such as waste haulers, cement mixers/pumpers, firetrucks, cranes, man lifts, etc.
- Power unit builders for pressure line.
- General industrial machine tools.
- Paper mill and sawmill.
- Primary metals.
- Power generation applications for speed control circuit.
- Automotive manufacturing machine tools.

FEATURES, BENEFITS, ADVANTAGES

DFE rated elements	G7 Dualglass and PE glass elements are DFE rated to assure performance even when exposed to the toughest hydraulic systems (See DFE literature for details)
Circumferential o-ring bowl seal	Circumferential seal on the bowl eliminates leading. (No Drips)
Low housing pressure drop	Unique internal flow paths provide low resistance to flow. (Low pressure drop)
HF2 compatible	Port to port dimension, mounting pattern, and element design meet HF2 automotive specification. (Automotive standard)
Drain plug standard	Bowl with drain plug comes standard. (No price adder)

PRODUCT SPECIFICATIONS

Pressure ratings	4000 psi (207 bar) max operating 12000 psi (638 bar) burst
Flow rate	20 gpm (75 lpm) max
Design safety factor	3:1
Element collapse	code 0: 150 psid (10 bar) code 1: 3000 psid (212 bar)
Housing material	Aluminum grade T6061
Fluid compatibility (ISO 2948)	Compatible with all petroleum, based oils, HWBF, water glycol, oil/water emulsion, and specified synthetic fluids with Viton or EPR seals (call factory)
Flow fatigue rating	2000 psi (178 bar)
Differential pressure indicator trigger	50 psid (3.5 bar) standard
Bypass valve crack	60 psid (4.2 bar) standard
Weight (w/element)	Single length bowl 3.8lb (1.7kg) Double length bowl 5.0lb (2.3kg)
Temperature rating	Buna = -40f(-40c) to 225f (107c) Viton = -15f(-26c) to 275f(135c)

PF2 FILTER ASSEMBLY PART NUMBER GUIDE

	table 1	table 2	table 3	table 4	table 5	table 6	table 7	table 8
PF2								

PF2 FILTER ELEMENT PART NUMBER GUIDE

	table 1		table 2		table 4	table 7
HP2		**L**		**-**		

table 1 code	element collapse
0	290 psid (20 bar)
1	3000 psid (200 bar)

table 2 code	element length
4	Single (4"/100mm nom)
8	Double (8"/200mm nom)

table 3 code	port type
S	SAE-12 threaded
M	Manifold top mount

table 4 code	filtration rating	media type	series
1M	$\beta 2.5_{[c]} = 1000$ ($\beta 1 = 200$)	G7 Dualglass	20
2M	$\beta 5_{[c]} = 1000$ ($\beta 3 = 200$)	G7 Dualglass	21
3M	$\beta 5_{[c]} = 1000$ ($\beta 3 = 200$)	G7 Dualglass	20
3SF	$\beta 5_{[c]} = 1000$ ($\beta 3 = 200$)	Dynafuzz	20, 21
6M	$\beta 7_{[c]} = 1000$ ($\beta 6 = 200$)	G7 Dualglass	20,21
10SF	$\beta 12_{[c]} = 1000$ ($\beta 12 = 200$)	Dynafuzz	20,21
12M	$\beta 12_{[c]} = 1000$ ($\beta 12 = 200$)	G7 Dualglass	20
15M	$\beta 17_{[c]} = 1000$ ($\beta 15 = 200$)	G7 Dualglass	21
25M	$\beta 22_{[c]} = 1000$ ($\beta 25 = 200$)	G7 Dualglass	20,21
25W	25µ nominal	Stainless mesh	20,21
40W	40µ nominal	Stainless mesh	20,21
74W	74µ nominal	Stainless mesh	20,21
149W	149µ nominal	Stainless mesh	20,21
300W	300µ nominal	Stainless mesh	20,21

table 5 code	bypass valve
5	60 psid (4.2 bar)
X	No bypass

table 6 code	indicator
M	Visual, mechanical
E	Electrical
X	No indicator port
Z	Port plugged

table 7 code	Seal
B	Buna -40f(-40c) to 225f(107c)
V	Viton -15f(-26c) to 275f(135c)

table 8 code	Special options
V	Vent plug (S port type option only)

PF2 FILTER ASSEMBLY SELECTION AND SIZING GUIDELINES

Effective filter sizing requires consideration of flow rate, viscosity (operating and cold start), fluid type, and degree of filtration. When properly sized bypass, during cold start can be avoided/minimized and optimum element efficiency and life achieved. The filter assembly differential pressure values provided for sizing differ for each media code assume 150 SSU (32cSt) viscosity and 0.86 fluid specific gravity. Use the following steps to identify the correct high pressure filter assembly.

1. Calculate Δp coefficient at both operating and cold start viscosity:

$$\Delta p \text{ Coefficient} = \frac{\text{Actual Operating Viscosity (SSU)}}{150} \times \frac{\text{Actual S.G.}}{0.86}$$

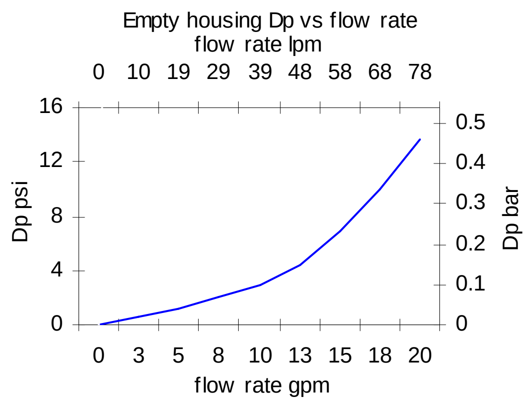
2. Calculate actual clean filter assembly Δp at both operating and cold start viscosity:

Actual assembly clean Δp = Flow rate x Δp Coefficient x Assembly Δp factor (from sizing table)

3. Sizing Recommendations to optimize performance and permit future flexibility:

- To avoid or minimize bypass during cold start actual assembly clean Δp calculation should be repeated for start-up conditions.
- Actual assembly clean Δp should not exceed 5 psid at normal operating viscosity.
- If suitable assembly size is approaching the upper limit of the recommended flow rate at the desired degree of filtration consider increasing the assembly to the next larger size if a finer degree of filtration might be preferred in the future. This practice allows the future flexibility to enhance fluid cleanliness without compromising clean Δp or filter element life.
- Consider increasing the assembly to the next larger size to optimize filter element life and avoid bypass during cold start.
- When using water glycol or other specified synthetics we recommend increasing the filter assembly by 1~2 sizes.

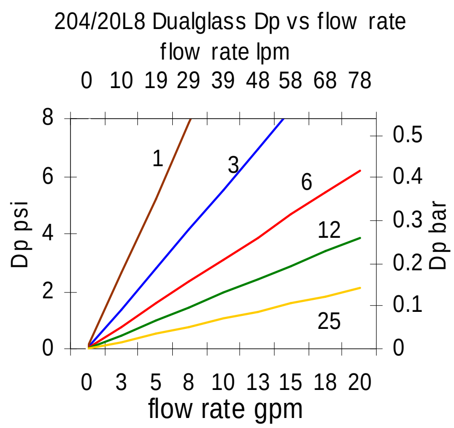
HOUSING and FILTER ELEMENT FLOW vs PRESSURE DROP and EFFICIENCY DATA

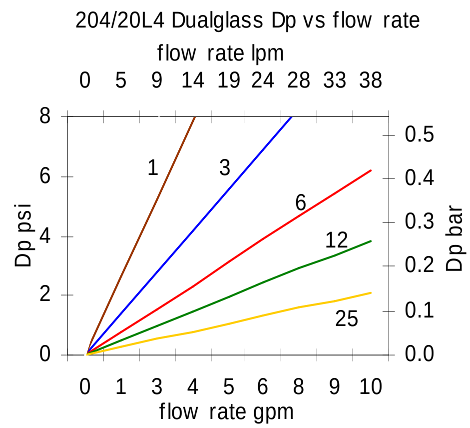


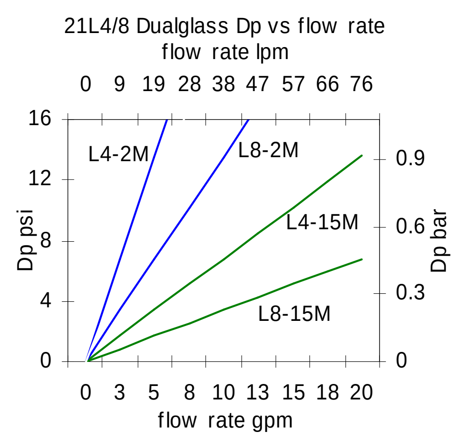
Pressure Drop Calculation

Pressure drop curves based on oil viscosity of 150 SSU, and specific gravity = 0.9. Dp across element is proportionally related to viscosity and specific gravity. For new DP use the following conversion formula:

DP element =
DP curve x Viscosity/150 x SG/0.86







HY-PRO FILTRATION

HIGH PERFORMANCE FILTER ELEMENTS - THE HEART OF A FILTER

Dynamic Filter Efficiency (DFE) Testing

Revolutionary test methods assure that DFE rated elements perform true to rating even under demanding variable flow and vibration conditions. Today's industrial and mobile hydraulic circuits require elements that deliver specified cleanliness under ALL circumstances. Wire mesh supports the media to ensure against cyclical flow fatigue, temperature, and chemical resistance failures possible in filter elements with synthetic support mesh. Contact your distributor or Hy-Pro for more information and published articles on DFE testing.

Media Options

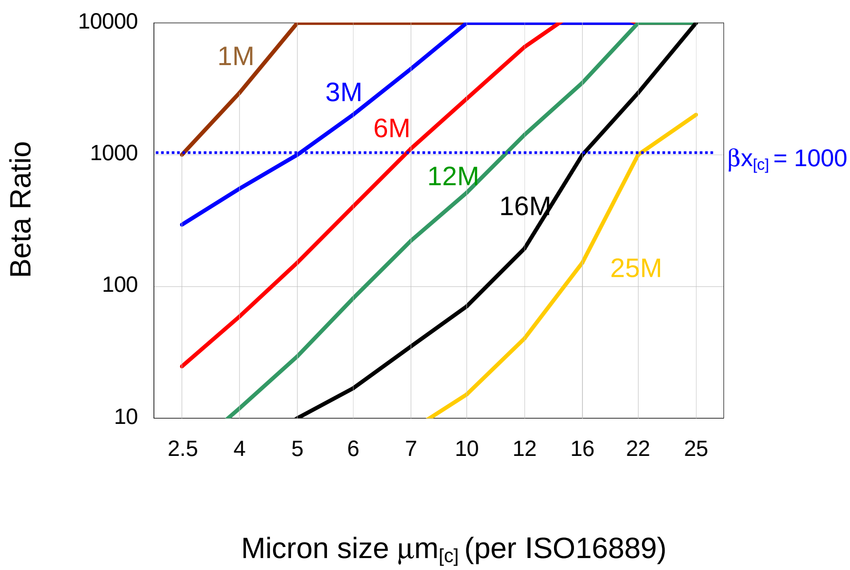
Through extensive testing we have developed media choices to handle any application. Options include G7 Dualglass, Dynafuzz (stainless fiber), and Wire mesh (stainless).

Fluid Compatibility

Petroleum based fluids, water glycol, polyol ester, phosphate ester, high water based fluids and many other synthetics. Contact us for seal material selection assistance.

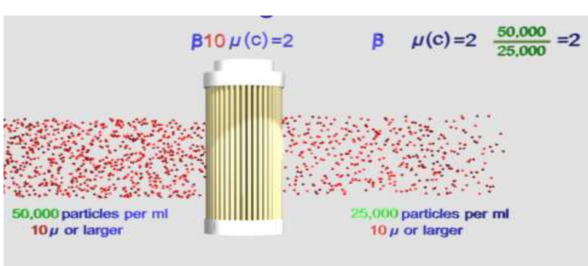
FILTER MEDIA SPECIFICATIONS

Glass Media Code Filtration Efficiency (Beta Ratio) vs Micron

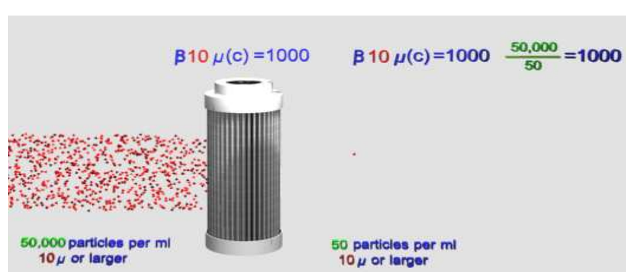


media code	media description
A	G7 Dualglass high performance media combined with water removal scrim. $\beta x_{[c]} = 1000$ ($\beta x = 200$)
M	G7 Dualglass our latest generation of DFE rated, high performance glass media for all hydraulic & lubrication fluids. $\beta x_{[c]} = 1000$ ($\beta x = 200$)
W	Stainless steel wire mesh media $\beta x_{[c]} = 2$ ($\beta x = 2$) nominally rated

Typical cellulose media performance

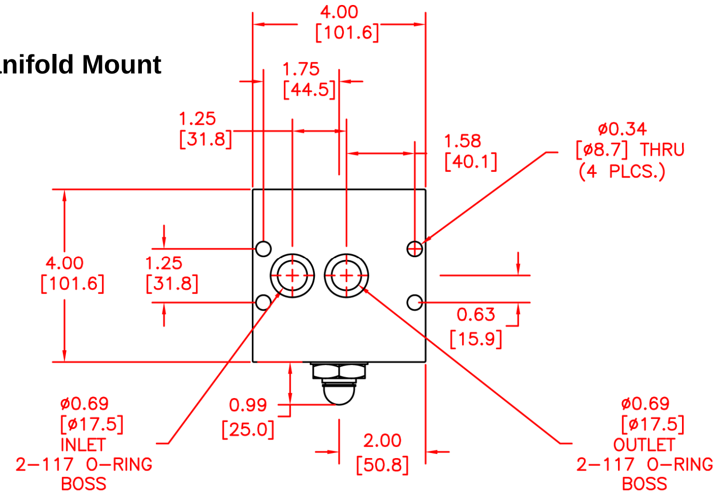


Hy-Pro G7 Dualglass media performance

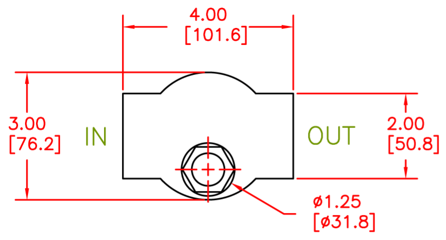


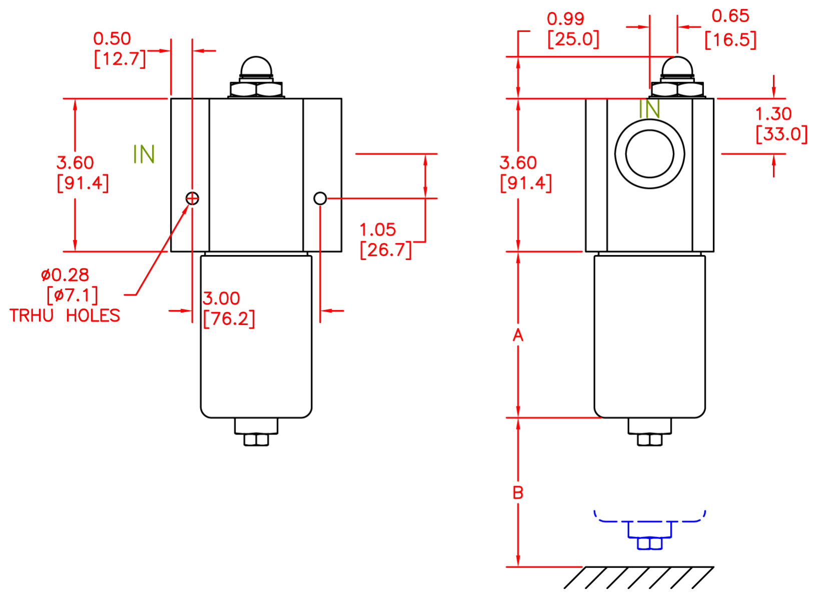
INSTALLATION DRAWING

Manifold Mount



In-Line Mount





Dim IN, Lb (mm, kg)		
	PF2*4	**PF2*8**
A	3.90 (99,1)	7.60 (193)
B	3.50 (90)	7.20 (184)
Weight	3.8 (1,7)	5.0 (2,3)

SPARE PARTS LIST

1	**Head**	**P/N**	5	**Drain plug**	**P/N**
	In-line w/bypass valve, w/indicator port	PF2HLBI		Buna o-ring	PF2DPB
	In-line w/bypass valve No indicator port	PF2HLBX		Viton o-ring	PF2DPV
	In-line No bypass valve, w/indicator port	PF2HLXI		EPR o-ring	PF2DPE
	In-line No bypass valve, No indicator port	PF2HLXX	6	**Indicator**	
	Top Mainfold w/bypass valve, w/indicator port	PF2HMBI		Visual, Buna o-ring	PFIVB
	Top Maniflod w/bypass valve, No indicator port	PF2HMBX		Visual, Viton o-ring	PFIVV
	Top Manifold No bypass valve, w/indicator port	PF2HMXI		Visual, EPR o-ring	PFIVE
	Top Manifold No bypass valve, No indicator port	PF2HMXX		Electrical, Buna o-ring	PFIEB
2	**Element** (see Element part number guide)			Electrical, Viton o-ring	PFIEV
3	**Bowl seal kit** (includes teflon back up ring)			Electrical, EPR o-ring	PFIEE
	Nitrile Buna	PF2BSKB	7	**Manifold mount kit** (includes 2 o-rings)	
	Viton Fluorocarbon	PF2BSKV		Buna o-ring	PF2SKMB
	EPR	PF2BSKE		Viton o-ring	PF2SKMV
4	**Bowl**			EPR o-ring	PF2SKME
	Single length w/drain port	PF2B1			
	Double length w/drain port	PF2B2			

HY-PRO
FILTRATION

PFH High Pressure In-Line Filter

615 bar, 8700 psi Operating Pressure
450 lpm, 120 gpm Max Flow Rate

APPLICATIONS

PFH high pressure filter assemblies are ideal for protecting sensitive components in hydraulic circuits, and should be located upstream of specific components or directly after the pressure pump (for smaller systems).

- Protect a component that is very sensitive to particulate contamination (ie servo valve) and requires clean pressurized fluid for reliable operation.
- To help meet mill/plant target cleanliness codes and required ISO 4406:1999 cleanliness standards set by hydraulic component manufacturers (warranty).
- To protect a component that is very expensive where minimizing the risk of failure and replacement cost justifies the cost of filtration.
- To protect a component or system that can affect overall mill productivity and cause downtime.

PRODUCT FEATURES

DFE rated elements (Dynamic Filter Efficiency)	G7 Dualglass media filter elements are DFE rated to assure performance even when exposed to the toughest hydraulic systems (See DFE literature for details)
Circumferential o-ring bowl seal	Circumferential seal on the bowl eliminates leaking and weeping.
Low housing pressure drop	Unique internal flow paths provide low resistance to flow. (Low pressure drop)
Coreless elements	PFH419 housings (with bypass valve) can be ordered with Hy-Pro coreless filter element for easy disposal (crush or incinerate).
Differential indicator	Available with visual, electrical, or electrical with LED (visual signal) differential indicators.

PRODUCT SPECIFICATIONS

Materials	
Head	Cast steel
Bowl	Cold forged steel
Seals	Buna or Viton
Media options	G7 Dualglass, Stainless mesh
Interior coating	Phosphate coating
Exterior coating	Powder coated
ISO standards	
ISO 2941	Collapse and burst resistance
ISO 2942	Fabrication and integrity test
ISO 2943	Material compatibility with fluids
ISO 3724	Flow fatigue test
ISO 3968	Pressure drop vs flow rate
ISO 16889	Multi-pass filter performance
DIN 24550	Nominal pressure rating
Temperature rating	Buna -40f(-40c) to 225f(107c) Viton -15f(-26c) to 275f(135c)
Fluid compatibility	Biodegradable and mineral based fluids. For high water based or specified synthetics consult factory

PFH FILTER ASSEMBLY SIZING & OPERATING PRESSURE GUIDELINES

PFH131 Series

Media code	Bowl length	Max flow rate* gpm (lpm)	Port size	Assembly Δp factor* psid / gpm	Max operating Pressure, fatigue rating
3M		5.5 (20.4)		2.751	**psi (bar)**
6M	4	6.2 (23.1)		2.433	4570 psi, 315 bar
10M	(single)	9.6 (36.1)	3/4"	1.557	10^7 pressure cycles
25M		14.4 (54.0)		1.042	6500 psi, 450 bar
25W		20.8 (78.1)		0.72	10^4 pressure cycles
3M		8.9 (33.5)		1.68	**psi (bar)**
6M	8	12.4 (46.5)		1.21	4570 psi, 315 bar
10M	(double)	15.3 (57.4)	3/4"	0.98	10^7 pressure cycles
25M		22.0 (82.5)		0.682	6500 psi, 450 bar
25W		27.3 (102.3)		0.55	10^4 pressure cycles

*Max flow rate and Δp factor assumes υ = 150 sus, 32 Centistokes. See Δp viscosity conversion formula for viscosity

PFH152 Series

Media code	Bowl length	Max flow rate* gpm (lpm)	Port size	Assembly Δp factor* psid / gpm	Max operating Pressure, fatigue rating
3M		9.4 (35.4)		1.59	**psi (bar)**
6M	4	11.7 (43.9)		1.28	4570 psi, 315 bar
10M	(single)	17.8 (66.8)	1"	0.842	10^7 pressure cycles
25M		24.3 (91.0)		0.618	6500 psi, 450 bar
25W		36.6 (137.2)		0.41	10^4 pressure cycles
3M		16.8 (63.0)		0.893	**psi (bar)**
6M	8	20.5 (77.1)		0.73	4570 psi, 315 bar
10M	(double)	27.4 (102.6)	1"	0.548	10^7 pressure cycles
25M		33.9 (127.3)		0.442	6500 psi, 450 bar
25W		48.9 (183.2)		0.307	10^4 pressure cycles

*Max flow rate and Δp factor assumes υ = 150 sus, 32 Centistokes. See Δp viscosity conversion formula for viscosity

PFH419 Series

Media code	Bowl length	Max flow rate* gpm (lpm)	Port size	Assembly Δp factor* psid / gpm	Max operating Pressure, fatigue rating
3M		19 (71.2)		0.809	**psi (bar)**
6M	4	23 (86.2)	SAE-20	0.627	6090 psi, 420 bar
10M	(single)	26 (97.5)	1 1/4"	0.46	10^7 pressure cycles
25M		32 (120)		0.335	8700 psi, 615 bar
25W		45 (168.7)		0.185	10^4 pressure cycles
3M		37 (138.7)		0.52	**psi (bar)**
6M	8	42 (157.5)	SAE-20	0.383	6090 psi, 420 bar
10M	(double)	50 (187.5)	1 1/4"	0.28	10^7 pressure cycles
25M		58 (217.5)		0.185	8700 psi, 615 bar
25W		72 (270)		0.119	10^4 pressure cycles
3M		60 (225)		0.42	**psi (bar)**
6M	13	66 (247.5)	SAE-20	0.308	6090 psi, 420 bar
10M	(triple)	74 (277.5)	1 1/4"	0.175	10^7 pressure cycles
25M		90 (337.5)	SAE-24	0.146	8700 psi, 615 bar
25W		118 (442.5)	1 1/2"	0.105	10^4 pressure cycles

*Max flow rate and Δp factor assumes υ = 150 sus, 32 Centistokes. See Δp viscosity conversion formula for viscosity

PFH FILTER ASSEMBLY SIZING & OPERATING PRESSURE GUIDELINES

Effective filter sizing requires consideration of flow rate, viscosity (operating and cold start), fluid type and degree of filtration. When properly sized, bypass during cold start can be avoided/minimized and optimum element efficiency and life achieved. The filter assembly differential pressure values provided for sizing differ for each media code, and assume 150 SSU (32 cSt) viscosity and 0.86 fluid specific gravity. Use the following steps to identify the correct high pressure filter assembly.

1. Calculate Δp coefficient at both operating and cold start viscosity:

$$\Delta p \text{ Coefficient} = \frac{\text{Actual Operating Viscosity (SSU)}}{150} \times \frac{\text{Actual S.G.}}{0.86}$$

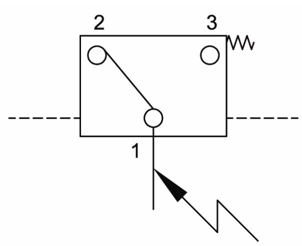
2. Calculate actual clean filter assembly Δp at both operating and cold start viscosity:

Actual assembly clean Δp = Flow rate x Δp Coefficient x Assembly Δp factor (from sizing table)

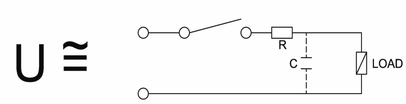
3. Sizing Recommendations to optimize performance and permit future flexibility:

- To avoid or minimize bypass during cold start the actual assembly clean Δp calculation should be repeated for start-up conditions if cold starts are frequent.
- Actual assembly clean Δp should not exceed 15 psid at normal operating viscosity.
- If suitable assembly size is approaching the upper limit of the recommended flow rate at the desired degree of filtration consider increasing the assembly to the next larger size if a finer degree of filtration might be preferred in the future. This practice allows the future flexibility to enhance fluid cleanliness without compromising clean Δp or filter element life.
- Once a suitable filter assembly size is determined consider increasing the assembly to the next larger size to optimize filter element life and avoid bypass during cold start.
- When using water glycol or other specified synthetics we recommend increasing the filter assembly by 1~2 sizes.
- High viscosity fluid (ie gear lube ISO 220) will typically display very high viscosity as the temperature drops below 100f. For such applications avoiding bypass during start-up might not be possible.

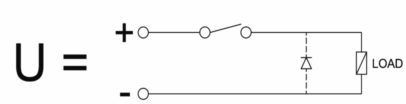
ELECTRICAL + LED, ELECTRICAL DIFFERENTIAL PRESSURE INDICATOR INFORMATION



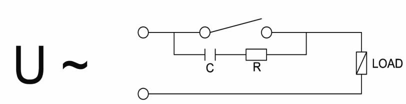
- Indication pressure - 73 psid (5.18 bar)
- Switching voltage - max 120 V AC / 175 V DC
- Switching current - max 0,17 A AC / 0,25 A DC
- Switching power - max 3,5 VA AC / 5 W DC
- Contact type - Change-over
- Electrical protection - IP 65



- Current limiter for DC and AC voltage. If loads are connected over long distances a protective resistor should be connected in series in order to limit the current.



- Spark suppression in DC applications. The contacts of reed switches open very fast which causes voltage peaks to be induced when switching off inductive loads (relays, lifting magnets, solenoids). The self-induction currents are short-circuited by connecting a diode in parallel to the inductive load



- Spark suppression in AC applications. In AC applications a diode connected in parallel to the load is not sufficient. RC elements should be connected in parallel to the reed switch.

PFH FILTER ASSEMBLY PART NUMBER GUIDE

	table 1	table 2	table 3	table 4	table 5	table 6	table 7	table 8	table 9	table 9
PFH									Option D	Option N

PFH FILTER ELEMENT PART NUMBER GUIDE

	table 1	table 2		table 3		table 5	table 6
HP			**L**		**-**		

Bold denotes standard product option. Non-standard options are subject to longer than standard lead time

table 1 code	Series and max operating pressure
131	6000 psi, 450 bar*
152	6000 psi, 450 bar*
419	8700 psi, 600 bar*

*See sizing / pressure guidelines

table 2 code	element collapse
N	450 psid
H	3000 psid
C*	250 psid

*coreless element PFH419 only

table 3 code	element length
4	single
8	double
13*	triple

*PFH419 series only

table 4 code	Port type	series availability
B1	G 1/2 BSPP threaded	PFH131
B2	G 3/4 BSPP threaded	PFH131, PFH152
B3	G1 BSPP threaded	PFH152
B4	G1 1/4 BSPP threaded	PFH419
F1	SAE-20 Flange (Code 62)	**PFH419**
S1	SAE-8 threaded	PFH131
S2	SAE-12 threaded	**PFH131,** PFH152
S3	SAE-16 threaded	**PFH152**
S4	SAE-20 threaded	**PFH419**
S5	SAE-24 threaded	PFH419

table 5 code	Media selection
1M	$\beta 2.5_{[c]} = 1000$, $\beta 1 = 200$
3M	$\beta 5_{[c]} = 1000$, $\beta 3 = 200$
6M	$\beta 7_{[c]} = 1000$, $\beta 6 = 200$
10M	$\beta 12_{[c]} = 1000$, $\beta 12 = 200$
25M	$\beta 22_{[c]} = 1000$, $\beta 25 = 200$
25W	25u nominal mesh media
40W	40u nominal mesh media
74W	74u nominal mesh media
149W	149u nominal mesh media

table 6 code	Seal
B	Buna -40f(-40c) to 225f(107c)
V	Viton -15f(-26c) to 275f(135c)

table 7 code	Bypass valve
7	102 psid bypass
X*	No bypass

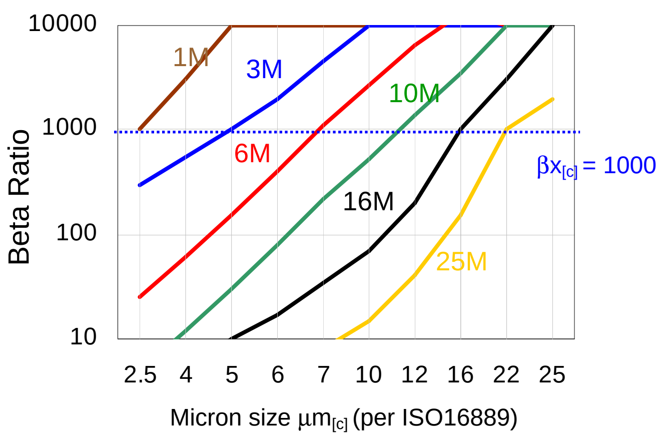
*No bypass "X" option only recommended with "H" element collapse rating (table 2)

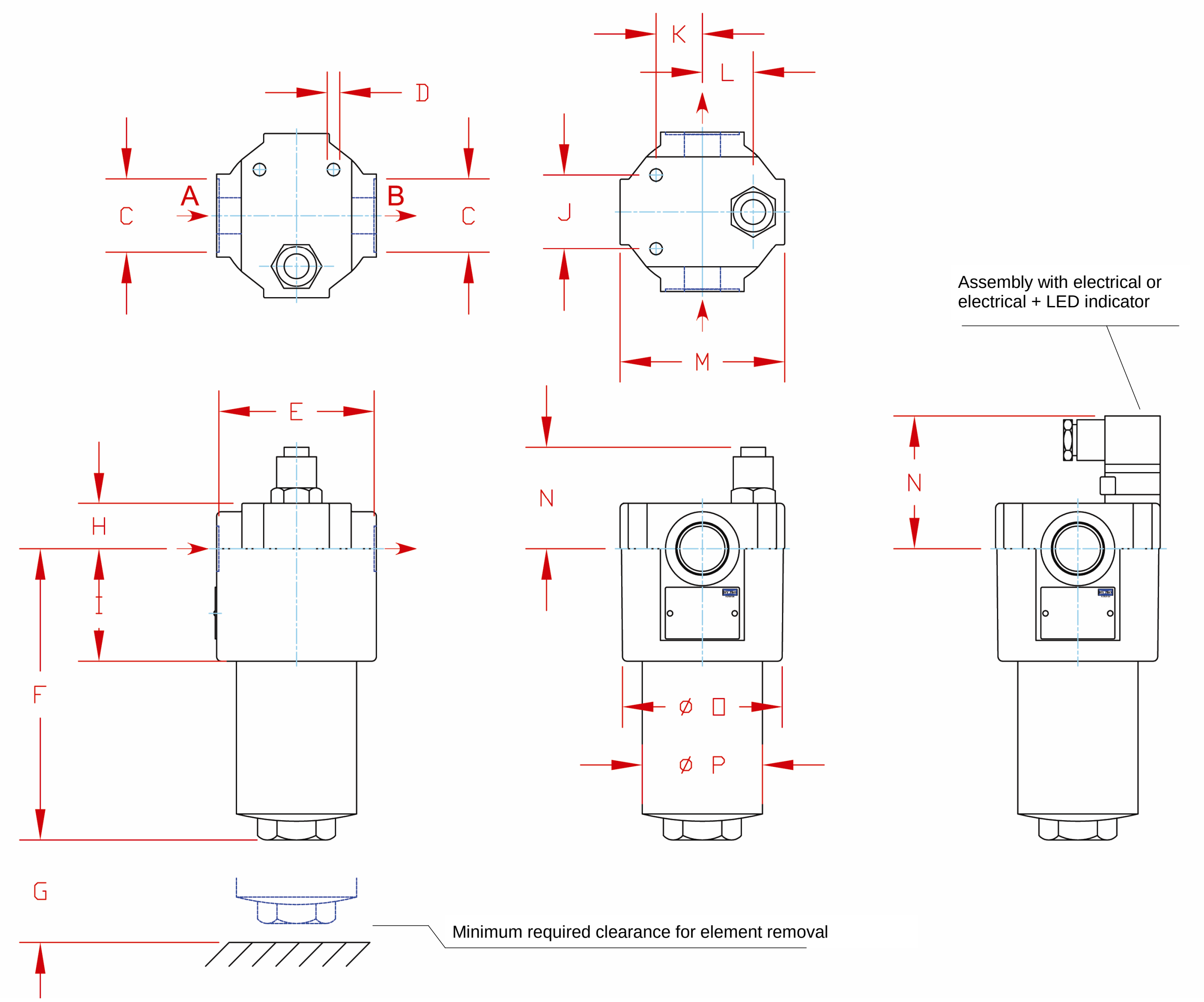
table 8 code	Δp indicator
V	Visual, mechanical
E	Electrical
L	Eletrical + LED visual
Z	Indicator port plugged

table 9 code	Special options (not required)
D	Bowl drain w/plug
N	Nickel coated for high straight water applications (call factory)

FILTER MEDIA SELECTION GUIDE

media code	media description
A	G7 Dualglass high performance media combined With water removal scrim. $\beta x_{[c]} = 1000$ ($\beta x = 200$)
M	G7 Dualglass our latest generation of DFE rated, high performance glass media for hydraulic & lubrication flulids. $\beta x_{[c]} = 1000$ ($\beta x = 200$)
W	Stainless steel wire mesh media $\beta x_{[c]} = 2$ ($\beta x = 2$)



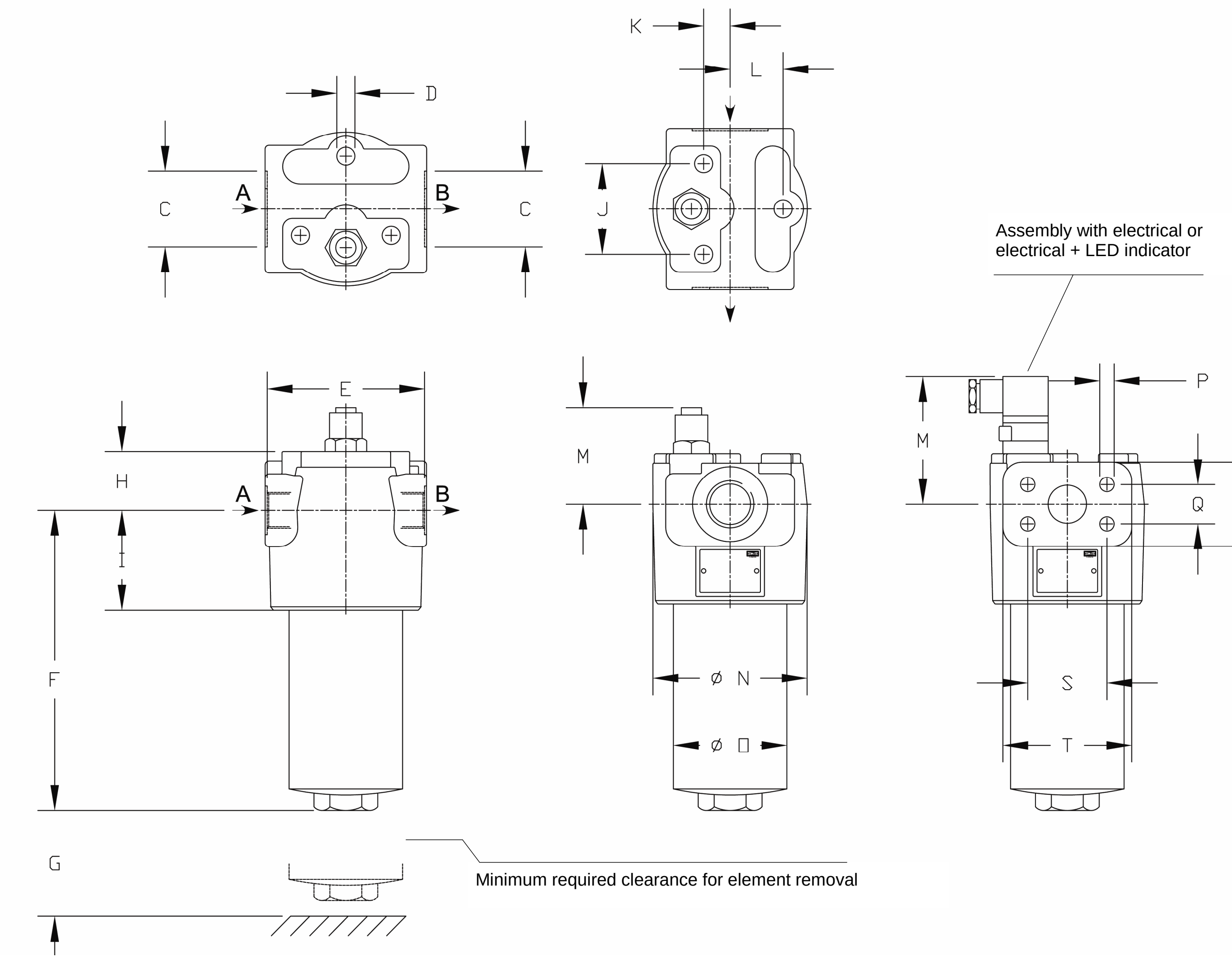


	PFH131*4 IN (mm)	PFH131*8 IN (mm)
A/B	G 1/2, G3/4, SAE-8, SAE-12 thread	G 1/2, G3/4, SAE-8, SAE-12 thread
C	1.653 (41,5)	1.653 (41,5)
D	M8 x 0.472 (11,98) depth	M8 x 0.472 (11,98) depth
E	3.310 (84,08)	3.310 (84,08)
F	6.225 (158,12)	10.008 (254,2)
G	2.167 (55,04)	2.167 (55,04)
H	0.965 (24,51)	0.965 (24,51)
I	2.403 (61,03)	2.403 (61,03)
J	1.576 (40,03)	1.576 (40,03)
K	0.985 (25,02)	0.985 (25,02)
L	1.084 (27,53)	1.084 (27,53)
M	3.507 (89,07)	3.507 (89,07)
N	Optical 2.167 (55,04) Electrical 2.837 (72,05)	Optical 2.167 (55,04) Electrical 2.837 (72,05)
O	3.349 (85,06)	3.349 (85,06)

1	**Element (see Element part number guide)**	**Part number**
2	**Bowl Seal kit**	
	Nitrile NBR	PFH131SKB
	Fluorocarbon	PFH131SKV
3	**Bowl**	
	Single length	PFB131
	Single length with drain port	PFB131D
	Double length	PFB132
	Double length with drain port	PFB132D
4	**Indicator**	
	Visual indicator, Buna o-ring	PFHIVB
	Visual, Viton o-ring	PFHIVV
	Electrical, Buna o-ring	PFHIEB
	Electrical, Viton o-ring	PFHIEV
	Electrical + LED visual, Buna o-ring	PFIHILB
	Electrical + LED visual, Viton o-ring	PFHILV

	PFH131*4 Lbs (kg)	PFH131*8 Lbs (kg)
Weight	8.6 (3.90)	11.3 (5.13)

PFH152 INSTALLATION DRAWING AND SPARE PARTS LIST



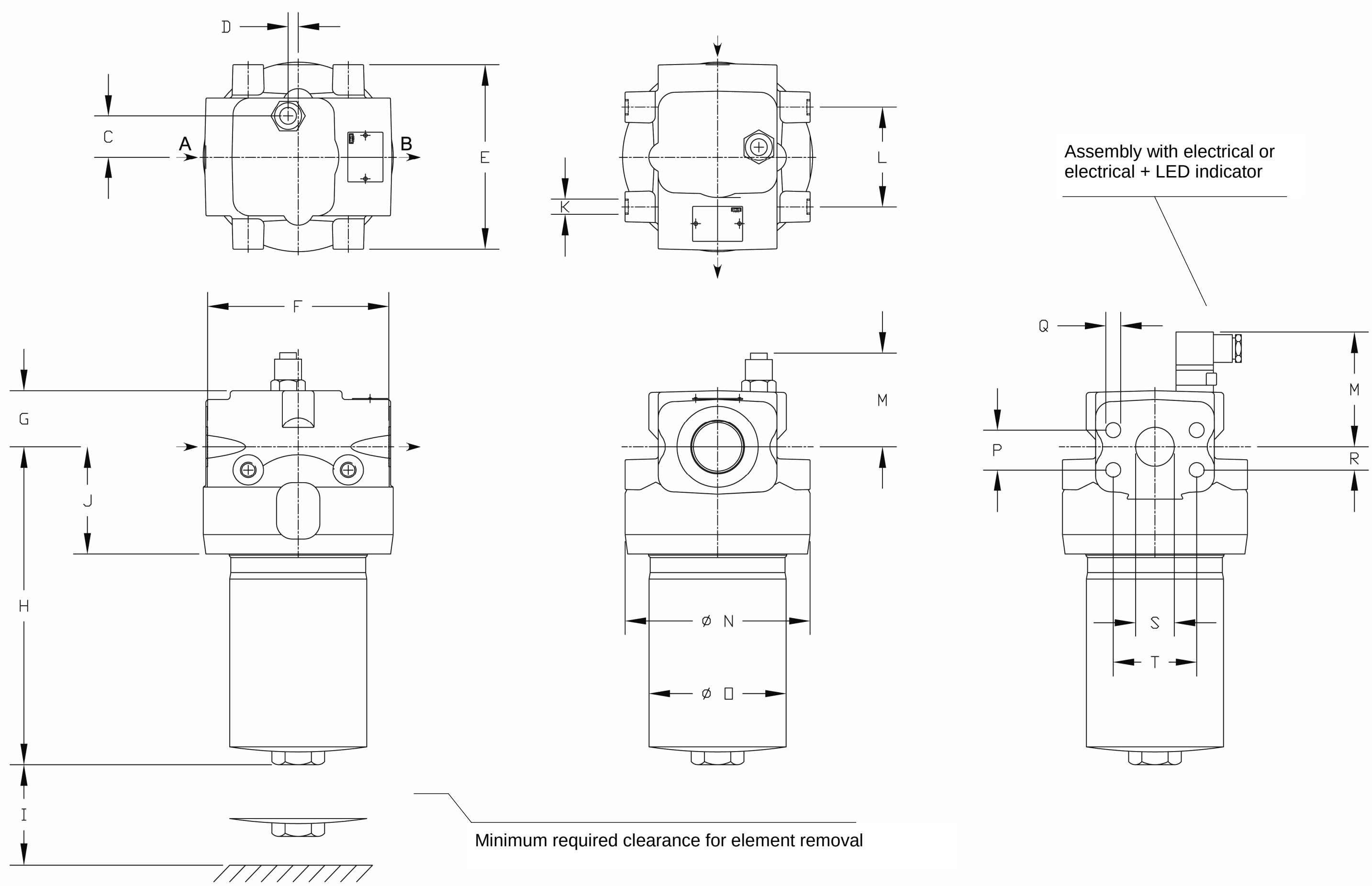
	PFH152*4 IN (mm)	PFH152*8 IN (mm)
A/B	G3/4, G1, SAE-12, SAE-16 thread, SAE-16 Code 62	G3/4, G1, SAE-12, SAE-16 thread, SAE-16 Code 62
C	1.950 (49,53)	1.950 (49,53)
D	M10 X 0.472 (11,98) depth	M10 X 0.472 (11,98) depth
E	4.094 (103,99)	4.094 (103,99)
F	8.819 (224,0)	11.220 (284,99)
G	2.756 (70,00)	2.756 (70,00)
H	2.953 (75,00)	2.953 (75,00)
I	2.598 (65,99)	2.598 (65,99)
J	2.362 (59,99)	2.362 (59,99)
K	0.689 (17,50)	0.689 (17,50)
L	1.378 (35,00)	1.378 (35,00)
M	Optical 2.677 (67,99) Electrical 3.327 (84,51)	Optical 2.677 (67,99) Electrical 3.327 (84,51)
N	4.016 (102,01)	4.016 (102,01)
O	2.953 (75,00)	2.953 (75,00)
P	Thread ?? (??)	Thread ?? (??)
Q	1.093 (27,76)	1.093 (27,76)
R	2.095 (53,21)	2.095 (53,21)
S	2.250 (57,15)	2.250 (57,15)
T	3.325 (84,45)	3.325 (84,45)

1	**Element (see Element part number guide)**	**Part number**
2	**Bowl Seal kit**	
	Buna	PFH152SKB
	Viton	PFH152SKV
3	**Bowl**	
	Single length	PFB1521
	Single length with drain port	PFB1521D
	Double length	PFB1522
	Double length with drain port	PFB1522D
4	**Indicator**	
	Visual indicator, Buna o-ring	PFH152IVB
	Visual, Viton o-ring	PFH152IVV
	Electrical, Buna o-ring	PFH152IEB
	Electrical, Viton o-ring	PFH152IEV
	Electrical + LED visual, Buna o-ring	PFH152ILB
	Electrical + LED visual, Viton o-ring	PFH152ILV

	PFH152*4 Lbs (kg)	PFH152*8 Lbs (kg)
Weight	15.5 (7.04)	18.5 (8.40)

HY-PRO FILTRATION

PFH419 INSTALLATION DRAWING AND SPARE PARTS LIST



	PFH419*4 IN (mm)	PFH419*8 IN (mm)	PFH419*13 IN (mm)
A/B	G1 1/4, SAE-20, SAE-24 thread SAE-20 code 62	G1 1/4, SAE-20, SAE-24 thread SAE-20 code 62	G1 1/4, SAE-20, SAE-24 thread SAE-20 code 62
C	1.30 (33,02)	1.30 (33,02)	1.30 (33,02)
D	0.32 (8,12)	0.32 (8,12)	0.32 (8,12)
E	5.83 (148,08)	5.83 (148,08)	5.83 (148,08)
F	5.71 (145,03)	5.71 (145,03)	5.71 (145,03)
G	1.77 (44,95)	1.77 (44,95)	1.77 (44,95)
H	10.05 (255,27)	12.57 (319,28)	16.55 (420,37)
I	3.15 (80,01)	3.15 (80,01)	3.15 (80,01)
J	3.39 (86,11)	3.39 (86,11)	3.39 (86,11)
K	M12 x 18mm depth	M12 x 18mm depth	M12 x 18mm depth
L	3.15 (80,01)	3.15 (80,01)	3.15 (80,01)
M	Optical 2.96 (75,18) Electrical 3.62 (91,95)	Optical 2.96 (75,18) Electrical 3.62 (91,95)	Optical 2.96 (75,18) Electrical 3.62 (91,95)
N	5.99 (152,15)	5.99 (152,15)	5.99 (152,15)
O	4.29 (108,96)	4.29 (108,96)	4.29 (108,96)
P	1.25 (31,75)	1.25 (31,75)	1.25 (31,75)
Q	M14 x 22mm depth	M14 x 22mm depth	M14 x 22mm depth
R	0.73 (18,54)	0.73 (18,54)	0.73 (18,54)
S	1.22 (30,99)	1.22 (30,99)	1.22 (30,99)
T	2.63 (66,80)	2.63 (66,80)	2.63 (66,80)

1	**Element**	**See element p/n**
2	**Bowl Seal kit**	
	Buna	PFH419SKB
	Viton	PFH419SKV
3	**Bowl**	
	Single length	PFB4191
	Single length w/drain port	PFB4191D
	Double length	PFB4192
	Double length w/drain port	PFB4192D
	Triple length	PFB4193
	Triple length w/drain port	PFB4193D
4	**Indicator**	
	Visual indicator, Buna	PFHIVB
	Visual, Viton	PFHIVV
	Electrical, Buna seal	PFHIEB
	Electrical, Viton	PFHIEV
	Electrical + LED, Buna	PFHILB
	Electrical + LED, Viton	PFHILV

	PFH419*4 Lbs (kg)	PFH419*8 Lbs (kg)	PFH419*13 Lbs (kg)
Weight	35.5 (16.12)	39.0 (17.71)	45.4 (20.61)

PF4 High Pressure Base Mounted Filter

Hy-Pro G7 Dualglass DFE rated high performance filter elements.

APPLICATIONS

Ideal for protecting sensitive components in hydraulic circuits, and should be located upstream of specific components or directly after the pressure pump.

- Protect a component that is very sensitive to particulate contamination (ie servo valve) and requires clean pressurized fluid for reliable operation.
- To help meet mill/plant target cleanliness codes and required ISO 4406:1999 cleanliness standards set by hydraulic component manufacturers (warranty).
- To protect a component that is very expensive where minimizing the risk of failure and replacement cost justifies the cost of filtration.
- To protect a component or system that can affect overall mill productivity and cause downtime.

PF4 FEATURES

DFE rated elements	G7 Dualglass and PE glass elements are DFE rated to assure performance even when exposed to the toughest hydraulic systems (See DFE literature for details)
Base mount Top loading	Element is removed by removing housing cover, minimizing mess, no heavy bowl to lift, ease of service
Low housing pressure drop	Unique internal flow paths provide low resistance to flow. (Low pressure drop)
Coreless elements	PF4 housings (with bypass valve option) can be ordered with Hy-Pro coreless filter element for easy disposal (crush or incinerate). Retro-fit kits available to convert conventional housings to coreless.
HF4 compatible	Port to port dimension, mounting pattern, and element design meet HF4 automotive specification. (Automotive standard)
High flow capacity	Triple length option allows for flow rates up to 150 gpm for select media

PRODUCT SPECIFICATIONS

Pressure ratings	5000 psi (354 bar) max operating 13500 psi (931 bar) burst
Flow rate	150 gpm (560 lpm) max with P port
Element collapse	code K: 150 psid (10 bar) code K3: 3000 psid (212 bar) code KC: 150 psid (10 bar) * *coreless element series
Temperature rating	Buna -45°F(-43°C) to 250°F(121°C) Viton -15°F(-26°C) to 275°F(135°C)
Housing material	Head and Cover: Ductile iron Bowl: Seamless steel tubing
Fluid compatibility (ISO 2948)	Compatible with all petroleum, based oils, HWBF, water glycol, oil/water emulsion, and specified synthetic fluids with Flurocarbon or EPR seals (call factory)
Flow fatigue rating	3500 psi (238 bar)
Differential pressure indicator trigger	Visual, electrical, combination, Thermal lock-out (see options)
Bypass valve crack	50/90 psid (3.5/6.4 bar) or none
Weight (no element)	Single length bowl 60 lbs (27 kg) Double length bowl 83 lbs (38 kg) Triple length bowl 110 lbs (50 kg)

HY-PRO FILTRATION

PF4 SPARE PARTS & ELEMENT SERVICE INSTRUCTIONS

1. Stop and /or isolate filter from system pressure.
2. Relieve pressure in filter line.
3. Drain filter housing to avoid cross contamination.
4. Remove the cover.
5. Remove the element from the housing.
6. Inspect filter housing o-ring seal for damage.
7. If damaged replace seal kit.
8. Inspect new element for damage.
9. Lubricate new element seals and install element.
10. Replace cover ,tighten to 5-10 ft.lbs. Torque.

1	**Element (see Element number guide)**	**p/n**
2	**Seal Kit**	
	Nitrile NBR	PF4SKB
	Fluorocarbon	PF4SKV
3	**Replacement Bowl Kits**	
	Single length code 9	PF4B9
	Double length code 18	PF4B18
	Triple length code 27	PF4B27

FILTER ASSEMBLY SIZING & OPERATING PRESSURE GUIDELINES

Effective filter sizing requires consideration of flow rate, viscosity (operating and cold start), fluid type, degree of filtration. When properly sized bypass during cold start can be avoided/minimized and optimum element efficiency and life achieved. The filter assembly differential pressure values provided for sizing differ for each media code, and assume 150 SSU (32Cts) viscosity and 0.86 fluid specific gravity. Use the following steps to identify the correct high pressure filter assembly.

1. Calculate Δp coefficient at both operating and cold start viscosity:

$$\Delta p \text{ Coefficient} = \frac{\text{Actual Operating Viscosity (SSU)}}{150} \times \frac{\text{Actual S.G.}}{0.86}$$

2. Calculate actual clean filter assembly Δp at both operating and cold start viscosity:

Actual assembly clean Δp = Flow rate x Δp Coefficient x (Empty filter housing Δp factor + Element Δp factor)

3. Sizing Recommendations to optimize performance and permit future flexibility:

- To avoid or minimize bypass during cold start the actual assembly clean Δp calculation should be repeated for start-up conditions if cold starts are frequent.
- Ideal actual assembly clean Δp should not exceed 15 psid at normal operating viscosity.
- If suitable assembly size is approaching the upper limit of the recommended flow rate at the desired degree of filtration consider increasing the assembly to the next larger size if a finer degree of filtration might be preferred in the future. This practice allows the future flexibility to enhance fluid cleanliness without compromising clean Δp or filter element life.
- Once a suitable filter assembly size is determined consider increasing the assembly to the next larger size to optimize filter element life and avoid bypass during cold start.
- When using water glycol or other specified synthetics we recommend increasing the filter assembly by 1~2 sizes.
- High viscosity fluid (ie gear lube ISO 220) will typically display very high viscosity as the temperature drops below 100^{o}F. For such applications avoiding bypass during start-up might not be possible.

PF4K**, PF4K1**, PF4KC** Empty Housing & Filter Element Δ Pressure Factor

Media code	Element Length	*Max recommended flow rate gpm (lpm)	*Empty Housing ΔP by port factor psid / gpm (bar / lpm)	*Filter Element Δp factor psid / gpm	*Filter Element Δp factor bar / lpm
1M	9 (single)	41 (152)	M1 = 0.12 (0.0021) C1, F1, N1, S1 = 0.10 (0.0018)	0.252	0.0046
3M		57 (215)		0.141	0.0026
6M		66 (250)		0.105	0.0019
12M		72 (270)		0.088	0.0016
16M		78 (292)		0.072	0.0013
25M		93 (349)		0.041	0.0008
**W		104 (393)		0.023	0.0004
1M	18 (double)	55 (207)	M1 = 0.12 (0.0021) C1, F1, N1, S1 = 0.10 (0.0018)	0.151	0.0028
3M		73 (275)		0.084	0.0015
6M		82 (310)		0.061	0.0012
12M		89 (334)		0.048	0.0009
16M		92 (345)		0.043	0.0008
25M		104 (390)		0.024	0.0005
**W		130 (487)		0.013	0.0003
1M	27 (triple)	66 (249)	M1 = 0.12 (0.0021) C1, F1, N1, S1 = 0.10 (0.0018)	0.106	0.0020
3M		82 (310)		0.061	0.0012
6M		91 (342)		0.044	0.0008
12M		97 (365)		0.034	0.0006
16M		103 (385)		0.026	0.0005
25M		109 (410)		0.017	0.0004
**W		150 (562)		0.010	0.0002

*Max flow rate and Δp factor assumes υ = 150 sus, 32 Centistokes. See Δp viscosity conversion formula for viscosity

PF4K3** Empty Housing & Filter Element Δ Pressure Factor (Non-bypass housing)

Media code	Element Length	Max recommended flow rate* gpm (lpm)	*Empty Housing ΔP by port factor psid / gpm (bar / lpm)	*Filter Element Δp factor psid / gpm	*Filter Element Δp factor bar / lpm
1M	9 (single)	27 (102)	M1 = 0.12 (0.0021) C1, F1, N1, S1 = 0.10 (0.0018)	0.428	0.0078
3M		42 (156)		0.239	0.0044
6M		50 (188)		0.178	0.0032
12M		55 (209)		0.149	0.0027
25M		78 (294)		0.071	0.0013
**W		104 (393)		0.023	0.0004
1M	18 (double)	40 (149)	M1 = 0.12 (0.0021) C1, F1, N1, S1 = 0.10 (0.0018)	0.256	0.0047
3M		57 (215)		0.142	0.0026
6M		67 (252)		0.104	0.0019
12M		74 (278)		0.082	0.0015
25M		93 (349)		0.041	0.0007
**W		130 (487)		0.013	0.0002
1M	27 (triple)	50 (187)	M1 = 0.12 (0.0021) C1, F1, N1, S1 = 0.10 (0.0018)	0.181	0.0033
3M		67 (252)		0.103	0.0019
6M		77 (289)		0.074	0.0013
12M		84 (316)		0.058	0.0011
25M		100 (377)		0.029	0.0005
**W		150 (562)		0.010	0.0002

*Max flow rate and Δp factor assumes υ = 150 sus, 32 Centistokes. See Δp viscosity conversion formula for viscosity

Dynamic Filter Efficiency (DFE) Testing

Revolutionary test methods assure that DFE rated elements perform true to rating even under demanding variable flow and vibration conditions. Today's industrial and mobile hydraulic circuits require elements that deliver specified cleanliness under ALL circumstances. Wire mesh supports the media to ensure against cyclical flow fatigue, temperature, and chemical resistance failures possible in filter elements with synthetic support mesh. Contact your distributor or Hy-Pro for more information and published articles on DFE testing.

Media Options

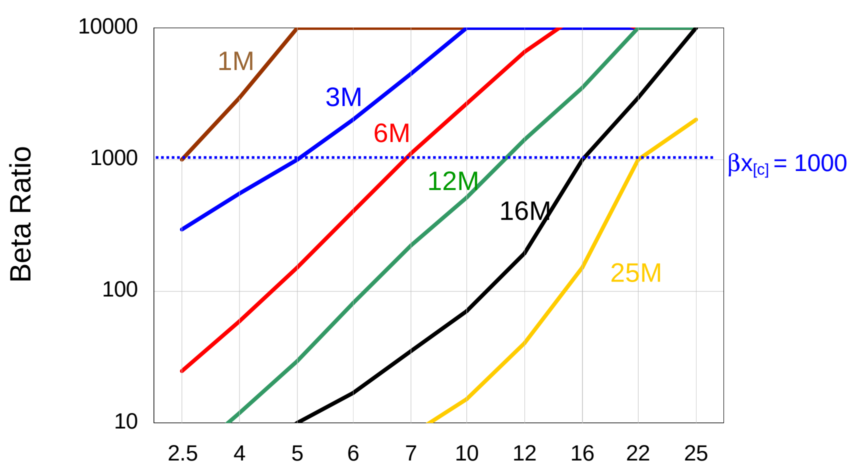
Through extensive testing we have developed media choices to handle any application. Options include G7 Dualglass, Dynafuzz (stainless fiber), and Wire mesh (stainless).

Fluid Compatibility

Petroleum based fluids, water glycol, polyol ester, phosphate ester, high water based fluids and many other synthetics. Contact us for seal material selection assistance.

FILTER MEDIA SPECIFICATIONS

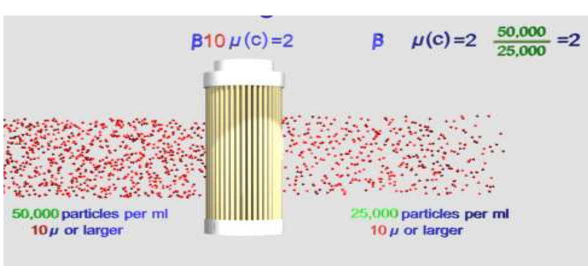
Glass Media Code Filtration Efficiency (Beta Ratio) vs Micron



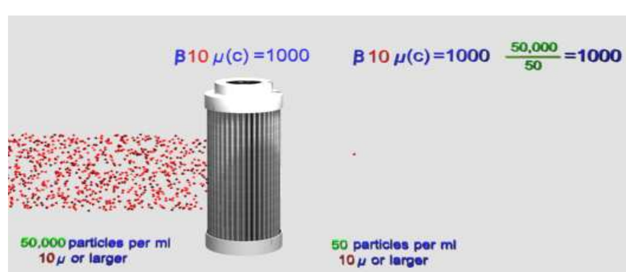
Micron size $\mu m_{[c]}$ (per ISO16889)

media code	media description
A	G7 Dualglass high performance media combined with water removal scrim. $\beta x_{[c]} = 1000$ ($\beta x = 200$)
M	G7 Dualglass our latest generation of DFE rated, high performance glass media for all hydraulic & lubrication fluids. $\beta x_{[c]} = 1000$ ($\beta x = 200$)
W	Stainless steel wire mesh media $\beta x_{[c]} = 2$ ($\beta x = 2$) nominally rated

Typical cellulose media performance



Hy-Pro G7 Dualglass media performance



PF4 FILTER ASSEMBLY PART NUMBER GUIDE

	table 1	table 2		table 3	table 4	table 5	table 6	table 7	table 8
PF4			-						

BOLD denotes quick ship options for porting, bypass and indicator

PF4 FILTER ELEMENT PART NUMBER GUIDE

	table 1		table 2		table 3	table 5
HP		**L**		-		

table 1 code	element collapse & seal configuration
K	150 psid (10 bar), HF4 element configuration
K3	3000 psid (212 bar), HF4 element configuration
KC	150 psid (10 bar), coreless, o-ring seals

table 3 code	filtration rating
1M	$\beta_{2.5[c]} = 1000$ ($\beta_1 = 200$)
3M	$\beta_{5[c]} = 1000$ ($\beta_3 = 200$)
6M	$\beta_{7[c]} = 1000$ ($\beta_6 = 200$)
6A	$\beta_{7[c]} = 1000$ + water removal
12M	$\beta_{12[c]} = 1000$ ($\beta_{12} = 200$)
12A	$\beta_{12[c]} = 1000$ + water removal
16M	$\beta_{17[c]} = 1000$ ($\beta_{17} = 200$)
16A	$\beta_{17[c]} = 1000$ + water removal
25M	$\beta_{22[c]} = 1000$ ($\beta_{25} = 200$)
25A	$\beta_{22[c]} = 1000$ + water removal
25W	25u nominal wire mesh
40M	$\beta_{35[c]} = 1000$ ($\beta_{40} = 200$)
40W	or 40u nominal wire mesh
74W	74u nominal wire mesh
149W	149u nominal wire mesh
250W	250u nominal wire mesh

table 2 code	element length
9	Single (9" nominal)
18	Double (18" nominal)
27	Triple (27" nominal)

table 4 code	porting option
N1	NPTF 1 1/2"
C1	1 1/2" SAE 4-bolt Flange (code 61)
S1	SAE-24 (1 7/8"-12 UN straight thread)
F1	**1 1/2" SAE 4-bolt Flange (code 62)**
M1	Manifold mount (see installation detail)

table 5 code	seal Material
B	**Buna (Nitrile)**
E-WS	EPR + stainless steel support mesh (Skydrol fluid)
V	Viton (Fluorocarbon)

table 6 code	bypass valve Setting
X	Non-Bypass (K3 element collapse only, table 1)
5	**50 psid (3.5 bar)**
9	90 psid (6.4 bar)

table 7 code	electrical indicator connection
X	Visual indicator, 3-wire lead electrical only
B	5 pin Receptacle 41512 (Brad Harrison)
H	4 pin DIN 43650 (Hirschmann)

table 8 code	∆p Indicator Type & set-point ∆PSI (∆BAR)
D*	**Electrical/visual 35 (2,2)**
E*	Electrical/visual 100 (7)
I	Visual only 70 (5)
J	Indicator port plugged
L	**Visual only 35 (2,5)**
N*	Electrical/visual 35 (2,5) 3 flying wire leads
O	Visual only 100 (7)
R*	**Electrical switch only 35 (2,5)**
S*	Electrical/visual 100 (7) 3 flying wire leads
T*	Electrical switch 100 (7)
U*	Electrical switch 70 (5)

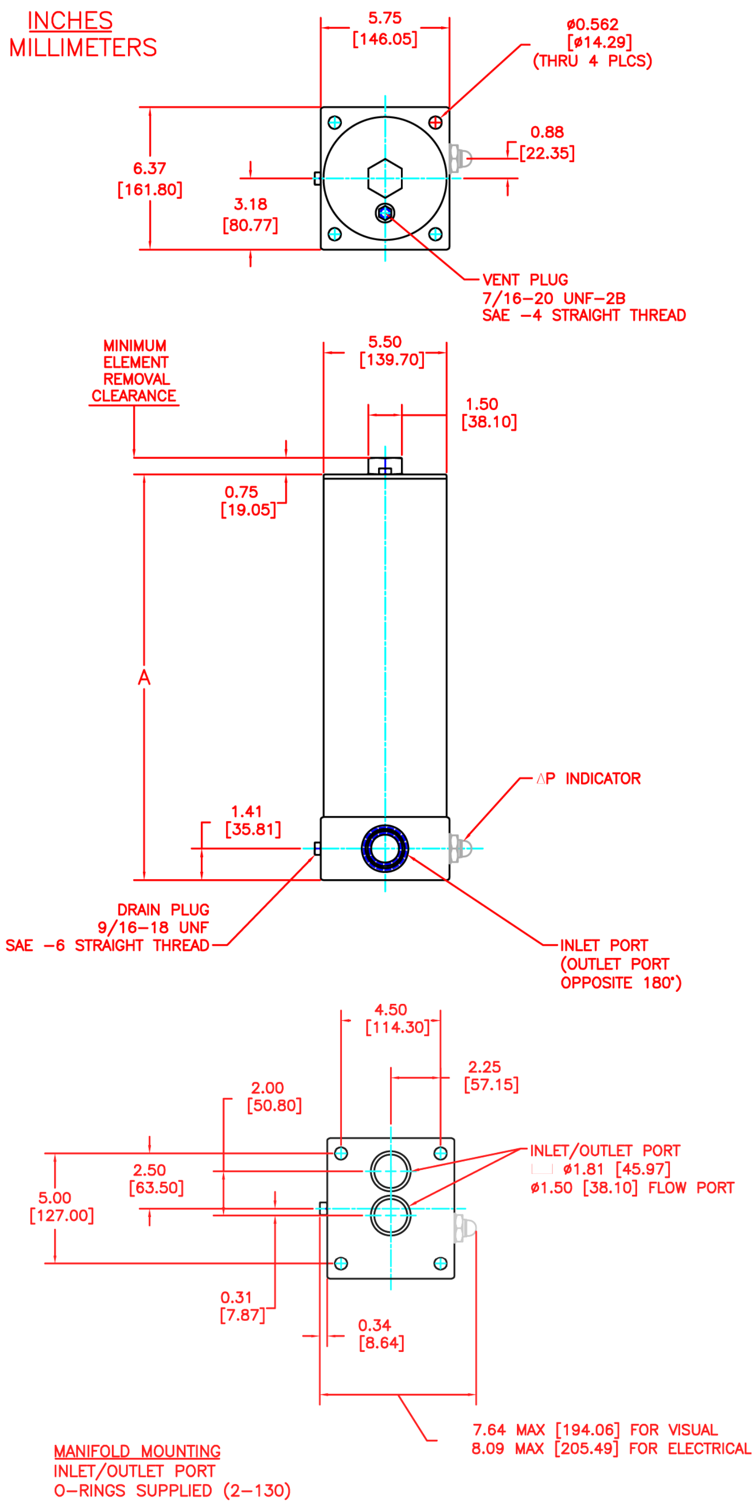
*Electrical indicator voltage: 115VAC / 28VDC.

∆P indicator set-point must be lower than bypass valve setting to ensure indication. Recommended indicator/bypass setting combinations below. Pop up visual indicators reset automatically once the pressure has subsided so filter ∆P condition must be inspected while the system is running.

Recommended bypass valve setting / ∆P indicator combinations

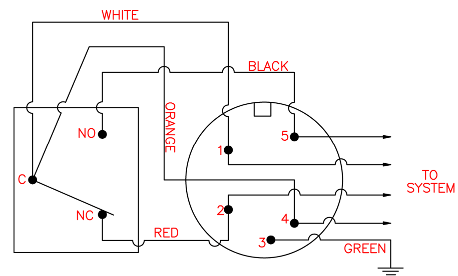
Bypass valve setting (code)	**X**	**5**	**9**
Recommended Indicator selection	E O S T	D L N R	I U

∆P indicators with thermal lockout and surge protection are available upon request.

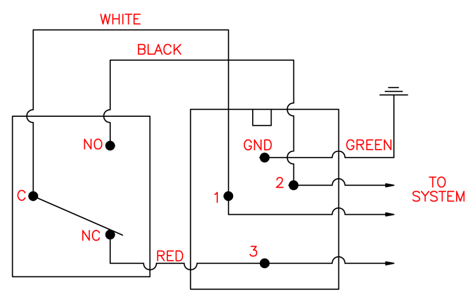


Dimension	L9	L18	L27
A (overall length)	15.31 (389)	24.7 (628)	34.0 (864)
Element removal	9.0 (229)	18.0 (457)	27.0 (686)

Electrical indicator wiring diagrams (Aluminum housing + thermal lockout)

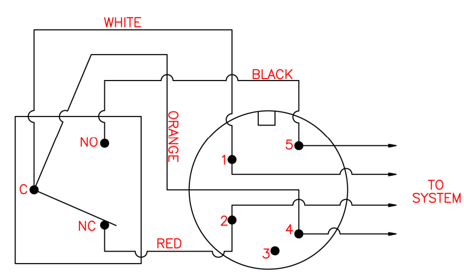


Brad Harrison 5-pin receptacle 41512

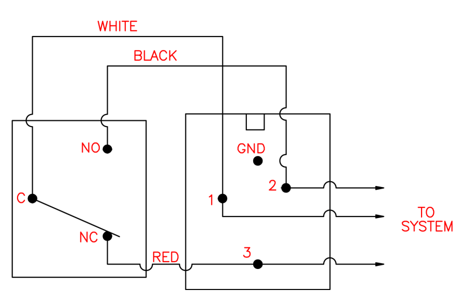


Hirschman 4-pin DIN 43650

Electrical indicator wiring diagrams (Plastic housing NO thermal lockout)



Brad Harrison 5-pin receptacle 41512



Hirschman 4-pin DIN 43650

High Pressure Full Flow Bi-Directional Filter

450 bar, 6225 psi Operating Pressure
300 lpm, 79 gpm Max Flow Rate
Bi-Directional Full Flow Filtration

APPLICATIONS

PFB high pressure filter assemblies are designed for applications where flow direction changes and fluid must be filtered full flow in both directions.

- To protect a component that is very sensitive to particulate contamination (ie servo valve) and requires clean pressurized fluid for reliable operation.
- To help meet mill/plant target cleanliness codes and required ISO 4406 cleanliness standards set by hydraulic component manufacturers (warranty).
- To protect a component that is very expensive where minimizing the risk of failure and replacement cost justifies the cost of filtration.
- Hydrostatic applications.

PRODUCT FEATURES

DFE rated elements (Dynamic Filter Efficiency)	G7 Dualglass media filter elements are DFE rated to assure performance even when exposed to the toughest hydraulic systems (See DFE literature for details)
Circumferential o-ring bowl seal	Circumferential seal on the bowl eliminates leaking and weeping.
Low housing pressure drop	Unique internal flow paths provide low resistance to flow. (Low pressure drop)
Coreless elements	PFH419 housings (with bypass valve) can be ordered with Hy-Pro coreless filter element for easy disposal (crush or incinerate).
Differential indicator	Available with visual, electrical, or electrical with LED (visual signal) differential indicators.

PRODUCT SPECIFICATIONS

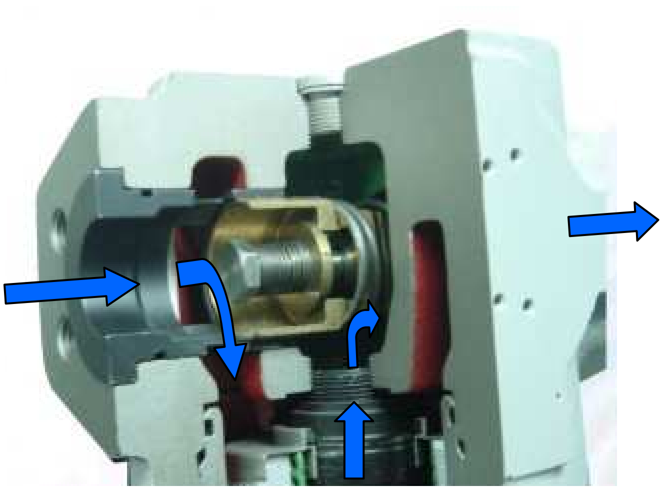
Materials	
Head	Cast steel
Bowl	Extruded steel
Seals	Buna or Viton
Media options	G7 Dualglass, Stainless mesh
Interior coating	Phosphate coating
Exterior coating	Power paint coated
ISO standards	
ISO 2941	Collapse and burst resistance
ISO 2942	Fabrication and integrity test
ISO 2943	Material compatibility with fluids
ISO 3724	Flow fatigue test
ISO 3968	Pressure drop vs flow rate
ISO 16889	Multi-pass filter performance
DIN 24550	Nominal pressure rating
Temperature rating	Buna -40f(-40c) to 225f(107c) Viton -15f(-26c) to 275f(135c)
Fluid compatibility	Biodegradable and mineral based fluids. For high water based or specified synthetics consult factory

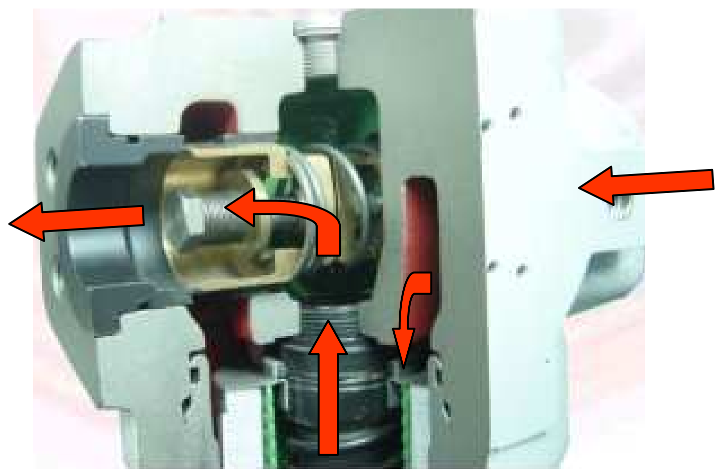
HY-PRO FILTRATION

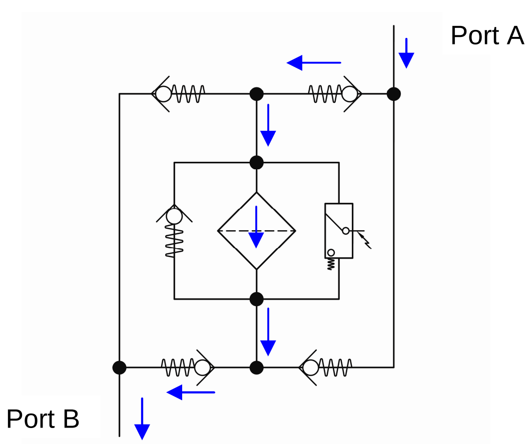
PFHB419 Series

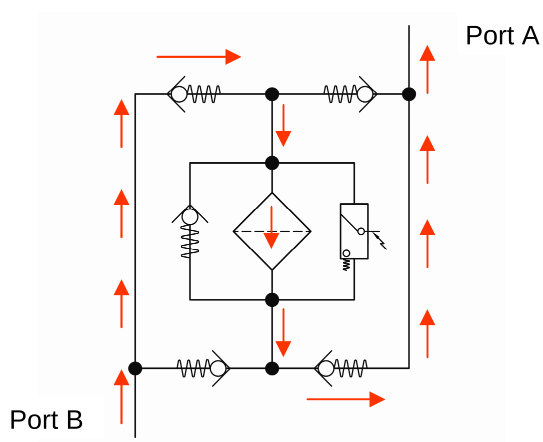
Media code	Bowl code Length	Max flow rate* gpm (lpm)	Port size	Assembly Δp factor* psid / gpm	Max operating Pressure, fatigue rating
3M		37 (138.7)		0.52	**psi (bar)**
6M	8	42 (157.5)	SAE-20	0.383	6090 psi, 420 bar
10M	(double)	50 (187.5)	1 1/4" Flange	0.28	10^7 pressure cycles
25M		58 (217.5)	Code 62	0.185	8700 psi, 615 bar
**W (mesh)		72 (270)		0.119	10^4 pressure cycles
3M		60 (225)		0.42	**psi (bar)**
6M	13	66 (247.5)	SAE-24	0.308	6090 psi, 420 bar
10M	(triple)	74 (277.5)	1 1/2" Flange	0.175	10^7 pressure cycles
25M		90 (337.5)	Code 62	0.146	8700 psi, 615 bar
**W (mesh)		118 (442.5)		0.105	10^4 pressure cycles

*Max flow rate and Δp factor assumes υ = 150 sus, 32 Centistokes. See Δp viscosity conversion formula for viscosity









PFHB FILTER ASSEMBLY SIZING & OPERATING PRESSURE GUIDELINES

Effective filter sizing requires consideration of flow rate, viscosity (operating and cold start), fluid type and degree of filtration. When properly sized bypass during cold start can be avoided/minimized and optimum element efficiency and life achieved. The filter assembly differential pressure values provided for sizing differ for each media code, and assume 150 SSU (32cSt) viscosity and 0.86 fluid specific gravity. Use the following steps to identify the correct high pressure filter assembly.

1. Calculate Δp coefficient at both operating and cold start viscosity:

$$\Delta p \text{ Coefficient} = \frac{\text{Actual Operating Viscosity (SSU)}}{150} \times \frac{\text{Actual S.G.}}{0.86}$$

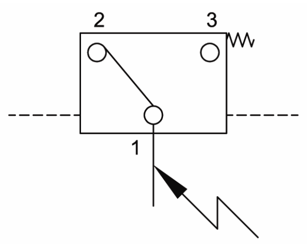
2. Calculate actual clean filter assembly Δp at both operating and cold start viscosity:

Actual assembly clean Δp = Flow rate x Δp Coefficient x Assembly Δp factor (from sizing table)

3. Sizing Recommendations to optimize performance and permit future flexibility:

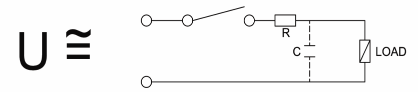
- To avoid or minimize bypass during cold start the actual assembly clean Δp calculation should be repeated for start-up conditions if cold starts are frequent.
- Actual assembly clean Δp should not exceed 15 psid at normal operating viscosity.
- If suitable assembly size is approaching the upper limit of the recommended flow rate at the desired degree of filtration consider increasing the assembly to the next larger size if a finer degree of filtration might be preferred in the future. This practice allows the future flexibility to enhance fluid cleanliness without compromising clean Δp or filter element life.
- Once a suitable filter assembly size is determined consider increasing the assembly to the next larger size to optimize filter element life and avoid bypass during cold start.
- When using water glycol or other specified synthetics we recommend increasing the filter assembly by 1~2 sizes.
- High viscosity fluid (ie gear lube ISO 220) will typically display very high viscosity as the temperature drops below 100f. For such applications avoiding bypass during start-up might not be possible.

ELECTRICAL + LED, ELECTRICAL DIFFERENTIAL PRESSURE INDICATOR INFORMATION

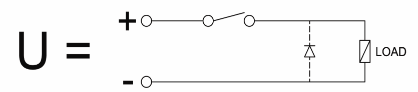


- Indication pressure - 73 psid (5.18 bar)
- Switching voltage - max 120 V AC / 175 V DC
- Switching current - max 0,17 A AC / 0,25 A DC
- Switching power - max 3,5 VA AC / 5 W DC
- Contact type - Change-over
- Electrical protection - IP 65

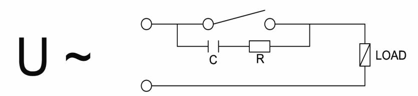
- Current limiter for DC and AC voltage. If loads are connected over long distances a protective resistor should be connected in series in order to limit the current.



- Spark suppression in DC applications. The contacts of reed switches open very fast which causes voltage peaks to be induced when switching off inductive loads (relays, lifting magnets, solenoids). The self-induction currents are short-circuited by connecting a diode in parallel to the inductive load



- Spark suppression in AC applications. In AC applications a diode connected in parallel to the load is not sufficient. RC elements should be connected in parallel to the reed switch.



Dynamic Filter Efficiency (DFE) Testing

Revolutionary test methods assure that DFE rated elements perform true to rating even under demanding variable flow and vibration conditions. Today's industrial and mobile hydraulic circuits require elements that deliver specified cleanliness under ALL circumstances. Wire mesh supports the media to ensure against cyclical flow fatigue, temperature, and chemical resistance failures possible in filter elements with synthetic support mesh. Contact your distributor or Hy-Pro for more information and published articles on DFE testing.

Media Options

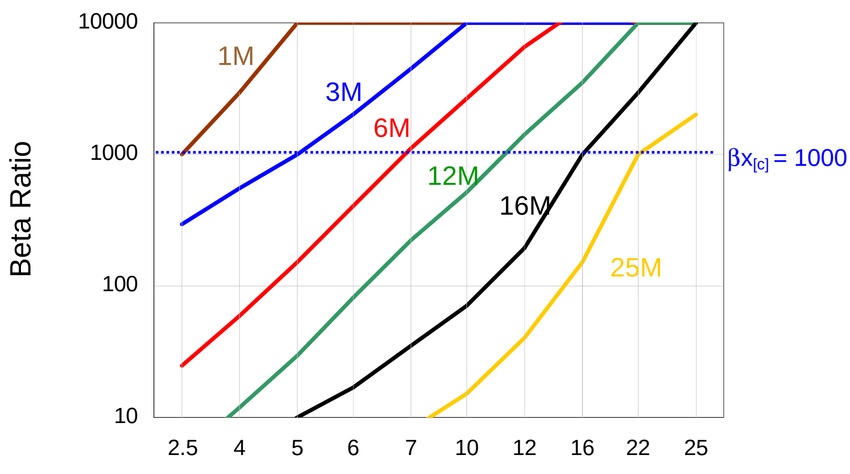
Through extensive testing we have developed media choices to handle any application. Options include G7 Dualglass, Dynafuzz (stainless fiber), and Wire mesh (stainless).

Fluid Compatibility

Petroleum based fluids, water glycol, polyol ester, phosphate ester, high water based fluids and many other synthetics. Contact us for seal material selection assistance.

FILTER MEDIA SPECIFICATIONS

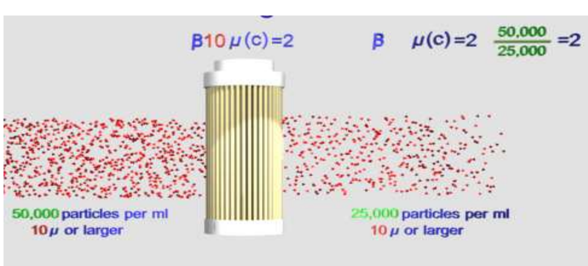
Glass Media Code Filtration Efficiency (Beta Ratio) vs Micron



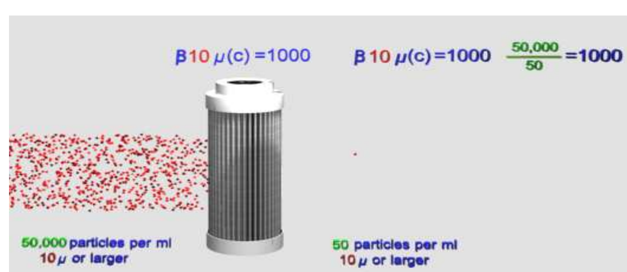
Micron size $\mu m_{[c]}$ (per ISO16889)

media code	media description
A	G7 Dualglass high performance media combined with water removal scrim. $\beta x_{[c]} = 1000$ ($\beta x = 200$)
M	G7 Dualglass our latest generation of DFE rated, high performance glass media for all hydraulic & lubrication fluids. $\beta x_{[c]} = 1000$ ($\beta x = 200$)
W	Stainless steel wire mesh media $\beta x_{[c]} = 2$ ($\beta x = 2$) nominally rated

Typical cellulose media performance



Hy-Pro G7 Dualglass media performance



PFHB FILTER ASSEMBLY PART NUMBER GUIDE

	table 1	table 2	table 3	table 4	table 5	table 6	table 7	table 8	table 8
PFHB								Option D	Option N

PFHB FILTER ELEMENT PART NUMBER GUIDE

	table 1		table 2		table 4	table 5
HP419		**L**		**-**		

Bold denotes standard product option. Non-standard options are subject to longer than standard lead time

table 1 code	element collapse
N	450 psid
H	3000 psid
C*	250 psid

*coreless element

table 2 code	element length
8	double
13	triple

table 3 code	port option
F1	SAE-20 Flange (Code 62)
F2	SAE-24 Flange (Code 62)

table 4 code	Media selection
1M	$\beta 2.5_{[c]} = 1000$, $\beta 1 = 200$
3M	$\beta 5_{[c]} = 1000$, $\beta 3 = 200$
6M	$\beta 7_{[c]} = 1000$, $\beta 6 = 200$
10M	$\beta 12_{[c]} = 1000$, $\beta 12 = 200$
25M	$\beta 22_{[c]} = 1000$, $\beta 25 = 200$
25W	25u nominal mesh media
40W	40u nominal mesh media
74W	74u nominal mesh media
149W	149u nominal mesh media

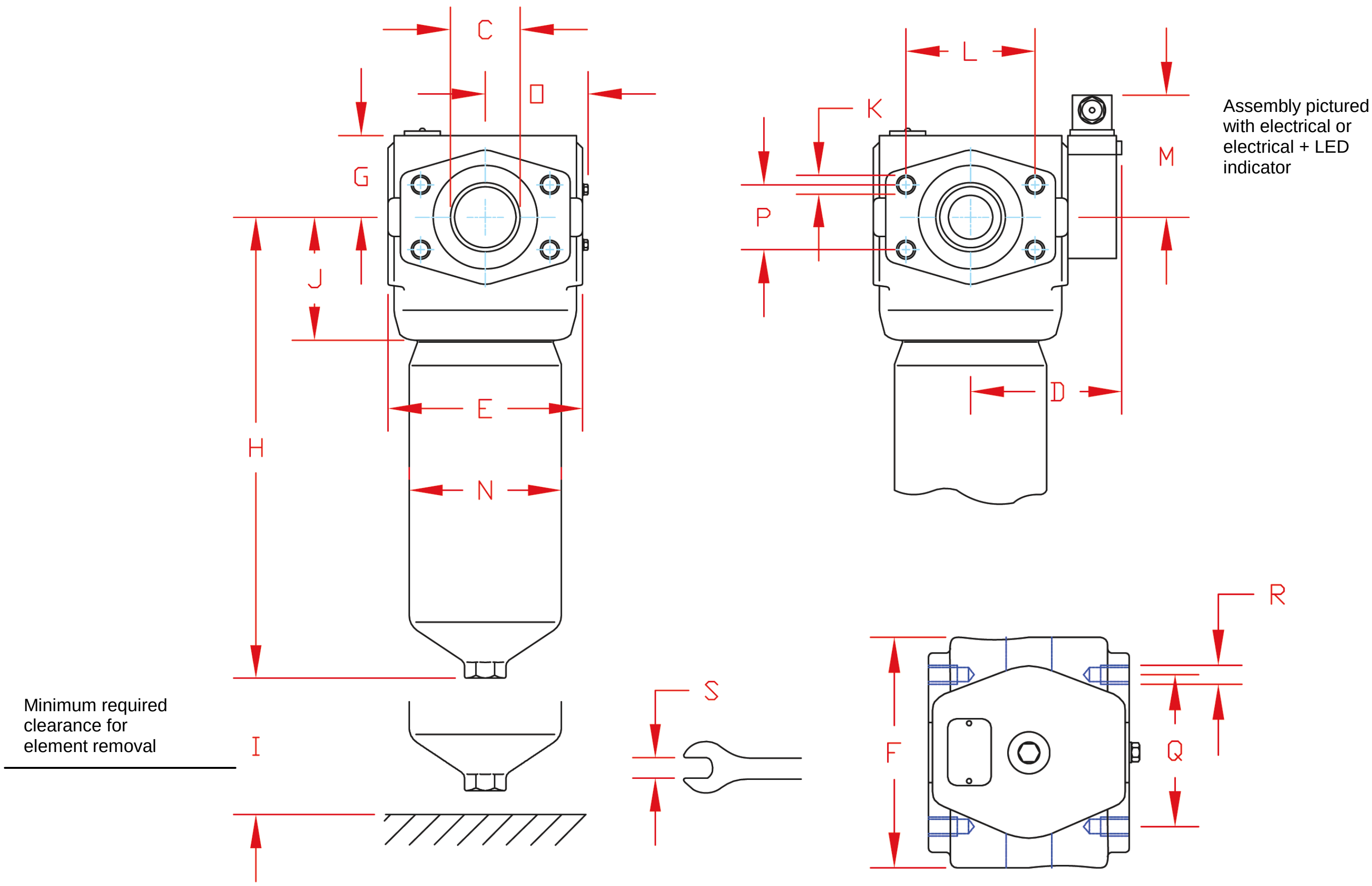
table 5 code	Seal
B	Buna -40f(-40c) to 225f(107c)
V	Viton -15f(-26c) to 275f(135c)

table 6 code	Bypass valve
7	102 psid bypass
X*	No bypass

*No bypass "X" option only recommended with "H" element collapse rating (table 2)

table 7 code	Δp indicator
V	Visual, mechanical
E	Electrical
L	Eletrical + LED visual
Z	Indicator port plugged

table 8 code	Special options (not required)
D	Bowl drain w/plug
N	Nickel coated for high straight water applications (call factory)



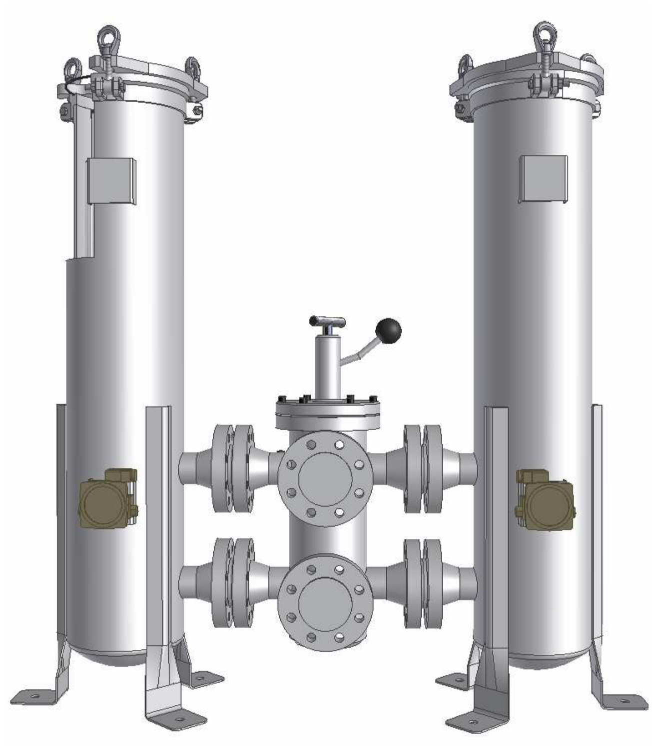
	PFHB419*8 IN (mm)	PFHB419*13 IN (mm)
A/B	SAE-20, SAE-24 code 62 flange	SAE-20, SAE-24 code 62 flange
C	1.24 (31,49)	1.24 (31,49)
D	4.02 (102,10)	4.02 (102,10)
E	5.44 (138,17)	5.44 (138,17)
F	6.15 (156,21)	6.15 (156,21)
G	2.29 (58,16)	2.29 (58,16)
H	12.92 (328,17)	16.86 (428,24)
I	3.15 (80,01)	3.15 (80,01)
J	3.45 (87,63)	3.45 (87,63)
K	F1: M14 x 22mm depth F2: M16 x 24mm depth	F1: M14 x 22mm depth F2: M16 x 24mm depth
L	F1 port: 2.63 (66,80) F2 port: 3.12 (79,25)	F1 port: 2.63 (66,80) F2 port: 3.12 (79,25)
M	Optical 2.96 (75,18) Electrical 3.43 (87,12)	Optical 2.96 (75,18) Electrical 3.43 (87,12)
N	4.26 (108,2)	4.26 (108,2)
O	2.88 (73,15)	2.88 (73,15)
P	F1 port: 1.25 (31,75) F2 port: 1.44 (36,57)	F1 port: 1.25 (31,75) F2 port: 1.44 (36,57)
Q	3.94 (100,07)	3.94 (100,07)
R	M12 x 0.71(18,0) depth	M12 x 0.71(18,0) depth
S	1.26 (32,00)	1.26 (32,00)

	PFHB419*8 lbs (kg)	PFH419*13 lbs (kg)
Weight	45 (19,98)	50 (22,70)

1	**Element**	**See element p/n guide**
2	**Bowl Seal kit**	
	Nitrile NBR	PFHB419SKB
	Fluorocarbon	PFHB419SKV
3	**Bowl**	
	Single length	PFB4191
	Single length w/drain port	PFB4191D
	Double length	PFB4192
	Double length w/drain port	PFB4192D
	Triple length	PFB4193
	Triple length w/drain port	PFB4193D
4	**Indicator**	
	Visual indicator, Buna seal	PFHIVB
	Visual, Viton seal	PFHIVV
	Electrical, Buna seal	PFHIEB
	Electrical, Viton seal	PFHIEV
	Electrical + LED, Nitrile seal	PFHILB
	Electrical + LED, Fluoro seal	PFHILV

DLF/LFM - High Flow Duplex Assemblies

Flow rates to 560 lpm, 150 gpm / DLFM flow rate to 16875 lpm, 4500 gpm



TYPICAL APPLICATIONS

- Uptime critical & continuous operations
- Pulp and Paper
- Hydraulic and Lubrication oil
- Fuel and Fuel oil
- Rolling mill oil
- Processing liquids
- Bulk oil handling - Transfer and clean up
- Off-line systems and flushing
- Power generation
- Primary metals
- Mobile flushing systems
- Particulate and water removal
- Transfer line machining coolants
- Large gearbox filtration
- High flow Return-line filtration

PRODUCT SPECIFICATIONS & FEATURES

Max Flow Rate Visc: 150 SUS, 32 cSt	**Recommended Series**
150 gpm (560 lpm)	LF Double length
4500 gpm (16875 lpm)	DLFM multiple element series (call for sizing assistance)
Operating Pressure	**Standard 150 psi (10 bar)**
	Available up to 450 psi (30 bar)
Pressure Indicators	
Up to 250 psi Operating	Differential pressure indicator (dual pressure gauges available)
450 psi and higher	Differential pressure Indicator required
Maximum Temperature	**Standard 250°F**
	Call for high temperature specs

- True 6-way transfer valve allows change over with one valve.
- Integrated pressure equalization and fill line.
- Carbon steel construction standard (304 stainless steel available).
- Duplexing option available for continuous filtration during filter element change-out.
- HP106 and HP107 element series have integral bypass valve (new bypass every time element is changed avoids bypass failure).
- Easy to service swing-lid design with eye nuts assures no lost hardware, hydraulic lift option available.
- Marine grade epoxy exterior finish for non-stainless steel assemblies
- Features Hy-Pro coreless element design with positive o-ring seals
- High differential pressure valve transfer capabilities.
- Drain and cleanout port allows for quick draining and easy access for sump cleanout.
- Hy-Pro Dualglass filter element media technology validated per ISO16889 multipass and DFE (modified ISO16889) industry leading multipass testing.

ASME U & UM CODE REQUIREMENTS

Standard vessels are manufactured to ASME code standards, but not certified. ASME U and UM code certification is available as an option. See table 11 under the duplex assembly housing selection ordering detail.

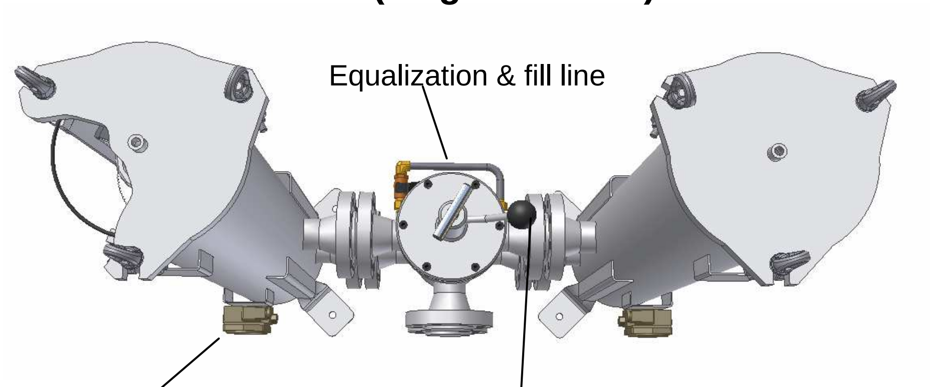
DLF & DLFM DUPLEX PRODUCT FEATURES

Top loading housing minimizes mess

No tools required for cover removal
150psi (10 bar) & 250 psi (17 bar)

DLF* (single element)

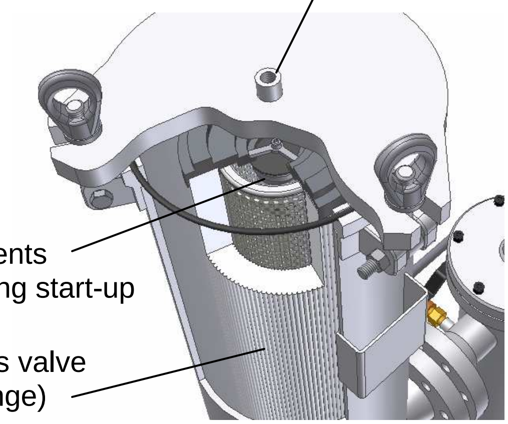
Equalization & fill line



Green to red ΔP gauges with optional electrical switch

Easy change valve handle

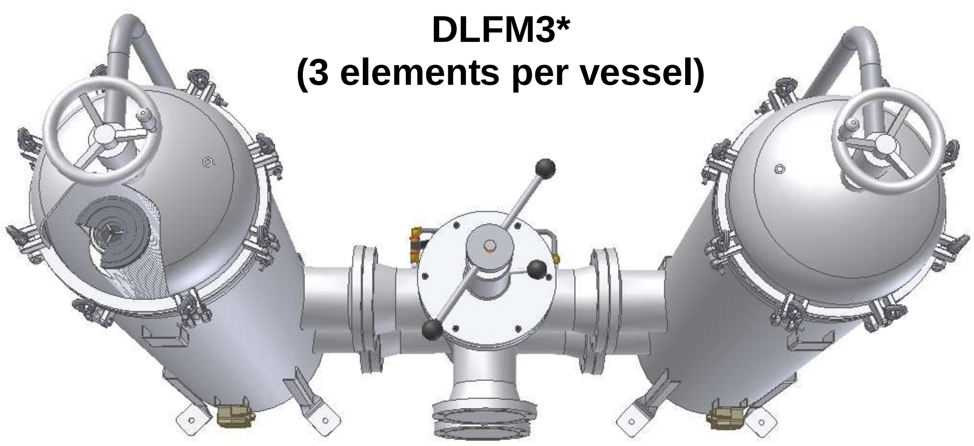
Air bleed vent port



Bypass valve location (top) prevents settled solids from passing during start-up

Coreless element with integral bypass valve (new bypass with every element change)

DLFM3*
(3 elements per vessel)



DLF & DLFM DUPLEX SELECTION AND SIZING GUIDELINES

Effective filter sizing requires consideration of flow rate, viscosity (operating and cold start), fluid type and degree of filtration. When properly sized, bypass during cold start can be avoided/minimized and optimum element efficiency and life achieved. The filter assembly differential pressure values provided for sizing differ for each media code, and assume 150 SSU (32Cts) viscosity and 0.86 fluid specific gravity. Use the following steps to identify the correct high pressure filter assembly.

1. Calculate Δp coefficient at both operating and cold start viscosity:

$$\Delta p \text{ Coefficient} = \frac{\text{Actual Operating Viscosity (SSU)}}{150} \times \frac{\text{Actual S.G.}}{0.86}$$

2. Calculate actual clean filter assembly Δp at both operating and cold start viscosity:

Actual assembly clean Δp = Flow rate x Δp Coefficient x Assembly Δp factor (from sizing table)

3. Sizing Recommendations to optimize performance and permit future flexibility:

- To avoid or minimize bypass during cold start the actual assembly clean Δp calculation should be repeated for start-up conditions if cold starts are frequent.
- Actual assembly clean Δp should not exceed 5 psid at normal operating viscosity.
- If suitable assembly size is approaching the upper limit of the recommended flow rate at the desired degree of filtration consider increasing the assembly to the next larger size if a finer degree of filtration might be preferred in the future. This practice allows the future flexibility to enhance fluid cleanliness without compromising clean Δp or filter element life.
- Once a suitable filter assembly size is determined consider increasing the assembly to the next larger size to optimize filter element life and avoid bypass during cold start.
- When using water glycol or other specified synthetics we recommend increasing the filter assembly by 1~2 sizes.
- High viscosity fluid (ie gear lube ISO 220) will typically display very high viscosity as the temperature drops below 100f. For such applications avoiding bypass during start-up might not be possible.

DLF Single Element Assembly (housing + element) Differential Pressure Factors

Media code	Port size	L36, 39 Max flow gpm (lpm)	Length code	Δp factor* (psid/gpm)	Δp factor* (bar/lpm)	Length code	Δp factor* (psid/gpm)	Δp factor* (bar/lpm)
1M	2" (DIN 050) Flange, NPT	100 (375)	16,18	0.059	0.00113	36,39	0.047	0.00090
3M		150 (560)		0.050	0.00096		0.042	0.00081
6M		150 (560)		0.048	0.00092		0.041	0.00079
10M		150 (560)		0.046	0.00087		0.040	0.00077
16M		200 (750)		0.043	0.00082		0.038	0.00073
25M		200 (750)		0.040	0.00077		0.037	0.00071
**W		300 (1125)		0.037	0.00071		0.035	0.00067
1M	3" (DIN 080) Flange, NPT	150 (560)	16,18	0.047	0.00078	36,39	0.034	0.00065
3M		200 (750)		0.038	0.00073		0.030	0.00058
6M		200 (750)		0.036	0.00069		0.029	0.00055
10M		250 (935)		0.034	0.00066		0.028	0.00053
16M		300 (1125)		0.031	0.00060		0.026	0.00050
25M		300 (1125)		0.028	0.00054		0.024	0.00046
**W		300 (1125)		0.025	0.00048		0.022	0.00042

*Max flow rate and Δp factor assumes υ = 150 sus, 32 Centistokes. See Δp viscosity conversion formula for viscosity

HY-PRO FILTRATION

DLFM3 Multi-Element Assembly (housing + element) Differential Pressure Factors

Media code	Length code	Max flow gpm (lpm)	Port size	Δp factor* (psid/gpm)	Δp factor* (bar/lpm)
1M	36, 39	600 (2250)	4" (DIN 100) Flange	0.0081	0.000154
3M		800 (3000)		0.0055	0.000105
6M		900 (3375)		0.0051	0.000098
10M		1300 (4875)		0.0045	0.000087
16M		1300 (4875)		0.0041	0.000079
25M		1500 (5625)		0.0035	0.000067
**W		1500 (5625)		0.0027	0.000052
1M	36, 39	600 (2250)	6" (DIN 150) Flange	0.0075	0.000144
3M		800 (3000)		0.005	0.000096
6M		900 (3375)		0.0045	0.000087
10M		1300 (4875)		0.0039	0.000058
16M		1300 (4875)		0.0035	0.000067
25M		1500 (5625)		0.0029	0.000059
**W		1500 (5625)		0.0021	0.000041

*Max flow rate and Δp factor assumes υ = 150 sus, 32 Centistokes. See Δp viscosity conversion formula for viscosity

DLFM4 Multi-Element Assembly (housing + element) Differential Pressure Factors

Media code	Length code	Max flow gpm (lpm)	Port size	Δp factor* (psid/gpm)	Δp factor* (bar/lpm)
1M	36, 39	600 (2250)	4" (DIN 100) Flange	0.0067	0.000129
3M		800 (3000)		0.0048	0.000092
6M		1000 (3750)		0.0044	0.000084
10M		1300 (4500)		0.0040	0.000077
16M		1400 (5250)		0.0037	0.000071
25M		1500 (6560)		0.0032	0.000061
**W		1500 (5625)		0.0025	0.000048
1M	36, 39	600 (2250)	6" (DIN 150) Flange	0.0062	0.000119
3M		800 (3000)		0.0043	0.000083
6M		900 (3375)		0.0039	0.000075
10M		1300 (4875)		0.0034	0.000065
16M		1300 (4875)		0.0031	0.000059
25M		1500 (5625)		0.0026	0.000050
**W		1500 (5625)		0.00207	0.000038

*Max flow rate and Δp factor assumes υ = 150 sus, 32 Centistokes. See Δp viscosity conversion formula for viscosity

HIGH PERFORMANCE FILTER ELEMENTS — THE HEART OF A FILTER

Dynamic Filter Efficiency (DFE) Testing

Revolutionary test methods assure that DFE rated elements perform true to rating even under demanding variable flow and vibration conditions. Today's industrial and mobile hydraulic circuits require elements that deliver specified cleanliness under ALL circumstances. Wire mesh supports the media to ensure against cyclical flow fatigue, temperature, and chemical resistance failures possible in filter elements with synthetic support mesh. Contact your distributor or Hy-Pro for more information and published articles on DFE testing.

Media Options

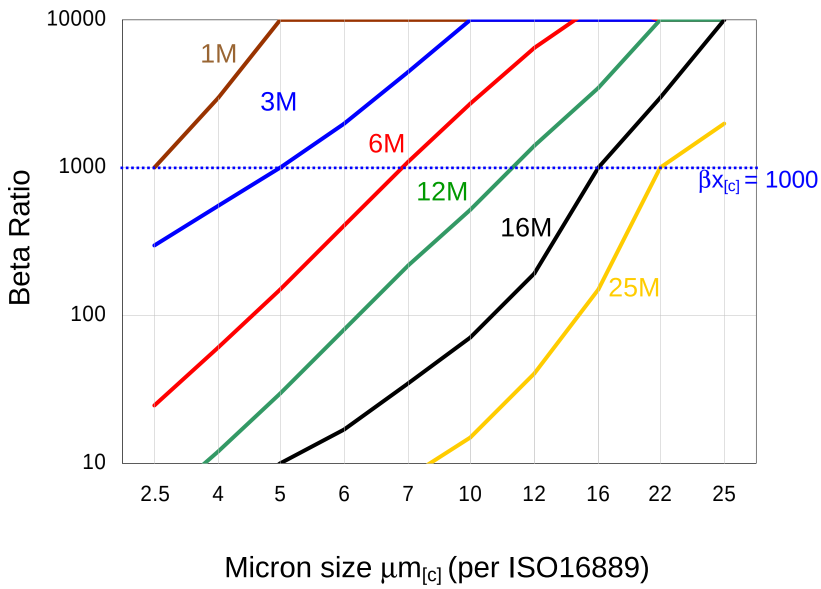
Through extensive testing we have developed media choices to handle any application. Options include G7 Dualglass, Dynafuzz (stainless fiber), and Wire mesh (stainless).

Fluid Compatibility

Petroleum based fluids, water glycol, polyol ester, phosphate ester, high water based fluids and many other synthetics. Contact us for seal material selection assistance.

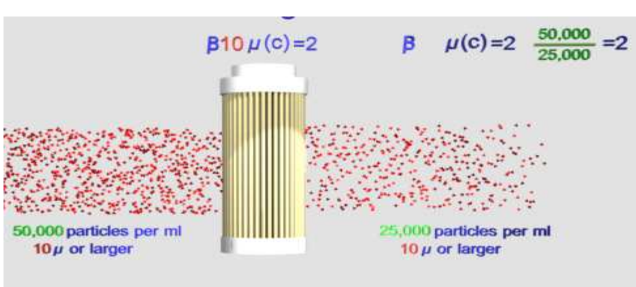
FILTER MEDIA SPECIFICATIONS

Glass Media Code Filtration Efficiency (Beta Ratio) vs Micron Size

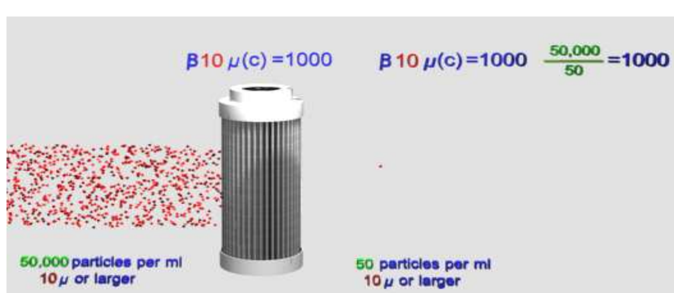


media code	media description
A	G7 Dualglass high performance media combined with water removal scrim. $\beta x_{[c]} = 1000$ ($\beta x = 200$)
M	G7 Dualglass our latest generation of DFE rated, high performance glass media for all hydraulic & lubrication fluids. $\beta x_{[c]} = 1000$ ($\beta x = 200$)
W	Stainless steel wire mesh media $\beta x_{[c]} = 2$ ($\beta x = 2$) nominally rated

Typical cellulose media performance



Hy-Pro G7 Dualglass media performance



HY-PRO
FILTRATION

DLF & DLFM DUPLEX ASSEMBLY - STEP 1 VALVE SELECTION

	table 1	table 2	table 3	table 4		
D					**-**	→ Continue Number

table 1 code	Port configuration
S	Same side porting (standard)
O	Opposite side porting (180°), in-line (different center line)

table 2 code	Connections
C2	2" SAE Code-61 Flange
C3	3" SAE Code-61 Flange
D2	DN50 DIN 2633 Flange
D3	DN80 DIN 2633 Flange
D4	DN100 DIN 2633 Flange
D5	DN125 DIN 2633 Flange
D6	DN150 DIN 2633 Flange
D8	DN200 DIN 2633 Flange
D10	DN250 DIN 2633 Flange
F2	2" ANSI Flange
F3	3" ANSI Flange
F4	4" ANSI Flange
F5	5" ANSI Flange
F6	6" ANSI Flange
F8	8" ANSI Flange
F10	10" ANSI Flange

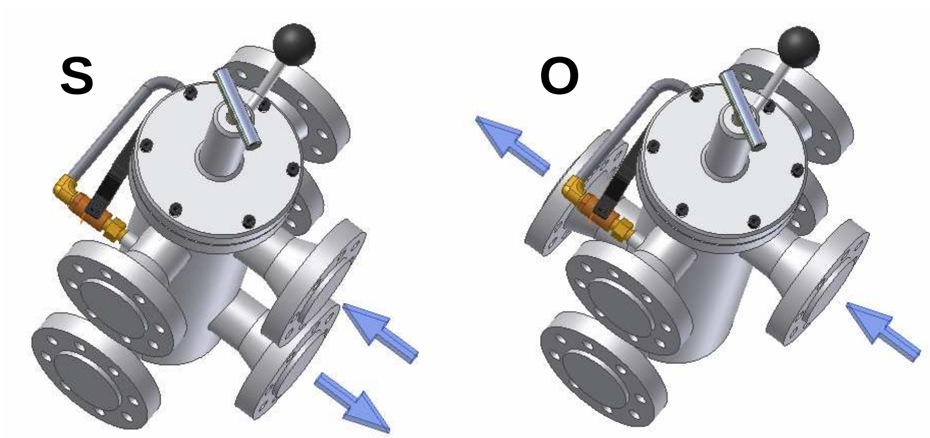
table 3 code	Material
omit	Carbon steel
S	304 Stainless steel

table 4 code	Max Operating Pressure
omit	150 psi, 10 bar max ANSI 150#, DIN PN10
V	250 psi, 17 bar max ANSI 300#, DIN PN16
W*	450 psi, 30 bar max

*W option housings feature a slip and blind bolt arrangement on the cover with up to 9 bolts per vessel.

VALVE PORTING OPTIONS (SAME SIDE OR OPPOSITE SIDE)

In table 1 two port configurations are available for the DLF* transfer valve, same side porting (photo S) and opposite side (photo O). Opposite side porting is ideal for applications where a duplex is being added to an existing line. Opposite side porting is ideal for off-line systems.



DLF & DLFM DUPLEX ASSEMBLY - STEP 2 HOUSING SELECTION

	table 5	table 6		table 7	table 8	table 9	table 10	table 11		table 12
- LF	☐	☐	-	☐	☐	☐	☐	☐	-	☐

FILTER ELEMENT PART NUMBER GUIDE

	table 6			table 7	table 8
HP10	☐	L36*	-	☐	☐

*For 8 element option use HP8314L39-** for element p/n

table 5 code	Elements per vessel
omit	1 element
M3	3 elements
M4	4 elements
M9	9 elements
M14	14 elements
M22	22 elements

table 8 code	Seals
B	Buna
E	EPR
V	Viton

table 6 code	Element Configuration
5	HP105 coreless series, positive o-ring seals. Recommended change-out 45 psid (3,2 bar) **NO BYPASS**
6	HP106 element with bypass, 25 psid (1,8 bar) bypass, orings change-out 22 psid (1,5 bar)
7	HP107 element with bypass 50 psid (3,5 bar) bypass, orings change-out 45 psid (3,2 bar)
8	USE element P/N HP8314L39-** Interchanges with Pall HC8314, **NO BYPASS,** oring seals, max change-out 45 psid (3,2 bar)

table 7 code	Filtration rating
1M	$\beta 2.5_{(c)} = 1000$ ($\beta 1 = 200$)
3M	$\beta 5_{(c)} = 1000$ ($\beta 3 = 200$)
6M	$\beta 7_{(c)} = 1000$ ($\beta 6 = 200$)
6A	$\beta 7_{(c)} = 1000$ + water removal
10M	$\beta 12_{(c)} = 1000$ ($\beta 12 = 200$)
10A	$\beta 12_{(c)} = 1000$ + water removal
16M	$\beta 17_{(c)} = 1000$ ($\beta 17 = 200$)
16A	$\beta 17_{(c)} = 1000$ + water removal
25M 25A 25W	$\beta 22_{(c)} = 1000$ ($\beta 25 = 200$) $\beta 22_{(c)} = 1000$ + water removal 25µ nominal wire mesh
40M 40W	$\beta 35_{(c)} = 1000$ ($\beta 40 = 200$) or 40µ nominal wire mesh
74W	74µ nominal wire mesh
149W	149µ nominal wire mesh
250W	250µ nominal wire mesh

table 9 code	Indicator
X	None (ported, plugged)
P	Two pressure gages
D	22 psid visual Δp gage, + electric alarm (120V AC)
E	22 psid visual Δp gage
F	45 psid visual Δp gage, + electric alarm (120V AC)
G	45 psid visual Δp gage

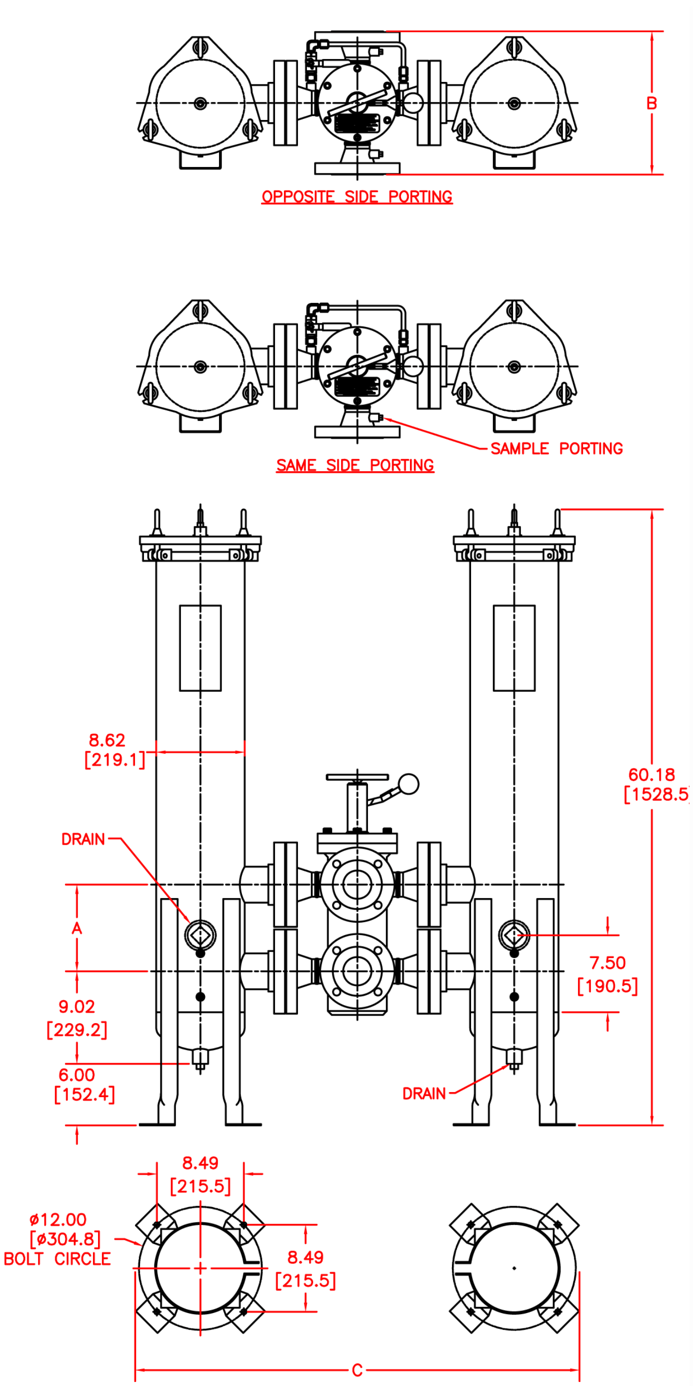
table 10 code	Max Operating Pressure
omit	150 psi, 10 bar max ANSI 150#, DIN P10
V	250 psi, 17 bar max ANSI 300#, DIN P16
W*	450 psi, 30 bar max

*450 psi (30 bar) operating pressure unit features slip & blind flange lid bolt arrangement.

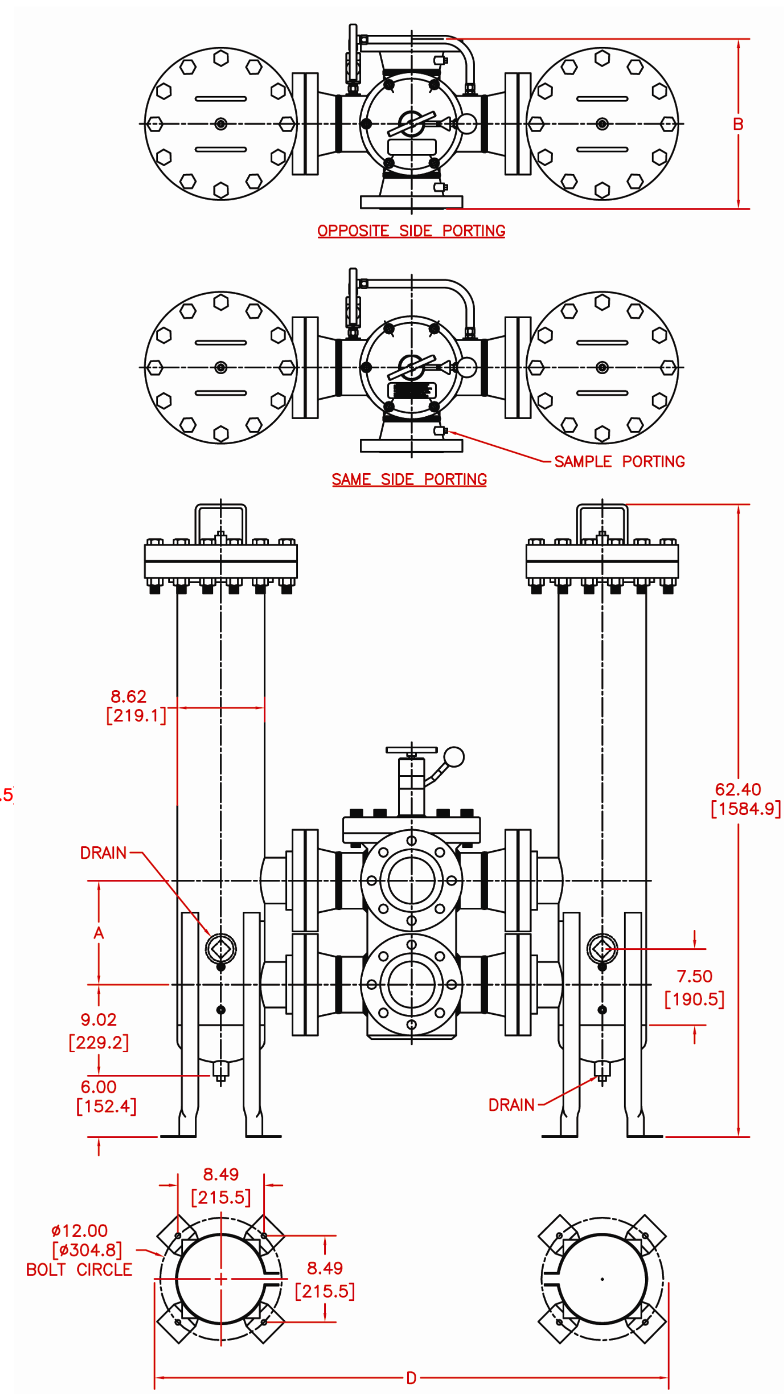
table 11 code	ASME code (optional)
omit	No Code (Standard)
U	U code
M	UM code

table 12 code	Special Options
omit	No special options selected
18	Single element length ~18" nom. (DLF only NOT DLFM)
S	304 Stainless steel vessels and hardwre

DLF - up to 250 PSI (17 BAR)

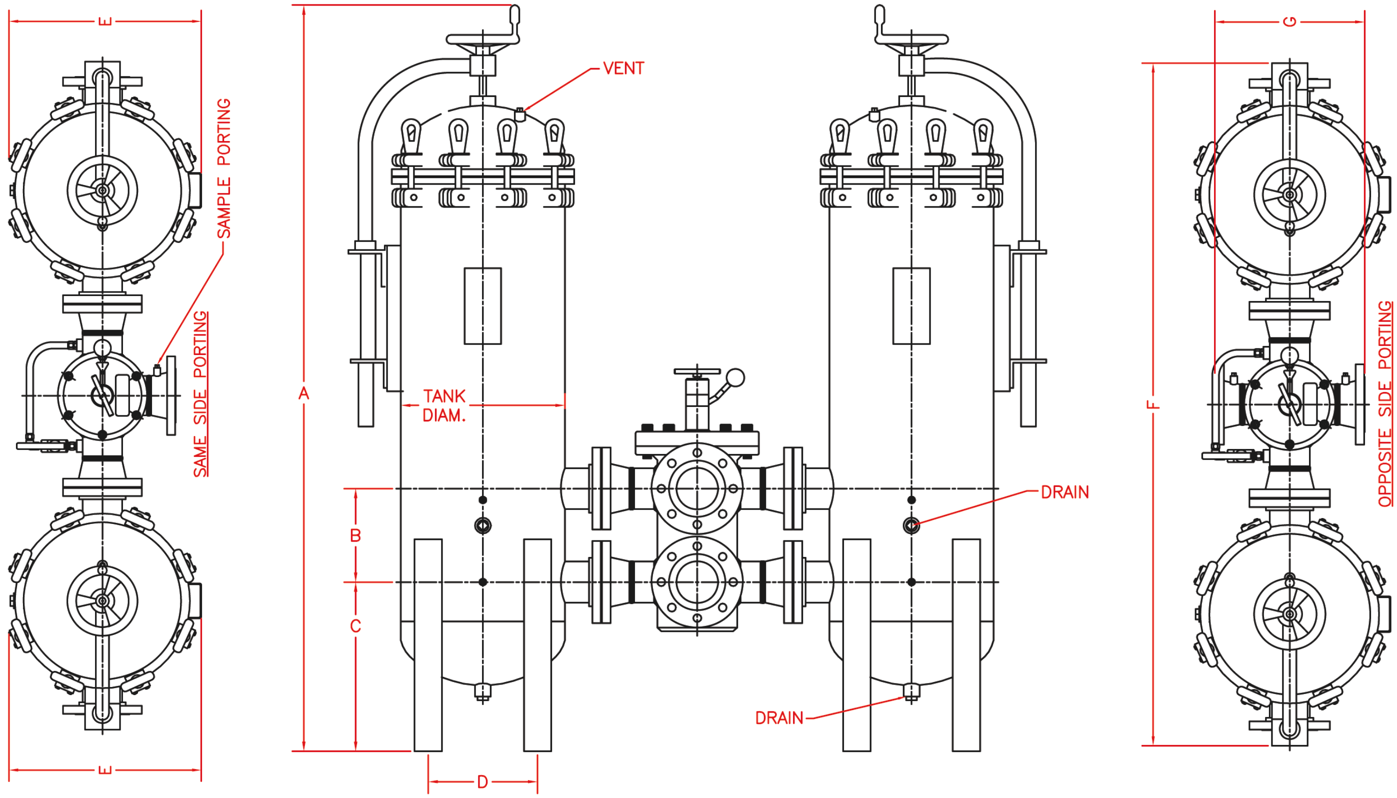


DLF - 450 PSI (30 BAR)



Dimension	Port Size ANSI Flange (DIN Flange)					
	2" (050)	3" (150#) (080, 10 bar)	3" (300#) (080, 17 bar)	4" (100)	6" (150#) (150, 10 bar)	6" (300#) (150, 17 bar)
A	6.75 (171,5)	7.75 (196,9)	8.50 (215,9)	10.25 (260,4)	11.50 (292,1)	13.00 (330,2)
B	14.00 (355,6)	14.00 (355,6)	14.00 (355,6)	16.75 (425,5)	19.75 (501,7)	19.75 (501,7)
C	41.35 (1050,3)	43.35 (1101,1)	43.35 (1101,1)	50.35 (1278,9)	55.35 (1405,9)	55.35 (1405,9)
D	41.70 (1059,2)	43.70 (1110,0)	43.70 (1110,0)	50.70 (1287,8)	55.70 (1414.8)	55.70 (1414,8)
Weight	389 lbs (180 kg)	451 lbs (205 kg)	490 lbs (225 kg)	544 lbs (250 kg)	721 lbs (330 kg)	835 lbs (380 kg)

DLFM* - 450 PSI (30 BAR)



Series	Elmt Qty.	Tank Diam.	Port Sizes	Weight Lbs (Kg)	A	B	C	D	E	F	G
DLFM3	3	16	2	1190 (541)	81.9 (2079,6)	6.8 (171,5)	18.5 (470,0)	10.0 (254,0)	19.5 (495,9)	63.5 (1612,9)	14.0 (355,6)
			3 (150 Lb)	1251 (568)	81.9 (2079,6)	7.8 (196,9)	18.5 (470,0)	10.0 (254,0)	19.5 (495,9)	65.5 (1663,7)	14.0 (355,6)
			3 (300 Lb)	1290 (586)	81.9 (2079,6)	8.5 (215,9)	18.5 (470,0)	10.0 (254,0)	19.5 (495,9)	65.5 (1663,7)	14.0 (355,6)
			4	1344 (611)	81.9 (2079,6)	10.3 (260,4)	18.5 (470,0)	10.0 (254,0)	19.5 (495,9)	72.5 (1841,5)	16.8 (425,5)
DLFM4	4	18	2	1360 (618)	81.9 (2079,6)	6.8 (171,5)	18.5 (470,0)	12.0 (304,8)	21.9 (557,9)	67.5 (1714,5)	14.0 (355,6)
			3 (150 Lb)	1421 (646)	81.9 (2079,6)	7.8 (196,9)	18.5 (470,0)	12.0 (304,8)	21.9 (557,9)	69.5 (1765,3)	14.0 (355,6)
			3 (300 Lb)	1460 (664)	81.9 (2079,6)	8.5 (215,9)	18.5 (470,0)	12.0 (304,8)	21.9 (557,9)	69.5 (1765,3)	14.0 (355,6)
			4	1514 (688)	81.9 (2079,6)	10.3 (260,4)	18.5 (470,0)	12.0 (304,8)	21.9 (557,9)	76.5 (1943,1)	16.8 (425,5)
DLFM9	9	24	3 (150Lb)	1811 (823)	81.9 (2079,6)	7.8 (196,9)	18.5 (470,0)	18.0 (457,2)	29.3 (743,9)	81.5 (2070,1)	14.0 (355,6)
			3 (300 Lb)	1850 (841)	81.9 (2079,6)	8.5 (215,9)	18.5 (470,0)	18.0 (457,2)	29.3 (743,9)	81.5 (2070,1)	14.0 (355,6)
			4	1904 (865)	81.9 (2079,6)	10.3 (260,4)	18.5 (470,0)	18.0 (457,2)	29.3 (743,9)	88.5 (2247,9)	16.8 (425,5)
			6 (150 Lb)	2081 (946)	81.9 (2079,6)	11.5 (292,1)	18.5 (470,0)	18.0 (457,2)	29.3 (743,9)	93.5 (2374,9)	19.8 (501,7)
			6 (300 Lb)	2195 (998)	81.9 (2079,6)	13.0 (330,2)	18.5 (470,0)	18.0 (457,2)	29.3 (743,9)	93.5 (2374,9)	19.8 (501,7)
DLFM14	14	30	3 (150 Lb)	2141 (973)	81.9 (2079,6)	7.8 (196,9)	18.5 (470,0)	24.0 (609,6)	36.6 (929,8)	93.5 (2374,9)	14.0 (355,6)
			3 (300 Lb)	2180 (991)	81.9 (2079,6)	8.5 (215,9)	18.5 (470,0)	24.0 (609,6)	36.6 (929,8)	93.5 (2374,9)	14.0 (355,6)
			4	2234 (1015)	81.9 (2079,6)	10.3 (260,4)	18.5 (470,0)	24.0 (609,6)	36.6 (929,8)	100.5 (2552,7)	16.8 (425,5)
			6 (150 Lb)	2411 (1095)	81.9 (2079,6)	11.5 (292,1)	18.5 (470,0)	24.0 (609,6)	36.6 (929,8)	105.5 (2679,7)	19.8 (501,7)
			6 (300 Lb)	2525 (1148)	81.9 (2079,6)	13.0 (330,2)	18.5 (470,0)	24.0 (609,6)	36.6 (929,8)	105.5 (2679,7)	19.8 (501,7)
DLFM22	22	36	4	2934 (1334)	81.9 (2079,6)	10.3 (260,4)	24.5 (622,3)	30.0 (762,0)	43.9 (1115,8)	112.5 (2857,5)	16.8 (425,5)
			6 (150 Lb)	3111 (1414)	81.9 (2079,6)	11.5 (292,1)	24.5 (622,3)	30.0 (762,0)	43.9 (1115,8)	117.5 (2984,5)	19.8 (501,7)
			6 (300 Lb)	3225 (1465)	81.9 (2079,6)	13.0 (330,2)	24.5 (622,3)	30.0 (762,0)	43.9 (1115,8)	117.5 (2984,5)	19.8 (501,7)
			8	3595 (1634)	81.9 (2079,6)	14.0 (355,6)	24.5 (622,3)	30.0 (762,0)	43.9 (1115,8)	122.0 (3098,8)	30.5 (774,7)
DLFM31	31	42	6 (150 Lb)	5831 (2650)	81.9 (2079,6)	11.5 (292,1)	24.5 (622,3)	36.0 (914,4)	51.3 (1301,8)	129.5 (3289,3)	19.8 (501,7)
			6 (300 Lb)	5945 (2702)	81.9 (2079,6)	13.0 (330,2)	24.5 (622,3)	36.0 (914,4)	51.3 (1301,8)	129.5 (3289,3)	19.8 (501,7)
			8	6315 (2870)	81.9 (2079,6)	14.0 (355,6)	24.5 (622,3)	36.0 (914,4)	51.3 (1301,8)	134.0 (3403,6)	30.5 (774,7)
			10	6640 (3018)	81.9 (2079,6)	CALL	24.5 (622,3)	36.0 (914,4)	51.3 (1301,8)	CALL	CALL
DLFM38	38	48	8	7315 (3334)	81.9 (2079,6)	14.0 (355,6)	24.5 (622,3)	42.0 (1066,8)	58.6 (1487,8)	146.0 (3708,4)	30.5 (774,7)
			10	7640 (3472)	81.9 (2079,6)	CALL	24.5 (622,3)	42.0 (1066,8)	58.6 (1487,8)	CALL	CALL
			12	7982 (3628)	81.9 (2079,6)	CALL	24.5 (622,3)	42.0 (1066,8)	58.6 (1487,8)	CALL	CALL

DFN Series Low Pressure Duplex Filter

25 bar / 63 bar, 350 psi / 888 psi Max
3M media - 30 GPM / 115 LPM Max
25M media - 58 GPM / 184 LPM Max
*W media - 102 GPM / 384 LPM Max

TYPICAL DUPLEX APPLICATIONS

Ideal for systems where filters must be serviced while continuous operation is not interrupted.

- Hydrogen Seal Oil
- Wind Turbine
- Hydraulic Systems
- Gearbox Systems
- Servo Systems
- Boiler Feed Pump
- Mechanical/Electro Hydraulic Controls
- Turbine Lube Oil
- Bearing Lube Oil
- Fuel Handling
- FD-ID-PA Fan Lube Oil
- Upgrade Cuno Auto-Kleen filters to a continuous use duplex filter assembly per Westinghouse Operation & Maintenance Memo 109.

PRODUCT SPECIFICATIONS

Materials	
Head	Aluminum
Bowl	Aluminum
Seals	Nitrile (buna) or Fluoro (viton)
Media options	G7 Dualglass, Stainless mesh
Interior coating	Anodized
Exterior coating	Powder coated or Anodized
Operating Pressure	
DFN19N Series	Maximum 63 Bar, 888 PSI (tested to 82 Bar, 1156 PSI)
DFN39N Series	Maximum 25 Bar, 352 PSI (tested to 32 Bar, 458 PSI)
Temperature rating	Buna -40°F(-40°C) to 225°F(120°C) Viton -15°F(-26°C) to 275°F(135°C)
Fluid compatibility	Biodegradable and mineral based fluids. For HWBF or specified synthetics consult factory

PRODUCT FEATURES

Duplex Assembly	Maintain continuous filtration while servicing the filter element
User Friendly Handle	Pistol grip handle with pressure equalization release allows for easy switching with one hand
Compact Assembly	All valve components are integrated into the filter assembly head which keeps the overall assembly size very compact
DFE Rated Filter Elements	DFE Rated filter elements ensure fluid cleanliness even under severe dynamic conditions of hydraulic systems

DFN FILTER ASSEMBLY SIZING & OPERATING PRESSURE GUIDELINES

DFN19N Series - Flow Rate vs. Differential Pressure (Assembly with Element)

Media code	Element Length	Max flow rate* gpm (lpm)	Port size	Assembly Δp factor* ΔBAR / lpm	Assembly Δp factor* ΔPSI / gpm
3M	4 (single)	4.0 (15)	1" SAE Code 61 Flange	0.055	2.871
6M		6.0 (22,5)		0.037	1.927
10M		9.2 (34,5)		0.026	1.303
25M		13.5 (50,6)		0.017	0.886
** W		21.5 (80,6)		0.009	0.47
3M	6 (double)	6.7 (25,4)	1" SAE Code 61 Flange	0.034	1.771
6M		9.5 (35,6)		0.023	1.198
10M		11.5 (43,2)		0.02	1.042
25M		14.3 (53,6)		0.016	0.834
** W		23 (86,2)		0.008	0.417
3M	10 (triple)	9.5 (35,7)	1" SAE Code 61 Flange	0.024	1.261
6M		11.5 (43,2)		0.02	1.042
10M		15.3 (57,5)		0.015	0.782
25M		19.2 (72)		0.012	0.625
** W		24.8 (93)		0.006	0.313

*Max flow rate and Δp factor assumes υ = 150 sus, 32 Centistokes (mm^2/s). See Δp viscosity conversion formula for viscosity change.

DFN39N Series - Flow Rate vs. Differential Pressure (Assembly with Element)

Media code	Element Length	Max flow rate* gpm (lpm)	Port size	Assembly Δp factor* ΔBAR / lpm	Assembly Δp factor* ΔPSI / gpm
3M	6 (single)	21.7 (81,5)	1 1/2" SAE Code 61 Flange	0.0106	0.552
6M		28.7 (107,9)		0.0080	0.417
10M		35.3 (132,4)		0.0066	0.344
25M		45.9 (172,4)		0.0050	0.261
** W		77.4 (290,3)		0.0024	0.155
3M	10 (double)	27.4 (102,7)	1 1/2" SAE Code 61 Flange	0.0084	0.438
6M		37.2 (139,3)		0.0062	0.323
10M		41.8 (156,8)		0.0059	0.287
25M		49.2 (184.5)		0.0041	0.234
** W		88.9 (333,3)		0.0019	0.135
3M	15 (triple)	30.7 (115,1)	1 1/2" SAE Code 61 Flange	0.0075	0.391
6M		39.9 (149,6)		0.0060	0.301
10M		49.2 (184.5)		0.0051	0.266
25M		58.4 (219)		0.0040	0.210
** W		102.5 (384,6)		0.0018	0.117

*Max flow rate and Δp factor assumes υ = 150 sus, 32 Centistokes (mm^2/s). See Δp viscosity conversion formula for viscosity change.

HY-PRO FILTRATION

DFN FILTER ASSEMBLY SIZING & OPERATING PRESSURE GUIDELINES

Effective filter sizing requires consideration of flow rate, viscosity (operating and cold start), fluid type and degree of filtration. When properly sized, bypass during cold start can be avoided/minimized and optimum element efficiency and life achieved. The filter assembly differential pressure values provided for sizing differ for each media code, and assume 150 SSU (32Cts) viscosity and 0.86 fluid specific gravity. Use the following steps to identify the correct high pressure filter assembly.

1. Calculate Δp coefficient at both operating and cold start viscosity:

$$\Delta p \text{ Coefficient} = \frac{\text{Actual Operating Viscosity (SSU)}}{150} \times \frac{\text{Actual S.G.}}{0.86}$$

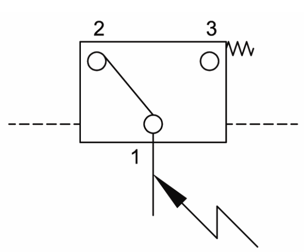
2. Calculate actual clean filter assembly Δp at both operating and cold start viscosity:

Actual assembly clean Δp = Flow rate x Δp Coefficient x Assembly Δp factor (from sizing table)

3. Sizing Recommendations to optimize performance and permit future flexibility:

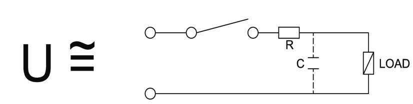
- To avoid or minimize bypass during cold start the actual assembly clean Δp calculation should be repeated for start-up conditions if cold starts are frequent.
- Actual assembly clean Δp should not exceed 15 psid at normal operating viscosity.
- If suitable assembly size is approaching the upper limit of the recommended flow rate at the desired degree of filtration consider increasing the assembly to the next larger size if a finer degree of filtration might be preferred in the future. This practice allows the future flexibility to enhance fluid cleanliness without compromising clean Δp or filter element life.
- Once a suitable filter assembly size is determined consider increasing the assembly to the next larger size to optimize filter element life and avoid bypass during cold start.
- When using water glycol or other specified synthetics we recommend increasing the filter assembly by 1~2 sizes.
- High viscosity fluid (ie gear lube ISO 220) will typically display very high viscosity as the temperature drops below 100f. For such applications avoiding bypass during start-up might not be possible.

ELECTRICAL + LED, ELECTRICAL DIFFERENTIAL PRESSURE INDICATOR INFORMATION

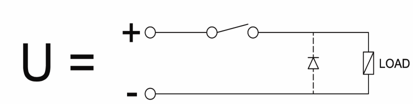


- Indication pressure - 32 psid, 2,2 bar
- Switching voltage - max 230 V ~/=
- Switching current - max 2,5 A
- Switching power - max 3,5 VA AC / 5 W DC
- Contact load - max 60 VA / 40 W
- Inrush current - 70 VA
- Electrical protection - IP 65
- Cable connection - PG11 0 6-10
- Contact type - Bistable

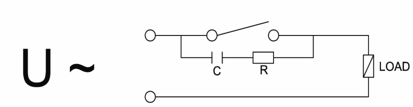
- Current limiter for DC and AC voltage. If loads are connected over long distances a protective resistor should be connected in series in order to limit the current.



- Spark suppression in DC applications. The contacts of reed switches open very fast which causes voltage peaks to be induced when switching off inductive loads (relays, lifting magnets, solenoids). The self-induction currents are short-circuited by connecting a diode in parallel to the inductive load



- Spark suppression in AC applications. In AC applications a diode connected in parallel to the load is not sufficient. RC elements should be connected in parallel to the reed switch.



HIGH PERFORMANCE FILTER ELEMENTS - THE HEART OF A FILTER

Dynamic Filter Efficiency (DFE) Testing

Revolutionary test methods assure that DFE rated elements perform true to rating even under demanding variable flow and vibration conditions. Today's industrial and mobile hydraulic circuits require elements that deliver specified cleanliness under ALL circumstances. Wire mesh supports the media to ensure against cyclical flow fatigue, temperature, and chemical resistance failures possible in filter elements with synthetic support mesh. Contact your distributor or Hy-Pro for more information and published articles on DFE testing.

Media Options

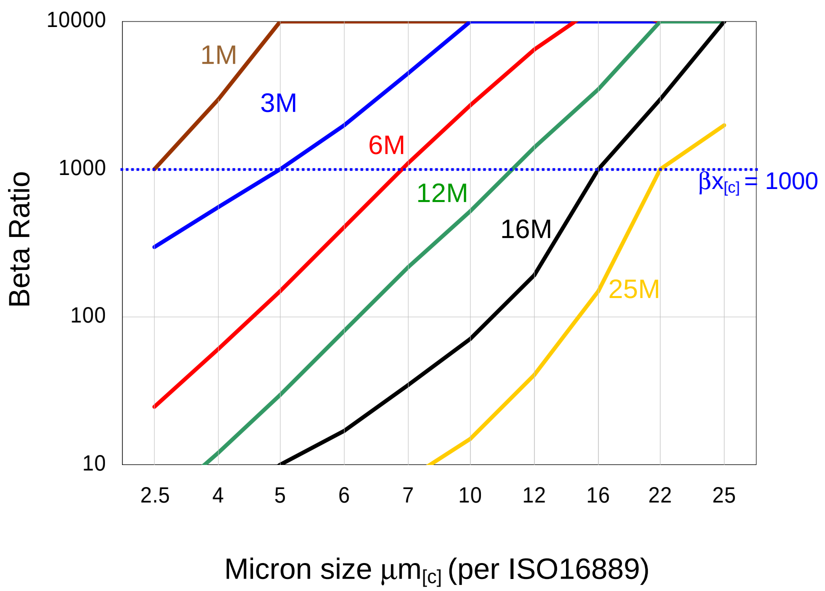
Through extensive testing we have developed media choices to handle any application. Options include G7 Dualglass, Dynafuzz (stainless fiber), and Wire mesh (stainless).

Fluid Compatibility

Petroleum based fluids, water glycol, polyol ester, phosphate ester, high water based fluids and many other synthetics. Contact us for seal material selection assistance.

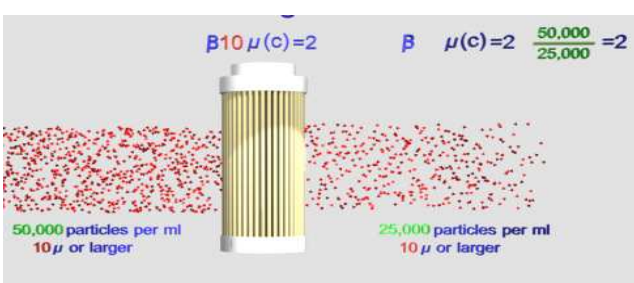
FILTER MEDIA SPECIFICATIONS

Glass Media Code Filtration Efficiency (Beta Ratio) vs Micron Size

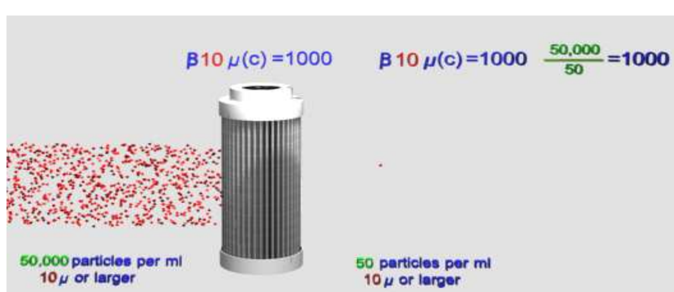


media code	media description
A	G7 Dualglass high performance media combined with water removal scrim. $\beta x_{[c]} = 1000$ ($\beta x = 200$)
M	G7 Dualglass our latest generation of DFE rated, high performance glass media for all hydraulic & lubrication fluids. $\beta x_{[c]} = 1000$ ($\beta x = 200$)
W	Stainless steel wire mesh media $\beta x_{[c]} = 2$ ($\beta x = 2$) nominally rated

Typical cellulose media performance



Hy-Pro G7 Dualglass media performance



HY-PRO FILTRATION

DFN FILTER ASSEMBLY PART NUMBER GUIDE

	table 1	table 2		table 3	table 4	table 5	table 6	table 7
DFN			-					

DFN FILTER ELEMENT PART NUMBER GUIDE

	table 1		table 4		table 6	table 7
HP		**L**		-		

Bold denotes standard product option. Non-standard options are subject to longer than standard lead time

table 1 code	Series option (max flow, max pressure)
19N	Small profile DFN Duplex Assembly 24.8 GPM, 93 LPM maximum flow rate 63 Bar, 888 PSI maximum operating pressure
39N	Large profile DFN Duplex Assembly 102 GPM, 382 LPM maximum flow rate 25 Bar, 350 psi maximum operating pressure

table 2 code	Bypass valve
B	3,5 bar, 50 psid bypass
X*	No bypass

* If maximum system pressure will exceed 25 Bar, 350 PSI and DFN19N assembly is selected the assembly must include a bypass valve (code B) for table 2. HP19N element collapse rating is 30 ΔBar, 450 ΔPSI.

table 3 code	Porting option (series)
B1	G1" BSPP thread (19N only)
B2	G1$^{1/2}$" BSPP thread (39N only)
F1	SAE 1" Code 61 Flange (19N only)
F2	SAE 1$^{1/2}$" Code 61 Flange (39N only)

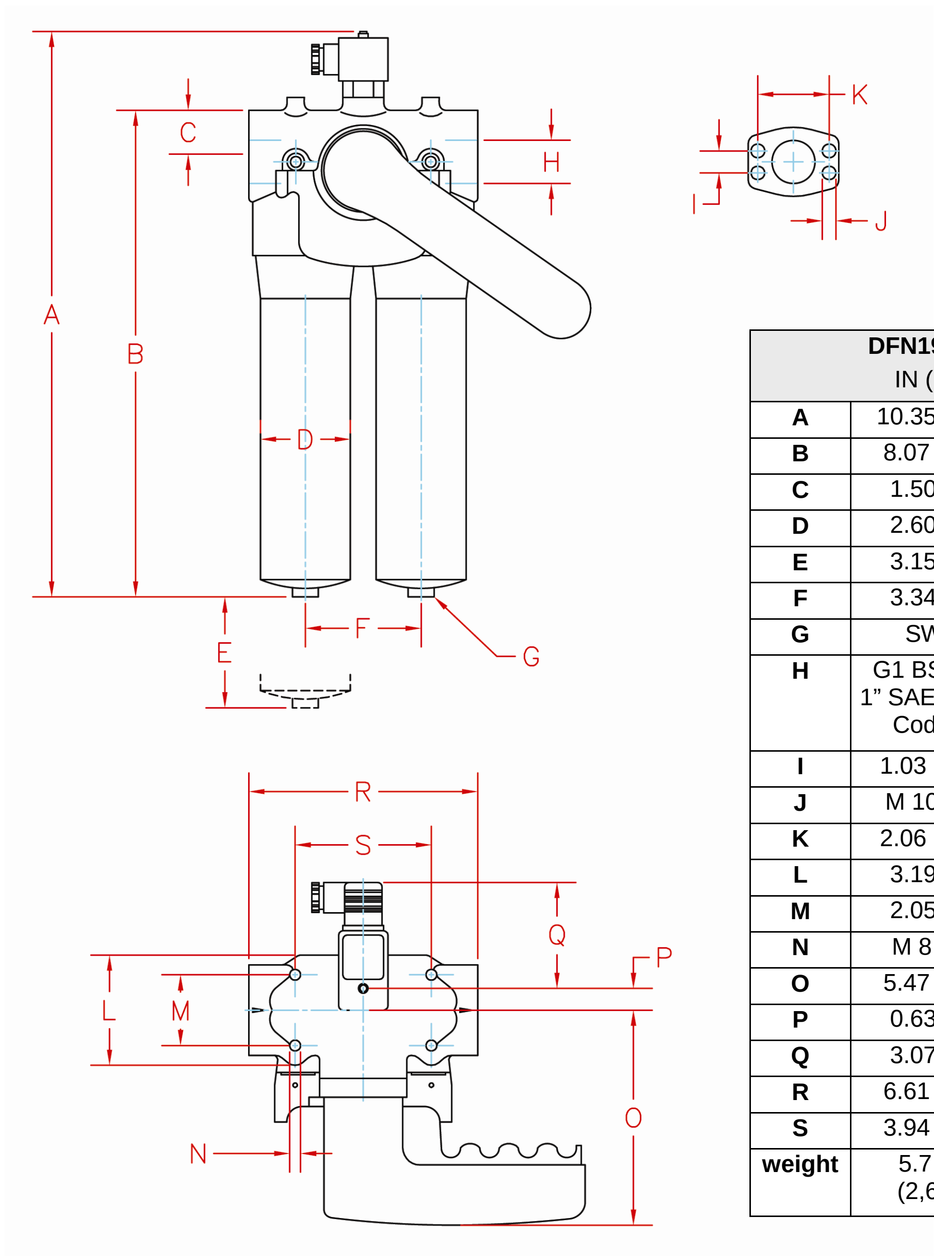
table 4 code	Element length
4	4" element nominal (19N only)
6	6" element nominal (19N, 39N)
10	10" element nominal (19N, 39N)
15	15" element nominal (39N only)

table 5 code	ΔP Indicator
V	Visual pop-up indicator only (manual reset) Indication: 2.2 barΔ, 32 psiΔ
L	Visual indicator with electrical alarm Indication: 2.2 barΔ, 32 psiΔ

table 6 code	Media selection
1M	$\beta 2.5_{[c]}$ = 1000, $\beta 1$ = 200
3M	$\beta 5_{[c]}$ = 1000, $\beta 3$ = 200
6M	$\beta 7_{[c]}$ = 1000, $\beta 6$ = 200
10M	$\beta 12_{[c]}$ = 1000, $\beta 12$ = 200
25M	$\beta 22_{[c]}$ = 1000, $\beta 25$ = 200
25W	25u nominal mesh media
40W	40u nominal mesh media
74W	74u nominal mesh media
149W	149u nominal mesh media

table 7 code	Seal material
B	Buna -40°F(-40°C) to 225°F(120°C)
V	Viton -15°F(-26°C) to 275°F(135°C)

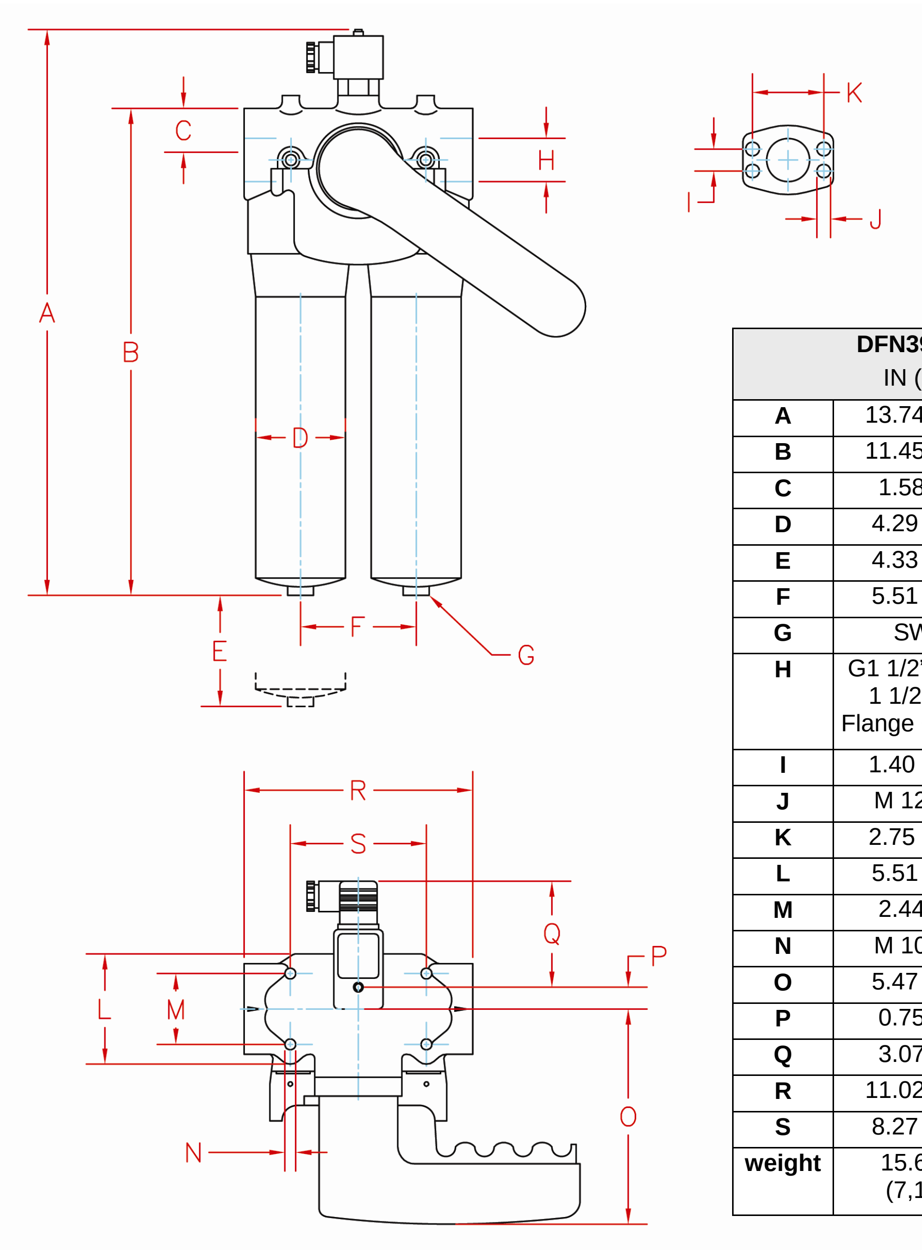
DFN19N INSTALLATION DRAWING AND SPARE PARTS LIST



	DFN19N*-* 4 IN (mm)	DFN419*-* 6 IN (mm)	DFN19N*-* 10 IN (mm)
A	10.35 (263)	12.72 (323)	16.38 (416)
B	8.07 (205)	10.43 (265)	14.1 (358)
C	1.50 (38)	1.50 (38)	1.50 (38)
D	2.60 (66)	2.60 (66)	2.60 (66)
E	3.15 (80)	3.15 (80)	3.15 (80)
F	3.34 (85)	3.34 (85)	3.34 (85)
G	SW27	SW27	SW27
H	G1 BSPP or 1” SAE Flange Code 61	G1 BSPP or 1” SAE Flange Code 61	G1 BSPP or 1” SAE Flange Code 61
I	1.03 (26,2)	1.03 (26,2)	1.03 (26,2)
J	M 10 x 20	M 10 x 20	M 10 x 20
K	2.06 (52,4)	2.06 (52,4)	2.06 (52,4)
L	3.19 (81)	3.19 (81)	3.19 (81)
M	2.05 (52)	2.05 (52)	2.05 (52)
N	M 8 x 16	M 8 x 16	M 8 x 16
O	5.47 (139)	5.47 (139)	5.47 (139)
P	0.63 (16)	0.63 (16)	0.63 (16)
Q	3.07 (78)	3.07 (78)	3.07 (78)
R	6.61 (168)	6.61 (168)	6.61 (168)
S	3.94 (100)	3.94 (100)	3.94 (100)
weight	5.7 Lbs (2,6 kg)	6.4 Lbs (2,9 kg)	7.3 Lbs (3,3 kg)

1	**Element (see Element number guide)**	**p/n**
2	**Seal Kit**	
	Nitrile NBR	DFN19SKB
	Fluorocarbon	DFN19SKV
3	**Replacement Bowl Kits**	
	Single length code 4	DFN19B4
	Double length code 6	DFN19B6
	Triple length code 10	DFN19B10

DFN39N INSTALLATION DRAWING AND SPARE PARTS LIST



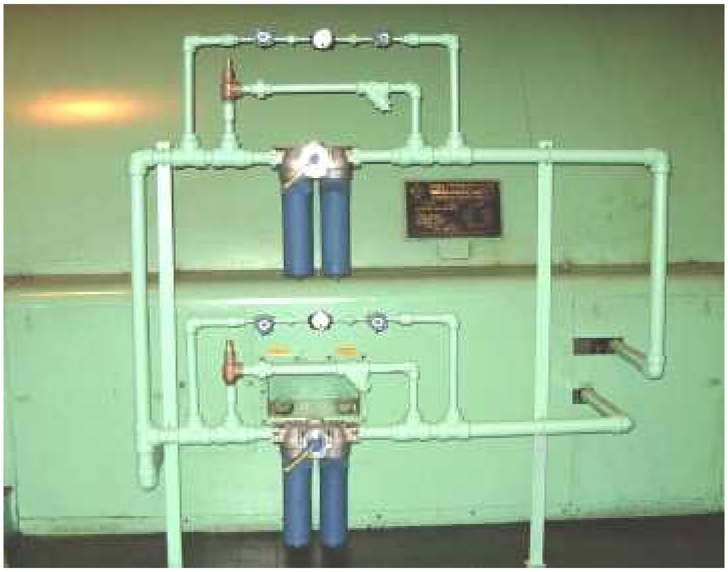
	DFN39N*-* 6 IN (mm)	DFN39N*-* 10 IN (mm)	DFN39N*-* 15 IN (mm)
A	13.74 (349)	17.48 (444)	23.15 (588)
B	11.45 (291)	15.20 (386)	20.87 (530)
C	1.58 (40)	1.58 (40)	1.58 (40)
D	4.29 (109)	4.29 (109)	4.29 (109)
E	4.33 (110)	4.33 (110)	4.33 (110)
F	5.51 (140)	5.51 (140)	5.51 (140)
G	SW32	SW32	SW32
H	G1 1/2” BSPP, 1 1/2” SAE Flange Code 61	G1 1/2” BSPP, 1 1/2” SAE Flange Code 61	G1 1/2” BSPP, 1 1/2” SAE Flange Code 61
I	1.40 (35,7)	1.40 (35,7)	1.40 (35,7)
J	M 12 x 20	M 12 x 20	M 12 x 20
K	2.75 (69,9)	2.75 (69,9)	2.75 (69,9)
L	5.51 (140)	5.51 (140)	5.51 (140)
M	2.44 (62)	2.44 (62)	2.44 (62)
N	M 10 x 20	M 10 x 20	M 10 x 20
O	5.47 (139)	5.47 (139)	5.47 (139)
P	0.75 (19)	0.75 (19)	0.75 (19)
Q	3.07 (78)	3.07 (78)	3.07 (78)
R	11.02 (280)	11.02 (280)	11.02 (280)
S	8.27 (210)	8.27 (210)	8.27 (210)
weight	15.6 Lbs (7,1 kg)	17.6 Lbs (8,0 kg)	35.9 Lbs (16,3 kg)

1	**Element (see Element number guide)**	**p/n**
2	**Seal Kit**	
	Nitrile NBR	DFN39SKB
	Fluorocarbon	DFN39SKV
3	**Replacement Bowl Kits**	
	Single length code 4	DFN39B6
	Double length code 6	DFN39B10
	Triple length code 10	DFN39B15

DFN39N POWER GENERATION FIELD APPLICATION EXAMPLES

Application: Hydrogen Seal Oil
Flow Rate: 40 GPM (150 LPM)
Oper. Pressure: 20 PSI (1.41 BAR)
Requirement: Continuous Operation

The filter was installed outside the turbine shell along with external bypass and differential pressure indicator loops since a low bypass cracking pressure (< 20 psid) was required to prevent hydrogen seal damage. The filter integral bypass cracking pressure is 50 psid. The external Δp gauge allows for filter condition monitoring, and the duplex arrangement allows for continuous filtration even when the filter element is being serviced. This installation satisfied the requirements detailed in Westinghouse Operation & Maintenance Memo 109.



Application: Mechanical Control Relay Oil
Flow Rate: 30 GPM (112 LPM)
Oper. Pressure: 150 PSI (10 BAR)
Requirement: Continuous Operation

The filter was installed outside the turbine shell along with external bypass and differential pressure indicator loops. In this case there was sufficient system operating pressure to utilize the filter assembly integral bypass valve with a setting of 50 psid (3.2 Bar) for pressure relief. No external bypass line or Δp gauge was required . This installation satisfied the requirements detailed in Westinghouse Operation & Maintenance Memo 109.

DFH Series High Pressure Duplex Filter

210 bar/250 bar, 3000 psi/3600 psi Max
3M media - 30 GPM / 115 LPM Max
25M media - 58 GPM / 184 LPM Max
*W media - 102 GPM / 384 LPM Max

TYPICAL DUPLEX APPLICATIONS

Ideal for systems where filters must be serviced while continuous operation is not interrupted.

- Marine Hydraulics
- Wind Turbine
- Hydraulic Systems
- Gearbox Systems
- Servo Systems
- Boiler Feed Pump
- Mechanical/Electro Hydraulic Controls
- Turbine Lube Oil
- Bearing Lube Oil
- Fuel Handling
- FD-ID-PA Fan Lube Oil

PRODUCT SPECIFICATIONS

Materials	
Head	Steel
Bowl	Forged Steel
Seals	Nitrile (buna) or Fluoro (viton)
Media options	G7 Dualglass, Stainless mesh
Interior coating	Corrosion resistant
Exterior coating	Powder paint coated or Anodized
Operating Pressure	
DFH19* Series	Maximum 250 Bar, 3600 PSI (tested to 325 Bar, 4700 PSI)
DFH39* Series	Maximum 200 Bar, 3000 PSI (tested to 260 Bar, 3750 PSI)
Temperature rating	Buna -40°F(-40°C) to 225°F(120°C) Viton -15°F(-26°C) to 275°F(135°C)
Fluid compatibility	Biodegradable and mineral based fluids. For High water based or specified synthetics consult factory

PRODUCT FEATURES

Duplex Assembly	Maintain continuous filtration while servicing the filter element
User Friendly Handle	Pistol grip handle with pressure equalization release allows for easy switching with one hand
Compact Assembly	All valve components are integrated into the filter assembly head which keeps the overall assembly size very compact
DFE Rated Filter Elements	DFE Rated filter elements ensure fluid cleanliness even under severe dynamic conditions of hydraulic systems

DFH FILTER ASSEMBLY SIZING & OPERATING PRESSURE GUIDELINES

DFH19* Series - Flow Rate vs. Differential Pressure (Assembly with Element)

Media code	Element Length	Max flow rate* gpm (lpm)	Port size	Assembly Δp factor* ΔBAR / lpm	Assembly Δp factor* ΔPSI / gpm
3M	4 (single)	4.0 (15)	1" SAE Code 61 Flange	0.055	2.871
6M		6.0 (22,5)		0.037	1.927
10M		9.2 (34,5)		0.026	1.303
25M		13.5 (50,6)		0.017	0.886
** W		21.5 (80,6)		0.009	0.47
3M	6 (double)	6.7 (25,4)	1" SAE Code 61 Flange	0.034	1.771
6M		9.5 (35,6)		0.023	1.198
10M		11.5 (43,2)		0.02	1.042
25M		14.3 (53,6)		0.016	0.834
** W		23 (86,2)		0.008	0.417
3M	10 (triple)	9.5 (35,7)	1" SAE Code 61 Flange	0.024	1.261
6M		11.5 (43,2)		0.02	1.042
10M		15.3 (57,5)		0.015	0.782
25M		19.2 (72)		0.012	0.625
** W		24.8 (93)		0.006	0.313

*Max flow rate and Δp factor assumes υ = 150 sus, 32 Centistokes (mm^2/s). See Δp viscosity conversion formula for viscosity change.

DFH39* Series - Flow Rate vs. Differential Pressure (Assembly with Element)

Media code	Element Length	Max flow rate* gpm (lpm)	Port size	Assembly Δp factor* ΔBAR / lpm	Assembly Δp factor* ΔPSI / gpm
3M	6 (single)	21.7 (81,5)	1 1/2" SAE Code 61 Flange	0.0106	0.552
6M		28.7 (107,9)		0.0080	0.417
10M		35.3 (132,4)		0.0066	0.344
25M		45.9 (172,4)		0.0050	0.261
** W		77.4 (290,3)		0.0024	0.155
3M	10 (double)	27.4 (102,7)	1 1/2" SAE Code 61 Flange	0.0084	0.438
6M		37.2 (139,3)		0.0062	0.323
10M		41.8 (156,8)		0.0059	0.287
25M		49.2 (184.5)		0.0041	0.234
** W		88.9 (333,3)		0.0019	0.135
3M	15 (triple)	30.7 (115,1)	1 1/2" SAE Code 61 Flange	0.0075	0.391
6M		39.9 (149,6)		0.0060	0.301
10M		49.2 (184.5)		0.0051	0.266
25M		58.4 (219)		0.0040	0.210
** W		102.5 (384,6)		0.0018	0.117

*Max flow rate and Δp factor assumes υ = 150 sus, 32 Centistokes (mm^2/s). See Δp viscosity conversion formula for viscosity change.

DFH FILTER ASSEMBLY SIZING & OPERATING PRESSURE GUIDELINES

Effective filter sizing requires consideration of flow rate, viscosity (operating and cold start), fluid type and degree of filtration. When properly sized, bypass during cold start can be avoided/minimized and optimum element efficiency and life achieved. The filter assembly differential pressure values provided for sizing differ for each media code, and assume 150 SSU (32cSt) viscosity and 0.86 fluid specific gravity. Use the following steps to identify the correct high pressure filter assembly.

1. Calculate Δp coefficient at both operating and cold start viscosity:

$$\Delta p \text{ Coefficient} = \frac{\text{Actual Operating Viscosity (SSU)}}{150} \times \frac{\text{Actual S.G.}}{0.86}$$

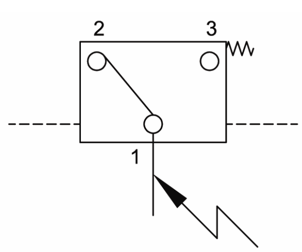
2. Calculate actual clean filter assembly Δp at both operating and cold start viscosity:

Actual assembly clean Δp = Flow rate x Δp Coefficient x Assembly Δp factor (from sizing table)

3. Sizing Recommendations to optimize performance and permit future flexibility:

- To avoid or minimize bypass during cold start the actual assembly clean Δp calculation should be repeated for start-up conditions if cold starts are frequent.
- Actual assembly clean Δp should not exceed 15 psid at normal operating viscosity.
- If suitable assembly size is approaching the upper limit of the recommended flow rate at the desired degree of filtration consider increasing the assembly to the next larger size if a finer degree of filtration might be preferred in the future. This practice allows the future flexibility to enhance fluid cleanliness without compromising clean Δp or filter element life.
- Once a suitable filter assembly size is determined consider increasing the assembly to the next larger size to optimize filter element life and avoid bypass during cold start.
- When using water glycol or other specified synthetics we recommend increasing the filter assembly by 1~2 sizes.
- High viscosity fluid (ie gear lube ISO 220) will typically display very high viscosity as the temperature drops below 100f. For such applications avoiding bypass during start-up might not be possible.

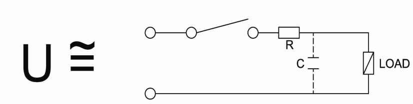
ELECTRICAL + LED, ELECTRICAL DIFFERENTIAL PRESSURE INDICATOR INFORMATION



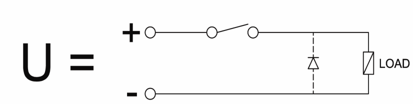
- Indication pressure - 32 psid, 2,2 bar
- Switching voltage - max 230 V ~/=
- Switching current - max 2,5 A
- Switching power - max 3,5 VA AC / 5 W DC
- Contact load - max 60 VA / 40 W
- Inrush current - 70 VA

- Electrical protection - IP 65
- Cable connection - PG11 0 6-10
- Contact type - Bistable

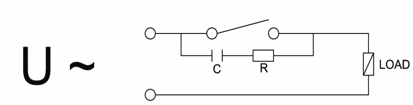
- Current limiter for DC and AC voltage. If loads are connected over long distances a protective resistor should be connected in series in order to limit the current.



- Spark suppression in DC applications. The contacts of reed switches open very fast which causes voltage peaks to be induced when switching off inductive loads (relays, lifting magnets, solenoids). The self-induction currents are short-circuited by connecting a diode in parallel to the inductive load



- Spark suppression in AC applications. In AC applications a diode connected in parallel to the load is not sufficient. RC elements should be connected in parallel to the reed switch.



HIGH PERFORMANCE FILTER ELEMENTS - THE HEART OF A FILTER

Dynamic Filter Efficiency (DFE) Testing

Revolutionary test methods assure that DFE rated elements perform true to rating even under demanding variable flow and vibration conditions. Today's industrial and mobile hydraulic circuits require elements that deliver specified cleanliness under ALL circumstances. Wire mesh supports the media to ensure against cyclical flow fatigue, temperature, and chemical resistance failures possible in filter elements with synthetic support mesh. Contact your distributor or Hy-Pro for more information and published articles on DFE testing.

Media Options

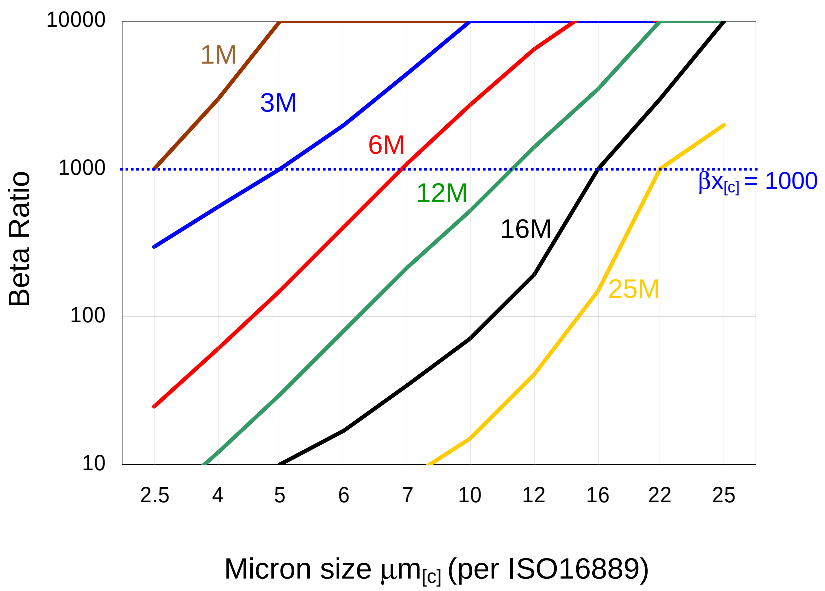
Through extensive testing we have developed media choices to handle any application. Options include G7 Dualglass, Dynafuzz (stainless fiber), and Wire mesh (stainless).

Fluid Compatibility

Petroleum based fluids, water glycol, polyol ester, phosphate ester, high water based fluids and many other synthetics. Contact us for seal material selection assistance.

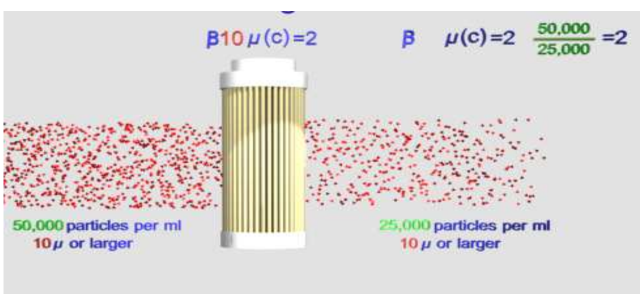
FILTER MEDIA SPECIFICATIONS

Glass Media Code Filtration Efficiency (Beta Ratio) vs Micron Size

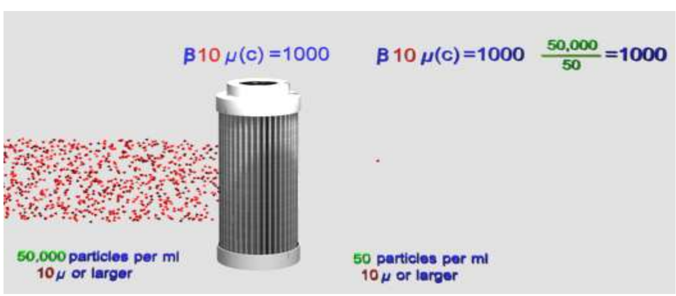


media code	media description
A	G7 Dualglass high performance media combined with water removal scrim. $\beta x_{[c]} = 1000$ ($\beta x = 200$)
M	G7 Dualglass our latest generation of DFE rated, high performance glass media for all hydraulic & lubrication fluids. $\beta x_{[c]} = 1000$ ($\beta x = 200$)
W	Stainless steel wire mesh media $\beta x_{[c]} = 2$ ($\beta x = 2$) nominally rated

Typical cellulose media performance



Hy-Pro G7 Dualglass media performance



HY-PRO FILTRATION

DFH FILTER ASSEMBLY PART NUMBER GUIDE

	table 1	table 2		table 3	table 4	table 5	table 6	table 7
DFH			**-**					

	table 1		table 4		table 6	table 7
HP		**L**		**-**		

Bold denotes standard product option. Non-standard options are subject to longer than standard lead time

table 1 code	Series option *max flow, max pressure
19H	Element collapse rating 3000 psid, 200 bar. 24.8 GPM, 93 LPM maximum flow rate. 250 Bar, 3600 PSI maximum operating pressure
19N	Element collapse rating 450 psid, 30 bar 24.8 GPM, 93 LPM maximum flow rate. 250 Bar, 3600 PSI maximum operating pressure
39H	Element collapse rating 3000 psid, 200 bar. 102 GPM, 382 LPM maximum flow rate. 210 Bar, 3000 psi maximum operating pressure
39N	Element collapse rating 450 psid, 30 bar. 102 GPM, 382 LPM maximum flow rate. 210 Bar, 3000 psi maximum operating pressure

*Adjusting for viscosity and temperature of actual system is critical to selecting the proper filter assembly.

table 2 code	Bypass valve
B	7 bar, 102 psid bypass
X*	No bypass

* If maximum system pressure will exceed 25 Bar, 350 PSI and DFH assembly is selected the assembly must include a bypass valve (code B) for table 2, or the H element collapse rating must be selected.

table 3 code	Porting option (series)
B1	G1" BSPP thread (DFH19* only)
B2	G1$^{1/2}$" BSPP thread (DFH39* only)
F1	SAE 1" Code 61 Flange (DFH19* only)
F2	SAE 1$^{1/2}$" Code 61 Flange (DFH39* only)

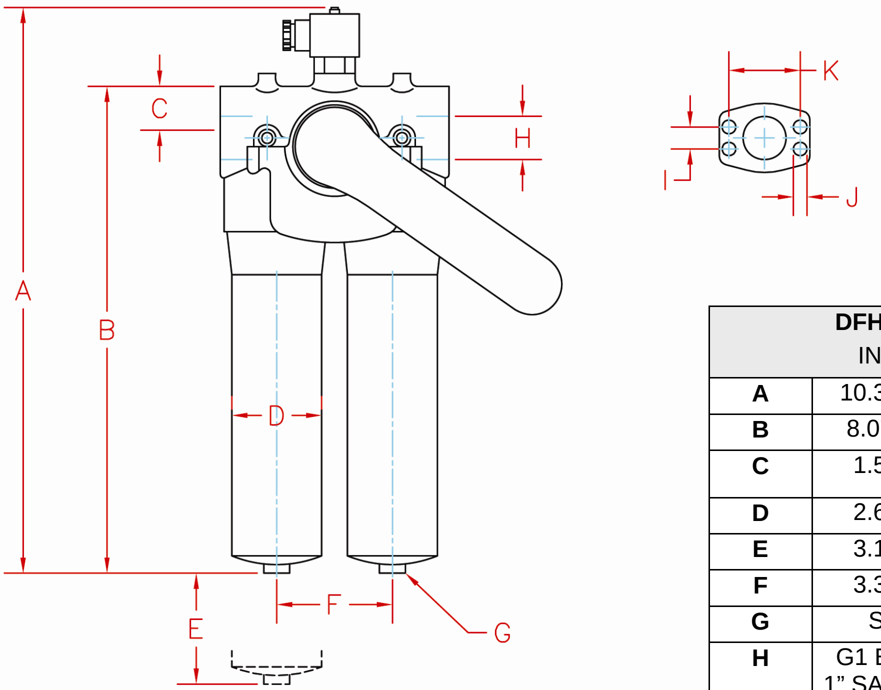
table 4 code	Element length
4	4" element nominal (19* only)
6	6" element nominal (19*, 39*)
10	10" element nominal (19*, 39*)
15	15" element nominal (39* only)

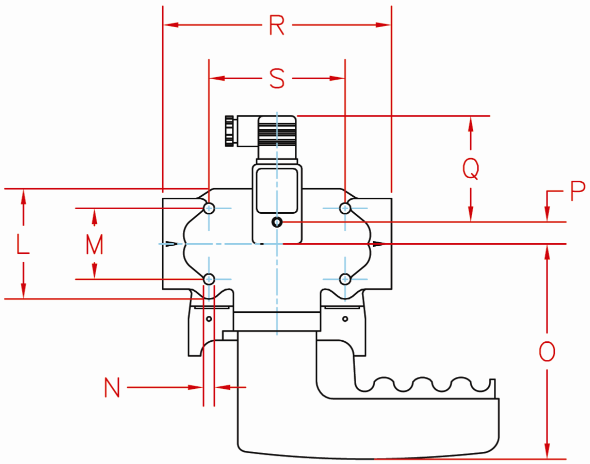
table 5 code	ΔP Indicator
V	Visual pop-up indicator only (manual reset) Indication: 5 barΔ, 72 psiΔ
L	Visual indicator with electrical alarm Indication: 5 barΔ, 72 psiΔ

table 6 code	Media selection
1M	$\beta 2.5_{[c]} = 1000$, $\beta 1 = 200$
3M	$\beta 5_{[c]} = 1000$, $\beta 3 = 200$
6M	$\beta 7_{[c]} = 1000$, $\beta 6 = 200$
10M	$\beta 12_{[c]} = 1000$, $\beta 12 = 200$
25M	$\beta 22_{[c]} = 1000$, $\beta 25 = 200$
25W	25u nominal mesh media
40W	40u nominal mesh media
74W	74u nominal mesh media
149W	149u nominal mesh media

table 7 code	Seal material
B	Buna -40°F(-40°C) to 225°F(120°C)
V	Viton -15°F(-26°C) to 275°F(135°C)

DFH19* INSTALLATION DRAWING AND SPARE PARTS LIST

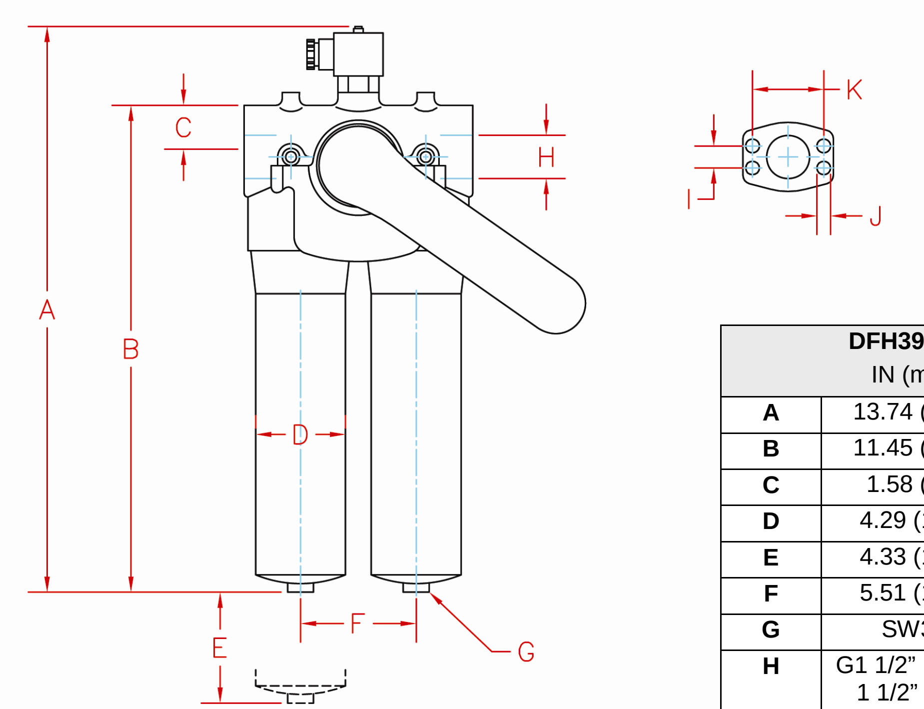


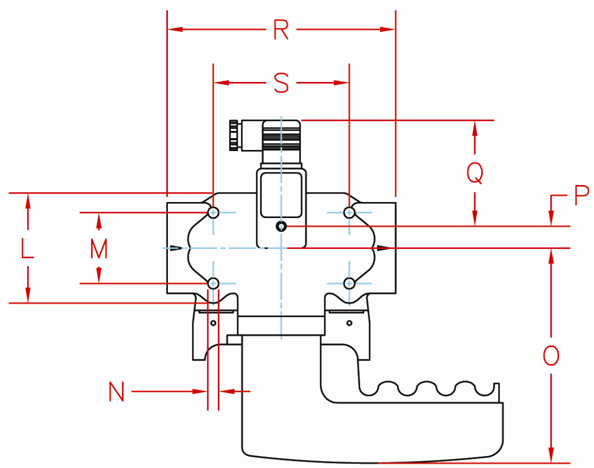


	DFH19**-* 4 IN (mm)	DFH19**-* 6 IN (mm)	DFH19**-* 10 IN (mm)
A	10.35 (263)	12.72 (323)	16.38 (416)
B	8.07 (205)	10.43 (265)	14.1 (358)
C	1.50 (38)	1.50 (38)	1.50 (38)
D	2.60 (66)	2.60 (66)	2.60 (66)
E	3.15 (80)	3.15 (80)	3.15 (80)
F	3.34 (85)	3.34 (85)	3.34 (85)
G	SW27	SW27	SW27
H	G1 BSPP or 1” SAE Flange Code 61	G1 BSPP or 1” SAE Flange Code 61	G1 BSPP or 1” SAE Flange Code 61
I	1.03 (26,2)	1.03 (26,2)	1.03 (26,2)
J	M 10 x 20	M 10 x 20	M 10 x 20
K	2.06 (52,4)	2.06 (52,4)	2.06 (52,4)
L	3.19 (81)	3.19 (81)	3.19 (81)
M	2.05 (52)	2.05 (52)	2.05 (52)
N	M 8 x 16	M 8 x 16	M 8 x 16
O	5.47 (139)	5.47 (139)	5.47 (139)
P	0.63 (16)	0.63 (16)	0.63 (16)
Q	3.07 (78)	3.07 (78)	3.07 (78)
R	6.61 (168)	6.61 (168)	6.61 (168)
S	3.94 (100)	3.94 (100)	3.94 (100)
weight	5.7 Lbs (2,6 kg)	6.4 Lbs (2,9 kg)	7.3 Lbs (3,3 kg)

1	**Element (see Element number guide)**	**p/n**
2	**Seal Kit**	
	Nitrile NBR	DFH19SKB
	Fluorocarbon	DFH19SKV
3	**Replacement Bowl Kits**	
	Single length code 4	DFH19B4
	Double length code 6	DFH19B6
	Triple length code 10	DFH19B10

DFH39* INSTALLATION DRAWING AND SPARE PARTS LIST





	DFH39**-* 6 IN (mm)	DFH39**-* 10 IN (mm)	DFH39**-* 15 IN (mm)
A	13.74 (349)	17.48 (444)	23.15 (588)
B	11.45 (291)	15.20 (386)	20.87 (530)
C	1.58 (40)	1.58 (40)	1.58 (40)
D	4.29 (109)	4.29 (109)	4.29 (109)
E	4.33 (110)	4.33 (110)	4.33 (110)
F	5.51 (140)	5.51 (140)	5.51 (140)
G	SW32	SW32	SW32
H	G1 1/2" BSPP, 1 1/2" SAE Flange Code 61	G1 1/2" BSPP, 1 1/2" SAE Flange Code 61	G1 1/2" BSPP, 1 1/2" SAE Flange Code 61
I	1.40 (35,7)	1.40 (35,7)	1.40 (35,7)
J	M 12 x 20	M 12 x 20	M 12 x 20
K	2.75 (69,9)	2.75 (69,9)	2.75 (69,9)
L	5.51 (140)	5.51 (140)	5.51 (140)
M	2.44 (62)	2.44 (62)	2.44 (62)
N	M 10 x 20	M 10 x 20	M 10 x 20
O	5.47 (139)	5.47 (139)	5.47 (139)
P	0.75 (19)	0.75 (19)	0.75 (19)
Q	3.07 (78)	3.07 (78)	3.07 (78)
R	11.02 (280)	11.02 (280)	11.02 (280)
S	8.27 (210)	8.27 (210)	8.27 (210)
weight	15.6 Lbs (7,1 kg)	17.6 Lbs (8,0 kg)	35.9 Lbs (16,3 kg)

1	**Element (see Element number guide)**	**p/n**
2	**Seal Kit**	
	Nitrile NBR	DFH39SKB
	Fluorocarbon	DFH39SKV
3	**Replacement Bowl Kits**	
	Single length code 4	DFH39B6
	Double length code 6	DFH39B10
	Triple length code 10	DFH39B15


HY-PRO
FILTER ELEMENT
FISHERS, IN.
317-849-3535
(ISO 4572)
(ISO 16889)
$\beta_{12} = 200$
$\beta_{12(c)} = 1000$
HP75L4-12MB
INSTRUCTIONS: SHUTDOWN EQUIPMENT AND DRAIN FLUID PRIOR TO REPLACING FILTER ELEMENT. LUBRICATE GASKET WITH OIL. SCREW ON UNTIL GASKET MAKES CONTACT. TIGHTEN ONE HALF TURN. START SYSTEM AND CHECK FOR LEAKS.


HY-PRO
HY-PRO
Remove air intake seal prior to installation.

Spin-on Breathers

Adaptors and Disposable Breathers

Fluid contamination is the root cause of most hydraulic system failures. Controlling airborne contamination is critical. The synergy of Hy-Pro fluid filter elements and Hy-Pro Spin-on breathers yields clean fluid and a healthy hydraulic system.

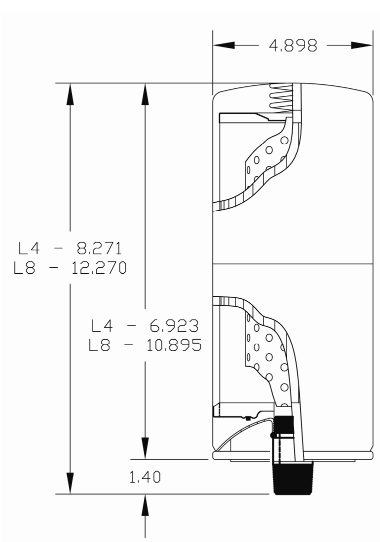
PRODUCT SPECIFICATIONS

Media Code	Media Efficiency (Air)
3M	0.3µ absolute
6M	0.6µ absolute
10C	3.0µ absolute
12M	1.0µ absolute
25C	10.0µ absolute
25M	2.5µ absolute
Operating temp.	-20°F (-28°C) to 200°F (93°C)

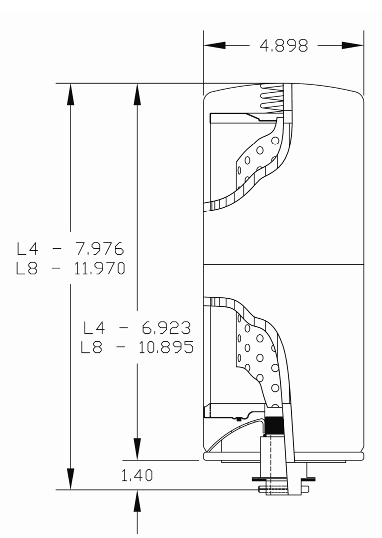
SPIN-ON BREATHER APPLICATIONS

- Replace ineffective filler / breather caps
- Control contaminant ingression with glass media elements
- High capacity, High efficiency pleated elements extend the life of other filters in the system.

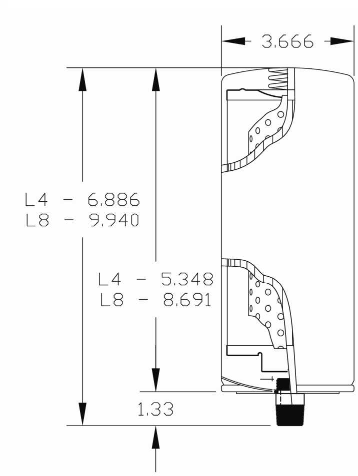
SPIN-ON BREATHER + ADAPTOR ASSEMBLY INSTALLATION DRAWINGS



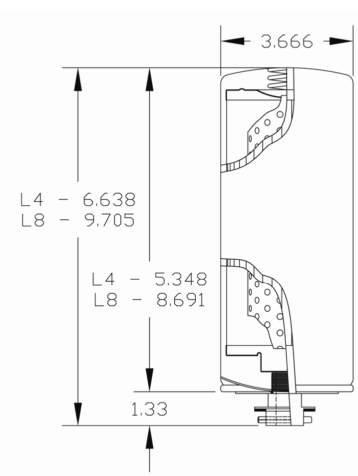
HP75L* -** + ADTB-75



HP75L*-** + ADBB-75



HP76L*-** + ADTB-76

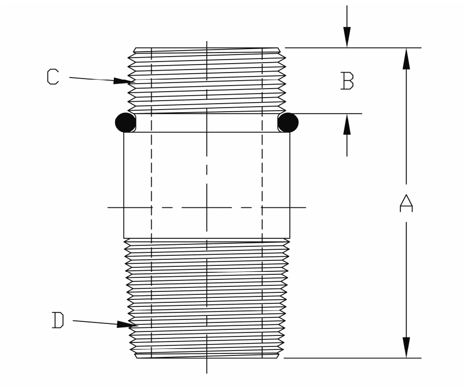


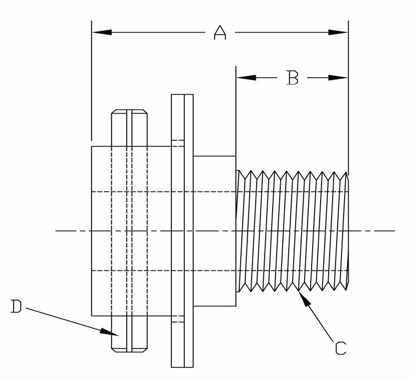
HP76L*-** + ADBB-76

SPIN-ON BREATHER ADAPTOR DIMENSIONS

Spin-on adaptor number	A - IN (mm) Overall length	B - IN (mm) Thread length	C - IN (mm) Element connection	D - IN (mm) Reservoir connection	Seal Material	Case qty
ADBB-75 (aluminum)	3.00 (76,2)	0.50 (12,7)	1 1/2" - 16 UN (HP75** series spin-on)	1.87" pin length 1.40" diameter boss	Buna-Nitrile	1
ADBB-76 (aluminum)	2.00 (50,8)	0.50 (12,7)	1" - 12 UNF-2A (HP76** series spin-on)	1.87" pin length 1.40" diameter boss	Buna-Nitrile	1
ADTB-75 (plated steel)	3.00 (76,2)	0.50 (12,7)	1 1/2" - 16 UN (HP75** series spin-on)	1 1/4" NPT	Buna-Nitrile	1
ADTB-76 (plated steel)	2.00 (50,8)	0.50 (12,7)	1" - 12 UNF-2A (HP76** series spin-on)	3/4" NPT	Buna-Nitrile	1
ADTB-76V (plated steel)	2.00 (50,8)	0.50 (12,7)	1 1/8" - 12 UNF-2A (HP76** series spin-on)	3/4" NPT	Buna-Nitrile	1

ADTB-75
ADTB-76
ADTB76V





ADBB-75
ADBB-76

REPLACEMENT ELEMENT ORDER GUIDE

table 1 table 2

HP ____ - ____ B

table 1 code	flow rate (spin-on size)
75L4	290 gpm, 39 cfm (5.0” OD x 11.0” OAL)
75L8	290 gpm, 39 cfm (5.0” OD x 11.0” OAL)
76L4	212 gpm, 28 cfm (3.75” OD x 5.4” OAL)
76L8	212 gpm, 28 cfm (3.75” OD x 8.7” OAL)

table 2 code	filtration rating
1M	0.1 μ absolute air filtration
3M	0.3 μ absolute air filtration
6M	0.6 μ absolute air filtration
12M	1.0 μ absolute air filtration
25M	2.2 μ absolute air filtration

HY-PRO FILTRATION

BF Breathers

High Flow Particulate Breathers with coreless glass media element and integral vacuum gage.

Fluid contamination is the root cause of most hydraulic system failures. Controlling airborne contamination is critical. The synergy of Hy-Pro fluid filter elements and Hy-Pro BF breathers yields clean fluid and a healthy hydraulic system.

PRODUCT SPECIFICATIONS

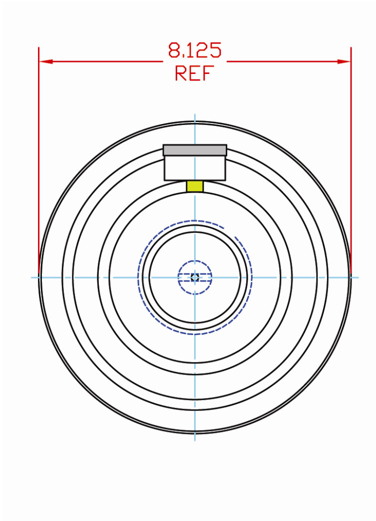
Construction materials	Tube assembly & Shroud: Plated steel Element: Synthetic end-caps, handle (element will incinerate at 1100°F)
Filtration Efficiency	Media code -3M: 0.3µ absolute Media code-6M: 0.6µ absolute Media code-10M: 1.0µ absolute Media code-25M: 2.5µ absolute
Weight	BF25*11, BF30*11 23.5 Lbs, 10.4 kg BF25*17, BF30*17 26.5 Lbs, 12 kg
Temperature	Nitrile: -40f(-40c) to 225f (107c) Fluorocarbon: -15f(-26c) to 275f(135c)

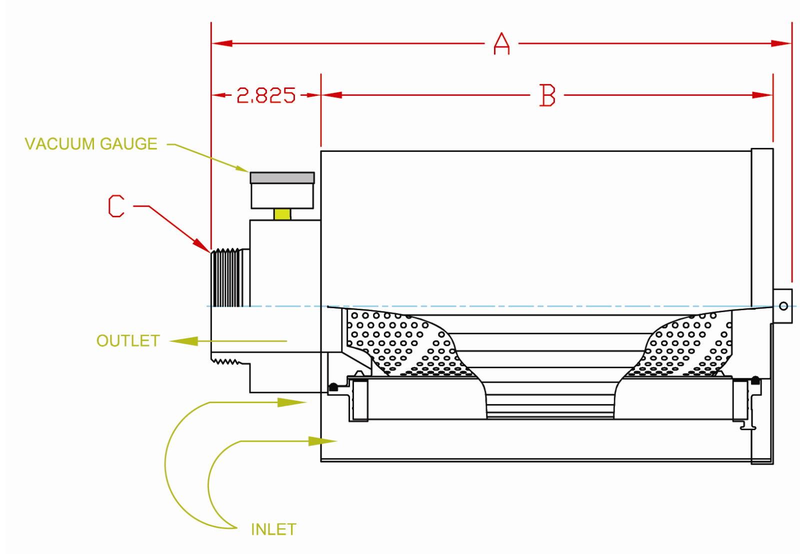
Breather Number	Air Flow		
	GPM	CFM	L/min
BF*2511	1450	195	5500
BF*2517	1580	212	6000
BF*3011	2100	280	8000
BF*3017	2375	317	9000

APPLICATIONS

- Replace ineffective filler / breather caps
- Control contaminant ingression with glass media elements
- High capacity, High efficiency pleated elements extend the life of other filters in the system.
- Large element surface area yields long life and extends service interval.

BF INSTALLATION DRAWING





Part Number	**A** (11 length)	**A** (17 length)	**B** (11 length)	**B** (17 length)	**C**
A20	16.95 (430)	22.55 (573)	13.64 (347)	19.23 (488)	2" ANSI Flange
A30	16.95 (430)	22.55 (573)	13.64 (347)	19.23 (488)	3" ANSI Flange
B25	14.95 (380)	20.55 (522)	11.64 (296)	17.23 (438)	2.5" Male BSPT
B30	14.95 (380)	20.55 (522)	11.64 (296)	17.23 (438)	3.0" Male BSPT
N25	14.95 (380)	20.55 (522)	11.64 (296)	17.23 (438)	2.5" Male NPT
N30	14.95 (380)	20.55 (522)	11.64 (296)	17.23 (438)	3.0" Male NPT

BF BREATHER ASSEMBLY PART NUMBER GUIDE

	table 1	table 2		table 3	table 4	
BF	☐	☐	**-**	☐	☐	**G**

REPLACEMENT FILTER ELEMENT PART NUMBER GUIDE

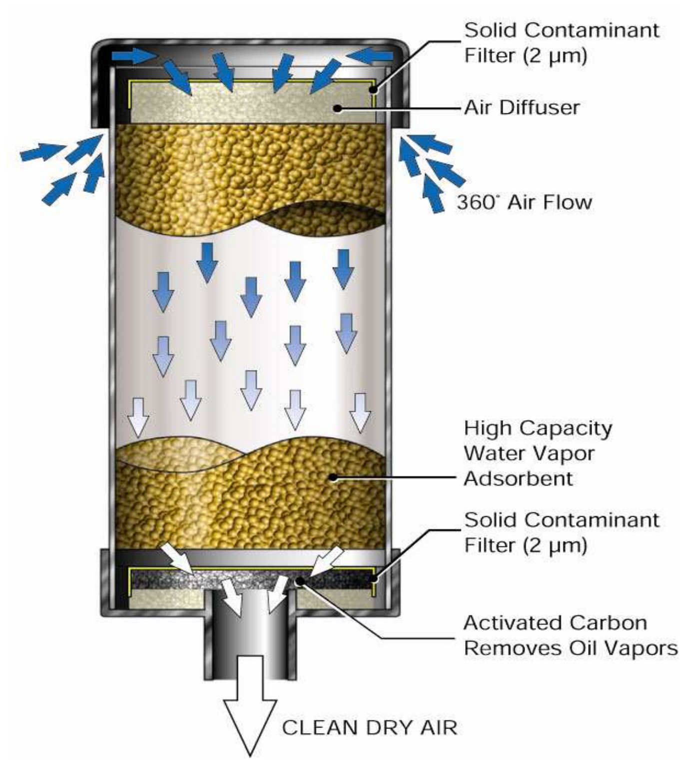
	table 2		table 3	table 4
HPBF30L	☐	**-**	☐	☐

table 1 code	Connection
A20	2" ANSI Flange
A30	3" ANSI Flange
B25	2.5" Male BSPT
B30	3.0" Male BSPT
N25	2.5" Male NPT
N30	3.0" Male NPT

table 2 code	Element length
11	Single length
17	Double length

table 3 code	Filtration rating	media type
3M	0.3μ absolute	G7 Dualglass
6M	0.6μ absolute	G7 Dualglass
10M	1.0μ absolute	G7 Dualglass
25M	2.5μ absolute	G7 Dualglass

table 4 code	Seal material
B	Nitrile-Buna
V	Fluorocarbon-Viton



Hy-Dry Breathers

Disposable Air Purifying Breathers

Fluid contamination is the root cause of most hydraulic system failures. Controlling airborne contamination is critical. The synergy of Hy-Pro fluid filter elements and Hy-Dry desiccant breathers yields fluid clarification and a healthy hydraulic system.

PRODUCT SPECIFICATIONS

Air flow rate	From 35 CFM (262 gpm) up to 250 CFM (1875 gpm).
Solid contaminant filtration efficiency	2 micron, 100% efficiency (35 CFM)
Chemical resistance	Impervious to alkalis, mineral oils, non-oxidizing acids, salt water, hydrocarbons, and synthetic oils.
HPB-34 (mini)	2.8 fl oz / 0.35 cup water capacity
HPB-100	3.1 fl oz / 0.4 cup water capacity
HPB-101	6.2 fl oz / 0.8 cup water capacity
HPB-102, B-302	13.9 fl oz / 1.7 cup water capacity
HPBR-102	13.9 fl oz / 1.7 cup water capacity
HPB-108	18.5 fl oz / 2.3 cup water capacity
HPB-109	18.5 fl oz / 2.3 cup water capacity
Operating temp.	-20°F (-28°C) to 200°F (93°C)

Contaminant	Problem	Solution
Water vapor	Rust & oxidation Additive depletion Freezing Increased conductivity Fluid degradation	Water adsorbent silica
Solid particulate	Component wear Stiction Orifice blockage	2 micron removal efficiency 100%
Acids & salts	Chemical reaction Microbial growth Overheating Corrosion	

FEATURES, BENEFITS, ADVANTAGES

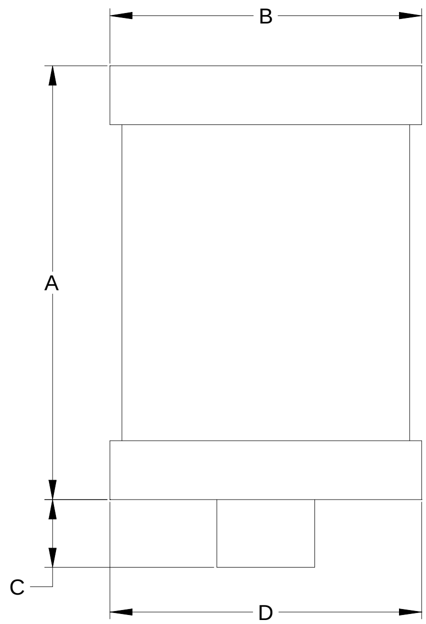
Retro-fit existing reservoirs	With adaptors a Hy-Dry breather can be installed on virtually any existing reservoir. (Versatility)
Water adsorption	Eliminate water contamination from reservoir ingression Minimize rust and acid corrosion. Reduce component wear. Reduce maintenance costs. Prolong fluid life. Reduce oil oxidation. Enhance lubricity of fluids.
Chemically inert	Gold silica gel is chemically inert, non toxic, non-deliquescent and non -corrosive. (chemically inert)
Disposable	Materials meet U.S Pharmacopoeia XXI Class VI toxicity requirements. Hy-Dry contains no metal components. (easy disposal)
Color indicator	When maximum adsorption is reached Hy-Dry will turn from Gold to Green as an indicator to replace it. (easy condition indicator)
Bi-directional air flow	Air inhaled is cleaned and dried, and oil is removed from exhausted air .
Activated carbon	As air is exhausted from the tank activated carbon removes oil vapor, fumes, and odors. (clean exhaust)

HY-DRY DISPOSAL CARTRIDGE ORDER GUIDE

Hy-Dry Number	A	B	C	D	Weight	CFM	GPM	Hy-Dry Connection
HPB-34	3.25" (3,3cm)	3.25" (3,3cm)	N/A	3.25" (3,3cm)	0.8lb (1,7kg)	10	75	1/2" FNPT
HPB-100	3.5" (9cm)	5.0" (12,8cm)	1.25" (3,2cm)	5.0" (12,8cm)	1.3lb (0.6kg)	35	262	Male 1" scd 40
HPB-101	5.0" (12,8cm)	5.0" (12,8cm)	1.25" (3,2cm)	5.0" (12,8cm)	1.9lb (0.9kg)	35	262	Male 1" scd 40
HPB-102	8.0" (20,5cm)	5.0" (12,8cm)	1.25" (3,2cm)	5.0" (12,8cm)	3.3lb (1.5kg)	35	262	Male 1" scd 40
HPB-302	8.5" (21,8cm)	5.0" (12,8cm)	N/A	5.2" (13,3cm)	3.3lb (1.5kg)	35	262	Male 1" scd 40
HPBR-102	9.5" (24,4cm)	5.0" (12,8cm)	N/A	5.2" (13,3cm)	5.0lb (2.3kg)	35	262	Male 1" scd 40
HPB-108	10.0" (25,4cm)	5.0" (12,8cm)	1.25" (3,2cm)	5.0" (12,8cm)	5.0lb (2.3kg)	100	750	2" MNPT
HPB-109	14.0" (35,5cm)	5.0" (12,8cm)	1.25" (3,2cm)	5.0" (12,8cm)	5.0lb (2.3kg)	250	1875	3" MNPT

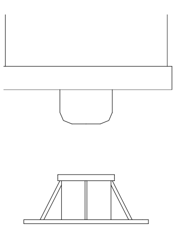
WHEN TO CHANGE THE HY-DRY BREATHER

New Hy-Dry breather silica is gold and as the silica adsorbs water the color will change to green and then to a very dark green.

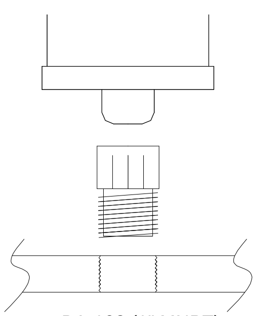


RESERVOIR ADAPTORS

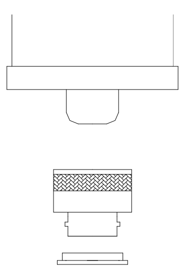
Adaptors are available to retrofit any reservoir or gearbox to accept the Hy-Dry breather. HPB-100 through HPB-102 will require one of the adaptors displayed below. HPB-108 through HPBR-102 do not require adaptors.



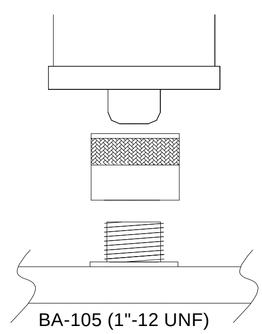
BA-101 (No Holes)
BA-114 (Six Holes)
Flange adaptors



BA-102 (1" MNPT)
BA-103 (3/4" MNPT)



BA-104
(Bayonet adaptor)
Fits filler breather flange



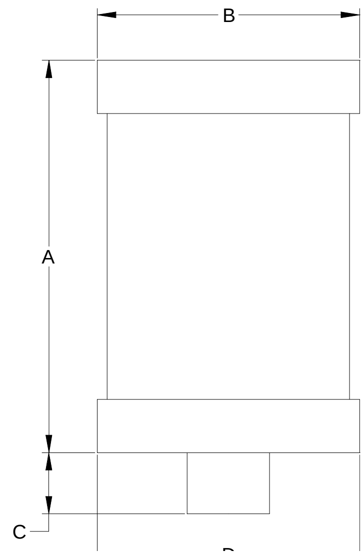
BA-105 (1"-12 UNF)
BA-106 (1.5"-16 UN)
BA-201 (1.125"-16UN-2B)

Hy-Dry Adaptor	Type
HPBA-101	Flange (no holes)
HPBA-102	1" Male NPT
HPBA-103	3/4" Male NPT
HPBA-104	Bayonet (standard filler/breather flange)
HPBA-105	1"-12 UNF
HPBA-106	1 1/2"-16 UNF
HPBA-114	Flange (6 holes)
HPBA-201	1 1/8"-16UNF

C SERIES HY-DRY BREATHERS FOR HIGH AMBIENT HUMIDITY APPLICATIONS

Hy-Dry Assembly	Check valve psi (bar)	A	B	C	Replacement Element	Weight	CFM (gpm,lpm)	Hy-Dry Stem
HPBC-101	0.3 (0,02) IN 2.1 (0,15) OUT	5.0" (12,8cm)	5.0" (12,8cm)	1.25" (3,2cm)	HPB-341	0.8lb (1,7kg)	35 (262,990)	1" schd 40
HPBC-102	0.3 (0,02) IN 2.1 (0,15) OUT	8.0" (20cm)	5.0" (12,8cm)	1.25" (3,2cm)	HPB-342	1.3lb (0.6kg)	35 (262,990)	1" schd 40
HPBC-121	0.3 (0,02) IN 2.1 (0,15) OUT	5.0" (12,8cm)	5.0" (12,8cm)	1.87" (4,7cm)	HPB-343	1.9lb (0.9kg)	35 (262,990)	2" MNPT
HPBC-122	0.3 (0,02) IN 2.1 (0,15) OUT	8.0" (20cm)	5.0" (12,8cm)	1.87" (4,7cm)	HPB-344	3.3lb (1.5kg)	35 (262,990)	2" MNPT

High humidity applications, such as paper mills and steel mills, need a Hy-Dry desiccant breather even more than a dry environment. The HPBC series breather utilizes dual check valves that control air flow in and out of the reservoir. Air does not enter or leave the reservoir unless the vacuum (0.3 psi, 0,02 bar) or pressure (2.1 psi, 0,15 bar) threshold is exceeded. The check valves prevent air exchange caused by temperature fluctuation with safeguards to protect the integrity of the tank while preventing exhaled air from coming in contact with the desiccant when exhausted (extending useful life). The HPBC-101 & HPBC-102 require and adaptor (see page 4). Assemblies include the element and permanent check valve cap. Upon service unscrew and keep the check valve cap and replace the element with identical part number shown on the element.



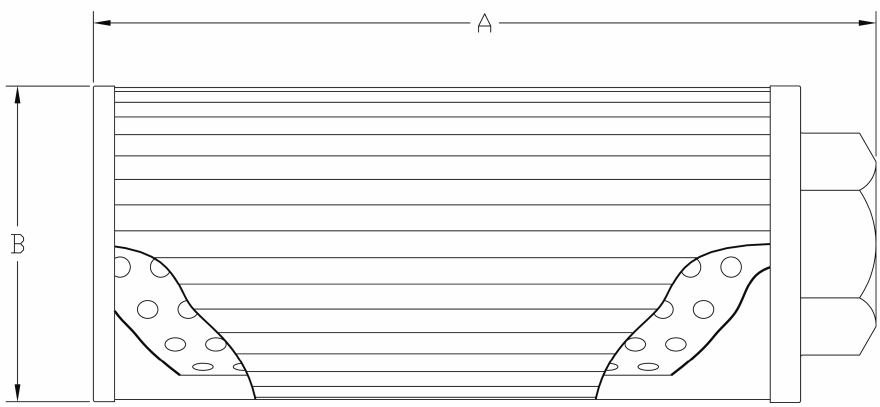
HPBR-102 FOR MOBILE AND HEAVY DUTY APPLICATIONS

*HPBR-102 assembly is complete with a metal reinforced base, that remains with the reservoir or gearbox. The replacement breather element (HPB-302) is securely threaded into the base. To service remove the element only (HPB-302) and replace with a new cartridge. The HPBR-102 assembly is recommended for Heavy Duty, Continuous vibration, Mobile, and Extreme climate applications (coal pulverizer gearbox) where a slip fit breather and adaptor could become dislodged. HPBR-102 has a 1” Male NPT connection. See page 4 table for dimensional and performance information.

In-Tank Suction Strainers

Product Description

- Threaded port sizes from 1/2” to 3” NPT or BSPT.
- 3 PSID (0,21 bar) bypass valve available.
- Max flow rate 100 gpm (378 lpm)
- 100 mesh (149m) standard. 30, 60, or 200 mesh available.
- Max Temperature 212°F (100°C)
- Compatible with petroleum and mineral based fluids only.
- Nylon Polymer threaded Open Cap.
- Corrosion resistant steel closed cap and support tube components (stainless steel is available upon request).



Series	Max rated flow GPM (5 ft/sec flow velocity)	Flow velocity at max rated flow (ft/sec)	Thread size (NPT or BSPT)	A Dimension IN (mm)	B Dimension IN (mm)	Unit weight LBS
S*05	4.7	5.3	1/2	3.1 (78,7)	2.6 (66,0)	0.5
S*08	8.3	4.8	3/4	3.5 (88,9)	2.6 (66,0)	0.5
S*10	13.5	3.7	1	5.4 (137,2)	2.6 (66,0)	0.7
S*20	23.3	4.3	1 1/4	6.9 (175,3)	3.4 (86,4)	1
S*30	31.7	4.8	1 1/2	8.1 (205,8)	3.4 (86,4)	1.2
S*50	50	7.9	1 1/2	10 (254)	3.9 (99,1)	1.4
S*51	52.2	4.8	2	10 (254)	3.9 (99,1)	1.8
S*75	74.7	5.1	2 1/2	10.1 (256,5)	5.1 (129,6)	2.3
S*100	114.8	4.4	3	11.8 (299,7)	5.1 (129,6)	3

Max flow and velocity ratings based on 225 SSU oil at 100F through standard 100 mesh media

SUCTION STRAINER PART NUMBER GUIDE

table 1	table 2		table 3		table 4
		-		-	

Bold print denotes standard options (1~4 week delivery)
Italicized print denotes non-standard options (1~12 week delivery)

table 1	
Code	Thread type
SN	**NPT thread**
SNG	*BSPT, G thread*

table 2		
Series	Max flow GPM (LPM)	Thread size
5	*4.7 (17,6)*	*1/2*
8	**8.3 (13,1)**	**3/4**
10	**13.5 (50,6)**	**1**
20	*23.3 (87,37)*	*1 1/4*
30	**31.7 (116,2)**	**1 1/2**
50	*50 (187,5)*	*1 1/2*
51	**52.2 (195,7)**	**2**
75*	**74.7 (280,1)**	**2 1/2**
*100**	*114.8 (430,5)*	*3*

*Available in SN (NPT thread only)

table 3	
Code	Stainless mesh media
30	*30 mesh*
60	*60 mesh*
100	**100 mesh (149µ nominal**)
200	*200 mesh (74µ nominal)*

table 4	
Code	Bypass valve setting
Omit	No Bypass
B3	**3 psid Bypass**

APPLICATION TOOLS

www.filterelement.com
12955 Ford Drive . Fishers, IN 46038 . USA . ph 317.849.3535 . fx 317.849.9201

PTK1 Oil Analysis Patch Test Kit

A valuable tool for visually analyzing contamination levels and contaminate types in hydraulic and lubrication systems in the field when you need results now.

PTK-1 Applications

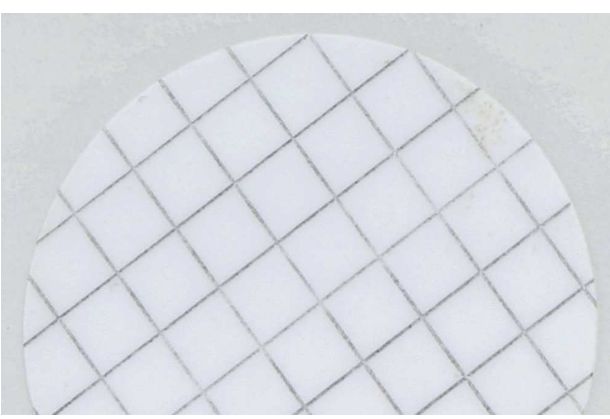
Monitoring fluid cleanliness in hydraulic and lubrication systems is a common practice. When the pressure is on waiting weeks for bottle samples from an independent lab might not be an option. Oil analysis practices vary from lab to lab and once the sample is shipped off you no longer have control of the sample or how it is processed.

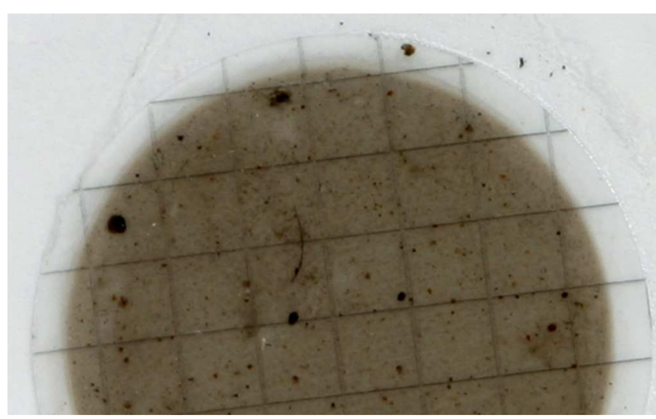
See The Difference, Control The Process

With PTK-1 oil cleanliness can be visually analyzed in the field without waiting for lab results and losing control of the analyzing process. The PTK-1 kit provides the opportunity to see the type, concentration, and actual size of particulate contamination inside the system. The kit includes reference photos so that the patch sample can be correlated to an approximate ISO Fluid Cleanliness Code. When used in conjunction with the PC4000 or PODS on-line particle counting equipment exact fluid cleanliness and visual analysis are at your fingertips. When you need results now the PTK-1 is great alternative to off-site oil analysis laboratories.

Complete PTK-1 Kit Includes

- 100x magnification field microscope
- 1.2m filter test patches
- Funnel assembly with ml fill line for accuracy
- Vacuum pump to extract fluid samples from the system and process 25ml sample through filter patch
- Sample bottles
- Forceps for filter patch handling
- Solvent dispenser with dispensing filters
- Instruction manual
- Visual correlation chart to determine approximate ISO Cleanliness Code of patch test kit sample
- Visual correlation chart to determine type of particles captured on the patch
- Patch mounting cards and adhesive covers to protect samples from ambient contamination and to preserve samples for future reference





VAC-U-Dry Application Questionnaire

From	To	Date

System Questions

Oil Volume	Litres	Gallons		
Oil Type	OEM	Grade		SG
Oil Temperature	Normal	Low		
ISO Cleanliness	Normal / /	Target / /		
Water in PPM	High	Normal	Target	
Water Ingress	Constant	Intermittent		
Current Unit	Make	Model	Series	
Coolers?	Temp setting?		Required?	
Objective in Hrs	High PPM to Target PPM	Hrs	Days	

Location Questions

Ambient Temperature				
High Temperatue				
Low Temperature				
Utility Services Available	Electrical	Volts	Hz	Amps
	Process Water	Yes/No		Temp
General Enviornment	Dry/wet/dust etc			
Unit - Mobile or Fixed in Position		Negative / Positive Head?		
Plant Application	EG. Turbine/Paper Mach etc			

Information & Respond

Reply Required	in Days

CUSTOMER OBJECTIVES

CONTACT INFORMATION	
Company Address	
NAME	POSITION
Tel No	
Email	
Fax	

HY-PRO FILTRATION

FILTER APPLICATION DATA SHEET

NAME		**Company**	
Phone		**Email**	
Mobile		**Fax**	

System Description	
Critical System Components	
Filter Location (pressure, return)	
Existing System Filtration (location, Micron rating)	

Fluid Information	Manufacturer/Trade name:		ISO VG:
	Viscosity cTs:	Viscosity SUS:	S.G:
	Emulsion mix:	Water content (PPM)	

Operating Temperature Range	FROM: ℉	TO: ℉
	FROM: ℃	TO: ℃
Cold start Temperature	℉	℃
	Time Interval to Operating Temp	Hours/Minutes

Contaminant Ingression Rate, Description (coal mill, paper mill)	LOW	MEDIUM	SEVERE

Contaminant (wear metal, gel)	
Maximum Clean Element ΔP	PSID / BAR (typically 15% - 30% indicator trip setting)
Maximum Loaded Element ΔP	PSID / BAR (dependent upon bypass valve setting)
Element Change Interval	
Target ISO Cleanliness Code (per ISO4406:1999, 4/6/14)	

System Pressure	Normal: PSI / BAR	Maximum: PSI / BAR
Pump Flow Rate	Normal: GPM / LPM	Maximum: GPM / LPM
Return Flow Rate	Normal: GPM / LPM	Maximum: GPM / LPM

Seal Material	Nitrile-Buna	Viton	EPR	Silicone	Other:		
Bypass valve psid	None	3	5	15	25	50	102
Differential Pressure Indicator		Visual Pop-Up	Electrical	Visual + Electrical	Δp Gauge	ΔP Gauge + Electric	None

Mounting Arrangement (bowl down, top loading, etc)	
Port Configuration (in-line 180°, 90°, dual inlet, etc)	
Other Requirements (Duplex, Reverse flow, Bi-Directional, etc)	
Space Restrictions (overhead) element removal, etc)	
Quantity and Required Delivery	

Notes:

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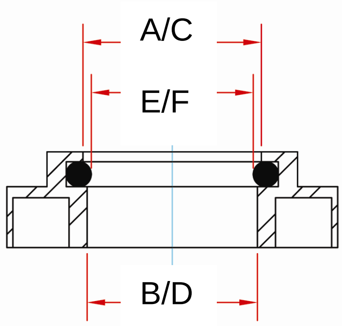
Non-Standard Filter Element Worksheet

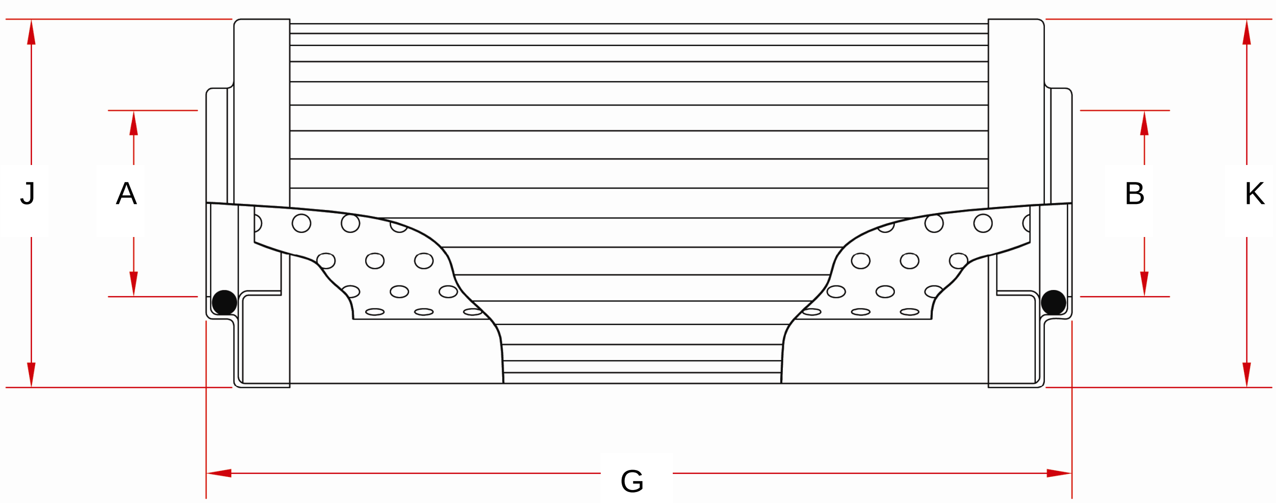
NAME		**Company**			
Phone		**Email**			
Part No.		**Element OEM**			
Element Style*	(select from grid pg2)	**Quantity required**			
End cap material	(plated steel, stainless steel, plastic molded)				
Support tube	(no-coreless, inner only, outer only, inner + outer)				
Bypass valve	(yes/no)	**Bypass setting**	(psid/bar)		
Media type	(cellulose, poly, glass, wire mesh, stainless fibre)				
Media rating	(nominal, absolute, βx = ?, $\beta x_{[c]}$ = ?)				
Seal location	(none, single end, double end)				
Seal type	(captured o-ring, male o-ring, flat gasket, grommet)				
Seal material	(Buna-nitrile, fluorocarbon-Viton, EPR, silicone, neoprene)				
Collapse rating	(psid/bar)	**Fluid type + ISO VG**			
Dimensions (must specify Inch or millimeter scale)	A (id1):	E (ort1):	I:		(in/mm**)**
	B (id1a):	F (ort2):	J (od1):		
	C (id2):	G (oal):	K (od2):		
	D (id2a):	H:	L:		

*If your element style is not on the grid (see page 2) please send a sketch and/or include digital photos



Dimension boxes H, I, L have been left blank for in a sketch or other features need to be added to the drawing. When measuring for dimensions E and F (o-ring touch-off) be sure that the o-ring is still installed and that the caliper blade makes only very light contact with the o-ring. Do not apply pressure to the o-ring.

With captured o-ring seal end caps the B or D dimension will typically be smaller than the A or C dimension respectively.



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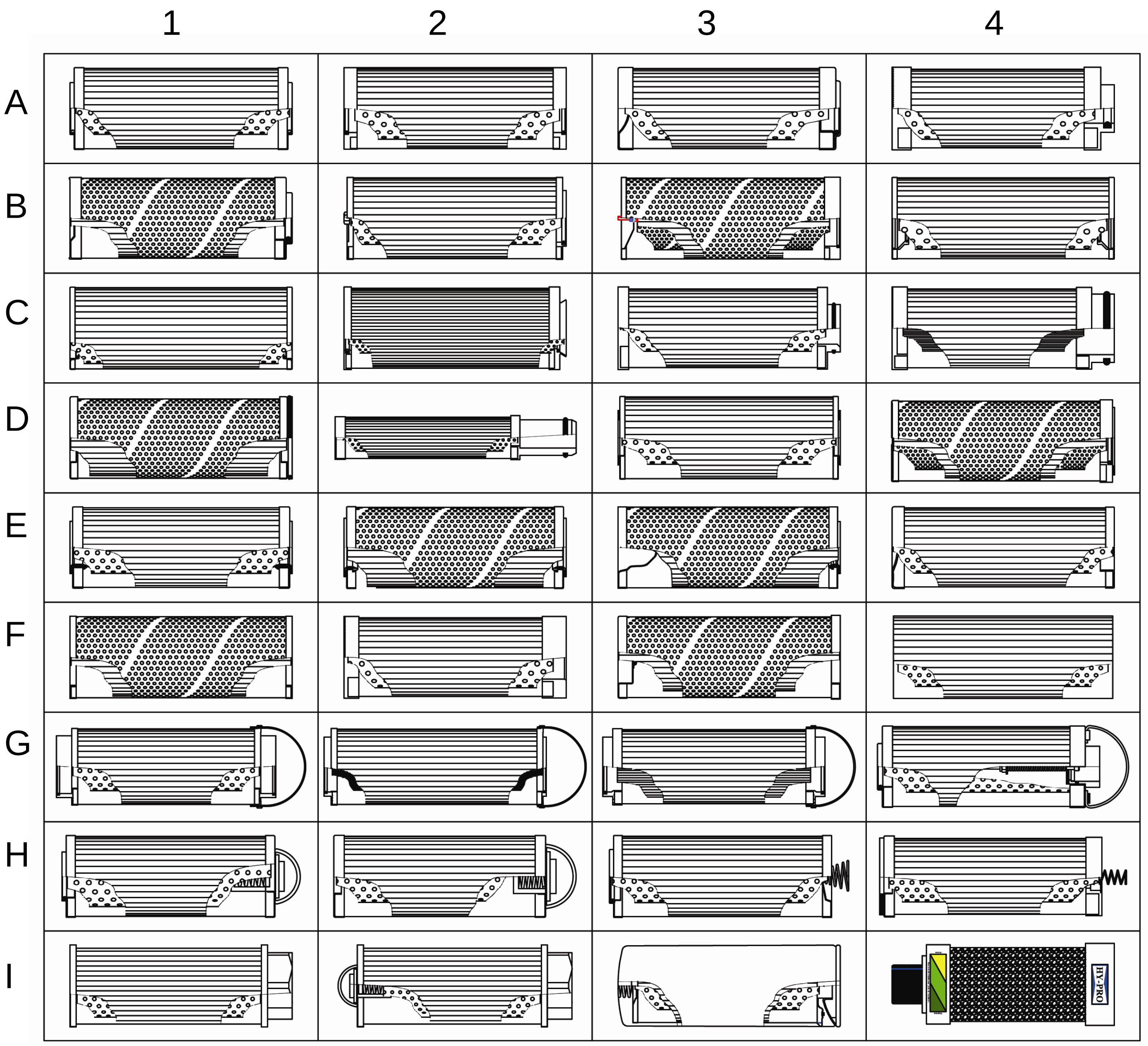
Non-Standard Filter Element Worksheet



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Warranty

Hy-Pro Filtration supplied equipment is warranted to be free from defective materials and workmanship for a period of one year from the date of shipment when used within the normal working parameters for which the equipment was designed. Hy-Pro Filtration assumes no responsibility for unauthorized installation of any added components, removal or repair of originally installed components or alterations or rewiring of originally supplied equipment. Any such changes without written instructions or prior approval from Hy-Pro Filtration will void all warranties. If any Hy-Pro Filtration supplied equipment does not perform as warranted, it will be repaired or replaced on a no-charge basis by Hy-Pro Filtration with the Purchaser initially bearing the cost of shipping to a Hy-Pro Filtration manufacturing facility.

This warranty does not apply to parts, which through normal use require replacement during the warranty period. Hy-Pro Filtration liability under this warranty shall be limited to repair or replacement. In no event however will Hy-Pro Filtration be liable for any labor or consequential damages. This warranty shall not apply to any assembly or component part of the equipment which has been furnished by Purchaser

Except for the express warranty set forth above, Hy-Pro Filtration hereby disclaims all warranties, express or implied, to Purchaser, including but not limited to, warranty of fitness for a particular purpose and warranty of merchantability. Hy-Pro Filtration shall not be liable for any incidental or consequential damages which might arise out of the use of this property.

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Material Return & Warranty Authorization Policy

Any material returned to the factory for warranty credit or replacement must be accompanied by a completed RGA (Return Goods Authorization) form. To complete the form you must contact the factory for a RGA number, which will be used to track the material sent to the factory.

All shipments must be sent to the factory freight prepaid, unless otherwise approved, to the appropriate address (confirm return location with customer service):

Hy-Pro Filtration
12955 Ford Drive
Fishers, IN 46038

Hy-Pro Filtration West
1909 Unit C
NE 5th Street
Vancouver, WA 98661

In the case of multiple item returns, all must be tagged with possible causes of failure. Please mark the outside of the shipping carton with the RGA number.

Return Disposition: Stock Items

1. Any items returned must be in unused condition unless otherwise authorized.
2. If items are returned for customer order error a restocking charge will be applied.
3. If items are returned for a Hy-Pro error a full credit will be issued.
4. Credit will not be issued on items which are no longer in specification with current design or were manufactured more than 12 months prior to the return date. Hy-Pro will determine if the items are suitable for return.

Return Disposition: Manufactured Items

1. Upon request a warranty claim form will be sent to the customer.
2. If the returned item has been determined to have a manufacturing defect and not suitable for repair a replacement part will be supplied at no cost to the customer.
3. If the returned item has been determined to have a manufacturing defect and is suitable for repair the item will be repaired or replaced at the discretion of the factory at no cost to the customer.
4. If the item has been determined not to have a manufacturing defect and is suitable for repair the customer will be sent a disposition report approval request to replace, repair, or return the part at the customer's expense.
5. If the item has been determined not to have a manufacturing defect and is not suitable for repair the customer will be sent a disposition report and asked for approval to replace or return the part at the customer's expense.

Note: All correspondence must reference the RGA# to ensure proper tracking return or claim.

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RGA # ____________________

This form must accompany any items being returned to Hy-Pro Filtration.

Customer Contact: ________________________ Position: __________________________

Company Name: ____

Customer Address: ________________________________

____

____

Machine Part No.: ____________________________________ Serial No.: _______________

Part No Returned (Description): ____

Part No Returned (Description): ____

Describe Machine Application (Use) and cause of failure:_______________________________

____

____

____

For Hy-Pro Internal Use Only

Hy-Pro Contact: ______________________ Customer Contact: ________________________

Date Form Completed: _________________ Date Item Received: ______________________

Received By: _________________________ Warranty Approved: ______ Yes ______ No

Warranty Approved By: _________________ Date of Approval: ________________________

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Hy-Pro Filtration
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Fax 317.849.9201

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