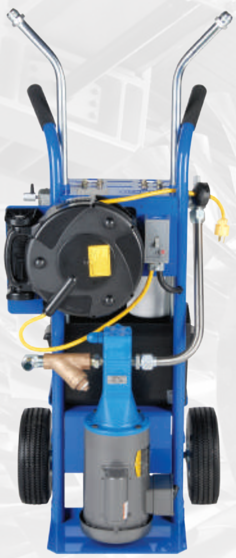


HY-PRO

FILTRATION

FLUID CONTAMINATION SOLUTIONS CATALOG 3.2

www.hyprofiltration.com

Fluid Contamination Under Control

DFE Rated Filter Element Upgrades

Upgrade existing hydraulic and lube filter elements to Hy-Pro G8 Dualglass for cleaner fluid and improved reliability. Hy-Pro Elements are validated to achieve $\beta x_{[c]} > 1000$ beta ratios. Establish a Total Cleanliness program with Hy-Pro element upgrades to achieve and maintain improved fluid cleanliness and optimize hydraulic and lubrication assets.

Element Upgrades For:

Pall	Hydac	Parker
Schroeder	MP Filtri	Internormen
Donaldson	Vickers	Eppensteiner
General Elec	Hilco	Kaydon
Indufil	PTI	Taisei Kogyo
Stauff	Western	Purolator
Porous Media	Finn	Fairey Arlon
Cuno	Baldwin	Fleetguard
Norman	Vokes	Yamashin

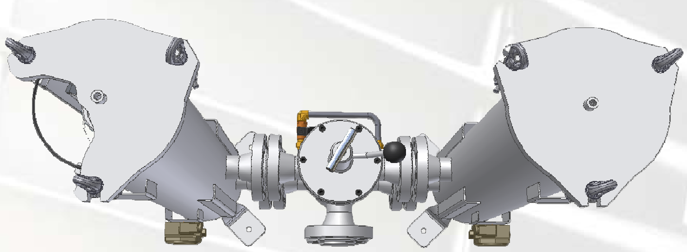
. . . And More!

High Pressure Filters

In-Tank Return Filters

High Flow Filters

High Flow Filter Assemblies & Duplexes



Off-line Filter Units

with innovative filtration products, support and solutions

Water and Entrained Gas Contamination Solutions

75% of all hydraulic component failures are caused by surface degradation which is related to fluid contamination. The effects of water in oil systems can drastically reduce lube performance and reliability. Bearing life and critical component life is greatly reduced by water 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

Hy-Pro Vac-U-Dry Vacuum Dehydrators remove water below 20 ppm (0.002%) with greater efficiency than centrifuge or air stripping technology. Intuitive design is more effective and operator friendly.

Before . . .

. . . After

COT30 Coalesce

Hy-Pro Turbine Oil and Diesel Coalesce Skids

Maintain turbine lube oil water levels below 150 ppm and remove gross free and entrained water rapidly when high water ingress from seal or heat exchanger leaks occur. High efficiency particulate filtration controls fluid cleanliness below target ISO codes.

Remove water from diesel fuels in a single pass or re-circulating configuration. Solutions include complete skids with control panel and pump to filtration only skids that can be installed in-line on existing delivery or re-circulating systems. high efficiency particulate filtration improves fuel cleanliness and protects injectors.

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 as standards.

Higher flow and flexible design allow Hy-Pro to customize a solution for any application.

Optional particle monitor.
Oil sampling ports standard.

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 and inversely as a code decreases by one the contaminant level is cut in half.

ISO 4406:1999 Code Chart		
Range Code	Particles per Milliliter	
	More Than	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

Particle Size	Particles per Milliliter	ISO 4406 Code Range	ISO Code
$4\mu_{(c)}$	**151773**	**80000~160000**	**24**
$4.6\mu_{(c)}$	87210		
$6\mu_{(c)}$	**38363**	**20000~40000**	**22**
$10\mu_{(c)}$	8229		
$14\mu_{(c)}$	**3339**	**2500~5000**	**19**
$21\mu_{(c)}$	1048		
$38\mu_{(c)}$	112		
$68\mu_{(c)}$	2		

Particle Size	Particles per Milliliter	ISO 4406 Code Range	ISO Code
$4\mu_{(c)}$	**69**	**40~80**	**13**
$4.6\mu_{(c)}$	35		
$6\mu_{(c)}$	**7**	**5~10**	**10**
$10\mu_{(c)}$	5		
$14\mu_{(c)}$	**0.4**	**0.32~0.64**	**6**
$21\mu_{(c)}$	0.1		
$38\mu_{(c)}$	0.0		
$68\mu_{(c)}$	0.0		

Succeed with a Total Systems Cleanliness Approach

Developing a Total System Cleanliness approach to control contamination and care for fluids from arrival to disposal will ultimately result in more reliable plant operation and save money. Several steps to achieve Total Systems Cleanliness include: evaluate and survey all hydraulic and lubrication systems, establish an oil analysis program and schedule, insist on specific fluid cleanliness levels for all new fluids, establish a baseline and target fluid cleanliness for each system, filter all new fluids upon arrival and during transfer, seal all reservoirs and bulk tanks, install high quality particulate and desiccant breathers, enhance air and liquid filtration on existing systems wherever suitable, use portable or permanent off-line filtration to enhance existing filtration, improve bulk oil storage and handling during transfer, remove water and make a commitment to fluid cleanliness.

The visible cost of proper contamination control and total systems cleanliness is less than 3% of the total cost of contamination when not kept under control. Keep your head above the surface and avoid the resource draining costs associated with fluid contamination issues including:

- Downtime and lost production
- Component repair/replacement
- Reduced useful fluid life
- Wasted materials and supplies ($)
- Root cause analysis meetings
- Maintenance labor costs
- Unreliable machine performance
- Wasted time and energy ($)

TARGET ISO 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 ($4\mu_{(c)}/6\mu_{(c)}/14\mu_{(c)}$). 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 $4\mu_{(c)}$ / $6\mu_{(c)}$ / $14\mu_{(c)}$

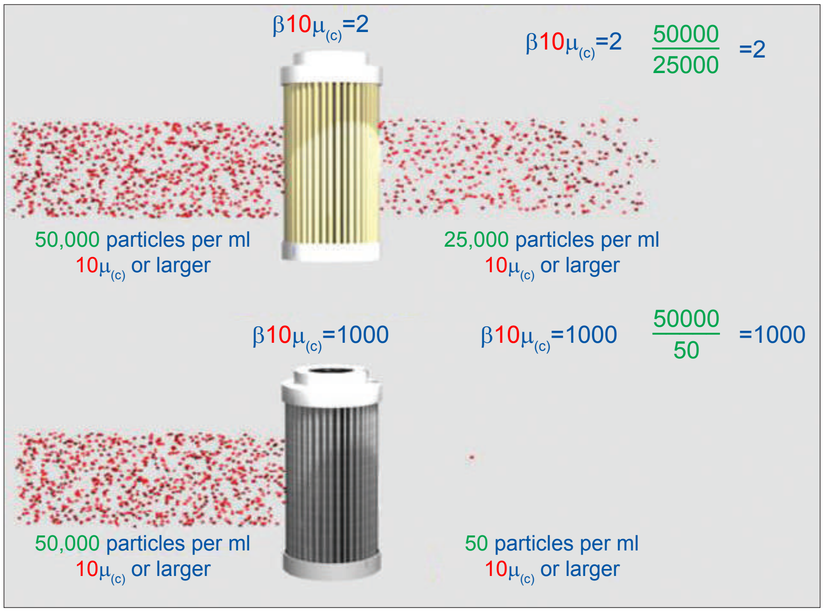
Pumps	Pressure < 138 bar < 2000 psi	Media $\beta x_{[c]} = 1000$ ($\beta x = 200$)	Pressure 138-207 bar 2000 - 3000 psi	Media $\beta x_{[c]} = 1000$ ($\beta x = 200$)	Pressure > 207 bar > 3000 psi	Media $\beta x_{[c]} = 1000$ ($\beta x = 200$)
Fixed Gear	20/18/15	$22\mu_{(c)}$ (25μ)	19/17/15	$12\mu_{(c)}$ (12μ)	-	-
Fixed Piston	19/17/14	$12\mu_{(c)}$ (12μ)	18/16/13	$12\mu_{(c)}$ (12μ)	17/15/12	$7\mu_{(c)}$ (6μ)
Fixed Vane	20/18/15	$22\mu_{(c)}$ (25μ)	19/17/14	$12\mu_{(c)}$ (12μ)	18/16/13	$12\mu_{(c)}$ (12μ)
Variable Piston	18/16/13	$7\mu_{(c)}$ (6μ)	17/15/13	$7\mu_{(c)}$ (6μ)	16/14/12	$5\mu_{(c)}$ (3μ)
Variable Vane	18/16/13	$7\mu_{(c)}$ (6μ)	17/15/12	$5\mu_{(c)}$ (3μ)	-	-
Valves						
Cartridge	18/16/13	$12\mu_{(c)}$ (12μ)	17/15/12	$7\mu_{(c)}$ (6μ)	17/15/12	$7\mu_{(c)}$ (6μ)
Check Valve	20/18/15	$22\mu_{(c)}$ (25μ)	20/18/15	$22\mu_{(c)}$ (25μ)	19/17/14	$12\mu_{(c)}$ (12μ)
Directional (solenoid)	20/18/15	$22\mu_{(c)}$ (25μ)	19/17/14	$12\mu_{(c)}$ (12μ)	18/16/13	$12\mu_{(c)}$ (12μ)
Flow Control	19/17/14	$12\mu_{(c)}$ (12μ)	18/16/13	$12\mu_{(c)}$ (12μ)	18/16/13	$12\mu_{(c)}$ (12μ)
Pressure Control (modulating)	19/17/14	$12\mu_{(c)}$ (12μ)	18/16/13	$12\mu_{(c)}$ (12μ)	17/15/12	$7\mu_{(c)}$ (6μ)
Proportional Cartridge Valve	17/15/12	$7\mu_{(c)}$ (6μ)	17/15/12	$7\mu_{(c)}$ (6μ)	16/14/11	$5\mu_{(c)}$ (3μ)
Proportional Directional	17/15/12	$7\mu_{(c)}$ (6μ)	17/15/12	$7\mu_{(c)}$ (6μ)	16/14/11	$5\mu_{(c)}$ (3μ)
Proportional Flow Control	17/15/12	$7\mu_{(c)}$ (6μ)	17/15/12	$7\mu_{(c)}$ (6μ)	16/14/11	$5\mu_{(c)}$ (3μ)
Proportional Pressure Control	17/15/12	$7\mu_{(c)}$ (6μ)	17/15/12	$7\mu_{(c)}$ (6μ)	16/14/11	$5\mu_{(c)}$ (3μ)
Servo Valve	16/14/11	$7\mu_{(c)}$ (6μ)	16/14/11	$5\mu_{(c)}$ (3μ)	15/13/10	$5\mu_{(c)}$ (3μ)
Bearings						
Ball Bearing	15/13/10	$5\mu_{(c)}$ (3μ)	-	-	-	-
Gearbox (industrial)	17/16/13	$12\mu_{(c)}$ (12μ)	-	-	-	-
Journal Bearing (high speed)	17/15/12	$7\mu_{(c)}$ (6μ)	-	-	-	-
Journal Bearing (low speed)	17/15/12	$7\mu_{(c)}$ (6μ)	-	-	-	-
Roller Bearing	16/14/11	$7\mu_{(c)}$ (6μ)	-	-	-	-
Actuators						
Cylinders	17/15/12	$7\mu_{(c)}$ (6μ)	16/14/11	$5\mu_{(c)}$ (3μ)	15/13/10	$5\mu_{(c)}$ (3μ)
Vane Motors	20/18/15	$22\mu_{(c)}$ (25μ)	19/17/14	$12\mu_{(c)}$ (12μ)	18/16/13	$12\mu_{(c)}$ (12μ)
Axial Piston Motors	19/17/14	$12\mu_{(c)}$ (12μ)	18/16/13	$12\mu_{(c)}$ (12μ)	17/15/12	$7\mu_{(c)}$ (6μ)
Gear Motors	20/18/14	$22\mu_{(c)}$ (25μ)	19/17/13	$12\mu_{(c)}$ (12μ)	18/16/13	$12\mu_{(c)}$ (12μ)
Radial Piston Motors	20/18/15	$22\mu_{(c)}$ (25μ)	19/17/14	$12\mu_{(c)}$ (12μ)	18/16/13	$12\mu_{(c)}$ (12μ)
Test Stands, Hydrostatic						
Test Stands	15/13/10	$5\mu_{(c)}$ (3μ)	15/13/10	$5\mu_{(c)}$ (3μ)	15/13/10	$5\mu_{(c)}$ (3μ)
Hydrostatic Transmissions	17/15/13	$7\mu_{(c)}$ (6μ)	16/14/11	$5\mu_{(c)}$ (3μ)	16/14/11	$5\mu_{(c)}$ (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, High Ingression Rate	17/15/12	Adjust Down One Class, Combination of Critical Nature, Severe Conditions

Hy-Pro G8 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”.

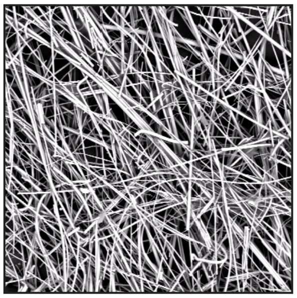


Elements of different media with the same “micron rating” can have substantially different filtration efficiency. Figure 1 provides a visual representation of the difference between absolute and nominal filter efficiency.

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.

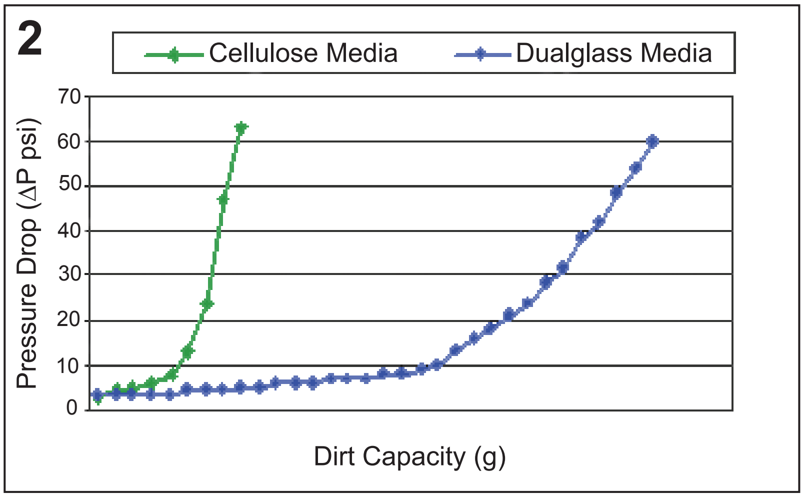
Inorganic glass fibers are much more uniform in diameter and are smaller than cellulose fibers. Organic cellulose fibers can be unpredictable in size and effective useful life. Smaller fiber size means more fibers and more void volume space to capture and retain contaminate.



Upgrading to Hy-Pro G8 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	-	-	-

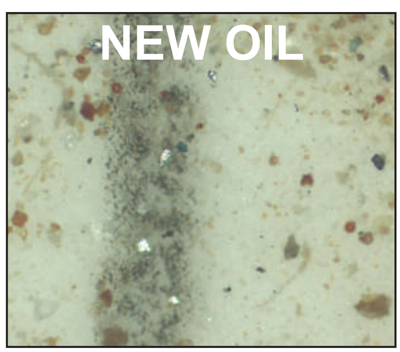
Develop a Fluid Cleanliness Target

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.



HY-PRO FILTRATION

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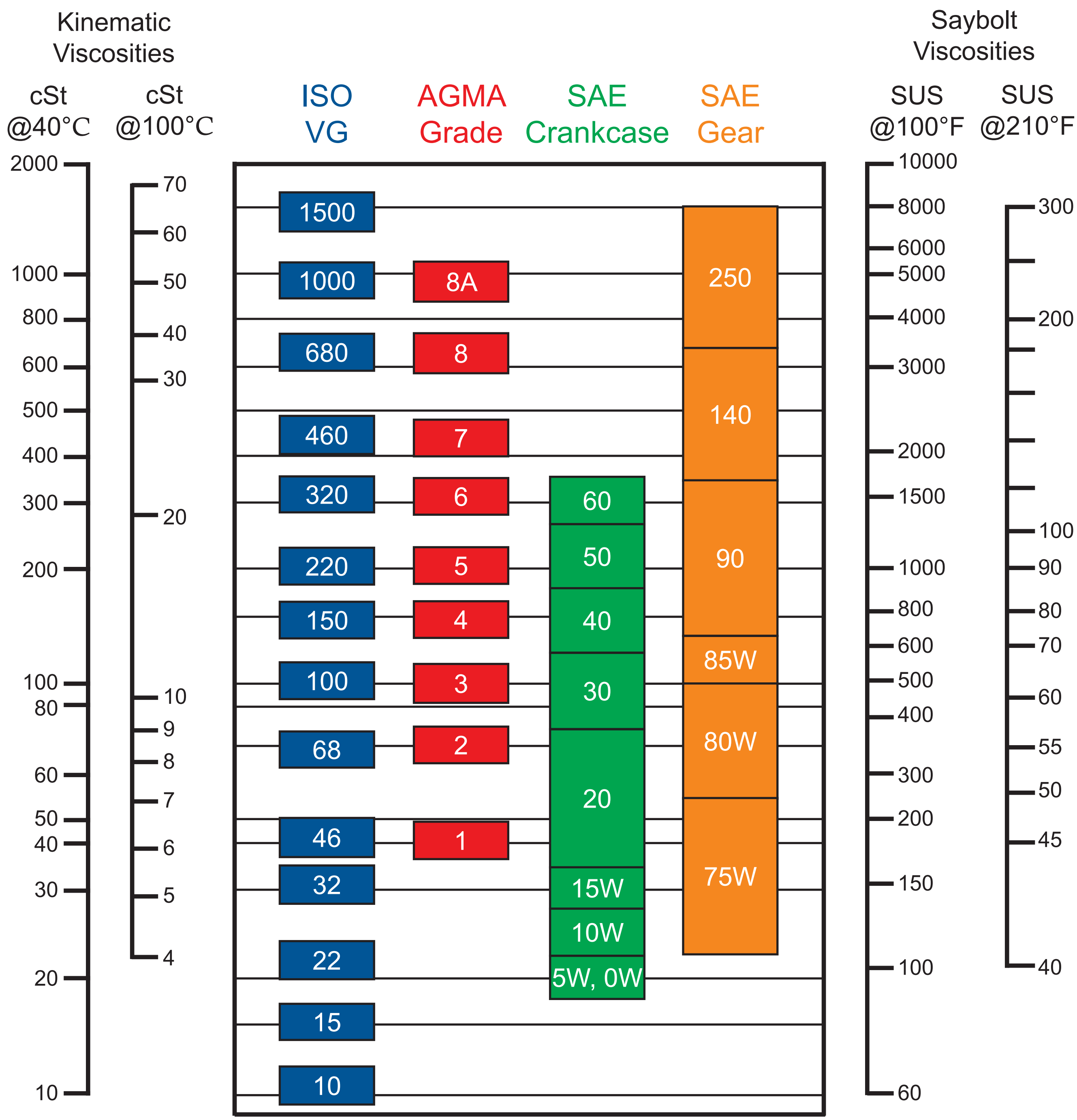
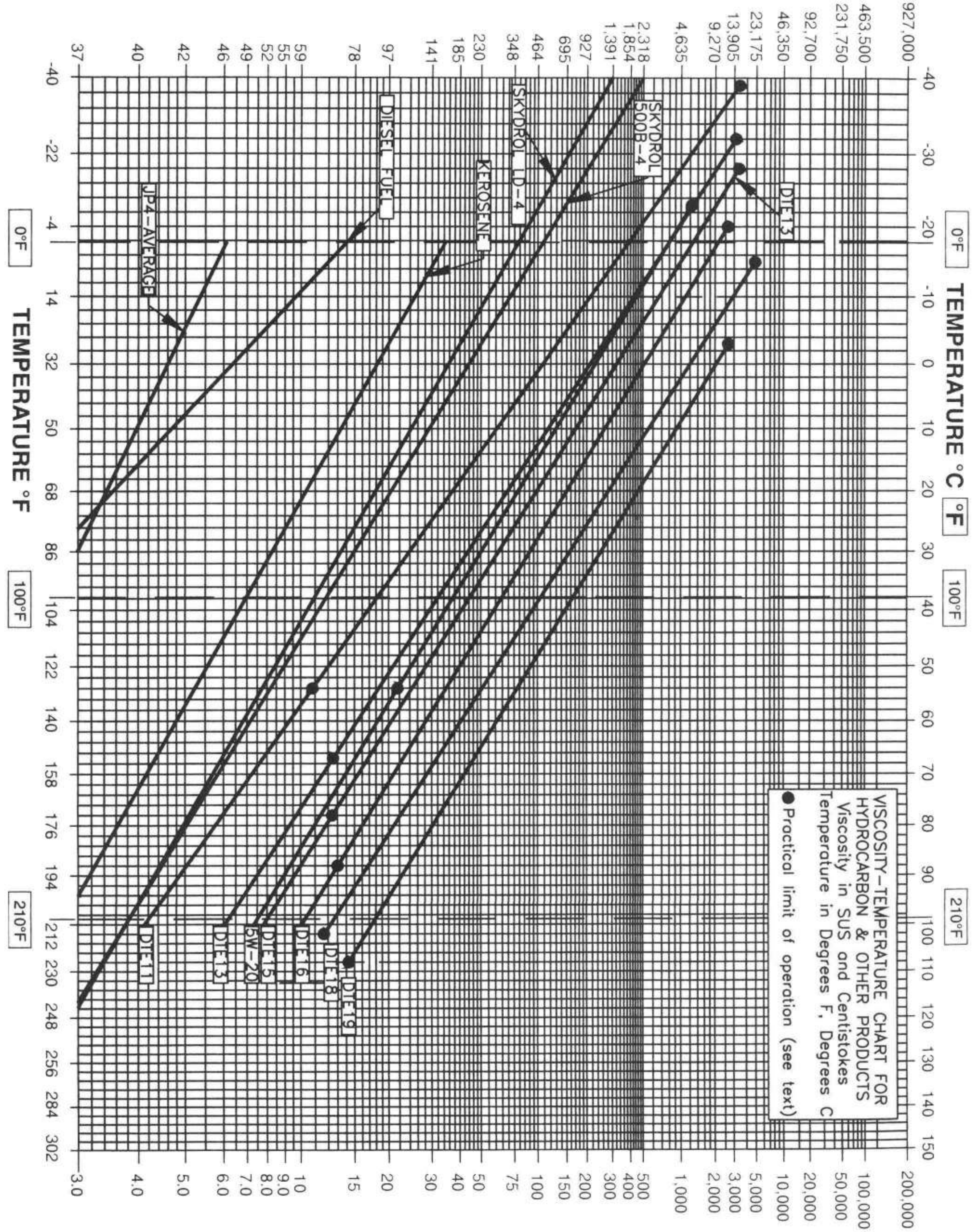
New Product

Viscosity



HY-PRO FILTRATION

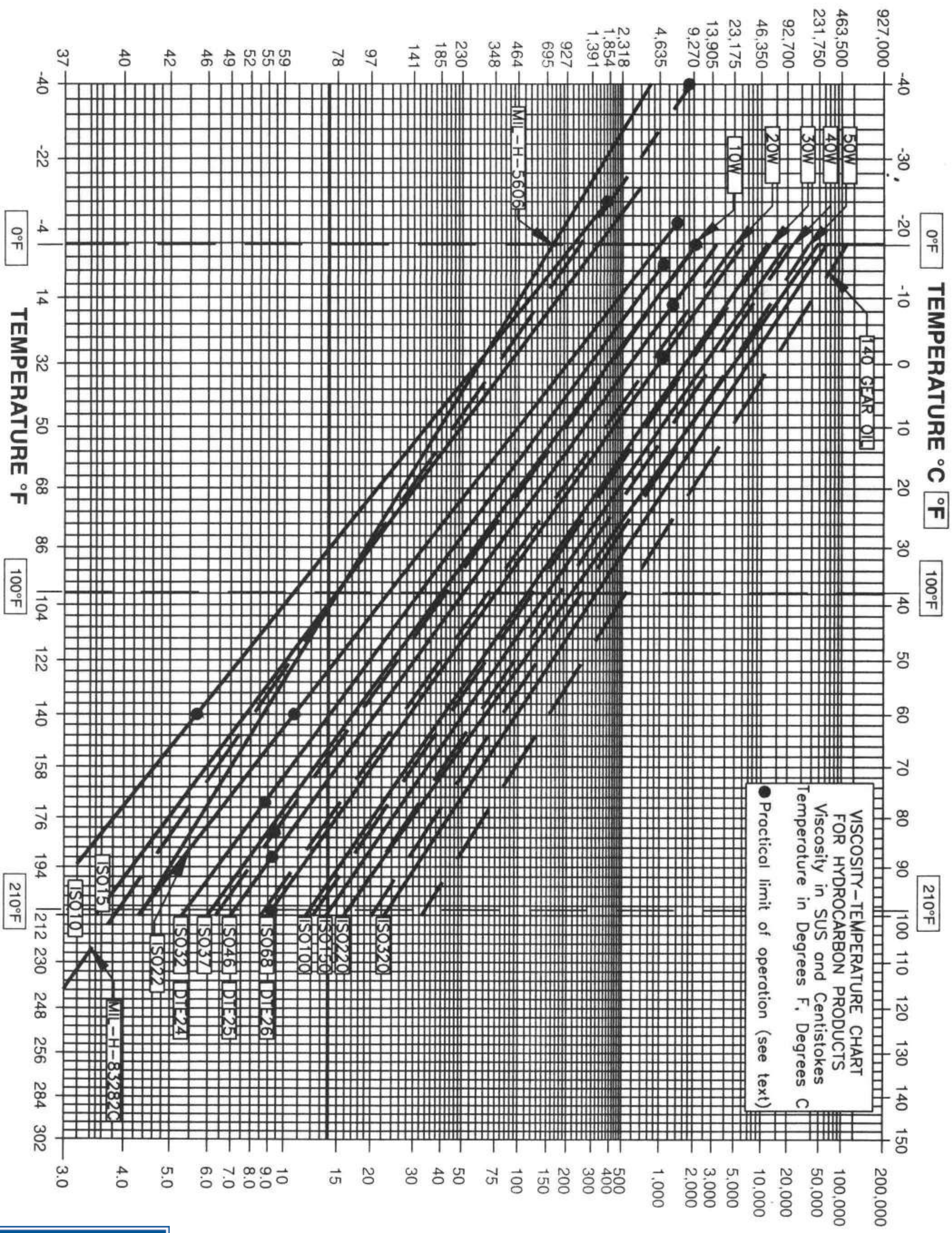
VISCOSITY (SUS)



VISCOSITY (CS)

HY-PRO FILTRATION

VISCOSITY (SUS)



VISCOSITY (CS)

HY-PRO

FILTRATION

DFE . . . The Evolution in Filter Element
Multi-Pass Development Testing
Hy-Pro's Competitive Advantage

HY-PRO

FILTRATION

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).

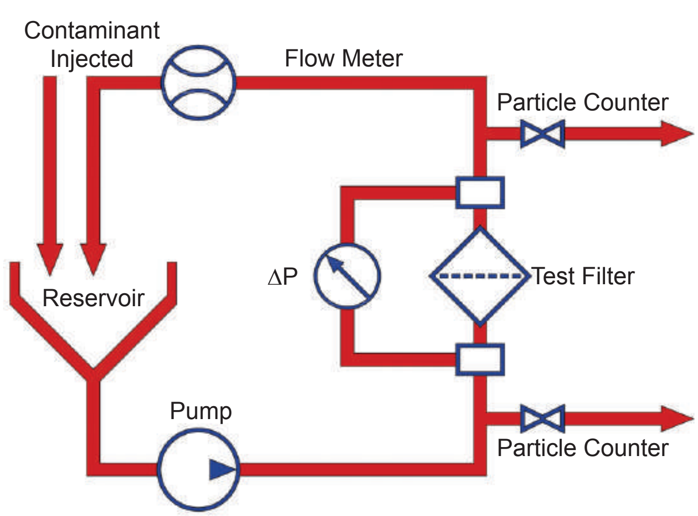
System design, filter performance and maintenance practices largely determine the contamination level in a system. Filters are expected to maintain contamination below critical tolerance levels. Filter performance in a dynamic operating system is variable based upon flow rate and flow density, changes 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.

Figure 1: ISO16889 Multi-Pass Test



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 x 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 2: Particle Counts Downstream of Filter $6\mu_{[c]}$

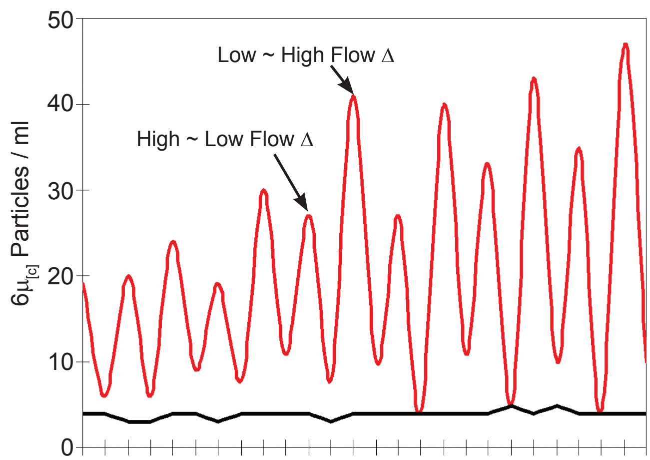


Figure 3 shows the particle counter raw data (top-upstream, bottom-downstream) for Element A1 before a change from low flow to high flow and Figure 4 shows the particle counter data for Element A1 during a change from low flow to high flow. The downstream particle count trace during the change reveals 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.

Figure 3: Element A1 Before Flow Change

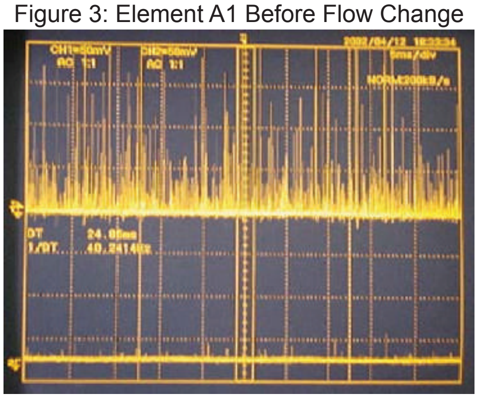
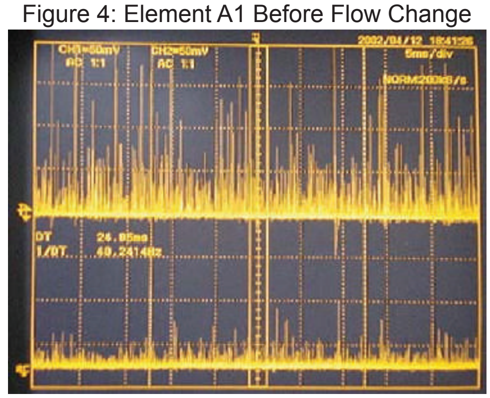


Figure 4: Element A1 Before Flow Change



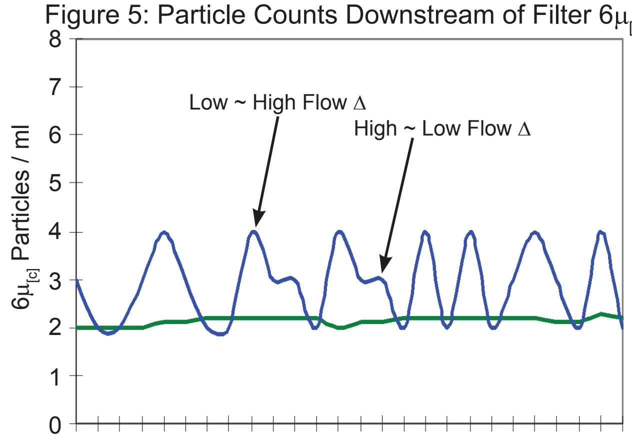
The DFE Testing Method - Quantifying Contaminant Capture and Retention

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 $\beta 7_{[c]} > 1000$. 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 G8 Dualglass media which have been designed and developed per the DFE multi-pass test method. All Hy-Pro elements that utilize the G8 or higher media carry the Hy-Pro DFE rating.

Filter Element	Hy-Pro 1	Hy-Pro 2
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

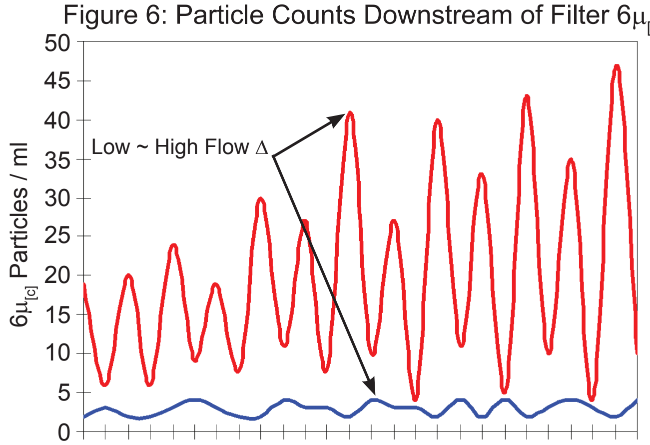
Figure 5: Particle Counts Downstream of Filter $6\mu_{[c]}$



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 $\beta 7_{[c]} > 1000$ 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.

Figure 6: Particle Counts Downstream of Filter $6\mu_{[c]}$



Filter Element	Element A1	Hy-Pro 1
Element Rating	$\beta 7_{[c]} > 1000$	$\beta 7_{[c]} > 1000$
High Flow (lpm)	112	112
Low Flow (lpm)	56	56
Contaminant Injection Rate	3 mg/l	3 mg/l

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: Particle Counts Downstream of Filter

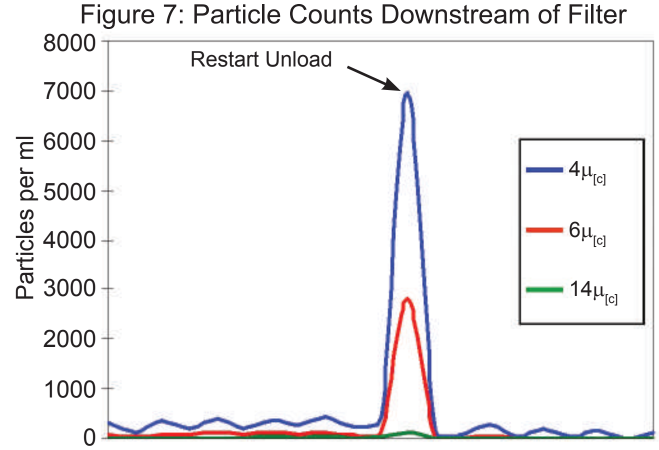
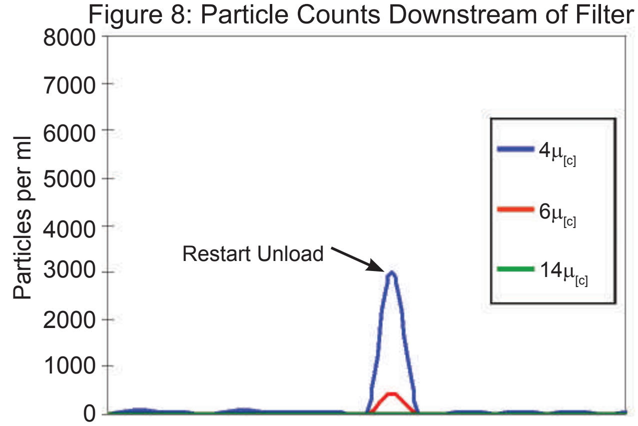


Figure 7 and the table below it show the performance of an element, from the same lot as filter elements A1 & A2 from figure 2, that was subjected to the DFE restart test. During the restart, particle counts after the filter increased by a factor of 20 on the $6\mu_{[c]}$ channel, and the ISO codes increased 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.

Figure 8: Particle Counts Downstream of Filter



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 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

HY-PRO FILTRATION

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.

Figure 9: Time Weighted Beta Ratio Comparison per ISO 16889 Multi-Pass for $\beta 5\mu_{[c]}$>200 or 1000 Filter Element

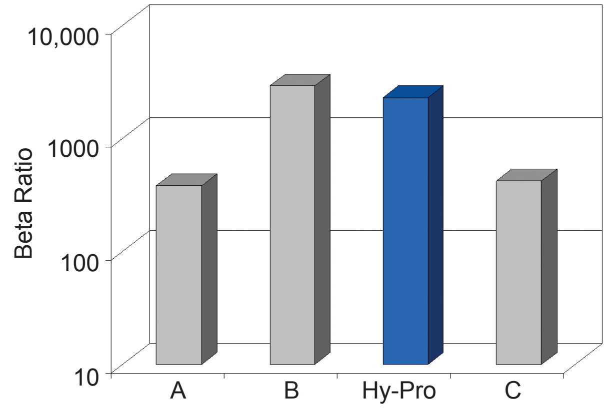


Figure 10: Time Weighted Beta Ratio Comparison per DFE Multi-Pass for $\beta 5\mu_{[c]}$>200 or 1000 Filter Element

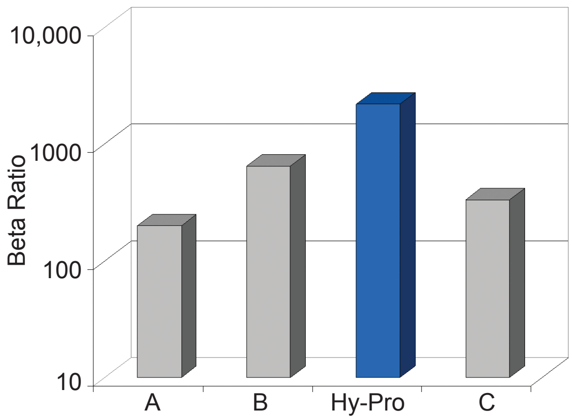
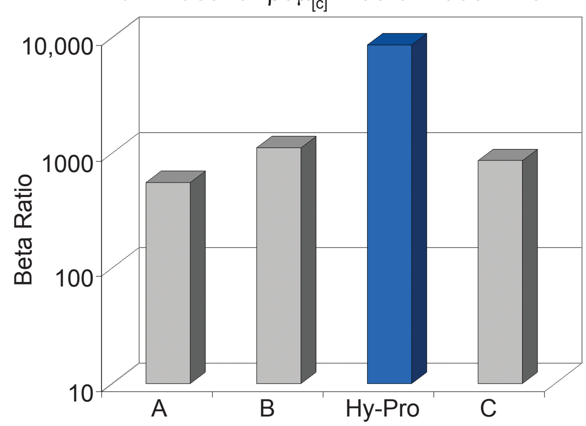


Figure 10 shows the time weighted performance of the like elements tested per DFE multi-pass. To illustrate the performance differences between DFE and ISO16889, the two tests were run similarly with the only difference being the DFE test flow rate. The flow through the element was cycled up and down 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.

Figure 11: 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.

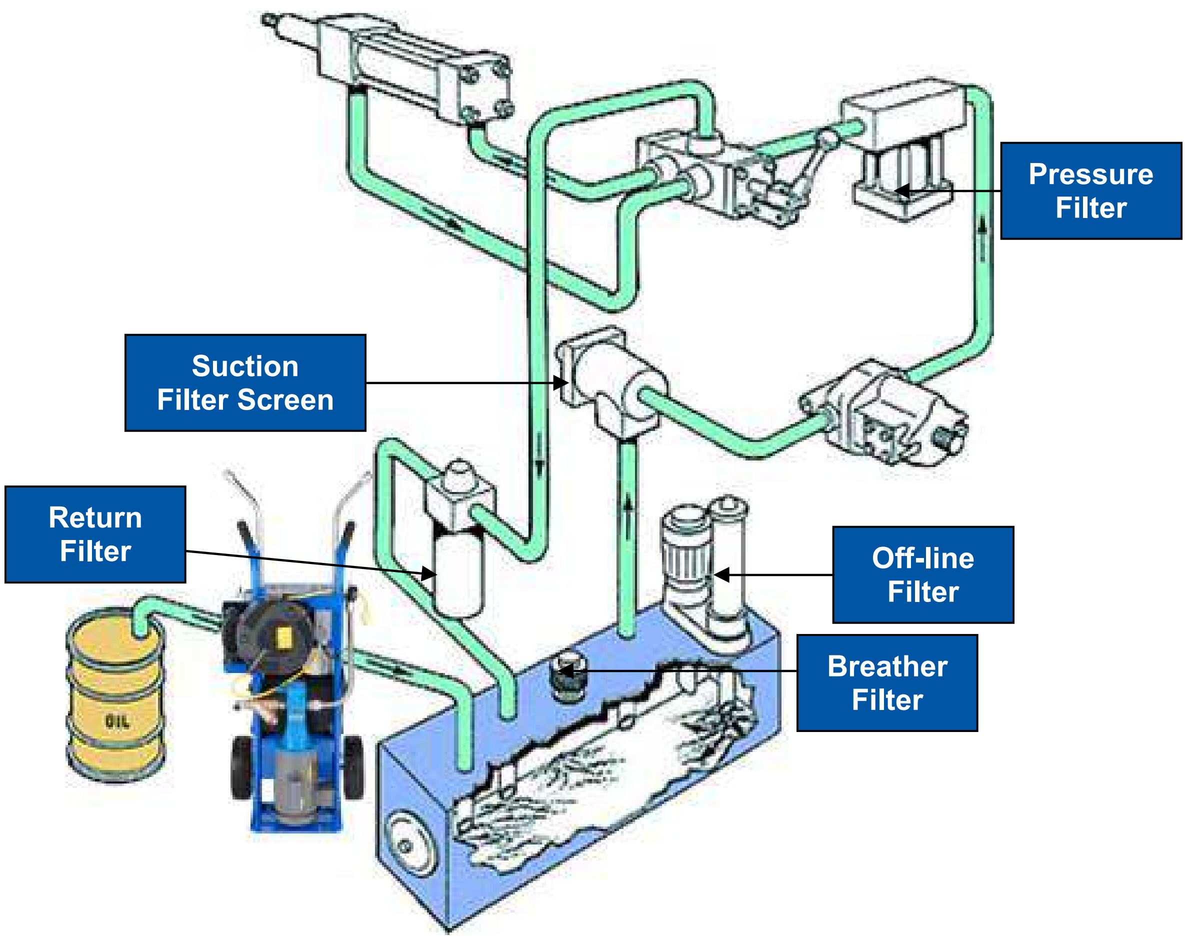
HY-PRO FILTRATION

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 to eliminate failure 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 handle the flow and 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 assemblies. 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.

Over sizing 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 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 appropriate \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. With one filter the maintenance cost will be greater than the 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, 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 the 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, requires the installation of a duplex

The Hy-Pro DLF and DLFM can handle high flow 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 make 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 run 24/7 or intermittently.

It can be fitted with a very fine filter element to clean the oil to several ISO codes 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 application.

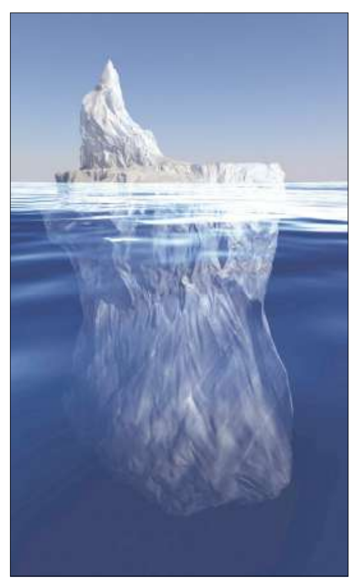
Commonly referred to as filter carts, they can be fitted with quick disconnect fittings and connected to a reservoir or tote for conditioning, used to filter fluids during transfer, and used for filtering oil during recovery. A filter cart fitted with two filters in series can have a rapid impact on fluid cleanliness and water content with the appropriate filter elements applied. They can also be fitted with online particle monitors that signal 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 micron 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 has a minimum of two components. They are the filter housing and 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. For most part we want the flow to go thorough 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 element gets dirty by collecting contaminants, the pressure drop across 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 fluid to go through it. Bypass valves have a cracking pressures typically range between 1,77 BAR (25 PSID) and 7 BAR (102 PSID). It is dependent upon the location of a filter. Return line filters have a lower setting than the filters in the pressure line.

Generally, the sizing of 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 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 the elements may be changed on a time interval regardless of element condition. This will ensure that the filter will not consistently operating in a bypass condition.

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 up the bypass valve for a short time while the fluid is being warmed up. In most cases, this condition is OK. See **Footnote** at the end for an explanation.

The fluid temperature 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 the system will ever see. Always consider the worst case. It 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 you 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, and in most cases it 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 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 Multipass test Method per ISO 16889. The engineer must select an element with 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 such that it gives you maximum life. General rule of thumb is to change an element when the differential pressure indicates the need for a change or based on a preventive maintenance schedule that can coincide with a planned shutdown regardless of the element condition.

FILTER ELEMENT SERVICE INTERVAL CONTINUED

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

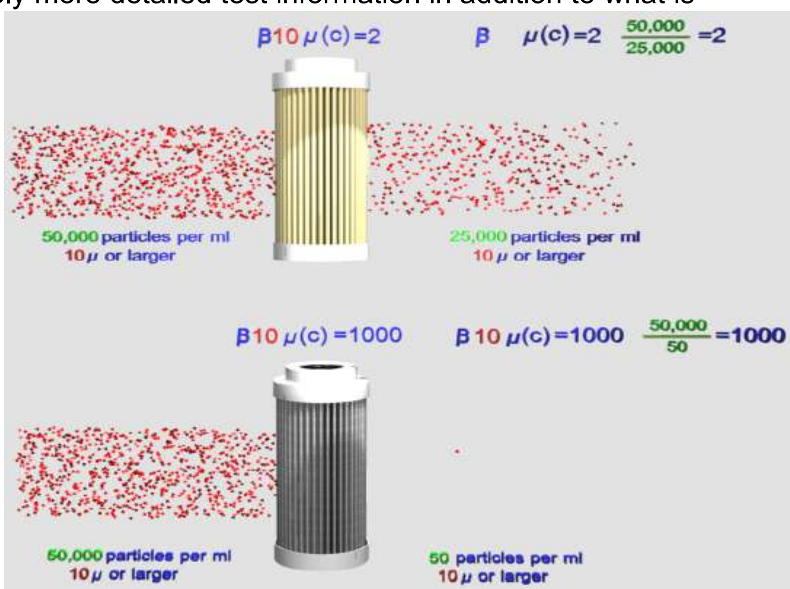
EL = BYPASS SETTING IN PSID – (H + E) where,

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 pressured drop will be lower. Element life is defined by the amount of time, or contaminant, that 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 the 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 in 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). Cleanable elements typically have a shorter life than their disposable counterparts made of glass or cellulose media, size for size. 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 at least be 1.5 times the full flow pressure drop across the bypass valve. This will provide ample protection from collapse or burst even if there was 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 surely cause catastrophic failure.

8. FLUID TYPE, PETROLEUM vs. SYNTHETIC

Petroleum base fluids have 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 system, such as water glycol or high water based fluid. High water based fluids are constructed of 95% to 98% water with additive package to provide lubricity, biocide, etc. Always consider the effect of specific gravity on pressure drop. Most filter manufacturers will provide recommendations for sizing a filter for use such fluids. 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. Contact Hy-Pro when synthetic fluids are used to ensure proper material selection.

Certain high water based fluids have a very high pH value to keep growth of bacterial low. These fluids can react aggressively with aluminum parts in housing. 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 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 an 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.

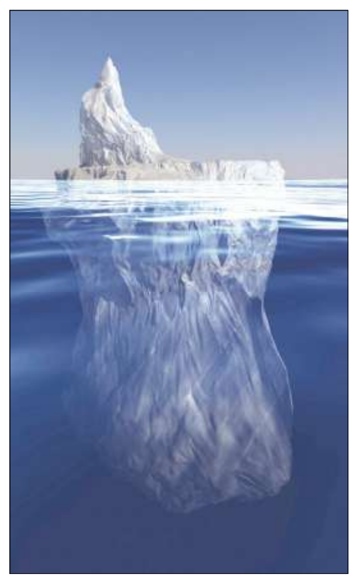
Footnote:

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 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 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.



HY-PRO FILTRATION

Hy-Pro Media Lube Design Modification

Hy-Pro G8 Dualglass

High Performance DFE Rated Filter Media

An option for high flow lube systems with low terminal element differential pressure indicator alarm and bypass settings (~15 psid, 1 bar). Lube design can extend element life (paper machine lube systems)

May be suitable for hydraulic systems where original housing is undersized or when upgrading to a higher efficiency media grade to improve ISO codes.

Dualglass Media Lube Design Modification

Hy-Pro DFE rated Dualglass media filter elements are optimized for capture and retention efficiency and long element life. When upgrading from some element manufacturers to Hy-Pro the clean element pressure drop experienced with the Hy-Pro element may be slightly higher. The Hy-Pro standard design with M media code (HP__L_-_**M**_) typically yields a drop (improvement) of one to two codes in each particle size of the ISO fluid cleanliness codes (4/6/14). In most hydraulic and lube applications the Hy-Pro element will also last longer than the original once it has cleaned up the fluid and achieved a clean fluid equilibrium.

There are some applications where the standard Hy-Pro media pack element design (HP__L_-_**M**_) clean pressure drop results in element life that is shorter than optimum. For these applications Hy-Pro has developed an alternate media pack design called the lube design denoted by replacing the M in the standard design with an L (HP__L_-_**L**_). The lube design will result in a lower clean element pressure drop because the glass pre-filter layer has been removed allowing a higher pleat count and lower flow resistance because the fluid only passes through a glass media layer and there are more pleats.

Lube Applications

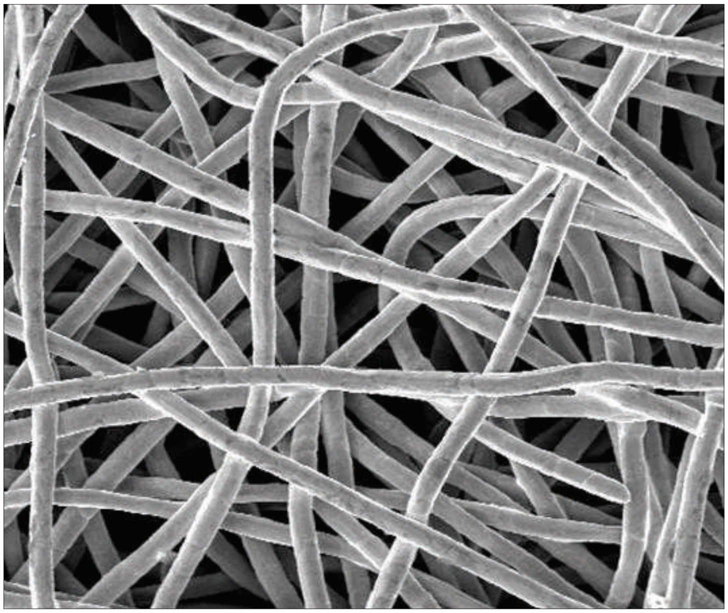
In some lube systems (i.e. paper machine main bearing lube) the fluid viscosity is high (i.e. ISO VG220) and the alarm for terminal differential pressure is relatively low (i.e. 15 psid, 1 bar). In such applications the lube design might yield longer element life because the clean element plays such an important role in overall element life. If the same system had a terminal differential pressure of 50 psid, 3.5 bar the standard M pack design would yield a longer element life than the lube design.

Hydraulic Applications

In some hydraulic systems the housing might be sized close to its maximum rated flow. In such cases the clean element differential pressure might be > than 15 psid, 1 bar. If this is the case the lube design will provide a lower clean element pressure drop and might be more suitable. Also, if the intent is to upgrade to a filter element with higher efficiency to achieve a lower ISO code the lube design might be required to avoid excessive clean element pressure drop. For example if the original element specified by the OEM was a 10 micron absolute and that element is replaced with a 3 micron the clean element pressure drop could double. In this instance the lube design could provide enough of a decrease from the standard M pack design to make the change possible.

STAINLESS FIBER

Filter elements for power generation and other fire resistant applications



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

Performance

Temperature: Viton®: -20°F ~ 250°F, -29°C ~ 121°C

Standard Element Collapse:
Up to ΔP 3000 psi, ΔP 204 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)

Dynamic Filter Efficiency Testing

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

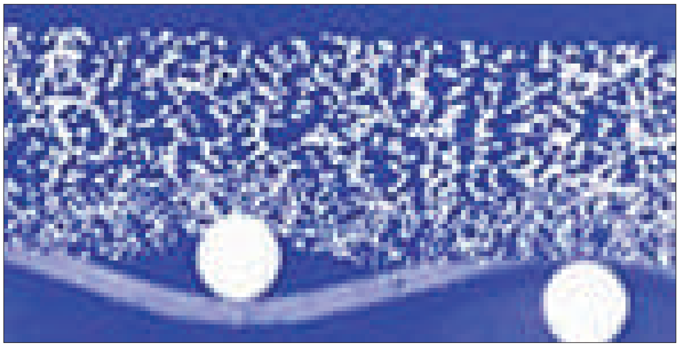
Today's industrial and mobile hydraulic circuits require elements that deliver specified cleanliness under all circumstances. Wire mesh supports the media to ensure against cyclical flow fatigue, temperature, and chemical resistance failures possible in filters with synthetic support mesh.

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	



HY-PRO FILTRATION

Typical Elements Upgraded to Stainless Fiber

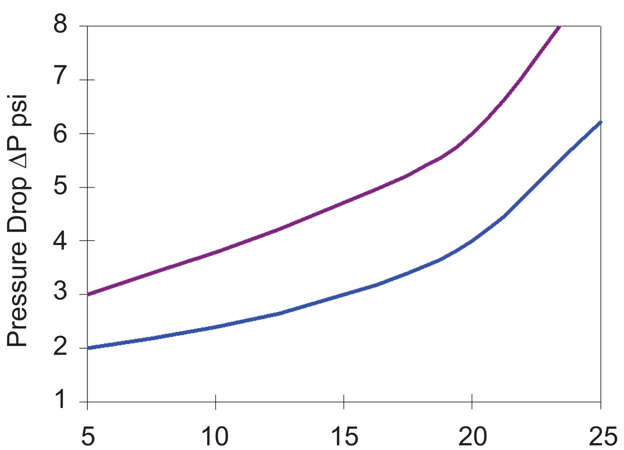
Pall	Hy-Pro
HC9401FDP13Z	HP41L13-3SFV
HC9401FDP13ZYGE	HP41L13-3SFV
HC9401FDT13Z	HP41L13-10SFV
HC9401FDT13ZYGE	HP41L13-10SFV
HC9601FDP11Z	HP61L11-3SFV
HC9601FDP11ZYGE	HP61L11-3SFV
HC9601FDT11Z	HP61L11-10SFV
HC9601FDT11ZYGE	HP61L11-10SFV
HC9601FDP16Z	HP61L16-3SFV
HC9601FDT16Z	HP61L16-10SFV
HC9601FDP21ZYGE	HP61L21-3SFV
HC9601FDT21Z	HP61L21-10SFV
HC9601FDT21ZYGE	HPz1L21-10SFV
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

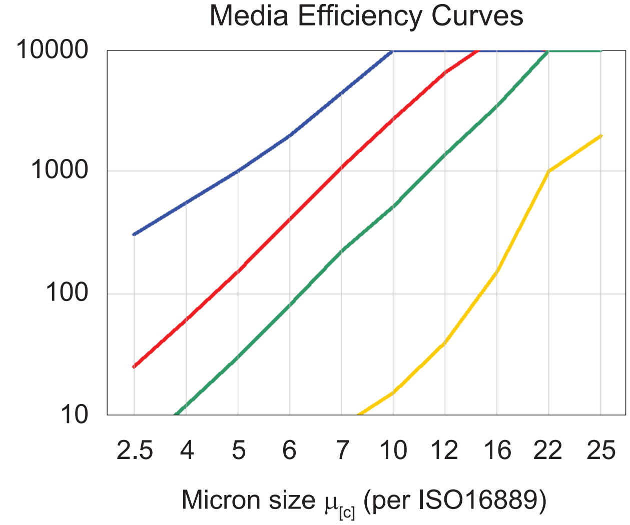
General Electric	Hy-Pro
234A6578P0002	HPQ210128L13-3SFV
234A6579P0002	HPQ210129L13-3SFV
254A7229P0005	HPQ210130L13-3SFV
254A7729P0008	HPQ210131L13-3SFV
254A7220P0008	HPQ210132L13-3SFV
258A4860P002	HPQ210133L11-3SFV
258A4860P004	HPQ210134L21-3SFV
361A6256P010	HPQ210135L18-3SFV
B984C302P012	HP21L4-10SFV

Typical Pressure Drop Performance vs Glass

Flow Rate vs Element Pressure Drop
(Test Fluid: Mil-H-5606, 100°, 150 sus viscosity)



Media Efficiency Curves



HY-PRO FILTRATION

Non-Sparking Elements

Hy-Pro G8 element and media technology optimized to prevent spark discharge and minimize potential energy in bearing lubrication and hydraulic control systems.

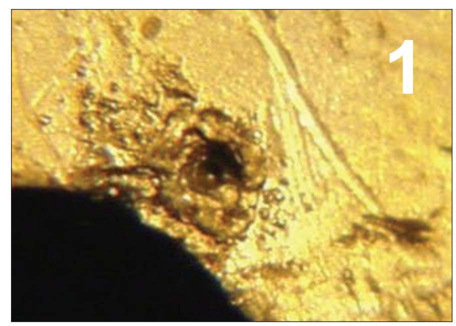
Prevent oil degradation caused by thermal events associated with element spark discharge.

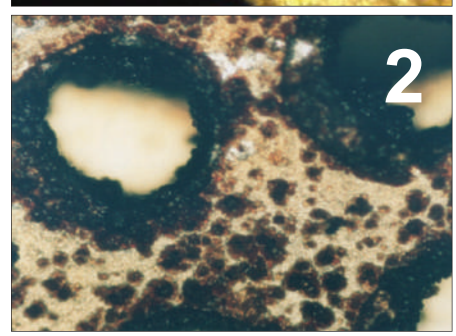
Prevent anti-oxidant additive depletion and extend useful fluid life.

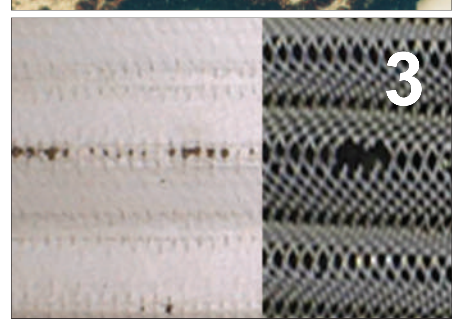
Hy-Pro NSD elements eliminate sparking without sacrificing fluid cleanliness.

Filter Element Spark Discharge

As fluid passes through the typical tortuous filter media fiber matrix turbulence increases resulting in thermal events as the fluid layers shear creating static accumulation on elements that can lead to high voltage spark discharge from media to support tube. Photos 1 and 2 show evidence of sparking on the filter element support tube (pitting and burning), and photo 3 shows filter media and support mesh from a lube filter element with spark discharge burn damage.







The change from Group I to Group II has enhanced the effect of spark discharge. 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. If the element cannot minimize and dissipate the charge, static on the element will build until it eventually arcs to a nearby surface.

Hy-Pro NSD Elements, Cleaner Fluid Without Sparking

For some the answer to preventing element sparking and high potential energy is to use coarse strainer type filters (Stat-Free) in the main bearing lube filter duplex. Although this may prevent sparking it renders the main bearing lube filter assembly useless in preventing catastrophic bearing failure due to contamination. Independent lab analysis proves that even Hy-Pro high efficiency 3 micron absolute (b5[c] > 1000) NSD elements are resistant to spark discharge.

The degree to which element spark discharge contributes to overall varnish problems is variable. Varnish can result from any combination of oxidation, anti-oxidant additive depletion, increased fluid stress from high turbine output, micro-dieseling, new oil formulations and spark discharge. With Hy-Pro NSD elements, any reduction in thermal sparking events and tribo-electric effect will have a positive impact by decelerating anti-oxidant additive depletion and extending useful fluid life. Field test data has shown that Hy-Pro NSD elements may even reduce or stabilize varnish potential values by preventing further degradation from sparking and collecting some insoluble oxidation by-products.

HY-PRO
FILTRATION

Original Number	Hy-Pro Part Number	Original Number	Hy-Pro Part Number	Original Number	Hy-Pro Part Number
HC2196F*S6H50	HP06RNL7-12EB-NSD	HC2618F*S36Z	HP102L36-12EV-NSD	HC9601F*P21ZYGE	HP61L21-2EV-NSD
HC2206F*S3Z	HP06DNL4-12EV-NSD	HC2618F*T18H	HP102L18-25EB-NSD	HC9601F*P4H	HP61L4-2EB-NSD
HC2206F*T3H	HP06DNL4-25EB-NSD	HC2618F*T18Z	HP102L18-25EV-NSD	HC9601F*P4Z	HP61L4-2EV-NSD
HC2207F*S3Z	HP06DHL4-12EV-NSD	HC2618F*T36H	HP102L36-25EB-NSD	HC9601F*P8H	HP61L8-2EB-NSD
HC2207F*T3Z	HP06DHL4-25EV-NSD	HC8400F*P8Z	P84L8-3EV-NSD	HC9601F*P8Z	HP61L8-2EV-NSD
0280D003BH*HC-V	HP16DHL14-3EV-NSD	HC8900F*N26HY550	HPQ98320L26-6EB-NSD	HC9601F*S8Z	HP61L8-15EV-NSD
**03384509 Stat-Free	HP102L18-12EB-NSD	HC8900F*N26ZY550	HPQ98320L26-6EV-NSD	HC9604F*N13Z	HP964L13-6EV-NSD
200EB10	HPQ20082S-12EV-NSD	HC8900F*N39HY550	HPQ98320L39-6EB-NSD	HC9650F*P16H	HP50L16-3EB-NSD
234A6578P0002	HP41L13-3EV-NSD	HC8900F*N39ZY550	HPQ98320L39-6EV-NSD	HC9650F*P16Z	HP50L16-3EV-NSD
234A6579P0002	HP41L13-3EV-NSD	HC8900F*S26HY550	HPQ98320L26-12EB-NSD	HC9650F*P16ZYGE	HP50L16-3EV-NSD
254A7220P0008	HP41L13-3EV-NSD	HC8900F*S26ZY550	HPQ98320L26-12EV-NSD	HC9650F*P8H	HP50L8-3EB-NSD
254A7229P0005	HP41L13-3EV-NSD	HC8900F*S39HY550	HPQ98320L39-12EB-NSD	HC9650F*P8Z	HP50L8-3EV-NSD
258A4860P002	HP61L11-2EV-NSD	HC8900F*S39ZY550	HPQ98320L39-12EV-NSD	HC9650F*P8ZYGE	HP50L8-3EV-NSD
258A4860P004	HP61L21-2EV-NSD	HC8900F*T26HYR11	HPQ20228-25EB-NSD	HC9651F*P16Z	HP51L16-2EV-NSD
315A2600P003	HP21L4-15EV-NSD	HC8904F*N13Z	HP894L13-6EV-NSD	HC9651F*P16ZYGE	HP51L16-2EV-NSD
361A6256P010	HPK3L18-3EV-NSD	HC9020F*S4Z	HP20L4-12EV-NSD	HC9651F*P8Z	HP51L8-2EV-NSD
363A4378P003	HPQ20082S-17EV-NSD	HC9021F*P4H	HP21L4-2EB-NSD	HC9651F*P8ZYGE	HP51L8-2EV-NSD
363A4378P004	HPQ20082S-12EV-NSD	HC9021F*P4Z	HP21L4-2EV-NSD	HC9651F*T8H	HP51L8-15EB-NSD
363A7485P0001	HPQ20082S-12EV-NSD	HC9021F*P4ZYGE	HP21L4-2EV-NSD	HC9651F*T8Z	HP51L8-15EV-NSD
932683Q, 932683	HPK3L18-3EV-NSD	HC9021F*P8H	HP21L8-2EB-NSD	HC9651F*T8ZYGE	HP51L8-15EV-NSD
B984C302P012	HP21L4-15EV-NSD	HC9021F*P8Z	HP21L8-2EV-NSD	HC9701F*P18H	HPK3L18-3EB-NSD
FQ19165	HPQ20082S-12EV-NSD	HC9021F*P8ZYGE	HP21L8-2EV-NSD	HC9701F*P18Z	HPK3L18-3EV-NSD
HC0101F*P18Z	HP101L18-3EV-NSD	HC9021F*T4H	HP21L4-15EB-NSD	HC9701F*P18ZYGE	HPK3L18-3EV-NSD
HC0101F*P18ZYGE	HP101L18-3EV-NSD	HC9021F*T4Z	HP21L4-15EV-NSD	HC9701F*P18ZYR82	HPK3L18-3EV-NSD
HC0101F*S18Z	HP101L18-12EV-NSD	HC9021F*T4ZYGE	HP21L4-15EV-NSD	HC9711F*P18H	HPK3L18-3EB-NSD
HC0101F*S18ZYGE	HP101L18-12EV-NSD	HC9021F*T8H	HP21L8-15E-NSD	HC9711F*P18Z	HPK3L18-3EV-NSD
HC2006F*N28Z	HPQ20082S-6EV-NSD	HC9021F*T8Z	HP21L8-15EV-NSD	HC9711F*P9Z	HPK3L9-3MV
HC2006F*S28Z	HPQ20082S-12EV-NSD	HC9021F*T8ZYGE	HP21L8-15EV-NSD	HC9801F*P4Z	HP81L4-2EV-NSD
HC2006F*T28Z	HPQ20082S-25EV-NSD	HC9100F*S4Z	HP900L4-12EV-NSD	HC9801F*T4Z	HP81L4-15EV-NSD
HC2216F*S6H	HP16DNL8-12EB-NSD	HC9600F*N13Z	HP60L13-6EV-NSD	HP311-12-GE	HP61L11-2EV-NSD
HC2216F*S6Z	HP16DNL8-12EV-NSD	HC9600F*N8Z	HP60L8-6EV-NSD	HP9650F*P16ZYGE	HP50L16-3EV-NSD
HC2286F*S15H50	HP66RNL18-12EB-NSD	HC9600F*P16H	HP60L16-3EB-NSD	PH426-** Hilco	HPQ20228-12EV-NSD
HC2295F*P14H	HP95RNL14-3EV-NSD	HC9600F*P4Z	HP60L4-3EV-NSD	PH528-** Hilco	HPQ20082S-12EV-NSD
HC2618F*N18H	HP102L18-6EB-NSD	HC9600F*P8H	HP60L8-3EB-NSD	**PH718-05CNVGE	HP102L18-12EV-NSD
HC2618F*N36H	HP102L36-6EB-NSD	HC9601F*P11H	HP61L11-2EB-NSD	**PH739-05-CG	HPQ220275L40-25EV-NSD
HC2618F*P18H	HP102L18-3EB-NSD	HC9601F*P11Z	HP61L11-2EV-NSD	PH739-11-CG	HPQ220275L40-12EV-NSD
HC2618F*P18Z	HP102L18-3EV-NSD	HC9601F*P11ZYGE	HP61L11-2EV-NSD	**PL718-05-GE	HP102L18-12EB-NSD
HC2618F*P18ZYGE	HP102L18-3EV-NSD	HC9601F*P16H	HP61L16-2EB-NSD	PMG528-10	HPQ20082S-17EV-NSD
HC2618F*S18H	HP102L18-12EB-NSD	HC9601F*P16Z	HP61L16-2EV-NSD	PMG528-10B200	HPQ20082S-12EV-NSD
HC2618F*S18Z	HP102L18-12EV-NSD	HC9601F*P16ZYGE	HP61L16-2EV-NSD	PMG528-10B200-GE	HPQ20082S-12EV-NSD
HC2618F*S18ZYGE	HP102L18-12EV-NSD	HC9601F*P21H	HP61L21-2EB-NSD	PMG528-10-GE	HPQ20082S-17EV-NSD
HC2618F*S36H	HP102L36-12EB-NSD	HC9601F*P21Z	HP61L21-2EV-NSD		

** Original element media code may be A, K, M, D, 3, 4. This does not create a change to the Hy-Pro non-spark NSD element part number.*

***Original element media has 30~40 micron removal efficiency. Hy-Pro element is glass media upgrade with b12[c] > 1000 efficiency. Hy-Pro recommends glass media upgrade for such coarse strainer type medias to prevent catastrophic bearing failure and maintain low ISO codes.*

If the part number that you require is not listed above please contact your Hy-Pro distributor or the factory for the appropriate part number and pricing.

HY-PRO FILTRATION

Water Removal

Available for all spin-on and cartridge filter elements.

Media code “A” specifies G8 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 / $2.5\mu_{[c]}$.

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 = G8 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 FILTRATION

Hy-Pro Upgrades

Hy-Pro Filter Element Upgrades for Kaydon Turbo-TOC* Conditioning Skid Element sets including pre-filter, coalesce, separator and post-filter polishing elements.

Hy-Pro G8 Dualglass

Performance

Temperature: Buna: -45°F ~ 225°F, -43°C ~ 107°C
EPR: -65°F ~ 300°F, -53°C ~ 148°C
Viton®: -20°F ~ 250°F, -29°C ~ 121°C

Media
G8 media pleat pack features our latest generation of graded density glass media that delivers required cleanliness while optimizing dirt capacity.

Dynamic Filter Efficiency
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.

Water Removal
Media code "A" specifies G8 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 / $2.5\mu_{[c]}$.

Fluid Compatibility
Petroleum based fluids, water glycols, polyol esters, phosphate esters, HWBF. Contact Hy-Pro for seal selection assistance.

Tested to ISO Quality Standards

ISO 2941	Collapse and burst resistance
ISO 2942	Fabrication and Integrity test
ISO 2943	Material compatibility with fluids
ISO 3724	Flow fatigue characteristics
ISO 3968	Pressure drop vs. flow rate
ISO 16889	Multi-pass performance testing

Optimize Your Turbo-TOC* performance with Hy-Pro Elements
Achieve lowest turbine lube oil reservoir ISO fluid cleanliness results and maximize element life by upgrading to Hy-Pro HP101L36-3MB series for pre-filter and HP101L36-1MB post-filter.

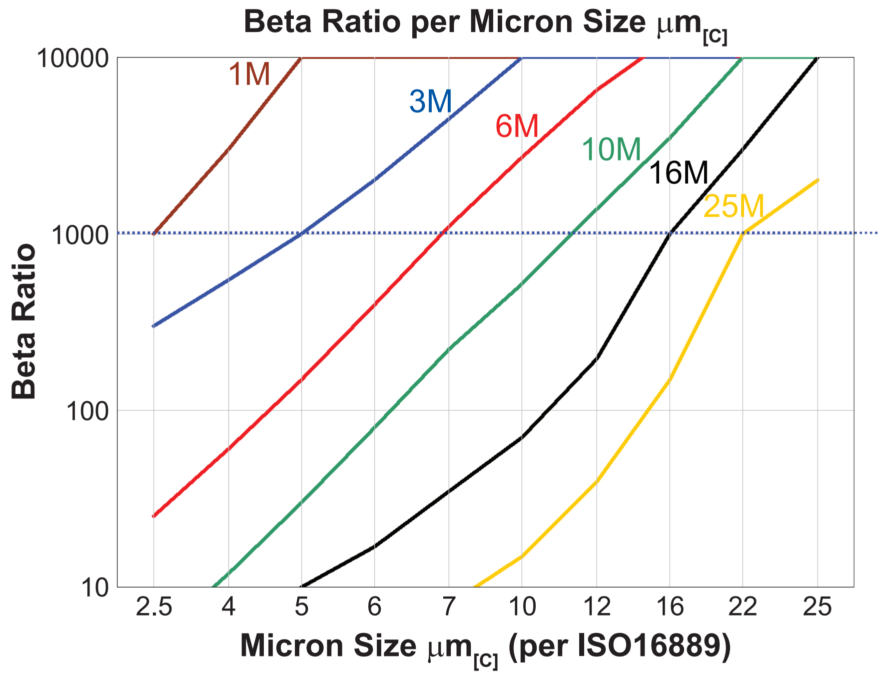
For optimum water removal efficiency and fluid compatibility use HPQK2G coalesce element and HPQK3P-3M separator / polisher elements (all synthetic media, non-cellulosic).

To reduce element change out costs on skids with pre-filter and post-filter housings install HP101L36-3MB in pre-filter with HPQK2G coalesce and HPQK3P-3M separator / polisher elements in the coalesce vessel (extends coalesce element life).

Upgrade to HPQK2G and HPQK3P-3M synthetic media elements and achieve > 95% single pass water removal efficiency.

HY-PRO FILTRATION

FILTER ELEMENT MEDIA PERFORMANCE



ELEMENT INTERCHANGE & UPGRADE INFORMATION

Kaydon Model No.	Kaydon Part No.	Hy-Pro Direct Interchange	Description	Hy-Pro Upgrade	Description
K1000	A910201	HP102L36-6MB	Pre-Filter Glass Media $\beta7_{[c]} > 1000$	HP101L36-3MB (High Capacity)	High Capacity Pre-Filter Glass Media $\beta7_{[c]} > 1000$
K1100 (Replaced K1000)	A910201, A910266	HP101L36-6MB	High Capacity Pre-Filter Glass Media $\beta7_{[c]} > 1000$	HP101L36-3MB (High Capacity)	High Capacity Pre-Filter Glass Media $\beta5_{[c]} > 1000$
K2000	A910202	HPQK2	Coalesce Element Cellulose Media	HPQK2G	Coalesce Element Synthetic Media
K2100 (Replaced K2000)	A910202, A920267	HPQK2G	Coalesce Element Synthetic Media	-	-
K3000	A910203, A910303	HPQK3	Separator Element Cellulose Media	HPQK3P-3M	Separator Layer + $\beta5_{[c]} > 1000$ Glass Media Polishing
K3100 (Replaced K3000)	A910203, A910268	HPQK3P-3M	Separator Layer + $\beta5_{[c]} > 1000$ Glass Media Polishing	-	-
K4000	A910204	HP102L36-3MB	High Capacity Post-Filter Glass Media $\beta5_{[c]} > 1000$	HP101L36-3MB (High Capacity)	High Capacity Post-Filter Glass Media $\beta5_{[c]} > 1000$
K4100 (Replaced K4000)	A910204, A910269	HP101L36-3MB	High Capacity Post-Filter Glass Media $\beta5_{[c]} > 1000$	HP101L36-1MB (High Capacity)	High Capacity Post-Filter Glass Media $\beta2.5_{[c]} > 1000$

HY-PRO FILTRATION

ICB Element Upgrades

Eliminate & prevent EHC servo valve sticking and reduce fluid maintenance requirements.

Replaces Fuller's Earth and Selexsorb for EHC systems using phosphate ester.

Eliminate the largest source of fluid contamination and reason for EHC failures.

Remove & maintain Acid Number to < 0.05.

Eliminate gels & deposits by removing dissolved metals (Ca, Mg, Fe, Na, Si, Al).

Phosphate Ester Fluids

For most EHC systems the primary operating fluid is phosphate ester. This is a very safe and effective fluid that when maintained in a narrow condition range regarding acid number, water and particulate can deliver years of trouble-free optimum performance.

When the fluid is not properly maintained the result is servo valve failure. Other issues include accelerated acid production, loss of resistivity, poor air release, premature fluid replacement, costly system flushes and fluid degradation related component failures.

Dissolved Metals, Gels & Deposits

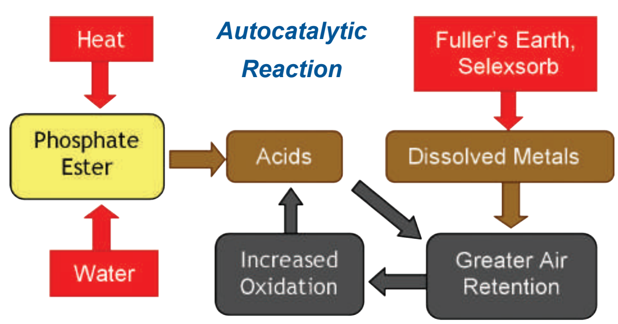
Airborne contamination (i.e. seawater & agriculture - Cl, Mg, Ca, Na) and traditional acid scavenging elements (Fuller's and Selexsorb - Al, Si, Na) contribute dissolved metals to EHC fluid.

As dissolved metals accumulate they act as a catalyst forming depots on servo valves and gels that can cause valve stiction and mask filter elements. ICB elements do not contribute metals and will remove dissolved metals from airborne ingress and element leaching to < 10ppm.

NO METALS = NO DEPOSITS / NO GELS

Acid Production

The primary sources of fluid degradation in phosphate ester are Oxidation (heat) and Hydrolysis (water) which act on phosphate ester to form acids. Dissolved metals from Fuller's and Selexsorb elements enable the acid creating a autocatalytic effect where air retention increases which accelerates oxidation (more acid).



Acid production rates are directly related to the existing Acid Number (AN or TAN). Acid production at AN > 0.20 is significantly higher than at AN of 0.05. The lowest fluid maintenance costs are achieved when the Acid Number is maintained at < 0.05.

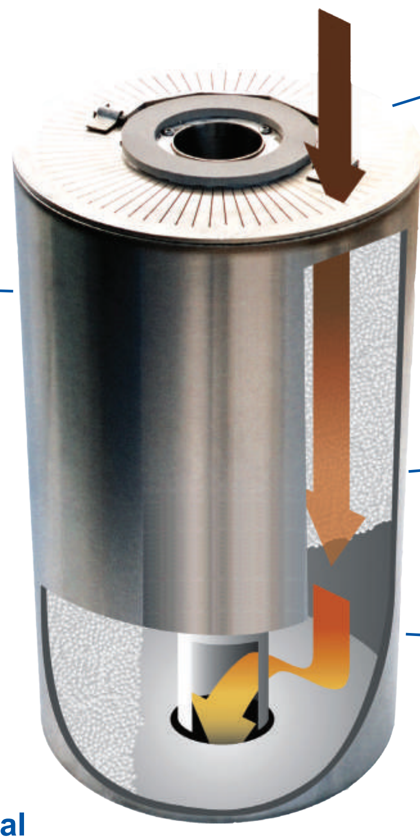
30 million hours of proven performance

Solving million dollar EHC problems on the largest fossil fuel plants in The U.S.A, Europe & Asia, and on the largest Gas & Steam turbines in the world

Stainless steel ensures compatibility with fluids and adsorbed acids.

Axial flow design maximizes fluid-media contact time and prevents formation of gels & precipitate.

Rugged rupture free design for absolute containment exceeds minimum ANSI standard for housing media.



ICB element technology is the upgrade for all other acid removal media.

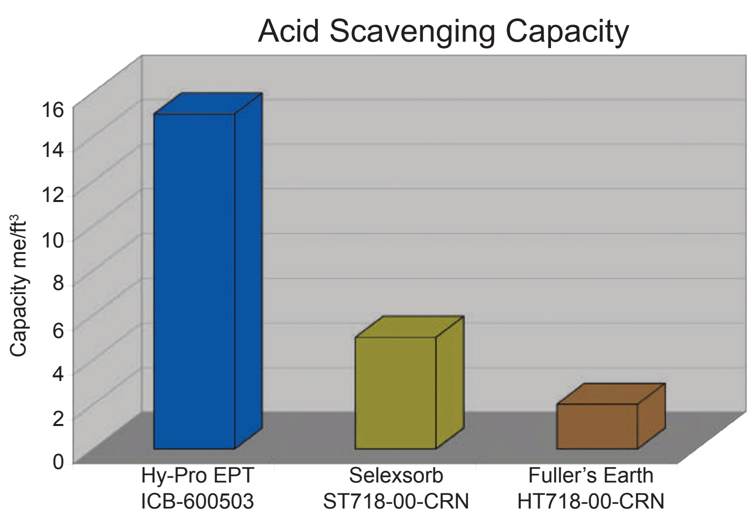
Highest capacity media available 15g me/ft^3.

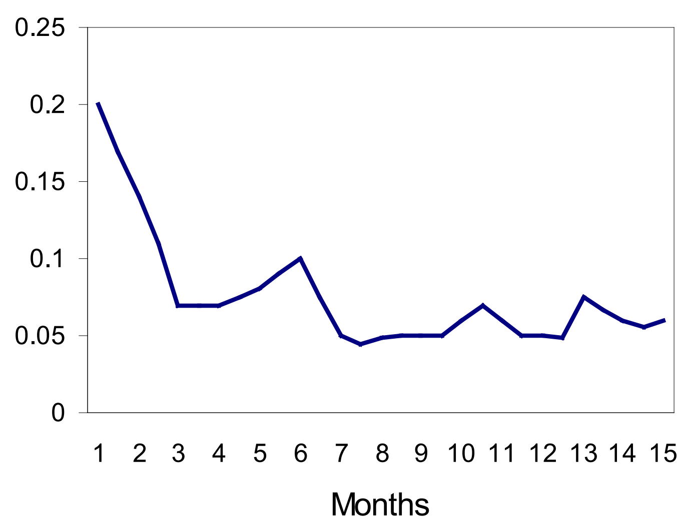
ICB element removes dissolved metals to EPRI specified Ca, Mg, Fe, Na < 10ppm per element.

Highest Capacity for Acid Removal

ICB element technology features the highest capacity to remove and retain acid when compared to other medias.

Maintains AN of < 0.05. AN reduction up to 0.5 AN in 24 hours has been achieved.





EPT

HY-PRO FILTRATION

ICB Single Use Element Upgrades

Single use ICB element designs are the standard replacing the original rechargeable element. The single use platform reduces cost of ownership by reducing element hardware & production costs and eliminating double freight and hazardous material shipping challenges.

ICB Single Use Elements –Materials of Construction

All Hardware- 304 Stainless Steel
Gasket seal material – 0.250” thick Silicone (600508 Utilizes Viton® gasket standard)
Bonded end caps cured with chemically compatible high strength epoxy (rated to 450 psi / 31 bar Max OP)
Static pressure tested to 120 psi / 8 bar

Disposal- The ICB cartridge should be disposed of in accordance with the disposal regulations of the fluid it is used to treat, same as standard hydraulic and lube filter elements.

Acid Scavenging Technology Comparison

ICB Ion Charge Bonding	Selexsorb	Fuller’s Earth
+ Eliminate regular fluid replacement	Made from purified activated Alumina as a Y-Zeolite	Made from magnesium oxide and hydroxide, processed from attapulgus clay or attapulgite
+ Eliminate costly system flushes		
+ Avoid unscheduled down time	Removes acid but re-contaminates your fluid (Sodium, Aluminum, Silicon)	
+ Avoid equipment failure resulting from fluid degradation		Removes acid but re-contaminates fluid (Magnesium, Iron, Calcium)
+ Does not produce gels	These by-products react with fluid to cause soft gel deposits	Produces hard salts and soap deposits that coat sensitive servo valves
+ Does not produce dissolved metals	Gels increase friction and restrict flow	
+ Before and after lab analysis to verify results provided	Cause reliability issues	Much lower capacity to remove acids than ICB
+ Axial flow design maximizes media and fluid contact time (residence time)	Selexsorb has a radial flow design as to an axial flow	Fuller’s Earth has a radial flow design as to an axial flow
+ Widest range of ICB acid scavenging elements available to solve any EHC problem to your requirements	Housing design not as robust as ICB	Housing design not as robust as ICB

HY-PRO FILTRATION

EPT

ICB ELEMENT PART NUMBER ORDER GUIDE AND DIMENSIONAL DESCRIPTION

ICB Part Number	Nominal ID x OD x Length
ICB-600501	$1^{1/8}$ x 3 x $9^{13/16}$
ICB-600502	$1^{7/8}$ x $4^{3/4}$ x 11
ICB-600503*	$2^{1/4}$ x $6^{1/4}$ x 18
ICB-600504*	$2^{7/8}$ x $6^{1/4}$ x 18
ICB-600506*	$2^{1/4}$ x $6^{1/4}$ x 18
ICB-600507*	$2^{7/8}$ x $6^{1/4}$ x 18
ICB-600508*	$2^{7/8}$ x $6^{1/4}$ x $32^{7/8}$
ICB-600509*	$2^{7/8}$ x 11 x $17^{7/8}$
ICB-600510*	$2^{7/8}$ x 11 x 19
ICB-600511*	$2^{7/8}$ x 11 x $19^{1/2}$
ICB-600512*	$2^{7/8}$ x 13 x $13^{3/8}$
ICB-600513*	$2^{7/8}$ x 13 x $19^{3/8}$
ICB-600514*	$2^{7/8}$ x 11 x $20^{3/8}$

*Single use element design is standard.

ICB ELEMENT UPGRADE CROSS REFERENCE

Hilco P/N	ICB P/N	Hilco P/N	ICB P/N
AT310-00-C	ICB-600501	ST511-00-C	ICB-600502
AT310-00-CV	ICB-600501	ST511-00-CV	ICB-600502
AT310-00-NC	ICB-600501	ST630-00-C	call
AT511-00-C	ICB-600502	ST718-00-CN	ICB-600504
AT718-00-CN	ICB-600504	ST718-00-CRN	ICB-600503
AT718-00-CRN	ICB-600503	ST718-00-CVN	ICB-600504
AT119-00-03ZXC0	ICB-600511	ST718-00-03ZXC0	ICB-600503
HT310-00-C	ICB-600501	ST119-00-03ZXC0	ICB-600511
HT310-00-CV	ICB-600501	FAC-310	ICB-600501
HT511-00-C	ICB-600502	FAC-511	ICB-600502
HT718-00-03ZXC0	ICB-600503	FAC-00	ICB-600503
HT718-00-CN	ICB-600504	FFC-000	ICB-600502
HT718-00-CRK	ICB-600503	FFC-00	ICB-600503
HT718-00-CRN	ICB-600503	FFC-00-2	ICB-600504
HT718-00-CVN	ICB-600504	FFC-00-10	ICB-600503
HT119-00-03ZXC0	ICB-600511	FFC-000	ICB-600503
HT119-00-03ZAGO	ICB-600511	FFC-1-600	ICB-600511

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.

Electric Motor Specifications

TEFC 56C Frame
60 Hz - 1750 RPM
50 Hz - 1450 RPM
*230VAC 1P or 440VAC 3P required for FC3
**No cord reel for FC3, any 3 phase or > 230 VAC

Recommended Viscosity Range*

Max recommended actual viscosity (based on pump suction line limitations through hoses)

FC1, FPL1 = 800 cSt
i.e. ISO220 ≥ 68°F (20°C), ISO320 ≥ 80°F (26°C), ISO460 ≥ 90°F (32°C)

FC2, FPL2 = 500 cSt
i.e. ISO220 ≥ 75°F (23°C), ISO320 ≥ 86°F (30°C), ISO460 ≥ 97°F (36°C)

FC3 = 500 cSt
i.e. ISO220 ≥ 75°F (23°C), ISO320 ≥ 86°F (30°C), ISO460 ≥ 97°F (36°C)

*FC / FPL series are design optimized for lower viscosity hydraulic oils. Media selection will be limited on FC/FPL when running high viscosity oils ≥ ISO220, contact factory for sizing & media selection. Consider FCL or FSL designed for high viscosity fluid conditioning with high efficiency medias and large elements.

Pump Specifications

Gear pump
Internal relief full flow 100 psi, 6.8 bar standard

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

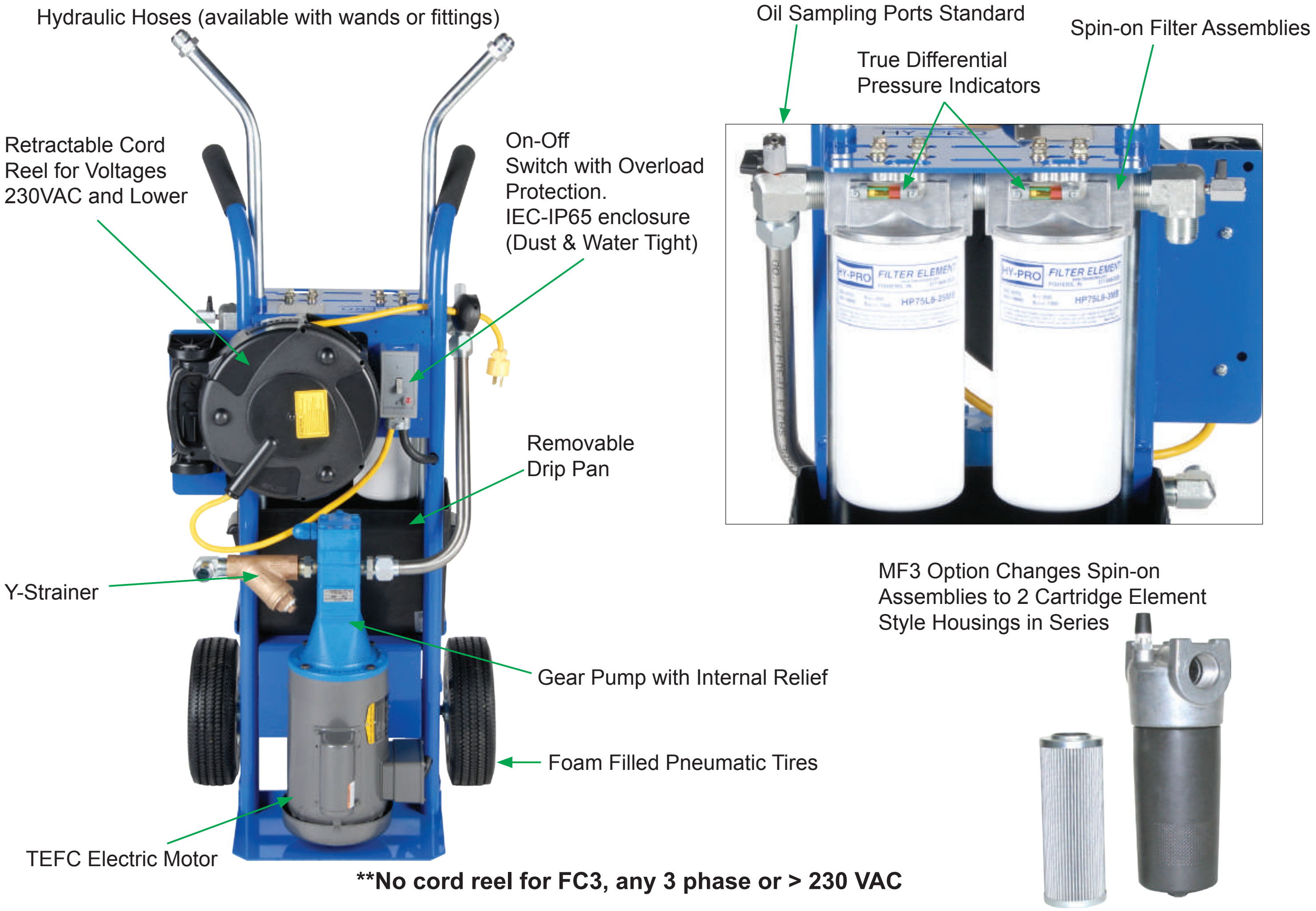
Explosion Proof NEC Article 501, Class 1, Div 1, Grp C & D optional. Call for IEC, Atex or other requirements.

Electrical Service

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

HY-PRO FILTRATION

FC1, FC2, FC3 FILTER CART APPLICATION INFO



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

FILTER CART DIMENSIONS

HY-PRO FILTRATION

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

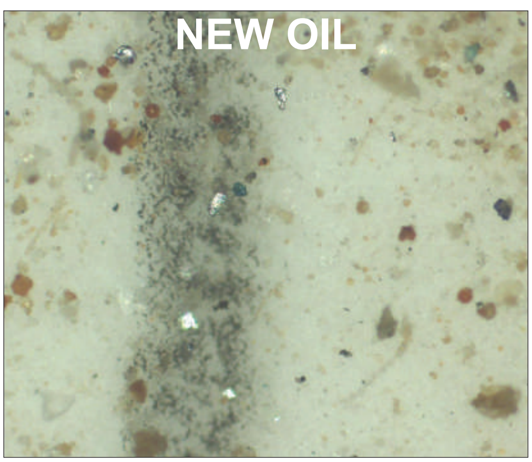
Current ISO Code	Target ISO Code	Target ISO Code	Target ISO Code	Target ISO Code
Start	2 x Life	3 x Life	4 x Life	5 x Life
28/26/23	25/22/19	22/20/17	20/18/15	19/17/14
27/25/22	23/21/18	21/19/16	19/17/14	18/16/13
26/24/21	22/20/17	20/18/15	19/17/14	17/15/12
25/23/20	21/19/16	19/17/14	17/15/12	16/14/11
22/22/19	20/18/15	16/16/13	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 service, using the 1M media code will yield the quickest result on particulate contamination.

Figure 2

Current Condition	Pre-Filter	Main-Filter
ISO 25/24/22 (New Oil) with High Water Content	HP75L8-25AB $\beta22_{[c]} = 1000$ + Water Removal	HP75L8-3MB $\beta5_{[c]} = 1000$
ISO 25/24/22 (New Oil)	HP75L8-12MB $\beta12_{[c]} = 1000$	HP75L8-1MB $\beta2.5_{[c]} = 1000$
ISO 27/19/16	HP75L8-3MB $\beta5_{[c]} = 1000$	HP75L8-1MB $\beta2.5_{[c]} = 1000$



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 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	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 lpm) 2 x S75, single element heads (in series)
2	10 gpm (37 lpm) 2 x S75, single element heads (in series)
3*	22 gpm (83 lpm) 2 x S75D, dual element heads (in series)

*Requires Power Option E2-E6

Table 2 Code	Filtration Rating	Media Type
1M	$\beta 2.5_{[C]}$ = 1000 ($\beta 1$ = 200)	G8 Dualglass
3A	$\beta 5_{[C]}$ = 1000 ($\beta 3$ = 200)	G8 Dualglass + Water Removal
3M	$\beta 5_{[C]}$ = 1000 ($\beta 3$ = 200)	G8 Dualglass
6A	$\beta 7_{[C]}$ = 1000 ($\beta 6$ = 200)	G8 Dualglass + Water Removal
6M	$\beta 7_{[C]}$ = 1000 ($\beta 6$ = 200)	G8 Dualglass
12A	$\beta 12_{[C]}$ = 1000 ($\beta 12$ = 200)	G8 Dualglass + Water Removal
12M	$\beta 12_{[C]}$ = 1000 ($\beta 12$ = 200)	G8 Dualglass
25A	$\beta 22_{[C]}$ = 1000 ($\beta 25$ = 200)	G8 Dualglass + Water Removal
25M	$\beta 22_{[C]}$ = 1000 ($\beta 25$ = 200)	G8 Dualglass
74W	74μ Nominal Wire Mesh	Wire Mesh
149W	149μ Nominal Wire Mesh	Wire Mesh

Table 3 Code	Seal Material
B	Nitrile (Buna)
V	*Specified synthetics or High Temperature (>150°F). Viton® seals, metal wands, & lined hoses.

*Phosphate Ester, Water Glycol, & other synthetics.

Table 4 Code	Hose Arrangement
W	Female JIC swivel hose ends with steel wands
S	Female JIC swivel hose ends (No Wands)
G	Female BSPP swivel hose ends (No Wands)

Table 5 Code	Power Options
*Omit (Standard)	115 VAC, 60Hz, 1P (1750 RPM Motor)
E1	120 VAC, 50Hz, 1P (1450 RPM Motor)
E2	230 VAC, 60Hz, 1P (1750 RPM Motor)
E3	230 VAC, 50Hz, 1P (1450 RPM Motor)
E4	24 VDC (Consult factory for application)
E5	440-480 VAC, 60Hz, 3P (1750 RPM Motor)
E6	380-420 VAC, 50Hz, 3P (1450 RPM Motor)
E7	575 VAC, 60Hz, 3P (1750 RPM Motor)
P	Pneumatic motor (call factory).

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

Table 6 Code	Special Options
B	Filter bypass line with manual ball or check valve isolation
C	CE Mark
H1*	Return-line only hose extension (10’, 3 meters)
H2*	Return-line only hose extension (20’, 6 meters)
MF3	Cartridge filter element style housings instead of spin-on filter assemblies
O+	On-board particle monitor for 230VAC only FCL1/2, up to 460VAC FCL3
X1	Explosion proof (NEC Article 501 Class 1, DIV 1, GRP 1 C&D) 230VAC only FC1/2, up to 460VAC FC3 (contact factory for >230VAC, IEC or ATEX)

+Longer lead times. Consult factory.

Model	Inlet / Outlet Connections
FC1	1” Male JIC Inlet / Outlet
FC2	1.25” Male JIC Inlet / 1” Male JIC Outlet
FC3	1.5” Male JIC Inlet / 1.25” Male JIC Outlet

FCL Filter Cart

Flow rate up to 22 gpm (83 lpm)

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

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.

Recommended Viscosity Range*

Max recommended actual viscosity (based on pump suction line limitations through hoses)

FCL1= 800 cSt
i.e. ISO220 ≥ 68°F (20°C), ISO320 ≥ 80°F (26°C), ISO460 ≥ 90°F (32°C)

FCL2 = 500 cSt
i.e. ISO220 ≥ 75°F (23°C), ISO320 ≥ 86°F (30°C), ISO460 ≥ 97°F (36°C)

FCL3 = 500 cSt
i.e. ISO220 ≥ 75°F (23°C), ISO320 ≥ 86°F (30°C), ISO460 ≥ 97°F (36°C)

*FCL series carts are design optimized for high viscosity lube oils, large filter element size allows media selection down to 1M on FCL1 & FCL2 even with high viscosity fluids. Contact factory for modified FCL/FSL units designed for high viscosity fluids at cold and ambient temperature.

Maximum Acceptable Suction Condition

Maximum operating pressure loss 6 psi, 12 Hg.

Pump Specifications

Gear pump
Internal relief full flow @ 100 psi standard.

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)	-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

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

Explosion Proof Option

Explosion Proof NEC Article 501, Class 1, Div 1, Grp C & D optional. Call for IEC, Atex or other requirements.

Electric Motor Specifications

TEFC 56C Frame
60 Hz - 1750 RPM
50 Hz - 1450 RPM

FCL1, FCL2, FCL3 FILTER CART APPLICATION INFO

Top loading housing minimizes mess.

On-Off Switch with Overload Protection. IEC-IP65 enclosure (Dust & Water Tight)

Suction and return hoses included standard (hose extensions available).

Anti-siphon valve keeps FCL primed and prevents housing from draining after use.

Dual locking front casters.

Retractable power cord reel on FCL1& FCL2 single phase 115VAC and 230VAC, FCL3 230VAC 1P 50Hz only.

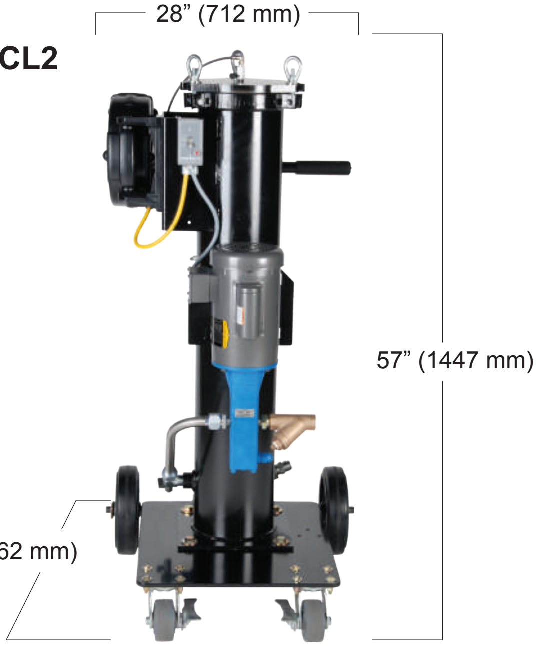
Non shredding solid wheels standard (Off road / severe duty inflatable tires optional).

True differential pressure gauge with green to red template (PSI and Bar).

Optional wire mesh spin-on strainer, pump protector (K option).

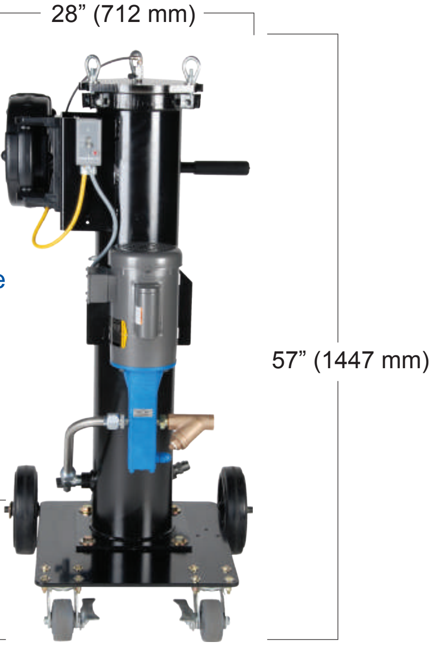
FCL DIMENSIONS

FCL1 & FCL2



FCL3

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



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.

True Differential Pressure Gauges & Switches

Differential pressure gauges with green to red display ensures proper monitoring of filter element condition. Visual and visual/ electrical options available.

HY-PRO
FILTRATION

Cleaner Fluid, Greater Reliability

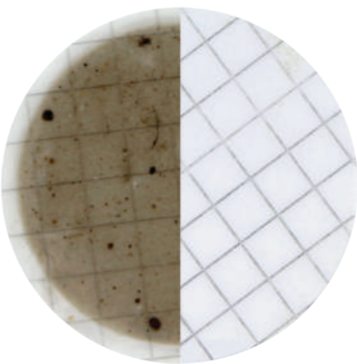
When establishing a target ISO cleanliness code first identify the most sensitive component. New oil added should be cleaner than the target ISO code for the system.

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.

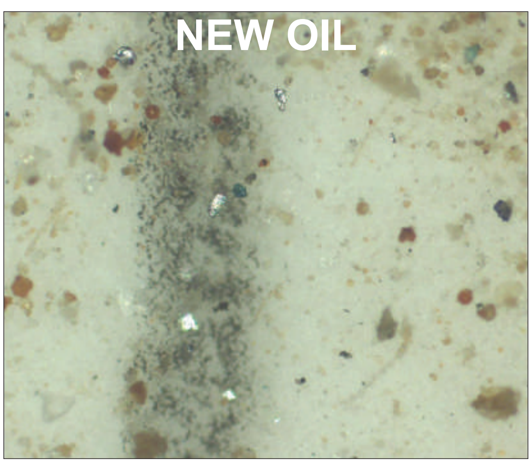
Figure 1

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
22/22/19	20/18/15	16/16/13	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	-	-	-



Don’t Put Dirty Oil Into Your System

This patch 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.



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 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.

FCL1, FCL2, FCL3 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	-	Seal	Hose	-	Δp Indictr	Power Option	Extra Option	Hy-Pro Mfg. Code

REPLACEMENT FILTER ELEMENT PART NUMBER GUIDE

	Table 2			Table 3	Table 4
HP10	Element Type	**L36***	-	Media Selection	Seal

Table 1 Code	Flow Rate gpm (lpm)
1	5 gpm (18 lpm)
2	10 gpm (37 lpm)
3*	22 gpm (83 lpm)

*Requires power option E2-E6

Table 4 Code	Seal Material
B	Nitrile (Buna)
V	*Specified synthetics or High Temperature (>150°F). Viton® seals, metal wands, Teflon lined hoses.

*Phosphate Ester, Water Glycol, & other synthetics.

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, o-rings change-out 22 psid (1,5 bar)
7	HP107 element with bypass 50 psid (3,5 bar) bypass, o-rings change-out 45 psid (3,1 bar)
8	USE HP8314 for element P/N Interchanges with Pall HC8314, NO BYPASS, o-ring seals, max change-out 45 psid (3,1 bar)

Table 3 Code	Filtration Rating	Media Type
1M	$\beta 2.5_{[C]}$ = 1000 (β1 = 200)	G8 Dualglass
3M	$\beta 5_{[C]}$ = 1000 (β3 = 200)	G8 Dualglass
6M	$\beta 7_{[C]}$ = 1000 (β6 = 200)	G8 Dualglass
10A*	$\beta 12_{[C]}$ = 1000 (β12 = 200)	G8 Dualglass + Water Removal
10M*	$\beta 12_{[C]}$ = 1000 (β12 = 200)	G8 Dualglass
25A	$\beta 22_{[C]}$ = 1000 (β25 = 200)	G8 Dualglass + Water Removal
25M	$\beta 22_{[C]}$ = 1000 (β25 = 200)	G8 Dualglass
25W	25μ Nominal Wire Mesh	Wire Mesh
40W	40μ Nominal Wire Mesh	Wire Mesh
74W	74μ Nominal Wire Mesh	Wire Mesh
149W	149μ Nominal Wire Mesh	Wire Mesh

*If element option code 8 (table 2) use 12A/12M instead of 10A/10M

Table 5 Code	Hose Arrangement
W	Female JIC swivel hose ends with steel wands
S	Female JIC swivel hose ends (No Wands)
G	Female BSPP swivel hose ends (No Wands)

*Extending hoses is not recommended on the suction line unless there is positive head pressure. Excessive negative suction head can create high pressure loss and high vacuum condition (consult factory).

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 7 Code	Power Options
*Omit (Standard)	115 VAC, 60Hz, 1P (1750 RPM Motor)
E1	120 VAC, 50Hz, 1P (1450 RPM Motor)
E2	230 VAC, 60Hz, 1P (1750 RPM Motor)
E3	230 VAC, 50Hz, 1P (1450 RPM Motor)
E4	24 VDC (Consult factory for application)
E5	440-480 VAC, 60Hz, 3P (1750 RPM Motor)
E6	380-420 VAC, 50Hz, 3P (1450 RPM Motor)
P	Pneumatic driven air motor (call factory).

*Not available for FCL3. 3 phase electrical option carts are supplied with terminated electrical cord only, and do not include electrical cord reel or electrical cord plug.

Table 8 Code	Special Options
18	L18 single length filter housing and element (not available for FCL3)
B	Filter bypass line with manual ball or check valve isolation
C	CE Mark
D+	High element ΔP shut-off with indicator light
H1*	Return-line only hose extension (10', 3 meters)
H2*	Return-line only hose extension (20', 6 meters)
K	149μ wire mesh spin-on pump suction strainer
L+	High element ΔP light (non-auto shutoff)
O+	On-Board Particle Monitor (PM-1)
R	Spill retention base fork guides/casters (instead of standard wheel & axle)
T	Large inflatable tires (off-road, severe duty)
X1+	Explosion proof electrical (Class 1, Div 1, Grp C/D)

+Longer lead times. Consult factory.

Model	Inlet / Outlet Connections
FCL1	1" Male JIC Inlet / Outlet
FCL2	1.25" Male JIC Inlet / 1" Male JIC Outlet
FCL3	1.5" Male JIC Inlet / 1.25" Male JIC Outlet

FCLCOD Diesel Fuel Conditioning Cart

Flow rate up to 22 gpm (83 lpm)

Extend the life of injectors and on-board fuel filters with high efficiency filtration ($\beta 5_{[C]} = 1000$, achieve 15/13/10 ISO cleanliness codes)

Reduce free & emulsified water content (in #2 diesel) from 1000ppm - 150ppm in a single pass

Ideal for mining & construction fueling depots, tank farms, conditioning stand-by diesel reservoirs and on-board fuel tanks

Condition fuel during bulk tank fill, service truck filling or as kidney loop to maintain clean & dry fuel

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

Fluid Compatibility

Diesel fuel #2, call for compatibility with other fuels.

Weight

FCLCOD1: 350 Lbs (159 kg) approximate
FCLCOD2: 360 Lbs (164 kg) approximate
FCLCOD3: 430 Lbs (195 kg) approximate

Pump Specifications

Gear pump
Internal relief full flow @ 100 psi standard.

Why is Diesel Fuel Cleanliness Important?

Today's sophisticated (expensive) electronic fuel injectors have increased pressures from 3,000 psi to 30,000 psi. Engine manufacturers have learned that ultra fine particles at higher pressures are causing premature failures, decreasing fuel injector and pump life while increasing unplanned downtime and lost production.

Water contamination in ULSD fuels lead to accelerated microbial growth and contributes to combustion engine failure and fuel efficiency loss.

Before **After**

HY-PRO FILTRATION

DIESEL FUEL COALESCE CART PART NUMBER GUIDE

	Table 1	Table 2		Table 3		Table 4	Table 5
FCLCOD	Flow Rate	Power	-	Seal	-	Hoses	Special Options

Table 1 Code	Flow Rate
1	5 gpm (18 lpm)
2	10 gpm (37 lpm)
3*	22 gpm (83 lpm)

*Requires 220 / 230 VAC 1P electrical service

Table 3 Code	Seal Material
V	Viton® (Standard)
E	EPR

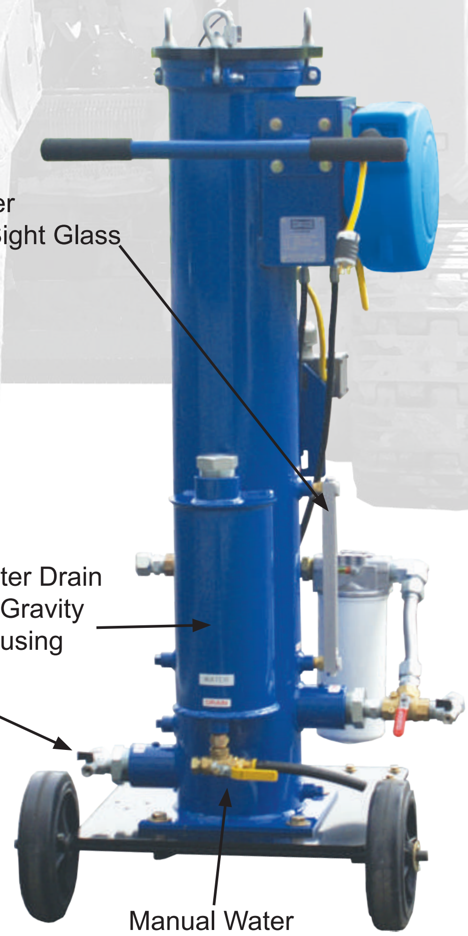
Table 4 Code	Hose Arrangement
W	Female JIC swivel hose ends with steel wands
S	Female JIC swivel hose ends (No Wands)
G	Female BSPP swivel hose ends (No Wands)

*Extension hoses are available in 10’ (3048mm) lengths, not recommended for suction line without positive head.

Table 2 Code	Power Options
Omit (Standard)	115 VAC, 60Hz, 1P (1750 RPM Motor)
E1	120 VAC, 50Hz, 1P (1450 RPM Motor)
E2	230 VAC, 60Hz, 1P (1750 RPM Motor)
E3	230 VAC, 50Hz, 1P (1450 RPM Motor)
E4	24 VDC (Consult factory for application)
E5	440-480 VAC, 60Hz, 3P (1750 RPM Motor)
E6	380-420 VAC, 50Hz, 3P (1450 RPM Motor)
E7	575 VAC, 60Hz, 3P (1750 RPM Motor)

Table 5 Code	Special Options
A[+]	Auto water drain (manual drain included)
C	CE mark
K	149m wire mesh spin-on pump suction strainer
D[+]	High element ∆P shut-off with indicator light (coalesce vessel only, 22∆P psid).
L[+]	Coalesce element high differential pressure indicator light
T	Large foam filled rubber tires
H1*	Return-line only hose extension (10’, 3 meters)
H2*	Return-line only hose extension (20’, 6 meters)

[+]Longer lead time (consult factory).



Model	Inlet / Outlet Connections
FCLCOD1	1” Male JIC Inlet / Outlet
FCLCOD2	1.25” Male JIC Inlet / 1” Male JIC Outlet
FCLCOD3	1.5” Male JIC Inlet / 1.25” Male JIC Outlet

FCLVAW portable filter cart for AW hydraulic oils with sludge and varnish problems

High efficiency particulate removal (< 0.7μ), water & insoluble sludge & varnish removal.

Ideal for AW type hydraulic fluids where sludge build-up is causing valve stiction.

Reduce ISO codes to <14/12/9 and prevent sensitive servo valve contamination related failures.

Prevent premature oil replacement and extend useful oil life

Ideal for in plastic injection molding, steel mill and other hydraulic control applications.

Fluid Compatibility

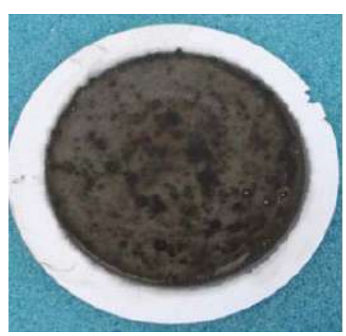
AW mineral based hydraulic oils and specified synthetic fluids (contact factory for details)

Plastic molding skin Injection & Clamp valve with varnish deposits

Performance

The filter patches below show the oil cleanliness improvement . 30 days after installing the FCLVAW-1 the MPC value had dropped from a critical value of 88.107 to a condition normal value of 12.110. By maintaining clean fluid deposits don't form in the valves and over time the clean can cause a reduction in existing deposits throughout the system. (filter patches analyzed by Method Membrane Patch Colorimetric (per ASTM D02.C0.01 WK 13070)

BEFORE
MPC ΔE = 88.107



AFTER
MPC ΔE = 9.610

HY-PRO FILTRATION

FCLVAW PART NUMBER GUIDE

	Table 1	Table 2		Table 3		Table 4
FCLVAW	Flow Rate	Hose Connec-tions	-	Power Option	-	Special Options

Table 1 Code	Flow Rate gpm (lpm)
0.5	0.7 gpm (2.6 lpm) Up to 400 Gallon (1,500 liter) reservoir, Filter element HP107L18-VTM710-V
1.0	1.4 gpm (5.2 lpm) Up to 800 Gallon (3,000 liter) reservoir, Filter element HP107L36-VTM710-V

Contact Hy-Pro for sizing and part number selection.

Table 2 code	Hose Connections
G	Female BSPP swivel hose ends (No Wands)
S	Female SAE/JIC swivel hose ends (No Wands)
W	Female SAE/JIC swivel hose ends with steel wands

Table 3 Code	Power Options
Omit (std)	115 VAC, 60Hz, 1P (1750 RPM motor)
E1	120 VAC, 50Hz, 1P (1450 motor)
E2	230 VAC, 60Hz, 1P (1750 RPM motor)
E3	230 VAC, 50Hz, 1P (1450 RPM motor)
E5	440-480 VAC, 60 Hz, 3P (1750 RPM motor)
E6	380-420 VAC, 50Hz, 3P (1450 RPM motor)
E7	575 VAC, 60 Hz, 3P (1750 RPM motor)

Table 4 Code	Special Options
B	Filter bypass line with manual ball or check valve isolation
C	CE Mark
K	149μ wire mesh spin-on pump suction strainer
L[+]	High element ΔP light (non-auto shutoff)
O[+]	On-board particle monitor PM-1
T	Large inflatable tires (off-road, severe duty)
X1[+]	Explosion proof (NEC Article 501 Class 1, DIV 1, GRP C&D) up to 460VAC (contact factory for >460VAC, IEC or ATEX)

[+] Longer lead times. Consult factory.

Viton® seals standard.

Model	Inlet \ Outlet Connections
All	1” Male JIC Inlet & Outlet

FCLVAW REPLACEMENT ELEMENT SPECIFICATIONS

Filter Element Features	
Integral Element Bypass	New bypass valve with each element change, Prevents pump and housing seal leakage from over pressure, Bypass valve cracking pressure 55 PSI / 3.9 Bar
HP107L**-VTM710-V Element Materials	Synthetic end cap materials, coreless element design for ease of disposal, high efficiency DFE Rated glass media + integrated water absorbing and insoluble oxidation by-product removal media
Large Filter Element	The large size of the filter element enables very efficient removal of the particulate, water and oxidation by-product contamination. Elements are changed on a 6~12 month service interval
Top Loading Housing	The top loading filter housing makes element service clean and easy preventing excess oil spilling
External gear pump (with internal relief)	External gear pump (spur gear) is cast iron (durable vs aluminum), Internal safety relief prevents over pressure

***Specified length of element can be either nominal L18 or L36*

FSLVAW off-line conditioning skids for AW hydraulic oils with sludge and varnish problems

High efficiency particulate removal ($< 0.7\mu$), water & insoluble sludge & varnish removal.

Ideal for AW type hydraulic fluids where sludge build-up is causing valve stiction.

Reduce ISO codes to <14/12/9 and prevent sensitive servo valve contamination related failures.

Prevent premature oil replacement and extend useful oil life

Ideal for in plastic injection molding, steel mill and other hydraulic control applications.

Fluid Compatibility

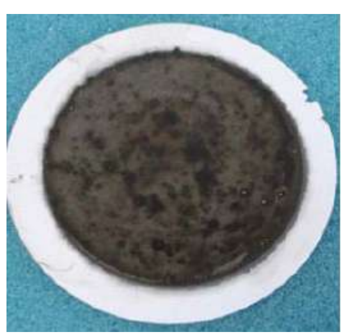
AW mineral based hydraulic oils and specified synthetic fluids (contact factory for details)

Plastic molding skin Injection & Clamp valve with varnish deposits

Performance

The filter patches below show the oil cleanliness improvement . 30 days after installing the FSLVAW-1 the MPC value had dropped from a critical value of 88.107 to a condition normal value of 12.110. By maintaining clean fluid deposits don't form in the valves and over time the clean can cause a reduction in existing deposits throughout the system. (filter patches analyzed by Method Membrane Patch Colorimetric (per ASTM D02.C0.01 WK 13070)

BEFORE
MPC ΔE = 88.107



AFTER
MPC ΔE = 9.610

HY-PRO FILTRATION

FSLVAW PART NUMBER GUIDE

	Table 1		Table 2		Table 3
FSLVAW	Flow Rate	-	Power Option	-	Special Options

Table 1 Code	Flow Rate gpm (lpm)
0.5	0.7 gpm (2.6 lpm) Up to 400 Gallon (1,500 liter) reservoir, Filter element HP107L18-VTM710-V
1.0	1.4 gpm (5.2 lpm) Up to 800 Gallon (3,000 liter) reservoir, Filter element HP107L36-VTM710-V

Contact Hy-Pro for sizing and part number selection

Table 2 Code	Power Options
Omit (std)	115 VAC, 60Hz, 1P (1750 RPM motor)
E1	120 VAC, 50Hz, 1P (1450 motor)
E2	230 VAC, 60Hz, 1P (1750 RPM motor)
E3	230 VAC, 50Hz, 1P (1450 RPM motor)
E5	440-480 VAC, 60 Hz, 3P (1750 RPM motor)
E6	380-420 VAC, 50Hz, 3P (1450 RPM motor)
E7	575 VAC, 60 Hz, 3P (1750 RPM motor)

Table 3 Code	Special Options
A[+]	Air cooled heat exchanger
C	CE Mark
K	149µ wire mesh spin-on suction filter with 3 psid bypass
L[+]	High element ∆P Light (Non-Auto Shutoff)
O[+]	On-board particle monitor PM-1
T	Spill retention tray with fork guides
X1[+]	Explosion proof (NEC Article 501 Class 1, DIV 1, GRP C&D) up to 460VAC (contact factory for >460VAC, IEC or ATEX)

[+]Longer lead times. Consult factory.

Viton® seals standard.

Model	Inlet \ Outlet Connections
All	1” FNPT Inlet & Outlet

3-Way Ball Valve Included on Inlet

FSLVAW REPLACEMENT ELEMENT SPECIFICATIONS

Filter Element Features	
Integral Element Bypass	New bypass valve with each element change, Prevents pump and housing seal leakage from over pressure, Bypass valve cracking pressure 55 PSI / 3.9 Bar
HP107L**-VTM710-V Element Materials	Synthetic end cap materials, coreless element design for ease of disposal, high efficiency DFE Rated glass media + integrated water absorbing and insoluble oxidation by-product removal media
Large Filter Element	The large size of the filter element enables very efficient removal of the particulate, water and oxidation by-product contamination. Elements are changed on a 6~12 month service interval
Top Loading Housing	The top loading filter housing makes element service clean and easy preventing excess oil spilling
External gear pump (with internal relief)	External gear pump (spur gear) is cast iron (durable vs aluminum), Internal safety relief prevents over pressure

***Specified length of element can be either nominal L18 or L36*

HY-PRO FILTRATION

FSA Fluid Conditioning for Phosphate Ester

Ideal for Maintenance of Steam Turbine EHC Fire Resistant Fluids

Prevent contamination related variable geometry valve failures, extend useful oil life.

Remove & maintain Acid Number to < 0.05 with ICB element technology .

Prevent & remove gels & deposit caused by other acid removal technologies (ICB technology removes dissolved metals).

Maintain H_2O below 200 ppm with TMRN2 and minimize acid producing hydrolysis.

Integrated TMRN2 (Nitrogen generator) prevents airborne water & metal ion ingression, and removes combustible dissolved gasses (prevent micro-dieseling).

Particulate & insoluble gel / sludge removal with high efficiency on-board filtration.

Fluid Condition Based Solutions

From a sample of in-service oil and system details we will help you specify and implement a fluid contamination solution to achieve reliable aero-derivative turbine operation. Take advantage of over 30 years of EHC fire resistant fluid maintenance experience. We know how.

Fluid Compatibility

FSA systems are compatible with a range of specified fire resistant fluids used in EHC (Phosphate ester).

Suitable Operating Temperature Range

90°F/32°C (minimum) to 160°F/71°C (maximum)
Operating below minimum can result in reduced Acid and metal ion removal efficiency

Warning: Do not operate above max temperature 160°F/71°C. Contact factory to add pre-cooler before ICB media (operating temp required).

High Contamination Fluid Recovery

For systems with high acid number, excessive gel / sludge buildup or extremely high water contact Hy-Pro for rapid fluid recovery solutions.

Specifications

Filter Assemblies: Epoxy coated steel (304 option)
Electrical Motor: 1 HP, TEFC
TMRN2 Air Consumption: 1.2 - 6.0 SCFM see sizing guidelines

FSA PART NUMBER GUIDE

	Table 1	Table 2		Table 3		Table 4
FSA	Fluid Type	Flow Rate	-	Power Option	-	Special Options

Table 1 Code	Fluid Type
PE	Phosphate Ester
BS	Biosyn
SK	Skydrol (call)
call	Other (call factory)

Table 2 Code	Flow Rate gpm / lpm
0.5	0.5 gpm / 1.87 lpm (max reservoir size 200 gal / 750 liter) + TMRN2-601902
1	1.0 gpm / 3.75 lpm (max reservoir size 400 gal / 1,500 liter) + TMRN2-601902
2	2 gpm / 7.5 lpm (max reservoir size 1,100 gal / 4,125 liter) + TMRN2-601903
4	4 gpm / 15 lpm (max reservoir size 2,200 gal / 8,250 liter) + TMRN2-601904

Contact Hy-Pro for sizing and part number selection

Table 3 Code	Power Options
Omit (std)	115 VAC, 60Hz, 1P (1750 RPM motor)
E1	120 VAC, 50Hz, 1P (1450 motor)
E2	230 VAC, 60Hz, 1P (1750 RPM motor)
E3	230 VAC, 50Hz, 1P (1450 RPM motor)
E5	440-480 VAC, 60 Hz, 3P (1750 RPM motor)
E6	380-420 VAC, 50Hz, 3P (1450 RPM motor)
E7	575 VAC, 60 Hz, 3P (1750 RPM motor)

Table 4 Code	Special Options
A+	Air cooled heat exchanger in-line for operating temp > 160°F / 71°C
C	CE Mark
H+	High Temp Shut Off preset for 160°F / 71°C (panel indicator light included) Temperature setting is adjustable
S	304 Stainless steel filter vessels
X1+	Explosion proof NEC Article 501 Class 1,Div 1, Grp C/D (contact factory for IEC or ATEX Exp. Proof requirements)
XT	Deselect TMRN2 moisture control and dissolved gas removal (N2 generator) unit. TMRN2 is included as a standard so if it is not desired it must be deselected.

+Longer lead times. Consult factory.

Model	Inlet \ Outlet Connections
All	1” FNPT Inlet & Outlet

3-Way Ball Valve Included on Inlet

FSA REPLACEMENT ELEMENT & SEAL KIT ORDER GUIDE

Model	Housing Seal Kits
FSA**0.5	SKV-FSA0.5 (2 x OVLF)
FSA**1	SKV-FSA0.5 (2 x OVLF)
FSA**2	SKV-FSJL2 (1 x OVLF, 1 x OVSVR12)
FSA**4	SKV-FSJL2 (1 x OVLF, 1 x OVSVR12)

Model	ICB Element x (qty)	High Efficiency Element x (qty)
FSA**0.5	ICB-600504-A x (1)	HP107L18-VTM710-V x (1)
FSA**1	ICB-600504-A x (2)	HP107L18-VTM710-V x (1)
FSA**2	ICB-600524-A x (1)	HP107L18-VTM710-V x (1)
FSA**4	ICB-600524-A x (2)	HP107L36-VTM710-V x (1)

FSJL Aero-derivative Jet Lube Oil Conditioning

Ideal for maintenance of aero-derivative jet lube oil & hydraulic systems

Prevent contamination related variable geometry failures and extend useful oil life.

Remove & maintain Acid Number to < 0.06 with ICB element technology (Ion Charge Bonding by EPT)

Prevent aero-derivative lube oil gel & deposit formation with ICB element technology.

Maintain H_2O to <200 ppm with TMRN2 and minimize acid production & slow oxidation.

Optional TMRN2 (Nitrogen generator) prevents airborne water & metal ion ingression, and removes combustible dissolved gasses (prevent micro-dieseling).

Particulate & insoluble gel / sludge removal with high efficiency on-board filtration.

Fluid Condition Based Solutions

From a sample of in-service oil and system details we will help you specify and implement a fluid contamination solution to achieve reliable aero-derivative turbine operation. Take advantage of over 30 years of aero-derivative turbine maintenance experience. We know how.

Fluid Compatibility

FSJL systems are fully compatible with MIL-L-23699 aero-derivative jet lube oils (ie polyol ester).

Suitable Operating Temperature Range

90°F/32°C (minimum) to 160°F/71°C (maximum)
Operating below minimum can result in reduced Acid and metal ion removal efficiency

Warning: Do not operate above max temperature 160°F/71°C. Contact factory to add pre-cooler before ICB media (operating temp required).

High Contamination Fluid Recovery

For systems with high acid number, excessive gel / sludge buildup or extremely high water contact Hy-Pro for rapid fluid recovery solutions.

Specifications

Filter Assemblies: Epoxy coated steel (304 option)
Electrical Motor: 1 HP, TEFC
TMRN2 Air Consumption: 1.0-3.6 SCFM see sizing guidelines

FSJL PART NUMBER GUIDE

	Table 1	Table 2		Table 3		Table 4	Table 5
FS	Fluid Type	Flow Rate	-	Power Option	-	Seal Material	Special Options

Table 1 Code	Fluid Type
JL*	Synthetic jet lube oil, jet oil
Call*	Other

**FSJL series fluid conditioning skids are designed for specified jet lube oil fluids used in aero-derivative turbine applications for the removal of acid, varnish, water, dissolved metal ions. For other fluids where acid remediation is needed (ie EHC phosphate ester) contact Hy-Pro for guidance on fluid analysis and solutions. The solutions are fluid type specific and not just for general acid removal in any type of fluid.*

Table 2 Code	Flow Rate gpm / lpm
0.5	0.5 gpm / 1.87 lpm (max reservoir size 150 gal / 560 liter) + TMRN2-601902 (if TMRN2 option selected in table 5)
1	1.0 gpm / 3.75 lpm (max reservoir size 300 gal / 1,125 liter) + TMRN2-601902 (if TMRN2 option selected in table 5)
2	2 gpm / 7.5 lpm (max reservoir size 800 gal / 3,000 liter) + TMRN2-601903 (if TMRN2 option selected in table 5)
4	4 gpm / 15 lpm (max reservoir size 1,600 gal / 6,000 liter) + TMRN2-601904 (if TMRN2 option selected in table 5)

Table 3 Code	Power Options
Omit (std)	115 VAC, 60Hz, 1P (1750 RPM motor)
E1	120 VAC, 50Hz, 1P (1450 motor)
E2	230 VAC, 60Hz, 1P (1750 RPM motor)
E3	230 VAC, 50Hz, 1P (1450 RPM motor)
E5	440-480 VAC, 60 Hz, 3P (1750 RPM motor)
E6	380-420 VAC, 50Hz, 3P (1450 RPM motor)
E7	575 VAC, 60 Hz, 3P (1750 RPM motor)

Table 4 Code	Seal Material
V	Fluorocarbon (Viton, standard)
Call	Other

Table 5 Code	Special Options
A+	Air cooled heat exchanger in-line for operating temp > 160°F / 71°C
C	CE Mark
H+	High Temp Shut Off preset for 160°F / 71°C (panel indicator light included) Temperature setting is adjustable
O+	On-board particle monitor PM-1
S	304 Stainless steel filter housings, plumbing mix of stainless & plated steel
T	TMRN2 added to FSJL for removal of existing water, reduced oxidation rate, and control of environmental contaminant ingression
X1+	Explosion proof NEC Article 501 Class 1,Div 1, Grp C/D (contact factory for IEC or ATEX Exp. Proof requirements)

+Longer lead times. Consult factory.

Model	Inlet \ Outlet Connections
All	1” FNPT Inlet & Outlet

3-Way Ball Valve Included on Inlet

FSJL REPLACEMENT ELEMENT & SEAL KIT ORDER GUIDE

Model	Housing Seal Kits
FSJL0.5	SKV-FSJL0.5 (2 x OVSVR8)
FSJL1	SKV-FSJL0.5 (2 x OVSVR8)
FSJL2	SKV-FSJL2 (1 x OVSVR8, 1 x OVSVR12)
FSJL4	SKV-FSJL2 (1 x OVSVR8 1 x OVSVR12)

Model	ICB Element x (qty)	High Efficiency Element x (qty)
FSJL0.5	ICB-600504-J x (1)	HP107L18-VTM710-V x (1)
FSJL1.0	ICB-600504-J x (2)	HP107L18-VTM710-V x (1)
FSJL2	ICB-600524-J x (1)	HP107L18-VTM710-V x (1)
FSJL4	ICB-600524-J x (2)	HP107L18-VTM710-V x (1)

FSTO Turbine Lube Oil Varnish Removal

Ideal for maintenance of small turbine lube oil & compressor reservoirs

Prevent varnish related servo valve failures on small gas turbines and compressor lube oil applications (ie gas transmission compressor units)

Remove & prevent varnish deposits with ICB element technology (Ion Charge Bonding)

Achieve & maintain MPC value < 20 (lower varnish potential)

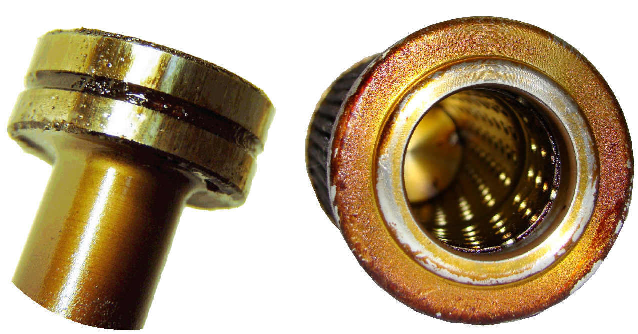
Lower ISO codes to 14/12/9 with high efficiency post filter element

Extend life of anti-oxidant additives & prevent premature oil replacement

Fluid Condition Based Solutions

From a sample of in-service oil and system details we will help you specify and implement a fluid contamination solution to achieve reliable operation and extend useful fluid life.

We know how to stop lube oil varnish before it stops you!



ICB & VTM, the 1, 2 varnish removal punch

ICB removes the soluble varnishing building oxidation by-products at the molecular level reversing the process of varnish deposits while VTM removes the gross insoluble by-products for a more rapid reduction in varnish potential.

Fluid Compatibility

Mineral based turbine oils and specified synthetic Fluids with R&O additive package (non-zinc AW). ***NOT for use on AW type hydraulic oils, contact Hy-Pro for fluid compatibility & selection.***

Suitable Operating Temperature Range

90°F/32°C (minimum) to 160°F/71°C (maximum)
Operating below minimum can result in reduced Acid and metal ion removal efficiency

Warning: Do not operate above max temperature 160°F/71°C. Contact factory to add pre-cooler before ICB media (operating temp required).

High Contamination Fluid Recovery

For systems with high acid number, excessive gel / sludge buildup or extremely high water contact Hy-Pro for rapid fluid recovery solutions.

FSTO PART NUMBER GUIDE

	Table 1		Table 2		Table 3
FSTO	Flow Rate	-	Power Option	-	Special Options

Table 1 Code	Flow Rate gpm (lpm)
0.5	0.5 gpm (1.8 lpm) reservoir size up to 600 gallons / 2,250 liters
1	1 gpm (3.7 lpm) reservoir size up to 1,200 gallons / 4,500 liters
2	2 gpm (7.5 lpm) reservoir size up to 2,500 gallons / 9,375 liters

Contact Hy-Pro for sizing & part selection

Table 2 Code	Power Options
Omit (std)	115 VAC, 60Hz, 1P (1750 RPM motor)
E1	120 VAC, 50Hz, 1P (1450 motor)
E2	230 VAC, 60Hz, 1P (1750 RPM motor)
E3	230 VAC, 50Hz, 1P (1450 RPM motor)
E5	440-480 VAC, 60 Hz, 3P (1750 RPM motor)
E6	380-420 VAC, 50Hz, 3P (1450 RPM motor)
E7	575 VAC, 60 Hz, 3P (1750 RPM motor)

Table 3 Code	Special Options
A[+]	Air cooled heat exchanger in-line for operating temp > 160°F / 71°C
C	CE Mark
H[+]	High Temp Shut Off preset for 160°F / 71°C (panel indicator light included) Temperature setting is adjustable
O[+]	On-board particle monitor PM-1
S	304 Stainless steel filter housings, plumbing mix of stainless & plated steel
X1[+]	Explosion proof NEC Article 501 Class 1,Div 1, Grp C/D (contact factory for IEC or ATEX Exp. Proof requirements)

[+]Longer lead times. Consult factory.

Model	Inlet \ Outlet Connections
All	1” FNPT Inlet & Outlet

3-Way Ball Valve Included on Inlet

FSTO REPLACEMENT ELEMENT & SEAL KIT ORDER GUIDE

Model	Housing Seal Kits
FSTO0.5	SKV-FSJL2 (1 x OVLF, 1 x OVSVR8)
FSTO1	SKV-FSTO1 (1 x OVLF, 1 x OVSVR8)
FSTO2	SKV-FSTO2 (1 x OVSVR8, 1 x OVSVR12)

Model	ICB Element x (qty)	High Efficiency Element x (qty)
FSTO0.5	ICB-600504-V x (1)	HP107L18-VTM710-V x (1)
FSTO1	ICB-600504-V x (2)	HP107L18-VTM710-V x (1)
FSTO2	ICB-600524-V x (1)	HP107L18-VTM710-V x (1)

FSL Filter Unit

Flow rate up to 22 gpm (83 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.

See Coal Mill Success Brochure for Gearbox & Oil Cost Benefit Analysis

Recommended Viscosity Range*

Max recommended actual viscosity (based on pump suction line limitations through hoses)

FSL/FSLD1= 1000 cSt
i.e. ISO220 ≥ 60°F (15°C), ISO320 ≥ 75°F (23°C), ISO460 ≥ 86°F (30°C)

FSL/FSLD2 = 650 cSt
i.e. ISO220 ≥ 70°F (21°C), ISO320 ≥ 82°F (27°C), ISO460 ≥ 94°F (34°C)

FSL/FSLD3 = 650 cSt
i.e. ISO220 ≥ 75°F (23°C), ISO320 ≥ 86°F (30°C), ISO460 ≥ 97°F (36°C)

*FSL large filter element size allows media selection down to 1M on FSL1 & FSL2 even with high viscosity fluids. Contact factory for inlet plumbing recommendations for dedicated skids to increase viscosity range for FSL & FSLD series (ie pipe diameter over-sizing, minimizing elbows, flooded suction). Contact factory for modified FSL/FSLD units designed for high viscosity fluids at cold and ambient temperature.

Maximum Acceptable Suction Condition

Maximum operating pressure Loss 6 psi, 12 Hg.

Pump Specifications

Gear pump
Internal relief full flow @ 100 psi standard.

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)	-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

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

Explosion Proof NEC Article 501, Class 1, Div 1, Grp C & D optional. Call for IEC, Atex or other requirements.

Electric Motor Specifications

TEFC 56C Frame
60 Hz - 1750 RPM
50 Hz - 1450 RPM

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

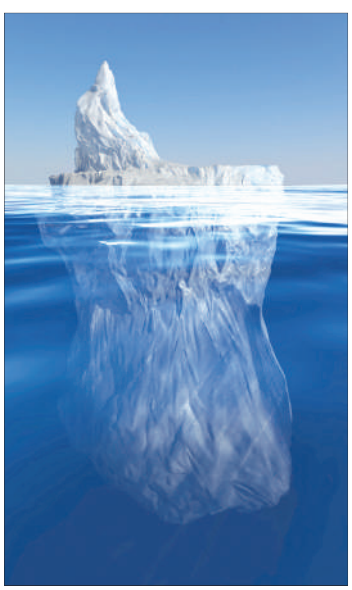
Coreless Filter Element Technology

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. Visual and visual/ electrical options available (see figure 5).

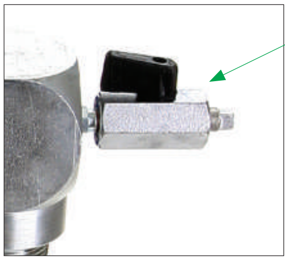


Cost of Contamination Control - The Tip of the Iceberg

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**

HY-PRO FILTRATION



Dual FSL Skids are Ideal for Conditioning Reclaimed Fluids or Fluids with High Dirt Load

The FSL series filter skids is now available with two housings in series which allows the flexibility to use staged element ratings to achieve very clean target ISO codes in fewer passes and also extend filter element life.

Any combination of elements can be applied to obtain the best result including a range of pleated stainless steel wire mesh as a pre-filter, water removal elements, high efficiency glass media, and even acid scavenging filter elements to control high acid numbers.

Contact Hy-Pro for a recommendation on the off-line FSL skid that is most suitable for your contamination challenge.

FSL FILTRATION UNIT SELECTION AND SIZING 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 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 (i.e. gear lube ISO 220) will typically display very high viscosity as the temperature drops below 100°F. 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	0.00090
3M		0.050	0.00096		0.042	0.00081
6M		0.048	0.00092		0.041	0.00079
10M		0.046	0.00087		0.040	0.00077
16M		0.043	0.00082		0.038	0.00073
25M		0.040	0.00077		0.037	0.00071
**W		0.037	0.00071		0.035	0.00067

HY-PRO FILTRATION

FSL FILTER CART PART NUMBER GUIDE

Table:	1	2		3	4	4		5	6		7	8	9	
FSL	Dual Housing Option	Flow Rate	-	Element Type	Media Selection Element 1	Media Selection Element 2*	-	Seals	Length	-	Δp Indicator	Power Option	Special Option	Hy-Pro Mfg. Code

*Omit if Not Selecting 'D' Option from 'Table 1'

REPLACEMENT FILTER ELEMENT PART NUMBER GUIDE

Table:	3	6		4		5
HP10	Element Type	Length	-	Media Selection	-	Seals

Table 1 Code	Dual Housing Option
Omit	Standard FSL with Single Housing
D	Dual FSL with Two Housings

Table 2 Code	Flow Rate gpm (lpm)
1	5 gpm (18 lpm)
2	10 gpm (37 lpm)
3*	22 gpm (83 lpm)

*Requires Power Option E2-E6

Table 3 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, O-Rings Change-Out 22 psid (1,5 bar)
7	HP107 Element with Bypass 50 psid (3.5 bar) Bypass, O-Rings Change-Out 45 psid (3.2 bar)
8	USE HP8314 for Element P/N Interchanges with Pall HC8314, **NO BYPASS,** O-Ring Seals, Max Change-Out 45 psid (3,2 bar)

Table 4 Code	Filtration Rating	Media Type
1M	$\beta 2.5_{[c]}$ = 1000 (β1 = 200)	G8 Dualglass
3M	$\beta 5_{[c]}$ = 1000 (β3 = 200)	G8 Dualglass
6M	$\beta 7_{[c]}$ = 1000 (β6 = 200)	G8 Dualglass
10A*	$\beta 12_{[c]}$ = 1000 (β12 = 200)	Water Removal +
10M*	$\beta 12_{[c]}$ = 1000 (β12 = 200)	G8 Dualglass
16A	$\beta 16_{[c]}$ = 1000 (β17 = 200)	Water Removal +
16M	$\beta 16_{[c]}$ = 1000 (β17 = 200)	G8 Dualglass
25A	$\beta 22_{[c]}$ = 1000 (β25 = 200)	Water Removal +
25M	$\beta 22_{[c]}$ = 1000 (β25 = 200)	G8 Dualglass
25W	25μ Nominal	Wire Mesh
40W	40μ Nominal	Wire Mesh
74W	74μ Nominal	Wire Mesh
149W	149μ Nominal	Wire Mesh
BAG	25μ Nominal Bag Housing (Suitable Only for Element 1 Selection	Polyester Bag HPKE25K2S

*If '8' option is selected from 'Table 2' use 12A/12M instead of 10A/10M.

Table 5 Code	Seal Material
B	Buna (Nitrile)
V	Viton® (Fluorocarbon) for Specified Synthetics or Temperatures Above 150°F

Table 6 Code	Element Length
18	Standard - 18" Nominal (FSL1, FSL2 Only)
36	Extended - 36" Nominal (FSL1, FSL2 & FSL3)

Table 7 Code	Differential Pressure Indicator
X	None (Ported, Plugged)
D	22 psid Visual Δp Gauge, + Electric Alarm (120V AC)
E	22 psid Visual Δp Gauge
F	45 psid Visual Δp Gauge, + Electric Alarm (120V AC)
G	45 psid Visual Δp Gauge
H	65 psid Visual Δp Gauge, + Electric Alarm (120V AC, Non-Bypass Element Options 5 & 8 Only)
J	65 psid Visual Δp Gauge (Non-Bypass Element Options 5 & 8 Only)
P	Two Pressure Gauges (Industrial Liquid Filled)

Table 8 Code	Power Options
*Omit (STD)	115 VAC, 60Hz, 1P (1750 RPM Motor)
*E1	120 VAC, 50Hz, 1P (1450 Motor)
E2	230 VAC, 60Hz, 1P (1750 RPM Motor)
E3	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)
E7	575 VAC, 60Hz, 3P (1750 RPM Motor)
P	Pneumatic Driven Air Motor (Call Factory)

FSL internal pump relief crack pressure is 85 psi (100 psi full flow).
For FSLD pump relief crack pressure is set to 125 psi.

Table 9 Code	Special Options
A⁺	Air cooled heat exchanger
C	CE Mark
D⁺	High element ΔP shut-off with indicator light
K	149μ wire mesh spin-on suction filter with 3 psid bypass
L⁺	High element ΔP Light (Non-Auto Shutoff)
O⁺	On-Board Particle Monitor (PM-1)
S⁺	Stainless Steel Vessel, Plumbing, Element Support
T*	Spill Retention Pan 24" x 24" (609mm x 609mm)
X1⁺	Explosion Proof Electrical (Class 1,Div 1, Grp C/D)

* If 'D' option is selected from 'Table 1' Spill Retention Pan is standard. Dimensions: 32" x 36" (813mm x 914mm)

* If '3' option is selected from 'Table 2' Spill Retention Dimensions will be 32" x 36" (813mm x 914mm)

⁺Longer lead times. Consult factory.

Model	Inlet / Outlet Connections
FSL1	1" FNPT Inlet / Outlet
FSL2	1" FNPT Inlet / Outlet
FSL3	1.5" FNPT Inlet / 1.25" FNPT Outlet

3-Way Ball Valve Included on Inlet

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

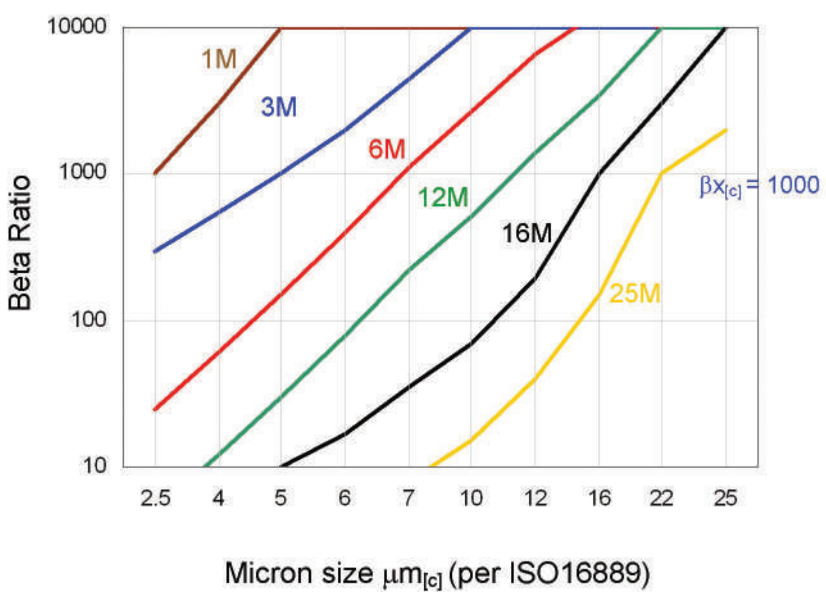
Through extensive testing we have developed media choices to handle any application. Options include G8 Dualglass, Dynafuzz (stainless fiber), and Wire mesh (stainless).

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.

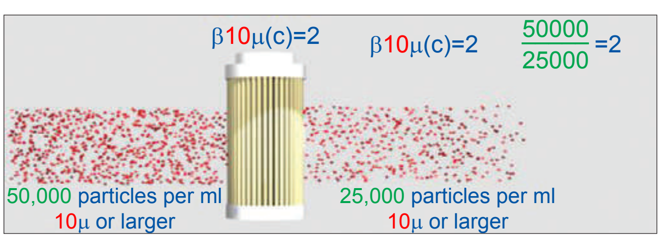
FILTER MEDIA SPECIFICATIONS

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

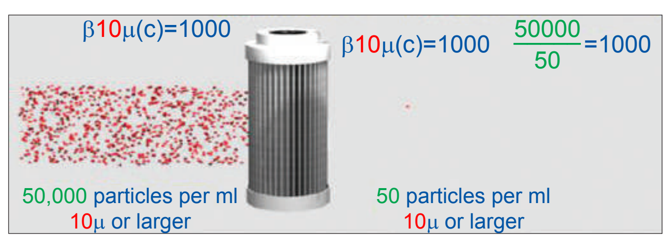


Media Code	Media Description
A	G8 Dualglass high performance media combined with water removal scrim. $\beta x_{[c]}$ = 1000 (βx = 200)
M	G8 Dualglass our latest generation of DFE rated, high performance glass media for all hydraulic & lubrication fluids. $\beta x_{[c]}$ = 1000 (βx = 200)
W	Stainless steel wire mesh media $\beta x_{[c]}$ = 2 (βx = 2) nominally rated

Typical Cellulose Media Performance

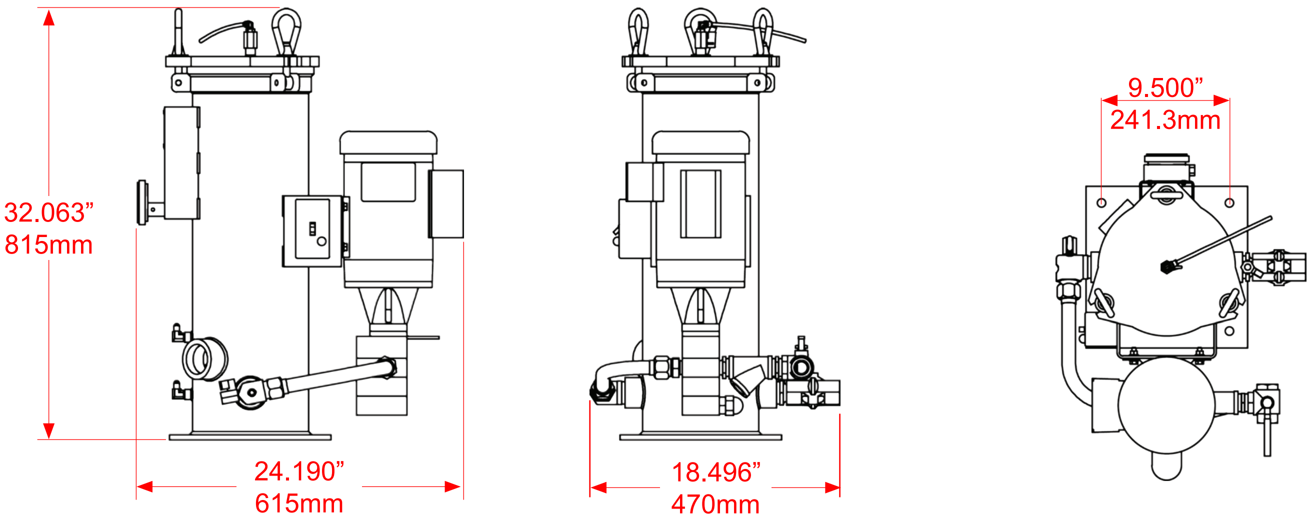


Hy-Pro G8 Dualglass Media Performance



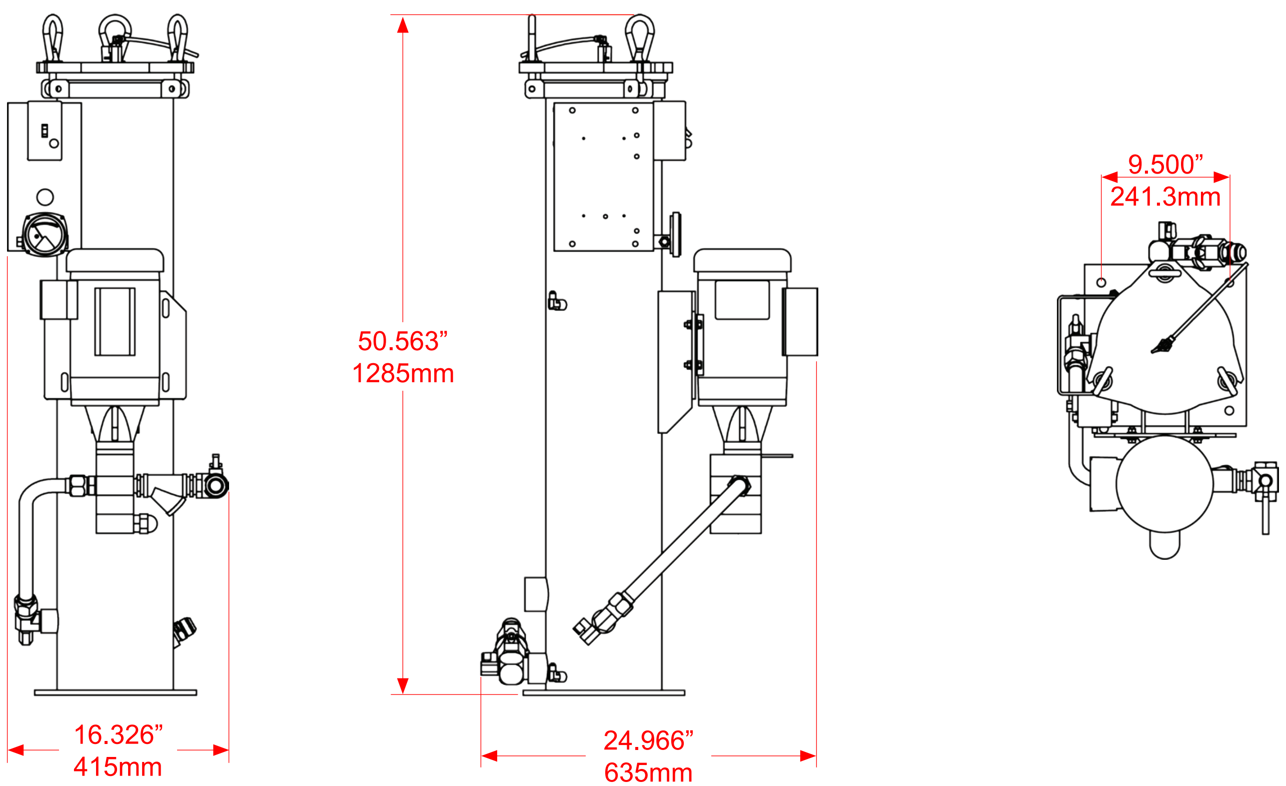
HY-PRO FILTRATION

FSL1, FSL2 18" LENGTH DIMENSIONS



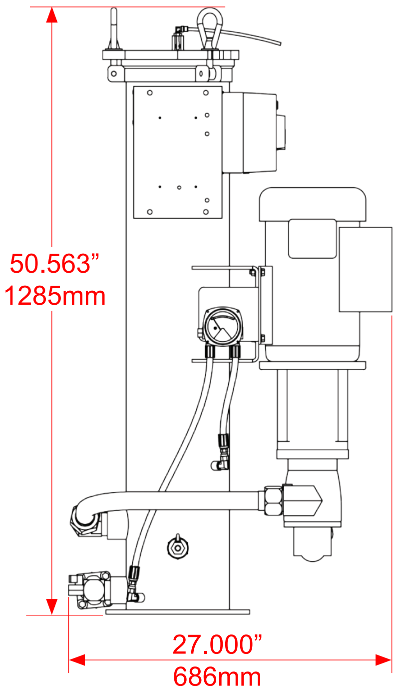
Overhead Clearance Required for Element Removal	
FSL1, FSL2 18" Length	17.250" 439mm
FSL1, FSL2, FSL 3 36" Length	36.250" 921mm

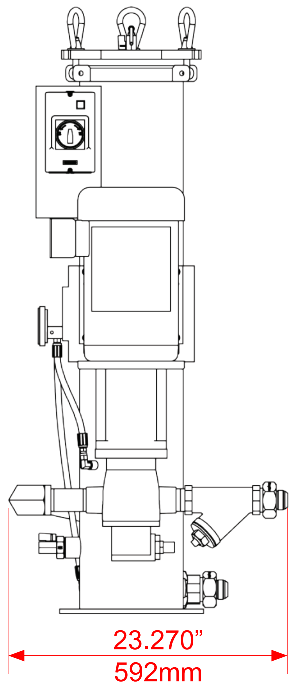
FSL1, FSL2 36" LENGTH DIMENSIONS

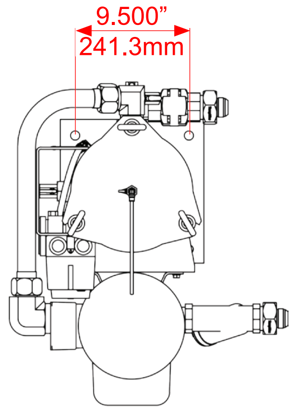


Optional spill retention pan 24" x 24" (609mm x 609mm) includes forklift guides. Pan increases overall height by 4.125" (105mm).

FSL3 36” LENGTH DIMENSIONS







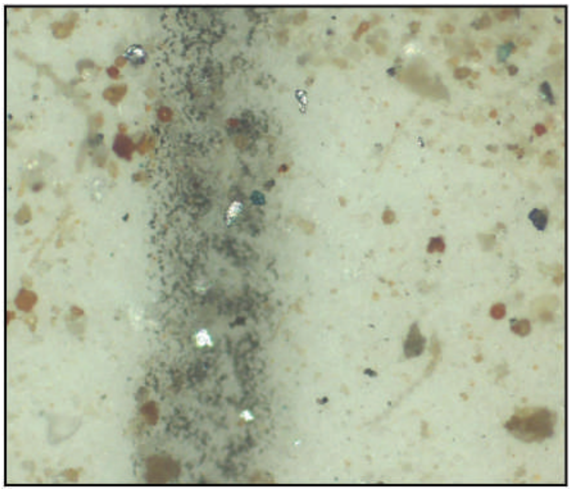
Overhead Clearance Required for Element Removal	
FSL 3 36” Length	36.250” 921mm

Optional spill retention pan 36” x 32” (914mm x 813mm) includes forklift guides.
Pan increases overall height by 4.125” (105mm).

NEW OIL IS TYPICALLY DIRTY OIL

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 $\beta X_{[C]} > 1000$).

HY-PRO FILTRATION

FPL Spin-On Filter Panel

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

- Permanent Mounted Solution for Hydraulic and Lube Oil Contamination
- 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
- Can Utilize DFN, DFH, MF3 and PFH assemblies*

*Contact Factory

Electric Motor Specifications

TEFC 56C Frame
60 Hz - 1750 RPM
50 Hz - 1450 RPM

Recommended Viscosity Range

Max recommended actual viscosity (based on pump suction line limitations through hoses)

FC1, FPL1 = 800 cSt
i.e. ISO220 ≥ 68°F (20°C), ISO320 ≥ 80°F (26°C), ISO460 ≥ 90°F (32°C)

FC2, FPL2 = 500 cSt
i.e. ISO220 ≥ 75°F (23°C), ISO320 ≥ 86°F (30°C), ISO460 ≥ 97°F (36°C)

*FC / FPL series are design optimized for lower viscosity hydraulic oils. Media selection will be limited on FC/ FPL when running high viscosity oils ≥ ISO220, contact factory for sizing & media selection. Consider FCL or FSL designed for high viscosity fluid conditioning with high efficiency medias and large elements.

Pump Specifications

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

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

Explosion Proof NEC Article 501, Class 1, Div 1, Grp C & D optional. Call for IEC, Atex or other requirements.

HY-PRO FILTRATION

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.

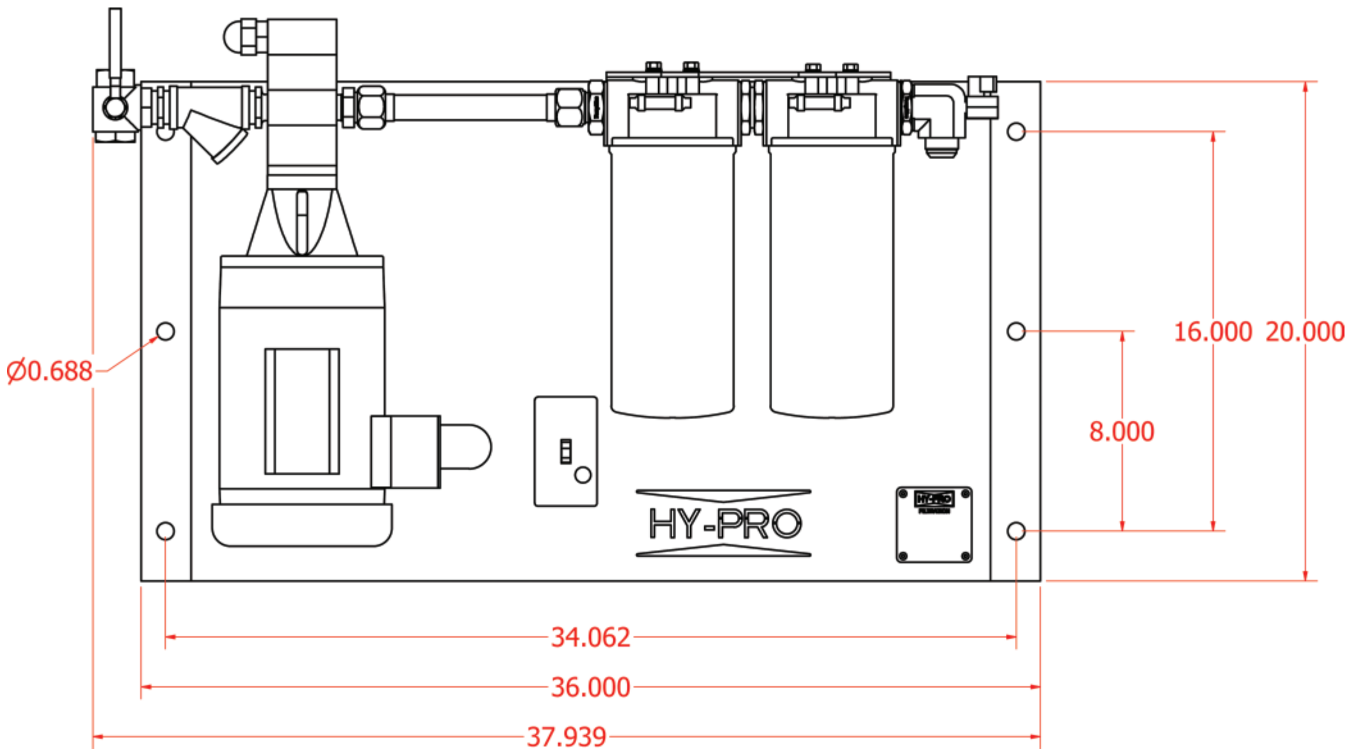
Lab and field tests prove time and again that Hy-Pro filters deliver lower ISO cleanliness codes, and do it with greater consistency.

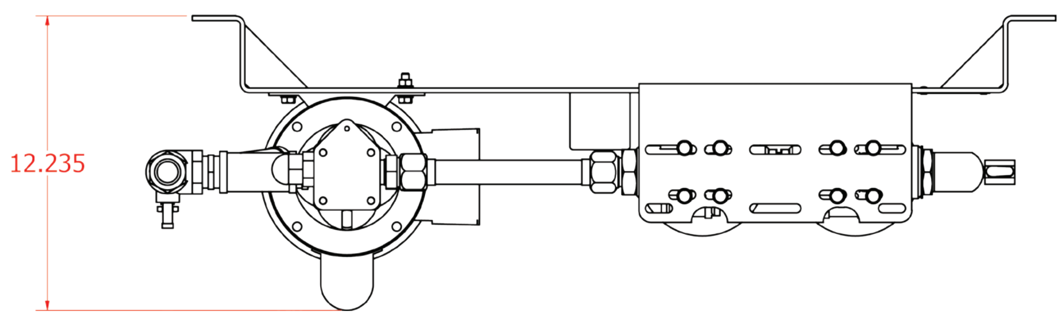
Figure 1

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
22/22/19	20/18/15	16/16/13	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	-	-	-

HY-PRO FILTRATION

FPL1, FPL2 DIMENSIONS





MF3 Option Changes Spin-on Assemblies to 2 Cartridge Element Style Housings in Series

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 $\beta 22_{[C]}$ = 1000 + Water Removal	HP75L8-3MB $\beta 5_{[C]}$ = 1000
ISO 25/24/22 (New Oil)	HP75L8-12MB $\beta 12_{[C]}$ = 1000	HP75L8-1MB $\beta 2.5_{[C]}$ = 1000
ISO 21/19/16	HP75L8-3MB $\beta 5_{[C]}$ = 1000	HP75L8-1MB $_{[C]}$ = 1000

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 (Pre-Filter)	-	Seal	-	Power Option	Extra Option

REPLACEMENT FILTER ELEMENT PART NUMBER GUIDE

	Table 2	Table 3
HP75L8 -	Media Selection	Seal

Table 1 Code	Flow Rate gpm (lpm)
1	5 gpm (18 lpm) 2 x S75 Single Element Heads In Series
2	10 gpm (37 lpm) 2 x S75 Single Element Heads In Series

Table 2 Code	Filtration Rating	Media Type
1M	$\beta 2.5_{[C]}$ = 1000 ($\beta 1$ = 200)	G8 Dualglass
3M	$\beta 5_{[C]}$ = 1000 ($\beta 3$ = 200)	G8 Dualglass
6M	$\beta 7_{[C]}$ = 1000 ($\beta 6$ = 200)	G8 Dualglass
12A*	$\beta 12_{[C]}$ = 1000 ($\beta 12$ = 200)	G8 Dualglass + Water Removal
12M*	$\beta 12_{[C]}$ = 1000 ($\beta 12$ = 200)	G8 Dualglass
25A	$\beta 22_{[C]}$ = 1000 ($\beta 25$ = 200)	G8 Dualglass + Water Removal
25M	$\beta 22_{[C]}$ = 1000 ($\beta 25$ = 200)	G8 Dualglass
25W	25μ Nominal Wire Mesh	Wire Mesh
40W	40μ Nominal Wire Mesh	Wire Mesh
74W	74μ Nominal Wire Mesh	Wire Mesh
149W	149μ Nominal Wire Mesh	Wire Mesh

Table 3 Code	Seal Material
B	Nitrile (Buna)
V	*Specified synthetics or High Temperature (>150°F). Viton® seals.

*Phosphate Ester, Water Glycol, & other synthetics.

Table 4 Code	Power Options
*Omit (Standard)	115 VAC, 60Hz, 1P (1750 RPM Motor)
E1	120 VAC, 50Hz, 1P (1450 RPM Motor)
E2	230 VAC, 60Hz, 1P (1750 RPM Motor)
E3	230 VAC, 50Hz, 1P (1450 RPM Motor)
E4	24 VDC (Consult Factory for Application)
E5	440-480 VAC, 60Hz, 3P (1750 RPM Motor)
E6	380-420 VAC, 50Hz, 3P (1450 RPM Motor)
E7	575 VAC, 60Hz, 3P (1750 RPM Motor)
P	Pneumatic Driven Air Motor (Call Factory).

Table 5 Code	Special Options
C	CE Mark
D	S75D Dual Head Spin-On Assemblies (Double Elements)
O+	On-board particle monitor for up to 230VAC 1P only
MF3	Cartridge Filter Element Style Housings Instead of Spin-On Filter Assemblies
X1+	Explosion Proof Electrical (Class 1, Div 1, Grp C&D)

*Phosphate Ester, Water Glycol, & other synthetics. Custom housings can be substituted. DFN, PFH- Call factory.

+Longer lead times. Consult factory.

Model	Inlet / Outlet Connections
FPL1	1" FNPT Inlet / Outlet
FPL2	1" FNPT Inlet / Outlet

3-Way Ball Valve Included on Inlet

Compact Filter Unit

Flow rate up to 2 gpm / 7.8 lpm

CFUL (low viscosity, 2 x HP409L9 spin-ons in series)

CFUL (low viscosity) Ideal for hydraulic fluids up to ISO VG100

CFUH (high viscosity) Ideal for lube & hydraulic fluids up to ISO VG460

Filter new fluids during transfer and top-off, or bulk oil before use

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

Remove particulate and water.

Materials of Construction

Assembly Frame: Painted Steel & Aluminum
Filter Assembly: Aluminum head, Steel canister
Element bypass valve
Differential pressure indicator
Hoses: Reinforced synthetic + steel wands

Operating Temperature

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

*High temperature, specified synthetics (phosphate ester)

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

CFU_ electric:	45 Lbs / 20.5 Kg
CFU_ pneumatic (P):	42 Lbs / 19 Kg
CFU_ pneumatic (B):	30 Lbs / 13 Kg

Pneumatic Option Air Consumption

P option air motor: ~15 cfm / 24.5 m^3/h
B option bladder pump: ~7 cfm / 11.9 m^3/h
Air consumption values are estimated maximums and will vary with regulator setting

Electric Motor Specifications

TEFC or ODP, 56C frame
1/4 -1/2 HP, 1750 RPM, thermal overload reset

Recommended Maximum Oil Viscosity

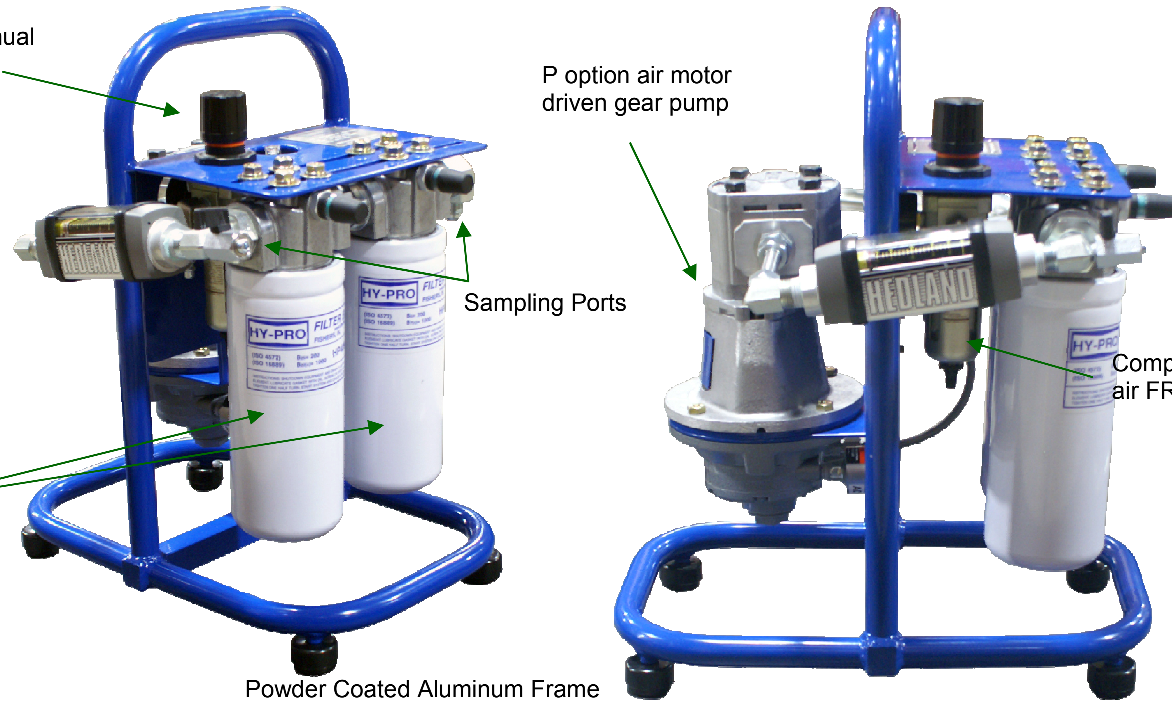
CFUH05:	ISOVG460 (75F/24C minimum)
CFUH1:	ISOVG460 (80F/26C minimum)
CFUH2:	ISOVG460 (100F/40C minimum)
CFUL05:	ISOVG100 (60F/15C minimum)
CFUL1:	ISOVG100 (68F/20C minimum)
CFUL2:	ISOVG100 (75F/24C minimum)

*High viscosity oils (ie ISO320-460) may require positive head pressure to ensure proper flow into the CFUH. Contact factory for guidance on high viscosity fluids to be treated at cold ambient temperatures for assistance with suction line pressure loss & element differential pressure.

Hazardous Environment Options

Select pneumatic powered unit (B or P power Option) or explosion proof NEC Article 501, Class 1, Div 1, Grp C & D optional. Call for IEC, Atex or other requirements.

CFUL (low viscosity) PNEUMATIC P OPTION AIR MOTOR



CFUH (high viscosity) ELECTRIC MOTOR POWERED OPTION

FILTER TOTE PART NUMBER GUIDE

	Table 1	Table 2		Table 3	Table 3	Table 4	Table 5		Table 6	Table 7
CFU	High, Low Visc.	Flow rate	-	Element 1 Media	Element 2 Media* ***CFUL only***	Seal	Hose	-	Power Option	Extra Option

******CFUL features 2 x HP409L9-___ elements in series, filtration rating for both must be selected in the CFU _L unit part number*

REPLACEMENT FILTER ELEMENTS by CFU_ TYPE

		Table 3	Table 4
CFUH:	**HP75L8 -**	Media	Seal
CFUL:	**HP409L9 -**	Media	Seal

Table 1 Code	CFU Model (Filter Selection)
H*	High & low viscosity oil up to ISO VG460 (1 x S75L8 spin-on assembly)
L	Low viscosity oil up to ISO VG100 (2 x S409L9 spin-on assemblies in series)

Table 2 Code	Flow Rate (lpm)	CFU Model
05	0.5 gpm (1,7 lpm)	H & L
1	1 gpm (3,7 lpm)	H & L
2	2 gpm (7,5 lpm)	H & L*
5	5 gpm (18.9 lpm)	L only*

*Actual viscosity at ambient temp is greater than ISOVG rating which is the viscosity at 100F/40C. Contact factory for selection assistance with ambient temp high viscosity oils.

Table 3 Code	Filtration Rating	Media Type	CFU_ Model
1M	$\beta 2.5_{[c]} = 1000$ ($\beta 1 = 200$)	G8 Dualglass	H & L
3M	$\beta 5_{[c]} = 1000$ ($\beta 3 = 200$)	G8 Dualglass	H & L
6M	$\beta 7_{[c]} = 1000$ ($\beta 6 = 200$)	G8 Dualglass	H & L
12A	$\beta 12_{[c]} = 1000$ ($\beta 12 = 200$)	G8 Dualglass + Water removal	H only
10M	$\beta 12_{[c]} = 1000$ ($\beta 12 = 200$)	G8 Dualglass	L only
12M	$\beta 12_{[c]} = 1000$ ($\beta 12 = 200$)	G8 Dualglass	H only
25A	$\beta 22_{[c]} = 1000$ ($\beta 25 = 200$)	G8 Dualglass + Water removal	H & L
25M	$\beta 22_{[c]} = 1000$ ($\beta 25 = 200$)	G8 Dualglass	H & L
74W	74u nominal	wire mesh	H only
149W	149u nominal	wire mesh	H only

Table 4 Code	Seal Material
B	Nitrile (Buna) element seals
V	Viton® element seals for specified synthetics or high temp (>150F)

Table 5 Code	Hose Connections Standard Hose Length 8' (1,9 m)
G	Female BSPP swivel hose ends (No Wands)
S	Female SAE/JIC swivel hose ends (No Wands)
W	Female SAE/JIC swivel hose ends + steel wands

Table 6 Code	Power Option
Omit	Electrical 120 vAC, 60Hz, 1P
E1	Electrical 120 vAC, 50Hz, 1P
E2	Electrical 230 vAC, 60Hz, 1P
E3	Electrical 220 vAC, 50Hz, 1P
P	Pneumatic air driven motor + FRL
B	Pneumatic bladder pump + FR

Table 7 Code	Special Options
B	3-Way valve on inlet for bypass
C	CE mark for European Union Directive
MF3	MF3 filter housings in place of S409 spin-on (CFUL only)
X1+	Explosion Proof (NEC Article 501 Class 1, DIV 1, GRP 1 C&D)

+Longer lead times. Consult factory.

Model	Inlet \ Outlet Connections
All	¾" Male JIC Inlet \ ½" Male JIC Outlet

HY-PRO

FILTRATION

VAC-U-DRY

VACUUM DEHYDRATION SKIDS

- Remove Free & Dissolved Water Down to 20 PPM (0.002%)
- Remove Free & Dissolved Gasses
- Standard Flow Range
  5~100 gpm,18~378 lpm
  (Larger Units Available)
- Visually Monitor Fluid and Process through Clear Chamber Covers
- High Water Removal Efficiency
- Enhance with Additional Fluid Conditioning Technologies Such as Coalesce, Acid Scavenging and Varnish Removal

- High Efficiency Particulate Filtration
- Low Watt Density Heaters
- Dual Condensate Water Tanks with Automatic Drain Standard for 24 x 7 Unattended Operation
- Electrical Phase Reversal Standard

VAC-U-DRY optimizes the balance between heat, vacuum and process design to rapidly remove dissolved water and gas. Keep your oil clean, dry and healthy!

V10 Model

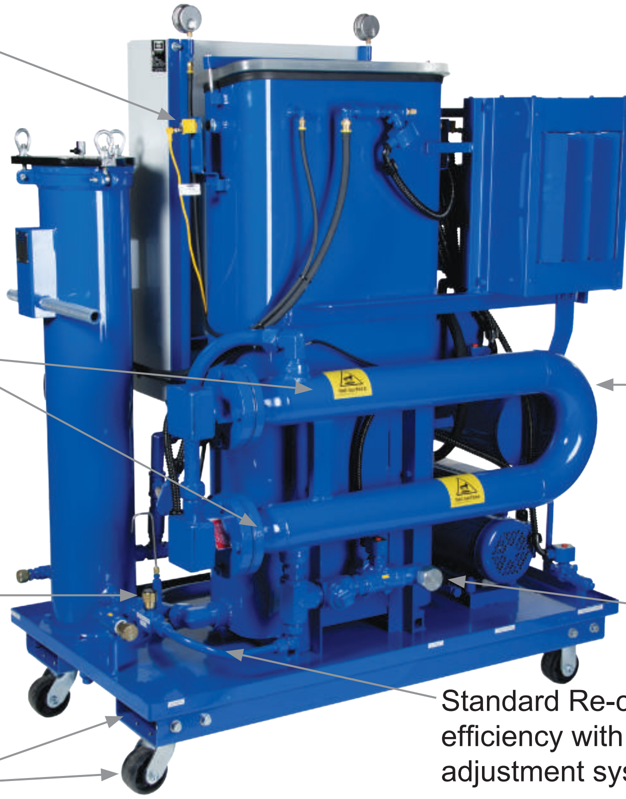
User Friendly . . . The easiest most reliable vacuum dehydrator to operate!
Flexible, we'll listen then customize a VAC-U-DRY for your specific application.

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

Optional foam sensor and knockdown circuit

All condensate wetted parts are 304 stainless steel (standard)

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



Ample plumbing makes Vac-U-Dry suitable for fluid viscosity to 680 cSt. Ideal for high viscosity lubricating fluids

Re-circulation line control valve

Vac-U-Dry inlet

Solid non-shedding wheels and forklift guides standard

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

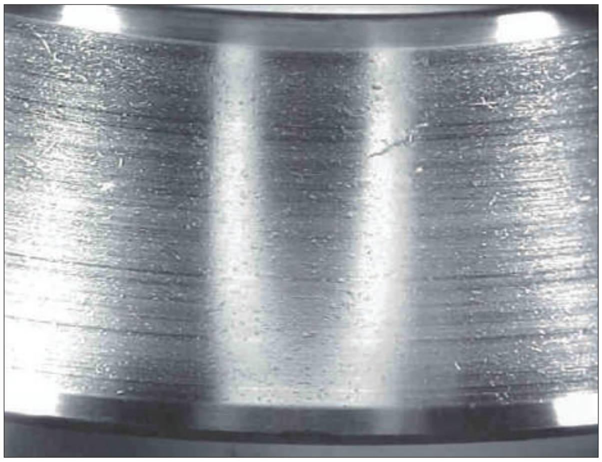
Integrate Coalesce, Varnish Removal or Acid Scavenging Technologies into Vac-U-Dry for the Ultimate in Oil Purification

VUD enhanced with coalesce for gross free water removal.

Combination coalesce & separator element.

ICB elements for varnish removal (mineral based lube oil). Remove dissolved metals, gels and deposits and control acid (phosphate ester, jet lube).

HY-PRO FILTRATION



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

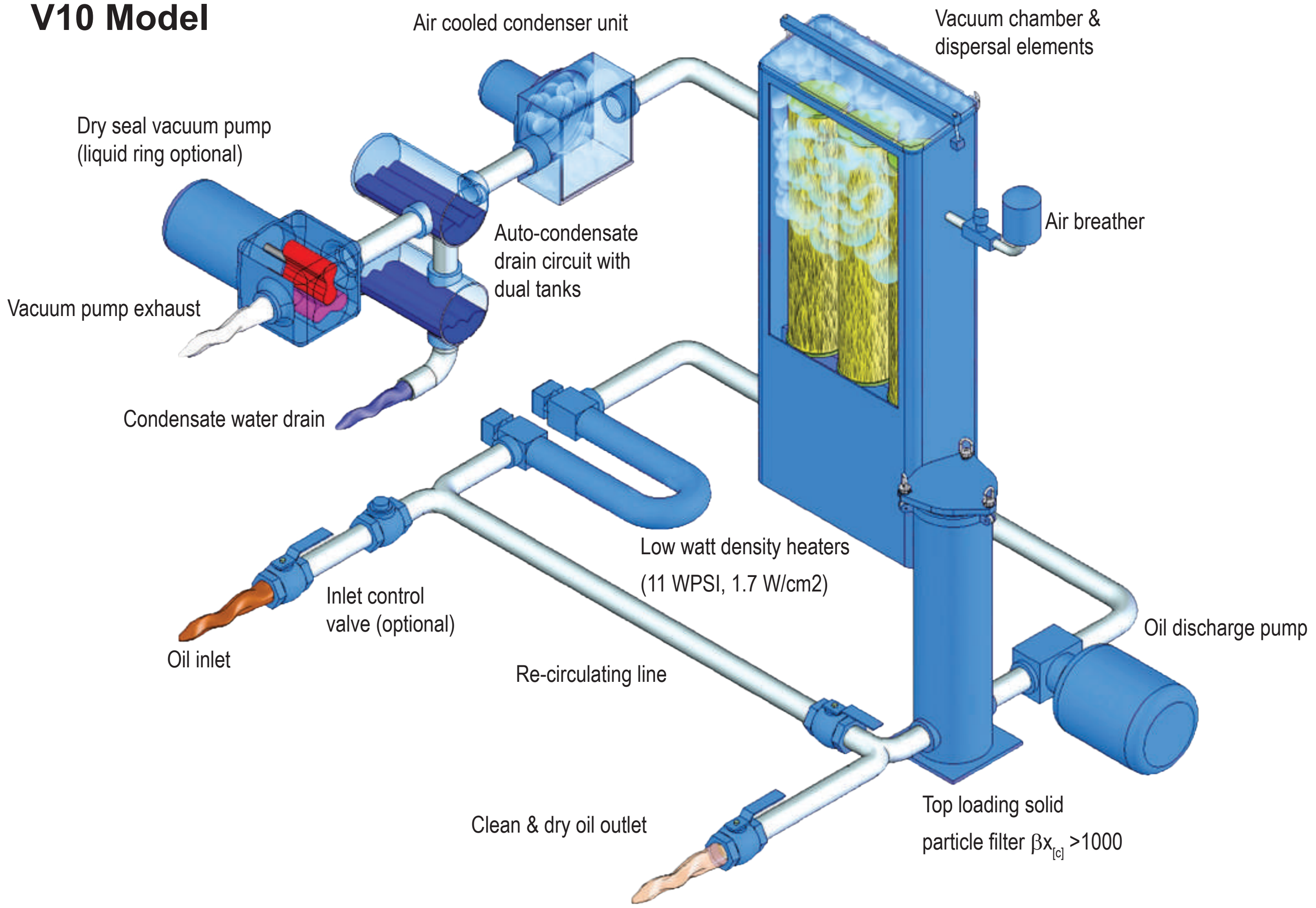
Centrifuges only remove free water that is well above the saturation point leaving harmful quantities of free and dissolved water in the oil. Desorbers and coalescing filters can achieve water levels of 150 ppm, but the process can be much slower or impossible with the presence of surfactants and additives.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

V10 Model



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 recirculating 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, allows unattended operation
Vacuum process	24" - 25" Hg vacuum yields rapid water and gas removal. Operational up to 20 meter (60 ft) negative head
Visual access	Clear cover 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 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

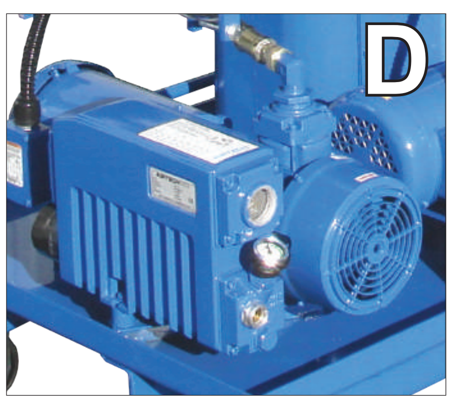
Operator Friendly Smart Relay - Smart relay enabled control panel performs controlled start-up & shut-down routines for ease of operation and keeps operators out of the control box. Includes machine drain sequence & automatic phase reversal (internally controlled, no guess work or switch to throw).

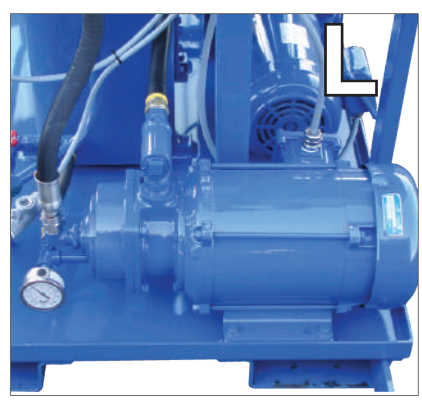
Programmable Thermostat - Programmable temperature controller for ease of operation and variable temp control with high limit safety setting.

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).

Vacuum Pump Option Selection

Code	Description	Maintenance	Requirements
C	Dry seal (dry rotary claw)	20,000 hour maintenance oil change	Long maintenance interval plus excellent portability
D	Dry seal (lubricated rotary vane)	500~750 hour maintenance oil/filter change	Excellent portability
L	Liquid ring (external process water line ~ 3 gpm required)	Monitor water supply line filter, vacuum pump compound gauge (positive pressure)	Ideal for hot, humid ambient conditions, limited portability

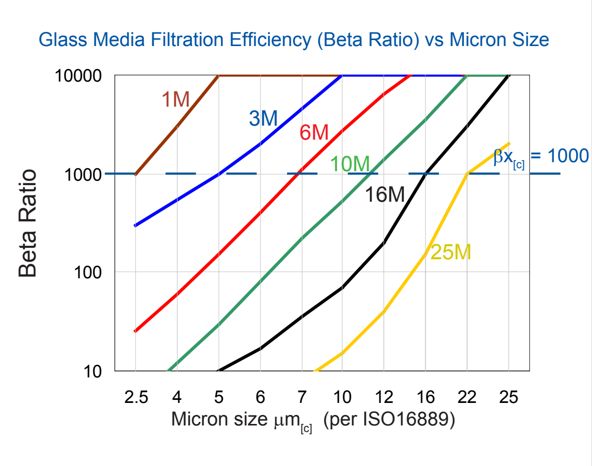




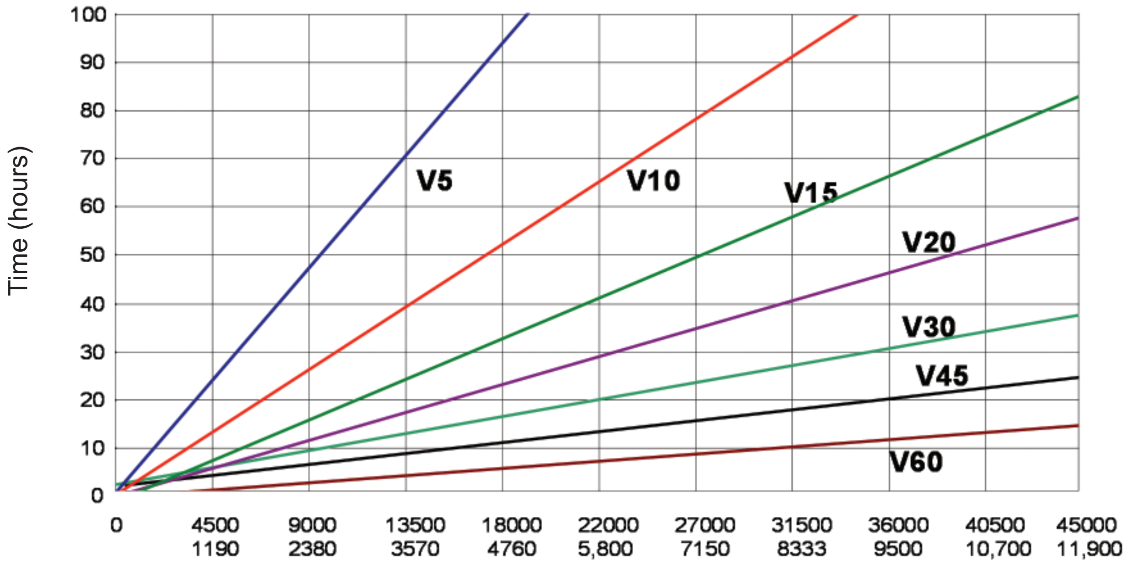
High Performance Particulate Filter Elements $\beta x_{[c]}$ > 1000

Particulate Filter - A generously sized filter with a high efficiency filter element yields lower ISO Fluid Codes and enhances overall reliability. Achieve world class turbine lube reservoir cleanliness down to 14/12/9 with Vac-U-Dry high efficiency coreless filter elements. All elements include an integral bypass valve so the bypass valve is new with each element.

Media Selection - Vac-U-Dry is available with a wide assortment of filter element media options to fit your specific application. Whether you're running low viscosity turbine lube oil requiring super cleanliness or conditioning high viscosity steel mill lubrication systems Hy-Pro will help you make the right selection.



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



Fluid volume (liters over gallons)

Model	Length Inch (mm)	Width Inch (mm)	Height Inch (mm)	Crated Weight Lbs (Kg)	Dispersal Element Qty.	Inlet Connection	Outlet Connection
V3	48 (1220)	32 (813)	54 (1372)	850 (386)	2	1" Male JIC	3/4" Male JIC
V5	56 (1422)	32 (813)	60 (1524)	1700 (771)	2	1" Male JIC	1" Male JIC
V10	56 (1422)	32 (813)	60 (1524)	1900 (863)	3	1 1/2" Male JIC	1" Male JIC
V15	56 (1422)	32 (813)	60 (1524)	1990 (904)	3	1 1/2" Male JIC	1" Male JIC
V20	72 (1829)	36 (914)	60 (1524)	2100 (954)	4	1 1/2" Male JIC	1" Male JIC
V30	84 (2134)	40 (1016)	60 (1524)	2500 (1136)	4 (ext. length)	2" Male JIC	1 1/2" Male JIC
V45	84 (2134)	48 (1219)	60 (1524)	2840 (1290)	8 (ext. length)	2" Male JIC	2" Male JIC
V60	84 (2134)	60 (1524)	60 (1524)	3210 (1457)	8 (ext. length)	3" Female NPT	2" Female NPT
V100	96 (2438)	96 (2438)	76 (1930)	7200 (3265)	16 (ext. length)	3" Female NPT	3" Female NPT

*Dimensions and weights are for standard models with D and L vacuum pump options. Selecting C vacuum pump option will add length and possibly width. For more exact dimensional information we invite you to build your part number and then contact us for possible deviation from standard dimensions.

VAC-U-DRY PART NUMBER GUIDE

	Table 1	Table 2	Table 3	Table 4	Table 5	Table 6	Table 7	Table 8		Table 9		Table 10
V	Flow Rate	Pump Type	Power	Dispersal Element	Media	Seal	Heater	Con-denser	-	Special Options	-	Multi Function Units

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)
100	100 (378)

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 5 Code	Discharge Filter Efficiency 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)
10M	$\beta 12_{[C]}$ = 1000 ($\beta 12$ = 200)
16M	$\beta 17_{[C]}$ = 1000 ($\beta 17$ = 200)
25M	$\beta 22_{[C]}$ = 1000 ($\beta 25$ = 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

Viton® is a registered trademark of E. I. du Pont de Nemours and Company or its affiliates.

Table 2 Code	Vacuum Pump Type
C	Dry seal (rotary claw)
D	Dry seal (lubricated rotary vane)
L	Liquid ring (external water supply required)

*Consult Literature for Vacuum Pump Selection

Table 4 Code	Dispersal Element
D	Pleated Dispersal Element All Synthetic Media (viscosity ≤ ISO VG220)
W	Pleated Stainless Steel Dispersal Element (ISO VG150-320)
P	Metallic Packed Dispersal Element (viscosity ≥ ISO VG460) Not for Use in PE Systems

Table 6 Code	Seal Material
V	Viton® (Standard)
E*	EPR (For Skydrol Use)

* Please Call if Other than Skydrol

Table 7 Code	Heater (KW)
9	9 KW
12	12 KW
24*	24 KW (2 x 12 KW)
36*	36 KW (3 x 12 KW)
48*	48 KW (4 x 12 KW)
64*	64 KW (4 x 16 KW)
80*	80 KW (5 x 16 KW)
96*	96 KW (6 x 16 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 (V5-60) + 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
O	On-board particle moitor (PM-1)
P	PLC Touch Screen Operation & Data
Q*+	Maintenance Spares and Repair Kit
R**	Electrical Phase Reversal Switch (Supplied Standard)
S	Inlet Line Strainer Basket
T*	Hose Kit (Suction & Return Hoses + Wands)
U	Electrical cord 50’ without Plug (15 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
**Standard supplied options, must be included in part number.
+ Q option repair & spares kit includes common consumables and select critical spares such as flow switch, fuses & tank lids.

Table 10 Code	Multi Function Units (Add options to p/n in order they appear in table)
Omit	Standard VUD Capabilities
COT	COT Coalesce Vessel Adder + Auto Water Drain Function (Sized to Handle 100% of VUD Flow). HP677L39-3MV (COT5). HP731L39-3CB Coalesce + HP582L30-S1MB Separator if COT10 or Larger (Coalesce and Separator Element Qty Shown as #C x #S)
SVR1200CT*	Varnish Removal & Prevention Side Loop (5 gpm Continuous Element Flow for up to 8000 Gallon / 30,000 Liter Reservoir)
ICBPE*	Phosphate Ester Acid & Dissolved Metal Removal (Contact Factory for Alternate Fluids i.e. jet lube)

* Varnish and ICB add-on technologies condition a portion of maximum VUD flow. Standard max SVR1200 flow rate ≤ 5 gpm. ICB add-on will be sized to reservoir volume.

HY-PRO FILTRATION

1 GPM VUD

Hy-Pro Vacuum Dehydration

Remove Free & Dissolved Water down to 20 PPM (0.002%)

Remove Free & Dissolved Gasses

Visually Monitor Fluid and Process through Clear Chamber Covers

High Water Removal Efficiency

High Efficiency Particulate Filtration

The VAC-U-DRY Purification Process

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 recirculating line helps the VAC-U-DRY reach optimum temperature in cold start situations and can be used to throttle machine inlet and outlet flow.

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.

Unit Specifications	
Flow Rate	.5 ~ 1.8 GPM (1.89 ~ 6.81 LPM)
Pump Type	Dry Seal Piston Pump
Amp Draw	120 VAC - 1KW Heat (15 FLA) 220 VAC - 4.5KW Heat (23 FLA) 230 VAC - 4.5KW Heat (23 FLA)
Condenser	Air Cooled

*Flow rate is adjustable based on recirculation line flow.
The V1 is designed for reservoirs ≤ 150 gallons @ 110-125°F.

HY-PRO FILTRATION

Appearance of Water in Oil

Dissolved Water- Oil appears bright and clear. Water can only be removed by vacuum dehydration.

500 ppm 1000 ppm 2500 ppm 5000 ppm 10000 ppm

Emulsified Water- Very small droplets dispersed in oil. Oil viscosity may go up and appear cloudy and milky. Tiny amounts of detergent engine oil can contaminate industrial oils.

Free Water- Large drops that readily settle out.

Harmful Effects of Water in Oil

Contamination Related Failure

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

Component Life Extension by Removing Water

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

A paper mill was experiencing severe water ingression problems and needed to dehydrate its fluids to avoid replacement. Hy-Pro suggested rotating a 1 GPM V1 vacuum dehydrator utilizing a pleated dispersal element among the affected fluids.

Application #1

Initially, Hy-Pro's V1 was placed on a Super Calender CC Lube Reservoir. This reservoir contained 200 gallons (757 liters) of PM220 Exxon Mobil at 110°F (43°C). The water level of this reservoir when the V1 was introduced was 1400 parts per million (ppm). After 48 hours of continuous operation the water level was reduced to less than 100 ppm.

- Initial Water Level: 1400 ppm
- Duration on Reservoir: 48 hours
- Ending Water Level: <100 ppm

Application #2

Next, the V1 was relocated to a vacuum pump oil reservoir on the wet end of the plant. This reservoir contained 300 gallons (1135 liters) of fluid at 125°F (51°C). At the time of installation the fluid contained 20,000 ppm of water. In less than 72 hours the V1 reduced the water level to 60 ppm.

- Initial Water Level: 20,000 ppm
- Duration on Reservoir: <72 hours
- Ending Water Level: 60 ppm

Application #3

Finally, the V1 was installed on a tote containing 200 gallons (757 liters) of reclaimed AW46 oil at ambient temperature (~70-80°F, ~21-26°C). At the time of installation the oil contained 10,000 ppm of water. In less than 24 hours the water was reduced to less than 100 ppm.

- Initial Water Level: 10,000 ppm
- Duration on Reservoir: <24 hours
- Ending Water Level: <100 ppm

V1P* | Power | Dispersal Element | Media | Seal | Heater | A | Special Options

*Denotes Dry Seal Piston Style Vacuum Pump

Table 1 Code	Power Options
12	120 VAC, 1P, 60 Hz
22	220 VAC, 1P, 50 Hz
23	230 VAC, 1P, 60 Hz

Call for higher voltage or 3 Phase power.

Table 2 Code	Dispersal Element
D	Pleated Dispersal (Viscosity < 150 cSt)
P	Metallic Packed Dispersal (Viscosity > 150 cSt)
W	Pleated Stainless Steel Element for Phosphate Ester (Viscosity < 150 cSt)

Table 3 Code	Discharge Filter Efficiency Rating
1M	$\beta_{2.5[c]}$ = 1000 (β1 = 200)
3M	$\beta_{5[c]}$ = 1000 (β3 = 200)
6M	$\beta_{7[c]}$ = 1000 (β6 = 200)
10M	$\beta_{12[c]}$ = 1000 (β12 = 200)
25M	$\beta_{22[c]}$ = 1000 (β25 = 200)
40W	40µ Nominal Wire Mesh
74W	74µ Nominal Wire Mesh

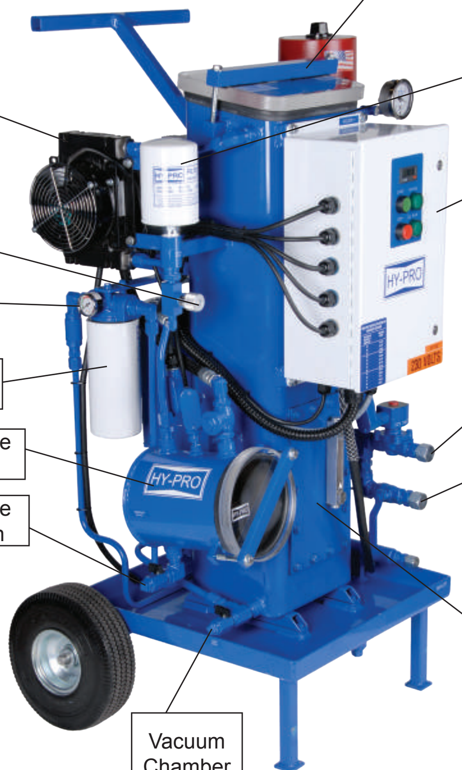
Table 4 Code	Seal Material
V	Viton® (Standard)
E	EPR

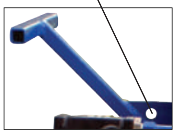
Table 5 Code	Heater (KW)
1*	1 KW
4*	4.5 KW

* Heater is dependant on power option. Power option 12 utilizes 1KW heater, power options 22 & 23 utilize 4.5 KW heater.

Table 6 Code	Special Options (Add Options to P/N in Order They Appear in Table)
A	Auto-Condensate Drain
C	CE Mark + International Crating
T	Hose Kit (Suction & Return Hoses + Wands) (Supplied Standard)
V*	Inlet Control Valve (For Positive Head Inlet)

* Recommended Option





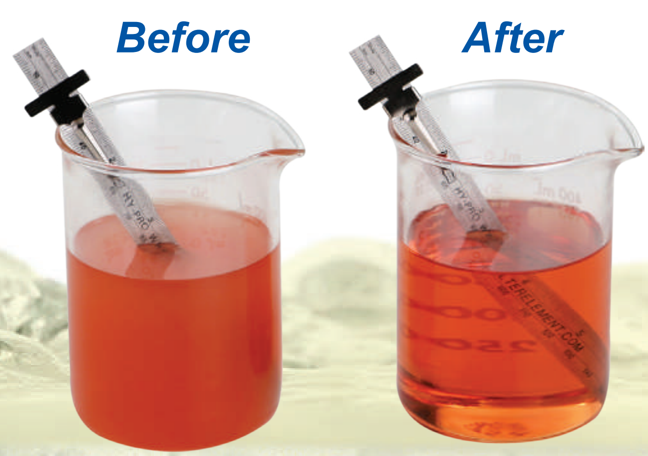
Height 48” x Width 28” x Depth 32”, Weight 350 lbs

HY-PRO
FILTRATION

TURBINE OIL COALESCE SKIDS

REMOVE HARMFUL WATER & ACHIEVE LOWER THAN TARGET ISO CODES

- Remove Free & Emulsified Water to Below 150 PPM / 0.0150%
- Rapid removal of free water in high concentrations (steam, cooler leak)
- High Efficiency Particulate Filtration
- Digitally adjustable Low Watt Density Heaters optional for system start-up
- Dimensional and Arrangement Design Flexibility
- Automatic Water Drain Circuit solid state sensors (no moving parts)
- Electrical Phase Reversal Standard
- Smart Relay Controlled Panel Yields Easy & Reliable Operation



High Efficiency Coalescence Combined with High Efficiency Particulate Filtration Keep Turbine Oil Clean, Dry and Healthy!

COT10

Davit & Swing Arm Lid Support

Auto Air Bleed Vent Valve

NEMA 4 Control Panel

Coalesce & Pre-Filter Vessels Equipped With True Green to Red ΔP Gauges

Multi-Element Coalesce & Separator Housing

Pressure and Differential Pressure Gauge Panel

Coalesce Vessel Bypass Loop

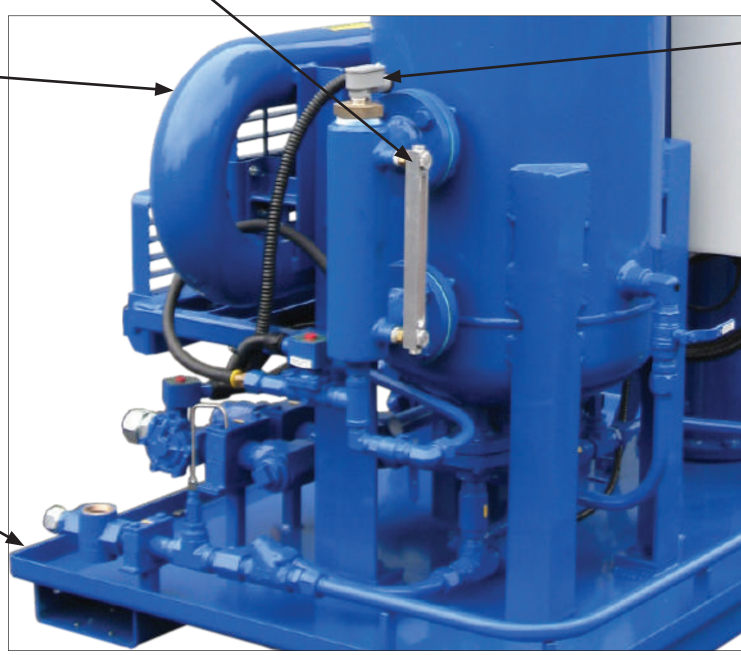
3-Way Bypass Line Selector Valve

High efficiency coreless pre-filter yields lower than target ISO Fluid Cleanliness Codes while extending coalesce element life!

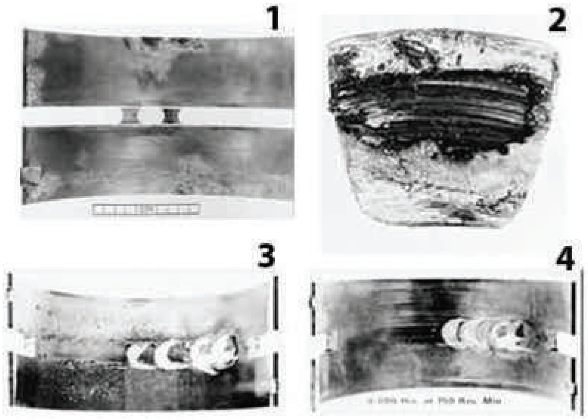
Coalesce element features 100% synthetic media (no cellulose media reducing compatibility related element failures).

Dual-stage separator and polishing filter element features water barrier and high efficiency glass media post-filtration.

HY-PRO
FILTRATION



HY-PRO
FILTRATION



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 Hydraulic & Lube Component failures are Caused by 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.

New Moisture Level PPM (%)

Component Life Extension by Removing Water*

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

*Courtesy of Noria

Intuitive Design Makes Hy-Pro Skids Easy to Operate.

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). System status is reported with illuminated lights or sequences of flashing lights.

Variable Frequency Drive Speed Control (Optional) - VFD controlled variable speed optimizes coalesce efficiency relative to fluid temperature by running slower until optimum oil temperature is achieved. Ideal for high flow systems (i.e. 100 gpm) where VFD can be used to provide a gradual start. Smart relay can be programmed to take temperature sensor input and automatically adjust flow for optimum performance.

Feature	Description
Common System Drain	All vessels and heater housings can be drained through a common drain (lowest point).
Easy Access Sample Ports	Monitor oil condition with sample ports located before the pre-filter and after the coalesce stage.
Safe Service Platform	Retractable grid for easy access to serviceable components.
Heater System	Low watt density heaters prevent coking. No direct heat element contact with oil. Heat applied only when needed.
High Single Pass Efficiency	High efficiency media design yields 95% single pass water removal efficiency at 5000 ppm.
Auto Water Drain	Ideal for continuous and unattended operation. Maximizes uptime (24/7 operation).
Gravity Float Level Control	Auto drain and high water sensor level detection based on thermal conductivity of fluid (solid state probes). No moving parts to fail or service.
Flexible Design & Dimensions	Flexible dimensions and process arrangement to suit your application (We listen to what you want).
Pleated Coalesce Element (all synthetic media)	Pleated coalesce elements yield more efficient water coalesce than traditional wrapped bun designs.
Combination Post-Filter & Separator Element (all synthetic media)	High efficiency pleated glass post filter with innovative separator sleeve knocks out water and consistently delivers lower ISO cleanliness codes.
True ΔP Gauges with Green to Red Display	True green to red ΔP gauges provide visual condition check and control panel signal. Sensors are located in the vessels for most accurate element condition monitoring.
Longer Element Life	Coalesce and separator routine change interval 1 year or change on element ΔP indication for contaminated systems.
Coreless Pre-filter	Coreless pre-filter element features $\beta 5[c] > 1000$ efficiency and integral bypass valve (new valve with each element change).
Totalizing Water Meter (optional)	Track amount of water removed from the system with optional totalizing water meter (can be integrated into optional PLC).

HY-PRO FILTRATION

TURBINE OIL COALESCE SKID SPECIFICATIONS & SIZING

Model	Length Inch (mm)	Width Inch (mm)	Height Inch (mm)	Weight Lbs (Kg)	Inlet Size (Female Pipe Port)	Outlet Size (Female Pipe Port)	Motor Size
COT5	56 (1423)	32 (813)	~72 (1828)	~875 (~397)	1.5”	1”	1 HP
CO10	60 (1524)	40 (1016)	~80 (2032)	~1600 (~726)	1.5”	1”	1.5 HP
COT30	84 (2134)	40 (1016)	~90 (2286)	~1600 (~726)	2”	1.5”	5 HP
COT60	84 (2134)	40 (1016)	~90 (2286)	~3500 (~1588)	3”	2”	5 HP
COT100	84 (2134)	40 (1016)	~90 (2286)	~3500 (~1588)	3”	2”	10 HP

COT Filter Elements Utilized by Model*

Model	Pre-Filter Elements	Coalesce Elements	Separator/Polish Elements
COT5	1	1 X **HP677L39-3MV***	(Combined Element)
COT10	1	2 x **HP731L39-CB**	1 x **HP582L30-S1MB**
COT30	1	5 x **HP731L39-CB**	3 x **HP582L30-S1MB**
COT60	2	8 x **HP731L39-CB**	5 x **HP582L30-S1MB**
COT100	3	8 x **HP731L39-CB**	5 x **HP582L30-S1MB**

*HP677L39-3MV combines coalesce and separator element functions into one element

COT Turbine Oil Model Sizing Recommendations

Model	Maximum Reservoir Volume
COT5	800 Gallons
COT10	1600 Gallons
COT30	4000 Gallons
COT60	8000 Gallons
COT100	13250 Gallons

WATER & PARTICULATE REMOVAL PERFORMANCE

Element Synergy - DFE rated G8 Dualglass pre-filter removes particulate before entering the coalesce vessel with high efficiency $\beta 5_{[c]}$ > 1000 media. Oil enters the two stage vessel passing first through the coalesce elements where water droplets form and fall. In the second stage of the coalesce process oil passes through the combination separator/polish element where the remaining water droplets are blocked then fall to the bottom of the coalesce vessel to be ejected by the auto-water drain circuit. The separator / polish elements also feature $\beta 2.5_{[c]}$ > 1000 G8 Dualglass media creating two passes through highly efficient glass media elements.

A properly sized Hy-Pro Coalesce Skid will deliver turbine reservoir cleanliness codes of 15/13/10 and better. Maintain water levels at or slightly below a typical saturation level of 150 ppm.

Coalesce Elements HP731L39-CB (No Cellulose) - Hy-Pro Coalesce elements contain no cellulose media which can be attacked by high water content resulting in media migration and a loss of coalescence efficiency. Threaded end cap locks into the housing without any washers, screws, or nuts to drop into the bottom of the coalesce vessel. The pleated synthetic configuration maximizes surface area and is contained by a rigid support tube. There are no wrapped outer layers to get soggy and shed fibers into the oil.

Separator - Polishing Elements (No Cellulose) HP582L30-S1MB - A water separating outer wrap knocks out remaining water droplets which shed to the bottom of the reservoir. The pleated G8 Dualglass media pack downstream of the water barrier removes solid contaminant to yield super clean and dry fluid leaving the Hy-Pro coalesce skid.

The $\beta 2.5_{[c]}$ > 1000 final element also reduces the population of sub-micronic insoluble particles that contribute to microbial growth and abrasive wear.

High Water Ingression - Common sources of gross water contaminant include seal, steam and heat exchanger leaks. Hy-Pro coalesce skids efficiently remove high quantities of gross water that can be present during water leaks. Avoid unplanned shut downs due to turbine lube system water leaks by removing gross water with a Hy-Pro coalesce skid and keep operating until the next planned outage.

COT30

COT5


TURBINE OIL COALESCE SKID PART NUMBER GUIDE

COT	Table 1	Table 2		Table 3	Table 4		Table 5
	Flow Rate	Power	-	Heat Capacity KW	Seal	-	Options

Table 1 Code	Flow Rate gpm (lpm)
5	5 (19)
10	10 (38)
30	30 (113)
60	60 (225)
100	100 (378)
Other	Call Factory

Table 4 Code	Seal Material
V	Viton® (Standard)
Other	Call Factory

Table 2 Code	Power Options
23*	230 VAC, 3P, 60Hz
38	380 VAC, 3P, 50Hz
41	415 VAC, 3P, 50Hz
46	460 VAC, 3P, 60Hz
52	525 VAC, 3P, 50Hz
57	575 VAC, 3P, 60Hz

*Only Available with COT5

Table 3 Code	Heat KW Options (Not for Fuel)
X	No Heaters
12	12 KW
24	24 KW
36*	36 KW
48*	48 KW
60*	60 KW
72*	72 KW
84*	84 KW

*Possible High Full Amp Load (Consider Special Option J)

Table 5 Code	Special Options (Add options to p/n in order they appear in table)
8	8" Solid Wheel Upgrade
A*	Auto Water Drain (Manual Drain Included)
B	Adjustable Coalesce Vessel Bypass Loop
C	CE Mark + International Crating
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	Water Discharge Totalizing Meter
O	On-board particle moitor (PM-1)
P	PLC Touch Screen Control (Does not Include VFD)
Q*+	Maintenance Spares and Repair Kit
S	Oil Sensing Safety Shut-Off in Water Discharge Line
T*	Hose Kit (Suction & Return Hoses + Wands)
U	Electrical cord 50' without Plug (15 Meter)
V	Inlet Control Valve (Recommended for Positive Head Inlet)
X1	Explosion Proof (Consult Factory)
Y	Variable Speed Control (VFD Drive PLC Included)
Z*	On-Site Start Up Training (1 x 10 Hour Shift)

*Recommended options

*+ Q option repair & spares kit includes several items such as fuses, common relay, panel bulb, replacement element set for coalesce chamber & particulate housing.

HY-PRO FILTRATION

HS Heater Skids

For hydraulic and lubricating oil heating applications

Low watt density heater elements prevent oil damage (no direct oil contact with element).

Programmable temperature control with integral no-flow switch prevents oil damage from stopping oil with heater energized.

Standard flow rates available to 100 gpm (375 lpm) plus.

Achieve and maintain target ISO codes with high efficiency on-board filtration

Large coreless filter elements yield low ISO codes & long filter element life

Ideal for hydraulic fluids and high viscosity lubricating oils up to ISO VG680

Operator Friendly Controls

Smart relay enabled controls makes the HS series heater skids easy to operate. Built in features include flow switch to prevent HS shut down with heater energized. Optional VFD speed control enables conditioning of a range of fluid viscosities with one machine

Fluid Compatibility

Mineral based oils and specified synthetic fluids that are compatible with Fluorocarbon (Viton®) seal materials.

Materials of Construction

Pump: External gear pump (with relief)
Filter housing: Carbon steel (coated)
Heater: Low watt density fin tube (aluminum)
Plumbing: Carbon steel (stainless optional)

Design Flexibility

Hy-Pro can accommodate any request for customization of components, dimensional flexibility and adding multiple functions to any skid (we'll listen).

Specifications

Hy-Pro systems can be produced to meet your specifications including:

ASME	NEC	IEC
ATEX	CE	ISO

Viton® is a registered trademark of E. I. du Pont de Nemours and Company or its affiliates.

HY-PRO FILTRATION

HS PART NUMBER GUIDE

	Table 1		Table 2	Table 3	Table 4	Table 5		Table 6		Table 7
HS	Flow Rate	-	Power Option	Filter Type	Filter Media	Seal Type	-	Heat Capacity	-	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)

Contact Hy-Pro for sizing & part number selection

Table 2 Code	Power Options
E2	230 VAC 60Hz 1P (1750 RPM motor), ONLY with 4kw heater option and 3 or 5 gpm max flow rate unit
E3	220 VAC 50Hz 1P (1450 RPM motor), ONLY with 4kw heater option and 3 or 5 gpm max flow rate unit
22	220 VAC 50Hz 3P (1450 RPM motor)
23	230 VAC 60Hz 3P (1750 RPM motor)
38	380 VAC 50Hz 3P (1450 RPM motor)
41	415 VAC 50Hz 3P (1450 RPM motor)
46	440-480 VAC 60 Hz 3P (1750 RPM motor)
57	575 VAC 60Hz 3P (1750 RPM motor)

Table 4 Code	Discharge Filter Efficiency Rating
1M	$\beta 2.5_{[c]}$ = 1000 (β1 = 200)
3M	$\beta 5_{[c]}$ = 1000 (β3 = 200)
6M	$\beta 7_{[c]}$ = 1000 (β6 = 200)
10M	$\beta 12_{[c]}$ = 1000 (β12 = 200)
16M	$\beta 17_{[c]}$ = 1000 (β17 = 200)
25M	$\beta 22_{[c]}$ = 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 3 Code	Filter Configuration
LF7	LF housing with HP107L36-_ _ _ element
LF8	LF housing with HP8314L39-_ _ _ element
X	No filter housing
call	Other (call factory)

Table 5 Code	Seal Material
V	Viton®(standard)
E-WS	EPR (specified Skydrol applications call factory)
call	Other (call factory)

Table 6 Code	Heat Capacity
4	1 x 4.5 kw heater
9	2 x 4.5 kw heaters
12	1 x 12 kw heater
24	2 x 12 kw heaters
36	3 x 12 kw heaters
48	3 x 16 kw heaters
64	4 x 16 kw heaters
-	-

Table 7 Code	Special Options
B	Basket strainer (instead of standard y-strainer)
C	CE Mark
D	Dirty filter high DP indicator light in panel door
J	Individual heater selector switch
M	Discharge line flow meter (visual)
O	On-line particle monitor PM-1
S	304 Stainless steel filter vessels
T	Hose kit (suction / return hoses, wands)
U	Electrical cord ~50' / 13 meters (no plug)
V	Inlet control valve N/C Solenoid
Y	VFD Variable speed motor frequency control (manual dial type)

HY-PRO

FILTRATION

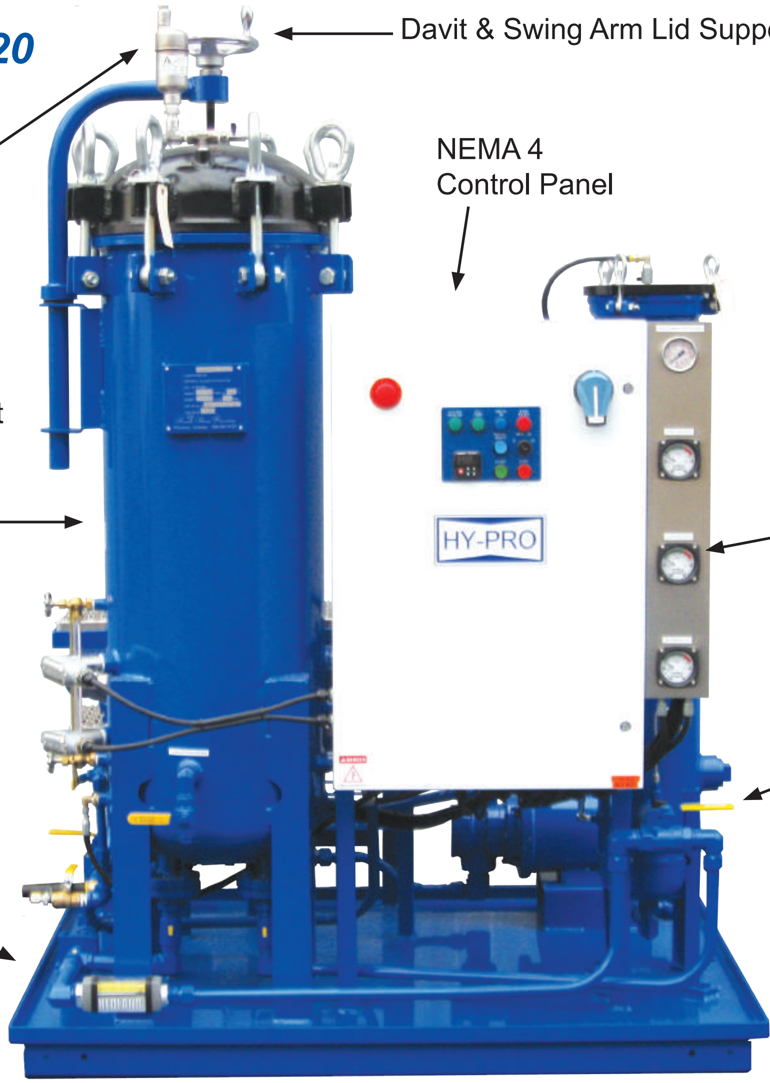
DIESEL FUEL CONDITIONING

REMOVE WATER & PARTICLES TO EXTEND FUEL INJECTOR LIFE & INCREASE COMBUSTION ENGINE FUEL EFFICIENCY

- Remove free water to saturation point with high single pass efficiency (achieve 150 ppm one pass #2 diesel)
- Rapid removal of free water in high concentrations.
- Ideal for mining & construction fueling depots and tank farms
- Available without pump & motor for installation into existing delivery system
- Condition fuel during bulk tank fill, service truck filling or as kidney loop to maintain clean & dry fuel
- Automatic water drain circuit for easy 24 / 7 unattended operation
- Auto-electrical phase reversal and smart relay control panel yields easy & reliable operation

High Efficiency Coalescence Combined with High Efficiency Particulate Filtration Keep Diesel Fuel Clean & Dry for Combustion Engine Reliability

COD120



Davit & Swing Arm Lid Support

Auto Air Bleed Vent Valve

NEMA 4 Control Panel

Coalesce & Pre-Filter Vessels Equipped With True Green to Red ΔP Gauges

Multi-Element Coalesce & Separator Housing

Pressure and Differential Pressure Gauge Panel

3-Way Bypass Line Selector Valve

Coalesce Vessel Bypass Loop

High efficiency coreless pre-filter yields lower than target ISO Fluid Cleanliness Codes while extending coalesce element life!

Coalesce element features 100% synthetic media (no cellulose media reducing compatibility related element failures).

Dual-stage separator and polishing filter element features water barrier and high efficiency glass media post-filtration.

COD200X (Non-Powered)

Multi-Element Coalesce & Separator Housing

Mechanical Auto-Water Drain Valve for CODX Non-Powered Coalesce Skids.

High Flow Pre-Filter with Coreless Filter Element (Top Loading)

Totalizing Water Meter

FCLCOD Series Portable Diesel Conditioning Cart

Ideal for service oriented stand-by diesel tanks (i.e. hospitals).

Removes water and particulate.

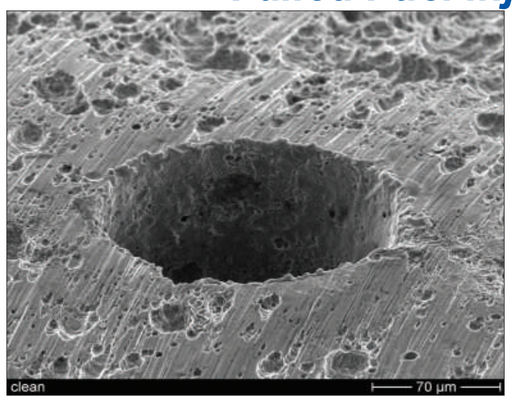
HY-PRO FILTRATION

Diesel Fuel Cleanliness Requirements - What Has Changed?

- Injector pressures have increased from 3,000 psi to over 30,000 psi (electronic).
- Fuel Injectors are now a sophisticated (expensive) electronic engine component.
- Diesel fuel lubricity and fuel energy content has decreased significantly with new Ultra Low Sulfur Diesel fuels.
- Water contamination in ULSD fuels leads to accelerated microbial growth.
- Engine manufacturers have learned that ultra fine particles at higher pressures are causing premature failures (warranty).
- Fuel injector and pump life has decreased yielding more unplanned downtime and lost production.
- Water contamination is also a major cause of combustion engine failure and fuel efficiency loss.

Before ***After***

Failed Fuel Injectors



Hy-Pro LF Style Filter Vessels Installed on Service Truck and Fuel Dispensing

Intuitive Design Makes Hy-Pro Skids Easy to Operate.

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). System status is reported with illuminated lights or sequences of flashing lights.

Variable Frequency Drive Speed Control (Optional) - VFD controlled variable speed optimizes coalesce efficiency relative to fluid temperature by running slower until optimum oil temperature is achieved. Ideal for high flow systems (i.e. 100 gpm) where VFD can be used to provide a gradual start. Smart relay can be programmed to take temperature sensor input and automatically adjust flow for optimum performance.

Feature	Description
Easy Access Sample Ports	Monitor fuel condition with sample ports located before the pre-filter and after the coalesce stage.
Safer Service Platform	Larger safe platform with railing and removable grid for easy access to serviceable components.
High Single Pass Efficiency	High efficiency media design yields nearly 100% single pass water removal efficiency. #2 diesel near 50 ppm in one pass.
Auto Water Drain	Ideal for continuous and unattended operation. Maximizes uptime (24/7 operation).
Gravity Float Level Control	Auto drain and high water sensor level detection based on thermal conductivity of fluid (solid state probes). No moving parts to fail or service.
Flexible Design & Dimensions	Flexible dimensions and process arrangement to suit your application (We listen to what you want).
Pleated Coalesce Element (all synthetic media)	Pleated coalesce elements yield more efficient water coalesce than traditional wrapped bun designs.
Combination Post-Filter & Separator Element (all synthetic media)	High efficiency pleated glass post filter with innovative separator sleeve knocks out water and consistently delivers lower ISO cleanliness codes.
True ΔP Gauges with Green to Red Display	True green to red ΔP gauges provide visual condition check and control panel signal. Sensors are located in the vessels for most accurate element condition monitoring.
Longer Element Life	Coalesce and separator routine change interval 1 year or change on element ΔP indication for contaminated systems.
Coreless Pre-filter	Coreless pre-filter element features $\beta 5[c] > 1000$ efficiency and integral bypass valve (new valve with each element change).
Totalizing Water Meter (optional)	Track amount of water removed from the system with optional totalizing water meter (can be integrated into optional PLC).

HY-PRO FILTRATION

DIESEL COALESCE SKID SPECIFICATIONS & SIZING

Model	Length Inch (mm)	Width Inch (mm)	Height Inch (mm)	Weight Lbs (Kg)
COD5 / 10 / 30	45 (1143)	32 (813)	72 (1828)	~875 (~397)
COD60 / 100	60 (1524)	40 (1016)	80 (2032)	~1600 (~726)
COD200	60 (1524)	40 (1016)	90 (2286)	~1600 (~726)
COD300 / 400	84 (2134)	40 (1016)	90 (2286)	~3500 (~1588)
COD500 / 600	84 (2134)	40 (1016)	90 (2286)	~3500 (~1588)

*Standard Connection ANSI Flange (for alternative connection types or sizes contact factory)

COD Filter Elements Utilized by Model*

Model	Pre-Filter Elements	Coalesce Elements	Separator/Polish Elements
COD5 / 10 / 30	1	1 X **HP677L39-25MV***	(Combined Element)
COD60 / 100	1	2 x **HP731L39-CB**	1 x **HP582L30-S25MB**
COD200	3	3 x **HP731L39-CB**	2 x **HP582L30-S25MB**
COD300 / 400	4	6 x **HP731L39-CB**	3 x **HP582L30-S25MB**
COD500 / 600	4	8 x **HP731L39-CB**	5 x **HP582L30-S25MB**

*HP677L39-25MV combines coalesce and separator element functions into one element.

Upgrades Existing Fuel Delivery Systems for Clean & Dry Fuel

For many applications there is already a fuel delivery system in place for filling service trucks or off-loading from tankers to fuel depots including a high flow centrifugal pump. The COD series diesel conditioning skids can be produced without pumping capabilities to be easily added to existing fueling systems.

To eliminate the need for power on the skid it can also be produced with manual drain capabilities only, which eliminates the need for solenoid valves and level sensing components.

When properly installed the diesel conditioning system can run continuously as a side loop to remove particles and water. When it becomes time to dispense fuel throw a valve and dispense through the conditioning skid to ensure clean and dry fuel every time.

COD5 Custom (Manual Water Drain)

WATER & PARTICULATE REMOVAL PERFORMANCE

Element Synergy - DFE rated G8 Dualglass pre-filter removes particulate before entering the coalesce vessel with high efficiency $\beta 5_{[c]}$ > 1000 media. Oil enters the two stage vessel passing first through the coalesce elements where water droplets form and fall. In the second stage of the coalesce process oil passes through the combination separator/polish element where the remaining water droplets are blocked then fall to the bottom of the coalesce vessel to be ejected by the auto-water drain circuit. The separator / polish elements also feature $\beta 2.5_{[c]}$ > 1000 G8 Dualglass media creating two passes through highly efficient glass media elements.

A properly sized Hy-Pro Coalesce Skid will deliver diesel fuel cleanliness codes of 15/13/10 and better. Maintain water levels at or slightly below a typical saturation level of 50 ppm.

Coalesce Elements HP731L39-CB (No Cellulose) - Hy-Pro Coalesce elements contain no cellulose media which can be attacked by high water content resulting in media migration and a loss of coalescence efficiency. Threaded end cap locks into the housing without any washers, screws, or nuts to drop into the bottom of the coalesce vessel. The pleated synthetic configuration maximizes surface area and is contained by a rigid support tube. There are no wrapped outer layers to get soggy and shed fibers into the oil.

Separator - Polishing Elements (No Cellulose) HP582L30-S1MB - A water separating outer wrap knocks out remaining water droplets which shed to the bottom of the reservoir. The pleated G8 Dualglass media pack downstream of the water barrier removes solid contaminant to yield super clean and dry fluid leaving the Hy-Pro coalesce skid.

The $\beta 2.5_{[c]}$ > 1000 final element also reduces the population of sub-micronic insoluble particles that contribute to microbial growth and abrasive wear.

Integral Bypass Loop - It is not uncommon to experience high levels of water in diesel storage bulk tanks. Hy-Pro diesel conditioning skids can remove high quantities of gross water in a single pass, but if you need to pump down free water from the tank bottom or heavily contaminated fluid use the coalesce housing bypass loop to pump around the coalesce vessel and preserve element life. Avoid pushing straight water through the coalesce housing.

COD300

COD5-10

	Table 1	Table 2		Table 3		Table 4
COD	Flow Rate	Power	-	Seal	-	Options

Table 1 Code	Flow Rate gpm (lpm)
5	5 (19)
10	10 (38)
30	30 (113)
60	60 (225)
100	100 (378)
200	200 (757)
300	300 (1135)
400	400 (1514)
500	500 (1892)
600	600 (2271)
Other	Call Factory

Table 2 Code	Power Options
X	Non-Powered COD: No pump-motor combo or electrical controls. Suitable for adding to existing fuel delivery system with existing pressure and flow. Auto water drain option is all mechanical. Minimum pressure requirement 70 psi (5 bar)
12	120 VAC, 1P, 60Hz (COD 5 & 10 Only)
E1	120 VAC, 1P, 50Hz (COD 5 & 10 Only)
E2	230 VAC, 1P, 60Hz (COD 5 & 10 Only)
E3	230 VAC, 1P, 50Hz (COD 5 & 10 Only)
32	320 VAC, 3P, 50Hz
38	380 VAC, 3P, 50Hz
41	415 VAC, 3P, 50Hz
46	460 VAC, 3P, 60Hz
52	525 VAC, 3P, 50Hz
57	575 VAC, 3P, 60Hz

Table 3 Code	Seal Material
V	Viton® (Standard)
B	Buna
Other	Call Factory

Table 4 Code	Special Options (Add options to p/n in order they appear in table)
8	8" Solid Wheel Upgrade
A*	Auto Water Drain (Manual Drain Included)
B	Adjustable Coalesce Vessel Bypass Loop
C	CE Mark + International Crating
H	Manual Reset Hour Meter (In Addition to Standard Non-Reset Hour Meter)
K	Sight Flow Indicator (Wheel Type)
L	Lifting Eye Kit
M	Water Discharge Totalizing Meter
O	On-board particle moitor (PM-1)
P	PLC Touch Screen Control (Does not Include VFD)
Q*+	Maintenance Spares and Repair Kit
T*	Hose Kit (Suction & Return Hoses + Wands)
U	Electrical cord 50' without Plug (15 Meter)
X1	Explosion Proof (Consult Factory)
Y	Variable Speed Control (VFD Drive PLC Included)
Z*	On-Site Start Up Training (1 x 10 Hour Shift)

*Recommended options

*+ Q option repair & spares kit includes several items such as fuses, common relay, panel bulb, replacement element set for coalesce chamber & particulate housing.

HY-PRO FILTRATION

SOLUBLE VARNISH REMOVAL

THE PROVEN LUBE OIL VARNISH SOLUTION

HY-PRO

FILTRATION

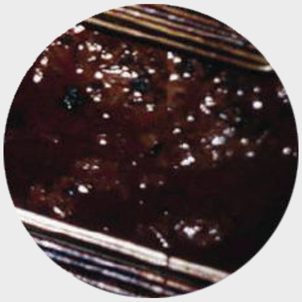
EPT

- Prevent varnish related gas turbine unit trip or fail-to-start conditions.
- Remove dissolved oxidation by-products to prevent varnish deposit formation.
- Restore fluid solubility and overall health.
- Prevent rapid anti-oxidant additive depletion.
- Lower ISO Fluid Cleanliness Codes with high efficiency post filter.
- Rapid on-site recovery services available.
- Oil analysis, results interpretation, and varnish mitigating strategy implementation.

BEFORE ***AFTER***

What is Varnish?

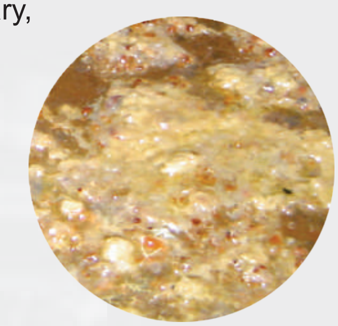
A thin, hard, lustrous, oil-insoluble deposit, composed primarily of organic residue, & most readily definable by color intensity. It is not easily removed by wiping with a clean, dry, soft, lint-free wiping material and is resistant to saturated [light hydrocarbon] solvents. Its color may vary, but it usually appears in gray, brown or amber hues.
ASTMD.02C.01 definition



Varnish can be soft and gooey *(Sludge)*

Varnish can be hard and brittle *(Lacquer)*

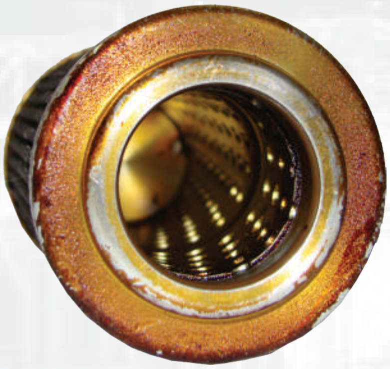
Varnish on reservoir ceiling *(Stalactites)*



Varnish deposits on reservoir floor *(Plated)*

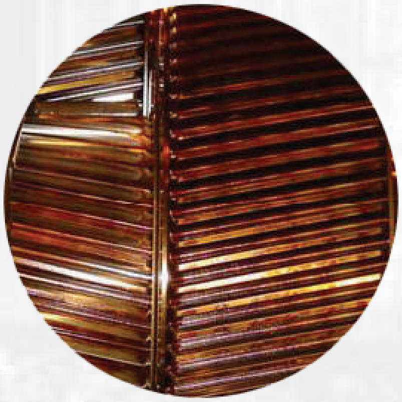
When gas turbines fall casualty to unit trip or fail-to-start conditions, lube oil varnish is the usual suspect!

Filter element cross section (Lacquer Varnish Deposits, Support Tube)

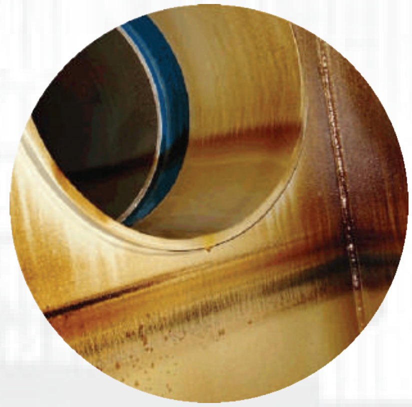


Varnish deposits on filter element (GE Frame 6B)

IGV valves and fuel control valves are typically the first problem components



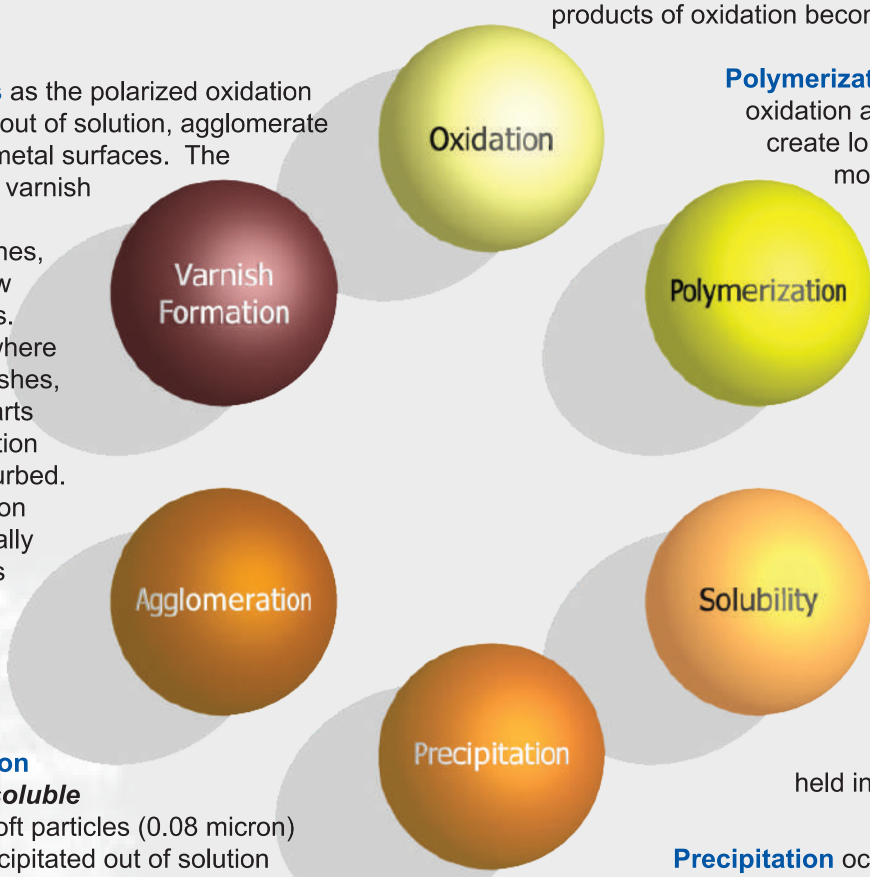
Varnish on load gear (Frame 6)



Lube oil reservoir coated (Varnish Deposits)

Varnish Formation Starts with Oxidation

Oxidation is the root cause of the problem. It creates free radicals resulting in acids, alcohols, esters and lactones. Anti-oxidant (AO) additives are designed to neutralize the products of oxidation. As oxidation occurs the phenol and amine additives are depleted. The products of oxidation become the building blocks of varnish.



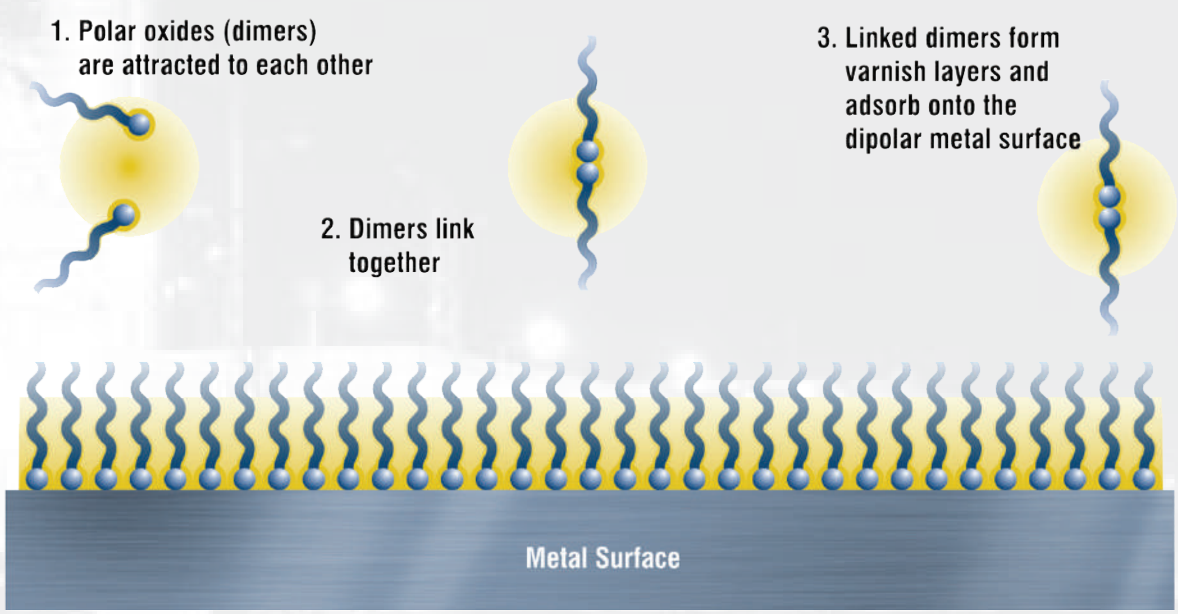
Polymerization occurs as the by-products of oxidation and additive reactions combine to create longer chain molecules with higher molecular weight. These molecules have lower ***solubility*** and are polarized. The rate of molecular polymerization is a function of ***temperature*** (as a catalyst) and the concentration of oxidation by-products (free radicals).

Solubility describes fluid's capacity to hold the varnish producing molecules in solution (dissolved). Solubility is directly affected by ***temperature***. As more oxidation by-products are generated the fluid approaches it's solubility saturation point, beyond which no additional polymerized molecules can be held in solution and can precipitate out.

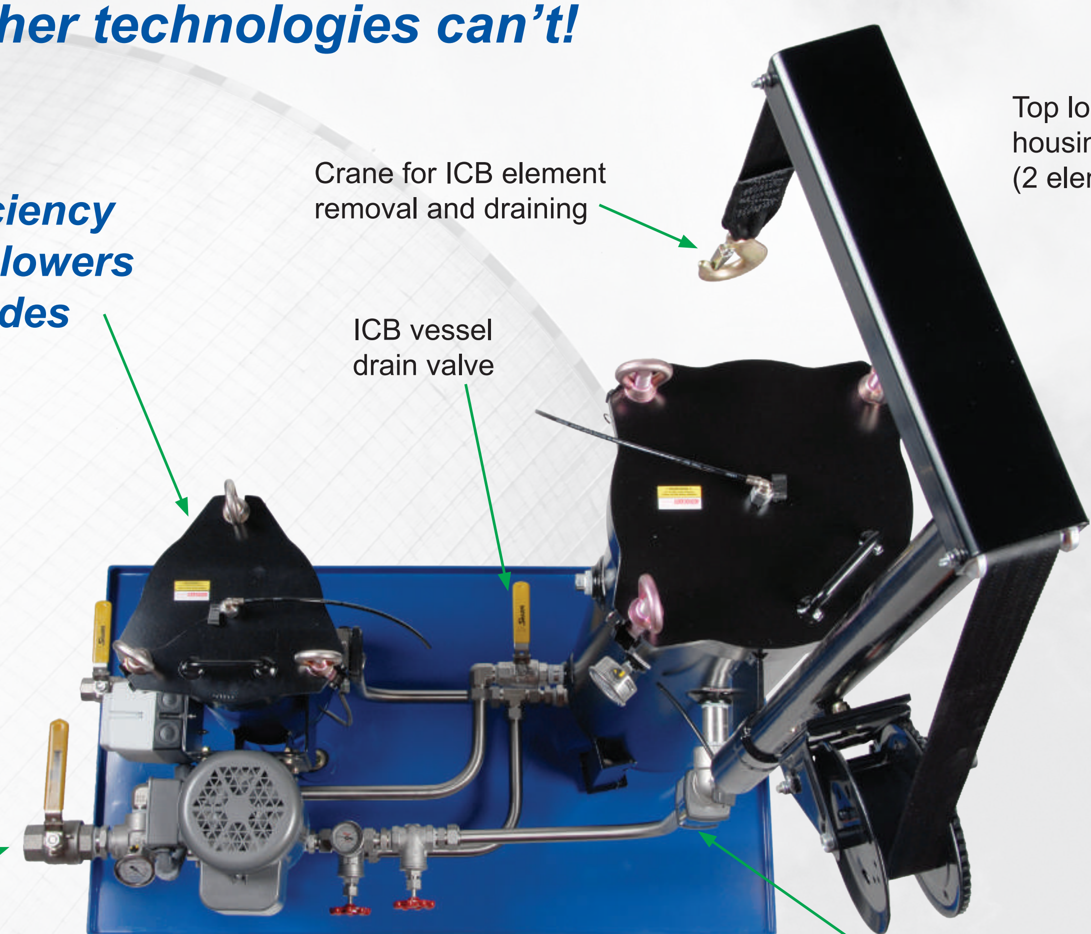
Precipitation occurs once the solubility threshold (saturation point) has been crossed or if there is a ***drop in temperature*** which reduces the solubility of the fluid. As additional oxidation by-products (free radicals) are generated they become ***insoluble*** and precipitate out and are free to form varnish deposits.

Agglomeration begins as ***insoluble*** sub-micron soft particles (0.08 micron) that have precipitated out of solution bond to form larger particles (1.0 micron). These agglomerated soft particles remain ***insoluble***, remain polarized, and maintain a higher molecular weight than the fluid itself.

Varnish Forms as the polarized oxidation products come out of solution, agglomerate and collect on metal surfaces. The surfaces where varnish typically forms include cool zones, low flow and low clearance areas. Why? This is where solubility diminishes, precipitation starts and agglomeration goes on undisturbed. Deposit formation also occurs locally where hot spots or sparking lead to varnish.



SVR removes varnish-causing soluble contamination where other technologies can't!



SVR element technology (ION Charge Bonding) eliminates varnish feedstock so deposits can't form.

SVR restores oil solubility & reduces anti-oxidant additive depletion rates.

Single use element design eliminates double freight.

Top to bottom (axial flow) maximizes fluid and resin bead contact time for improved efficiency.

Rugged stainless steel construction ensures rupture free operation.

Why SVR (Soluble Varnish Removal)?

SVR goes where other technologies can't to remove soluble contamination!

By removing the oxidation by-products while in solution SVR prevents the oil from becoming saturated and losing it's ability to hold varnish molecules, ***in solution***. SVR stops varnish before it starts by removing the feedstock of varnish formation while still in solution. Electrostatic, depth, and agglomerating technologies can't remove the varnish building blocks until the fluid is saturated and the molecules precipitate out of solution putting turbines at risk for unit trip or fail to start conditions.

Before SVR After SVR

What happens when the oil cools? Solubility goes down, Varnish forms!

When the oil cools (off-peak, turning gear) the solubility goes down and varnish causing molecules will fall out of solution at a rapid rate to create varnish. With SVR installed the soluble oxidation by-products have already been removed and can't precipitate out (they're gone).

Serious Problem! SVR is the proven recovery solution, Guaranteed!

Varnish potential unaddressed will inevitably lead to valve and/or bearing problems. When fitted to a system with varnish deposits SVR attacks the source of the problem, polarized molecules (free radicals). As soluble contamination is removed the solubility of the oil is restored. Once the oil regains its solubility it can remove the varnish deposits that plague lubrication and hydraulic systems.

Restoring a turbine lube oil reservoir (up to 8000 gallons) with the SVR1200 takes 45~60 days. Depending on the severity of the deposits and oil condition, installing a second set of elements might be required to achieve single digit varnish potential results (per MPC). Hy-Pro varnish potential test kits (VFTK, VLTK) provide critical oil condition data before starting the fluid restoration and to track results toward success (weekly). Check our case studies!

Extend useful fluid life, the case for prevention with SVR!

Modern Group II turbine oil formulations rely on Phenol and Amine AO additives to arrest the products of oxidation and prevent sludge and deposit formation. Once AO levels are depleted to 20% of new the oil may be condemned. The Phenol AO is typically the first to be depleted leading to high risk of varnish formation.

VFTK

SVR performs a parallel function to the Phenol AO by removing products of oxidation while still in solution. It is proven that with SVR installed, the life of oil even with no remaining phenols can be extended without the formation of varnish deposits.

One plant specifically was losing ~20% of Phenol additives each year and after one oil change installed the SVR 1200. After 20 months Phenol levels were still above 92% of new proving that SVR can substantially extend oil life.

SVR1200 Dropped MPC value from 60 to 6 in 45 days!

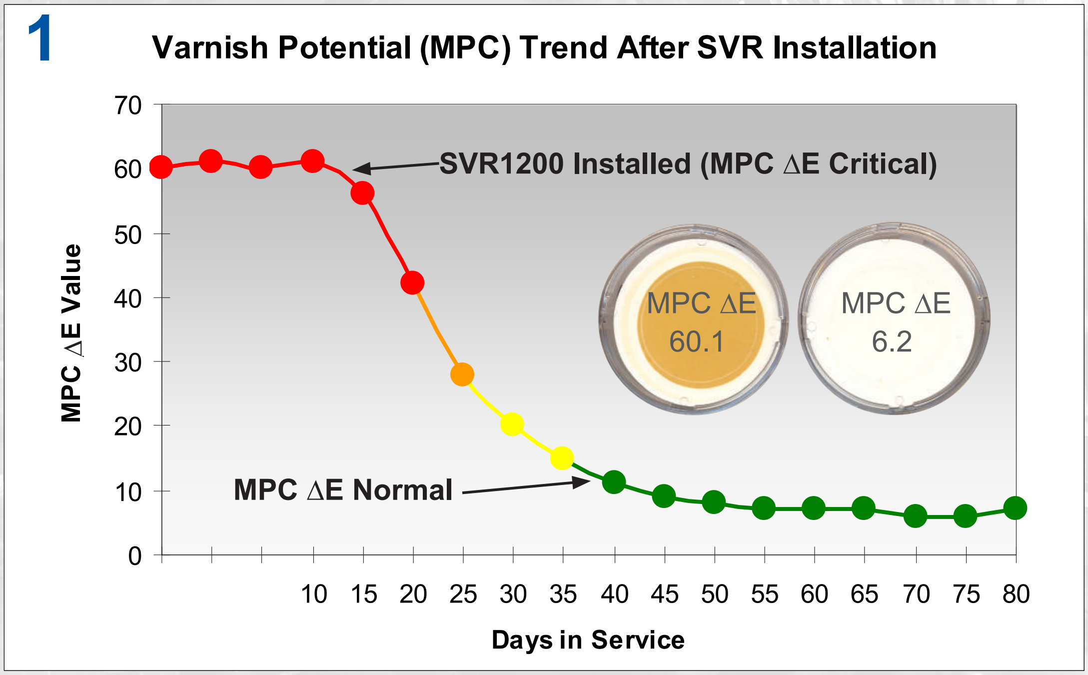
Colorimetric analysis per ASTM D02.C0.01 WK13070 is used to determine varnish potential. A petroleum ether mixture agglomerates soluble by-products rendering them insoluble and visible for patch analysis. The patch is analyzed with a spectrometer measuring DE reported as the MPC ΔE value.

MPC ΔE Condition Scale

Normal	Monitor	Abnormal	Critical
<15	15-29	30-40	>40

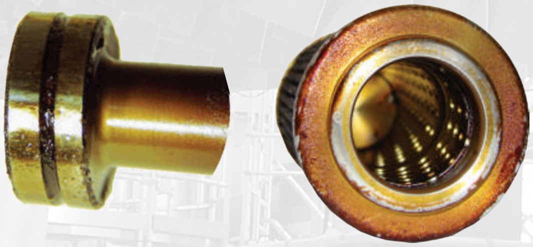
Figure 1 depicts SVR1200 installed on 7FA gas turbine experiencing unit trips from sticking servos. The SVR1200 had an immediate impact on the 6000 gallon turbine lube reservoir running GST32 lube oil. Within 45 days the lube oil varnish potential had been reduced from critical to condition normal.

Starting phenol level was ~5 which means it only had 5% phenols relative to a new sample, well below the lower threshold to condemn the oil for low levels of anti-oxidant additive package. Even though phenols were depleted the SVR was able to restore and maintain condition normal.



Since installing the SVR1200 there have been no CT varnish related fail-to-start conditions or unit trips!

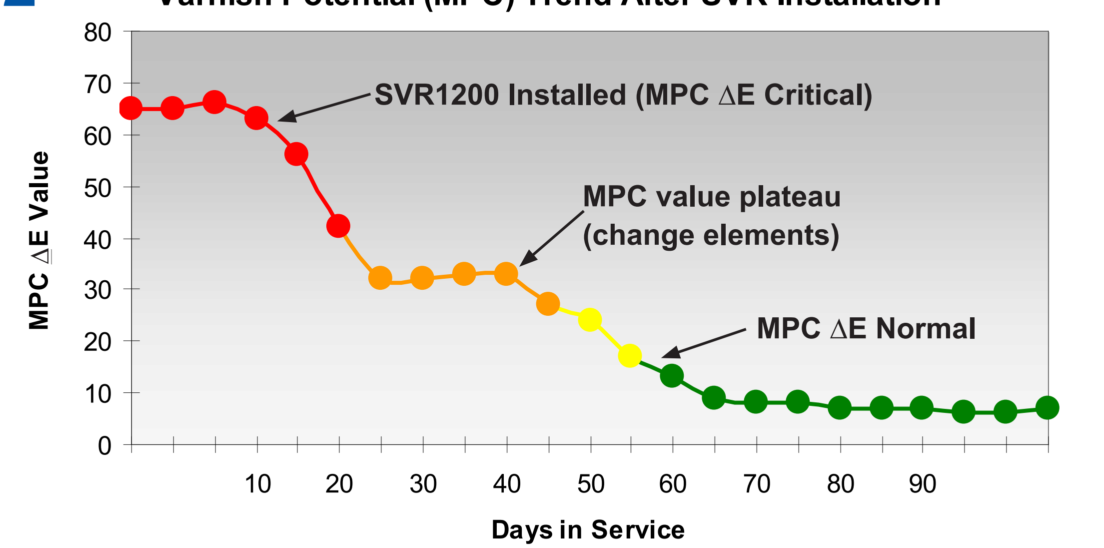
Before installing the SVR the filter elements and servo valves were accumulating varnish deposits. To prevent unit trips the plant was changing servos and elements monthly in hopes of avoiding unit trip. After the successful restoration of the fluid with the SVR1200 the filter change interval has been extended back to 12 months PM and there has been no evidence of varnish deposits on filter elements or servo valve components.



SVR1200 Restores Heavily Varnished Gas Turbine!

Figure 2 depicts the restoration of a heavily varnished CT where the MPC varnish potential value dropped to ~35 and then remained at that level indicating the need to change the SVR filter elements. Once the elements were changed the MPC drop continued and single digit MPC values were achieved. Condition monitoring via MPC or QSA is the most reliable way to know the elements are spent. A heavily varnished system might require two sets of elements to reach Normal condition and get into maintenance mode.

2



Extending Fluid Life - Preventing Anti-Oxidant Depletion

RULER (Remaining Useful Life Evaluation Routine) is used to quantify and trend remaining levels of Phenol and Amine anti-oxidant (AO) levels which is one of the factors considered in determining useful oil life. Once phenol AO levels drop below 20% of new, the rate of sludge and deposit formation can increase rapidly and the oil may be condemned.

Figure 3 shows AO level trending after the installation of SVR1200 on a combustion turbine lube reservoir after the oil was replaced. After a year in service with SVR on board there is very little change in AO levels. This same turbine was losing ~20% of the phenol AO package annually without SVR. In addition to controlling varnish the SVR also extends the useful life of the oil by protecting the AO additive package.

3

RULER TEST (EXAMPLE)						
Date		7/22/2009	4/15/2009	1/6/2009	8/29/2008	6/1/2008
Lab No	Reference					
RUL %	>25%	92.3	86.7	91.2	96.7	91.3
Amines		94.7	100	98.2	98.0	
Phenols		99.1	97	94.7	93.6	

3% Margin of Error

SVR The case for prevention!

As long as the elements are maintained, this turbine lube oil system will not have problems with varnish deposit formation and this new group II fluid has the potential to greatly exceed useful life expectations with high anti-oxidant additive levels. In addition to reducing AO additive depletion the SVR enables oil below 20% remaining phenols to stay in service.

SVR PART NUMBER GUIDE & SPECIFICATIONS

SVR	Table 1	Table 2	Table 3	Table 4	-	
SVR	Model	Fluid Type	Power Option	Special Option	-	Manufac-turing Code

Table 1 Code	Model
1200	Up to 8,000 Gallon 30,000 Liter Reservoir
-	-

Table 2 Code	Fluid Type
CT	Combustion Turbine Mineral Oil, High Temp Applications (T > 130ºF, 55ºC)
ST	Steam Turbine Mineral Based Oil, Additized Hydraulic Oil (AW)
Call	Other (Call Factory)

Table 3 Code	Power Options
Omit (standard)	120 VAC 60Hz 1P
E1	120 VAC 50Hz 1P
E2	230 VAC 60Hz 1P
E3	230 VAC 50Hz 1P
E5	460 VAC 60Hz 3P
E6	380 VAC 50Hz 3P
E7	575 VAC, 60Hz, 3P

Table 4 Code	Special Options
A+	Air cooled heat exchanger installed on inlet line if operating temperature > 160ºF, 71ºC. User max temperature value required.
C	CE Mark and International Crating
CSA	Canadian CSA Rated Control Panel
O+	PM-1 on board particle monitor for 120VAC power
X1+	Class 1 DIV 1 Group C/D (Consult Factory for Other Explosion Proof Options)
Z	On-Site Start Up Training (1 x 10 hr Shift)

+Longer lead times. Consult factory.

Model	Inlet / Outlet Connections
1200	1.5" FNPT Inlet / 1" FNPT Outlet

Materials of Construction	
Filter Housing Materials	Carbon Steel (Coated)
Frame	Carbon Steel (Coated)
ICB Element	Stainless Steel
Post Filter Element	High Efficiency Glass Media $\beta 5_{[c]}$>1000
Electrical Enclosure	NEMA 4 Weather Proof
Tubing	Stainless Steel
Valves & Fittings	Stainless Steel
Steel Vessel Coatings	Marine Grade Epoxy
Specifications	
Maximum Operating Temperature	160ºF, 71ºC
Weight (SVR1200 Full Skid)	700 Lbs, 318 Kg (Includes Crane and Elements Installed)
Dimensions (Crane On)	27" x 48" x 92" Height / 68cm x 121cm x 234cm Height
Dimensions (Crane Removed)	27" x 48" x 57" Height / 68cm x 121cm x 145cm Height
ICB-6005** Element (2 per Unit)	75 lbs Each (Wetted), 34kg Each
Inlet Connection	1 1/2" FNPT
Outlet Connection	1" FNPT
Electric Motor	1 HP TEFC, 1200 RPM (for 60Hz), 1450 RPM (for 50Hz)
Gear Pump	Gear Pump with Internal Relief
Electrical Supply Options	120VAC 1P 60Hz (Standard)
	E1: 120VAC 1P 50Hz
	E2: 230VAC 1P 60Hz
	E3: 230VAC 1P 50Hz
	E5: 460VAC 3P 60Hz
	E6: 380VAC 3P 50Hz
	E7: 575VAC 3P 60Hz
Maximum Allowable Pressure Loss	Maximum Suction Line Pressure Loss 6 PSI, 12.2 Hg Vacuum
Max Full Load AMP Rating	12.8 Amps (120 VAC 1P), 2.5 Amps (460 VAC 3P)
System Flow Rating	7 gpm, 26 lpm (60 Hz) / 8.5 gpm 22 lpm (50Hz)
Max ICB Vessel Flow	5 gpm, 18 lpm (Manual Flow Control Valve, Monitor Flow Meter)
Element Storage Requirements	Store Elements at Temperature > 32ºF, 0ºC (Do Not Allow to Freeze)

TMRN2 - Active Headspace Dehydrator & Nitrogen Generator

Reduce & Maintain H_2O to < 200 ppm

Nitrogen barrier at oil - air interface

Prevents airborne water, particulate & metal ions from entering the reservoir

Removes combustible dissolved gases

Reduces oxidation & fluid breakdown catalysts yielding extended fluid life

Equilibrium (Oil and Headspace Air)

TMRN2 is an active breather system that maintains the air in the headspace that continuously introduces clean dry Nitrogen. As the dry N2 transfers through the headspace at RH < 1% the oil gives up its water striving to achieve equilibrium with the dry Nitrogen in the headspace.

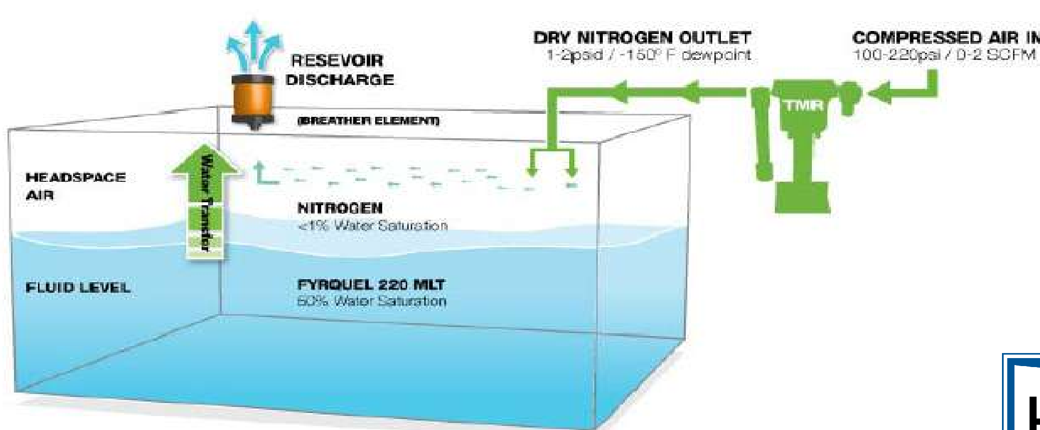
Nitrogen is an inert gas so it will also remove combustible gases (ie CO2, C2H2, CO, C2H4, C2H6, CH4, H2) from the oil to reduce oxidation and fluid breakdown.

How TMRN2 Works (see illustration below)

Compressed air (100psi - 220psi) is connected to the TMRN2 regulator inlet. The air passes through particulate and water removal filters then through a membrane that separates the N2 from the air. TMRN2 under normal operating conditions will generate 98% N2 on the outlet.

A precision orifice on the TMRN2 outlet controls the N2 flow into the reservoir headspace. The connection is made to the reservoir headspace above the maximum fluid level opposite the breather location. N2 is introduced into the headspace at 1~2 psi and sweeps across the oil air interface.

The extremely clean and dry N2 (-90F to -150Fdew point) fills the reservoir headspace with a continuous supply of N2. The N2 slowly passes through headspace exiting through the breather removing water and dissolved gases that are released by the oil into the N2.



EPT

HY-PRO FILTRATION

TMRN2 SIZING & SELECTION GUIDELINES

TMRN2 systems are regulated, intrinsically safe, and have a non-adjustable orifice to prevent excess air flow. A properly sized TMRN2 is designed to remove up to 200 ppm per day under normal operating conditions. Reservoirs need a breather element or suitable exhaust to prevent over-pressurizing the reservoir. Excess reservoir access points should be sealed to ensure proper transfer of N2 from TMRN2 reservoir connection point to exhaust breather location. Reservoir headspace extraction fans are not suitable for use with TMRN2 and should be turned off to ensure TMRN2 can function as designed.

Base Part Number	TMRN2-601902	TMRN2-601903	TMRN2-601904	TMRN2-601905
Estimated Fluid Volume	< 400 gallons (1,500 liters)	< 400 gallons	< 800 gallons	< 1000 gallons
Headspace Volume	< $15FT^3$ $0.42m^3$	< $22FT^3$ $0.62m^3$	< $36FT^3$ $1.02m^3$	< $100FT^3$ $2.80m^3$
Inlet / Outlet Connections	FNPT 1/4" In FNPT 1/4" Out	FNPT 1/4" In FNPT 1/4" Out	FNPT 1/4" In FNPT 1/4" Out	FNPT 1/4" In FNPT 1/4" Out
Dimensions with Optional Enclosure	24” x 12” x 36”	24” x 12” x 48”	24” x 12” x 48”	24” x 12” x 75”
Air Consumption @ 100 PSIG minimum	< 1.2 SCFM	< 2.0 SCFM	< 3.6 SCFM	< 6.0 SCFM

SELECTION & SPECIFICATIONS

	Table 1
TMRN2-60190* -	Special Options

*Select the proper TMRN2 unit based on the sizing guidelines in the table above

Table 1 Code	**Special Options**
-E1	NEMA 4 style enclosure for TMRN2-601902
-E2	NEMA 4 style enclosure tor TMRN2-601903
-E3	NEMA 4 style enclosure for TMRN2-601904 & TMRN2-601905
-H	Heater options for applications requiring increased flow rate or > 99% N2 purity (requires 120vAC 1P 60Hz power supply to operate the heater)
-H50	Heater options for applications requiring increased flow rate or > 99% N2 purity (requires 120vAC 1P 50Hz power supply to operate the heater)
-M1	Manifold to share 1 TMRN2 with 2 reservoirs (for TMRN2-601903 / 6010904 only)
-M2	Manifold to share 1 TMRN2 with 2 reservoirs (for TMRN2-601904 / 6010905 only)

TMR Reservoir Headspace Dehydrator

Ideal for EHC systems using phosphate ester.

Eliminate the primary catalyst of Acid production in EHC fluids (Hydrolysis) & optimize phosphate ester performance.

TMR controls the moisture equilibrium in the reservoir. Dry air mass transfer extracts dissolved water from the fluid.

Minimize fluid degradation with TMR maintaining water levels < 200 ppm.

Equilibrium (Oil and Headspace Air)

With passive breather devices and no continuous exchange of air through the reservoir headspace the air above the oil will achieve thermal and moisture equilibrium with the oil. At the top of the reservoir headspace the air cools yielding condensation and recontamination of the water into the oil.

TMR is an active breather system that maintains the air in the headspace at a dry enough level to ensure that condensation cannot take place. As the dry air transfers through the headspace at RH < 5% the oil gives up its water striving to achieve equilibrium with the dry air in the headspace.

The TMR also promotes air release in the EHC reservoir providing an additional degassing function.

Installation

If there is a headspace evacuation system on the reservoir to which the TMR is being added this system should be disabled and any reservoir holes should be sealed with the exception of the breather.

How TMR Works (see illustration page 2)

A slight positive pressure is created to prevent water and debris from migrating into the reservoir (leak points) . TMR introduces extremely cleaned and dried air free of oil, water aerosols or particles with 150°F dew point suppression. The dew point suppression enables the TMR to take normal compressed air at +80°F dew point and reduce it to -70°F dew point.

The TMR inlet is located as far from the reservoir breather or vent as possible. The clean, dry air enters the reservoir above the oil surface and flows toward the breather. As the air sweeps through the reservoir, moisture from the headspace and oil is adsorbed into the air. The air is then exhausted through the breather or vent. If there is no breather a Hy-Dry desiccant breather should be installed to dry and filter any necessary make-up air.

Total EHC Fluid Solution

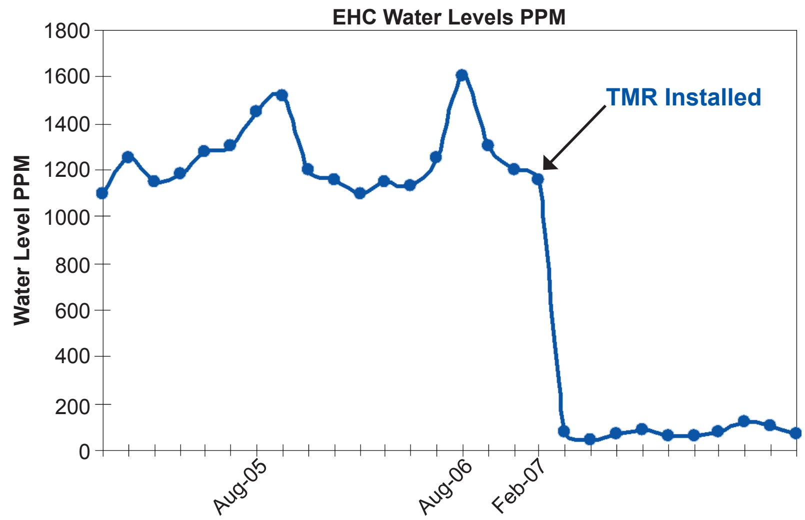
The total EHC solution of TMR, ICB (Ion Charge Bonding) acid scavenging elements, DFE rated glass media filter elements for particulate control, and ECR electrostatic oil cleaner will provide years of trouble free EHC system operation when installed together.

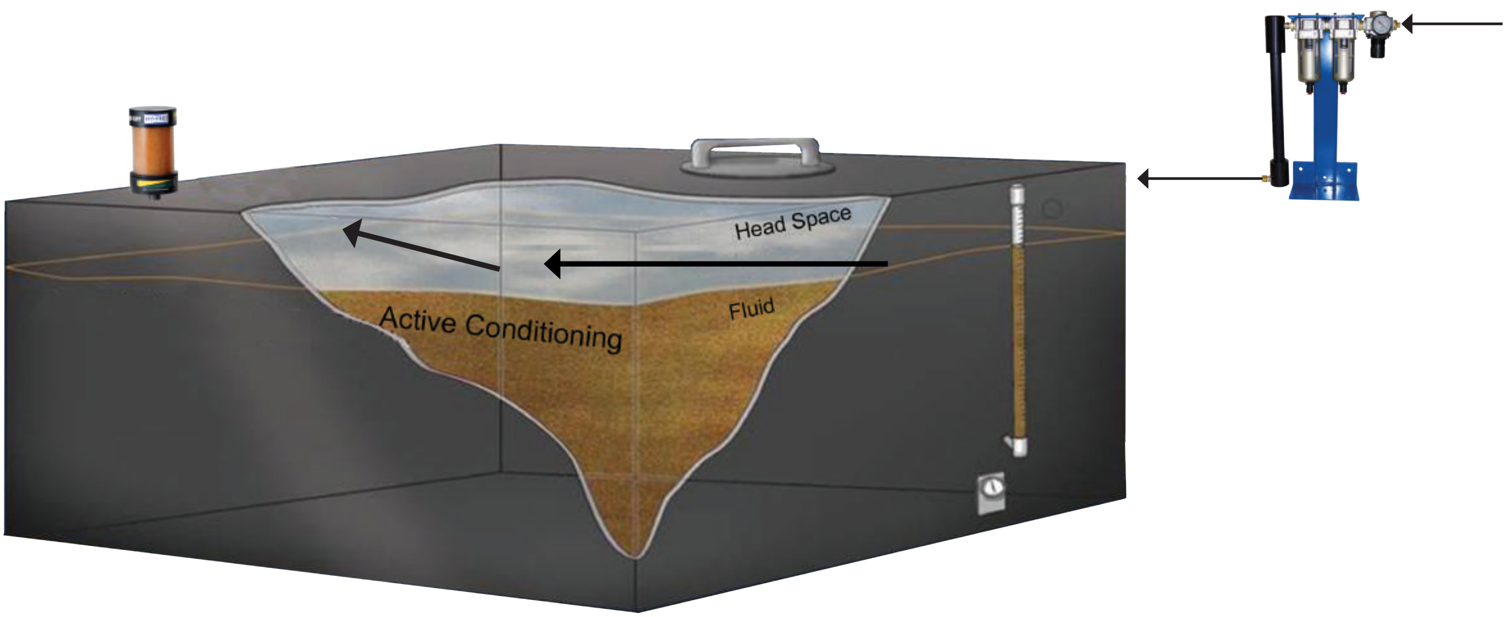
PROVEN PERFORMANCE

In many EHC systems water levels fluctuate with seasonal humidity levels. Generally water levels rise in the summer months when relative humidity peaks. Water levels may range from 800ppm to 2000ppm with typical values being 1100ppm.

Graph 1 depicts a seasonal peak water level in the summer with the TMR installed in the following winter (water levels were dramatically reduced). Water was reduced from 1100ppm to less than 100ppm in under 7 days.

Since installation of the TMR water levels have remained lower than 200ppm at which levels fluid degradation rates are greatly reduced.





SELECTION & SPECIFICATIONS

Part Number	TMR-600902	TMR-600903	TMR-600904
Reservoir Size	< 400 gallons	< 800 gallons	< 1000 gallons
Daily Water Removal Capacity	32 ~ 48 Oz.	56 ~ 80 Oz.	96 ~ 120 Oz.
Inlet / Outlet Connections	1/4" In x 1/4" Out	3/8" In x 1/4" Out	3/8" In x 1/4" Out
Dimensions	15" x 20"	15" x 20"	15" x 20"
Air Consumption @ 80 PSIG min	< 1 SCFM	1~ 2 SCFM	3 ~ 5 SCFM
Shipping Weight	21 lbs	21 lbs	21 lbs

ECR - Electrostatic Contamination Removal

Prevent EHC control valve failures and extend useful fluid life

Removes sub-micron insoluble contamination from EHC fluid (i.e. Fyrquel- phosphate ester)

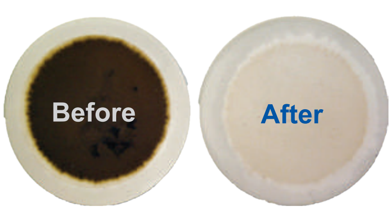
Restores EHC fluid color & clarity from black to original condition

Removal of sub-micron insolubles promotes better resistivity & air release

Why ECR?

Phosphate ester fluids (i.e. Fyrquel) used in turbine EHC systems are very safe fire resistant fluids that must be maintained in a narrow operating condition to ensure trouble-free operation. Pressure induced dieseling and element spark discharge generate sub-micron insoluble carbon based particles that cannot be removed by traditional particulate filtration.

The ECR combines a high voltage electrostatic field with a proprietary collector element design to remove the sub-micron insoluble particles that turn EHC fluids black and compromise fluid resistivity and air release properties. ECR rapidly removes the insoluble contaminant to effectively restore fluid condition to original color & clarity.



ECR Model Sizing Recommendations	
Model	Reservoir Volume / Condition
ECR 4000	Reservoir $\leq$ 400 gal., (1514l) Maintenance Mode
ECR 8000	Reservoir $\leq$ 400 gal., (1514l) Recovery Mode* Reservoir > 400 gal., (1514l) Recovery or Maintenance Mode*

*ECR 8000 contains two collector elements and has a doubled flow rate compared to ECR 4000. This allows the ECR 8000 to quickly remediate systems with high levels of sub-micron contamination.

EPT

HY-PRO FILTRATION

ECR SIZING & SPECIFICATION GUIDE

Model	ECR 4000	ECR 8000
Dimensions		
Length	42 1/4", 1073 mm	56 1/4", 1429 mm
Width	27 1/4", 692 mm	27 1/4", 692 mm
Height	57", 1448 mm	57", 1448 mm
Weight	309 lbs, 140 kg	494 lbs, 224 kg
ECR Elements		
Dirt Holding Capacity	15 lbs / 6.8 kg per Element	
Change Interval	Approximately 4,000 Hours	
Elements	1 per change	2 per change
Connection Details (BSP Connections Available Upon Request)		
Inlet	1" MNPT	1" MNPT
Outlet	1" MNPT	1" MNPT
Mechanical & Electrical Specifications		
Flow Rate	5.0 gpm / 18 lpm	10.0 gpm / 37.5 lpm
* Electrical Service (standard)	120VAC 60Hz Single Phase	120VAC 60Hz Single Phase
Max Allowable Suction Line Pressure Loss	6 Psi, 12.2 Hg Vacuum	6 Psi, 12.2 Hg Vacuum
Max Allowable Water Level	< 500 ppm for Maximum Efficiency	< 500 ppm for Maximum Efficiency
Electrical Motor (standard)	1/2 Horsepower	3/4 Horsepower
Pump Type	Gear Pump	Gear Pump
High Voltage Capacity	12,000 V	12,000 V
Control Enclosure	NEMA 4 Enclosure Ensures Weather Resistance Without Additional Protection	NEMA 4 Enclosure Ensures Weather Resistance Without Additional Protection
Seals	Viton®	Viton®
Sample Port	Lid Bleed Valves	Lid Bleed Valves

ECR PART NUMBER GUIDE

Table 1 Table 2

ECR__000-__

Table 1 Code	Number of Collector Elements
4	1 Collector Element
8	2 Collector Elements

Table 2 Code	Element Specification (Based on Fluid Resistivity)
Omit	Fluid Resistivity Values > 8G-OHMS/cm Collector Element: COL-600990
LR	Fluid Resistivity Values < 8G-OHMS/cm Collector Element: COL-600907

TF4 In-Tank Filter Assembly

Featuring Hy-Pro G8 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	G8 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 Fluorocarbon 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)

HY-PRO FILTRATION

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)

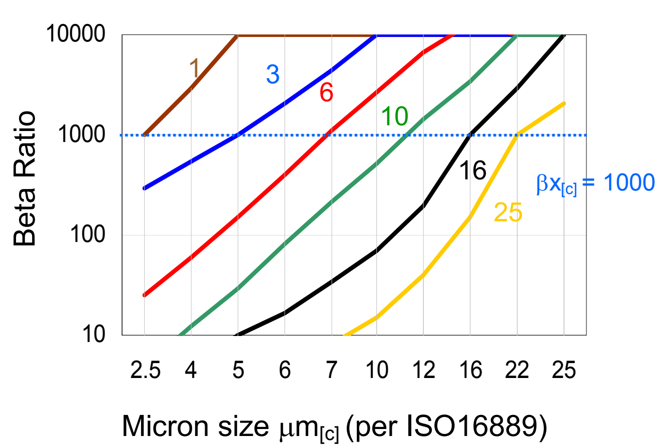
3. Sizing Recommendations to optimize performance and permit future flexibility:

- 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°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	G8 Dualglass high performance media combined with water removal scrim. $\beta x_{[c]} = 1000$ ($\beta x = 200$)
M	G8 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		Table 7
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^o orientation

*Available only with
'S4' option from Table 3.

Table 4 Code	Seal Material
B	Buna-Nitrile
V	Viton®-Fluorocarbon

Table 2 Code	Filtration Rating	Media Type
1M	β2.5[c] = 1000 (β1 = 200)	G8 Dualglass
3M	β5[c] = 1000 (β3 = 200)	G8 Dualglass
6M	β7[c] = 1000 (β6 = 200)	G8 Dualglass
10A	β12[c] = 1000 (β12 = 200)	Water removal
10M	β12[c] = 1000 (β12 = 200)	G8 Dualglass
16A	β16[c] = 1000 (β17 = 200)	Water removal
16M	β16[c] = 1000 (β17 = 200)	G8 Dualglass
25A	β22[c] = 1000 (β25 = 200)	Water removal
25M	β22[c] = 1000 (β25 = 200)	G8 Dualglass
25W	25u nominal	wire mesh
40W	40u nominal	wire mesh
74W	74u nominal	wire mesh
149W	149u nominal	wire mesh

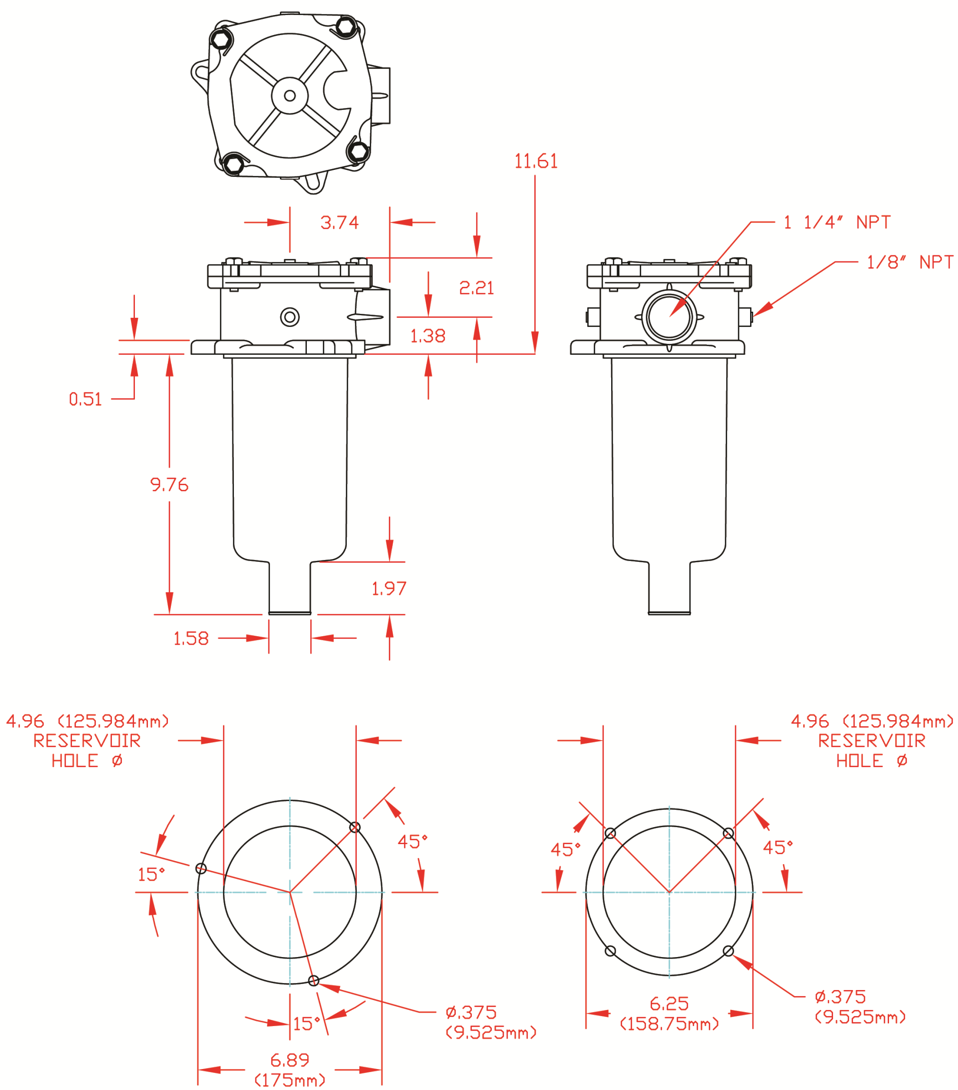
Table 3 Code	Porting Options
B4	BSPT 1 1/4"
S4	SAE-20, 1 1/4"
N4	NPT 1 1/4"

Table 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)

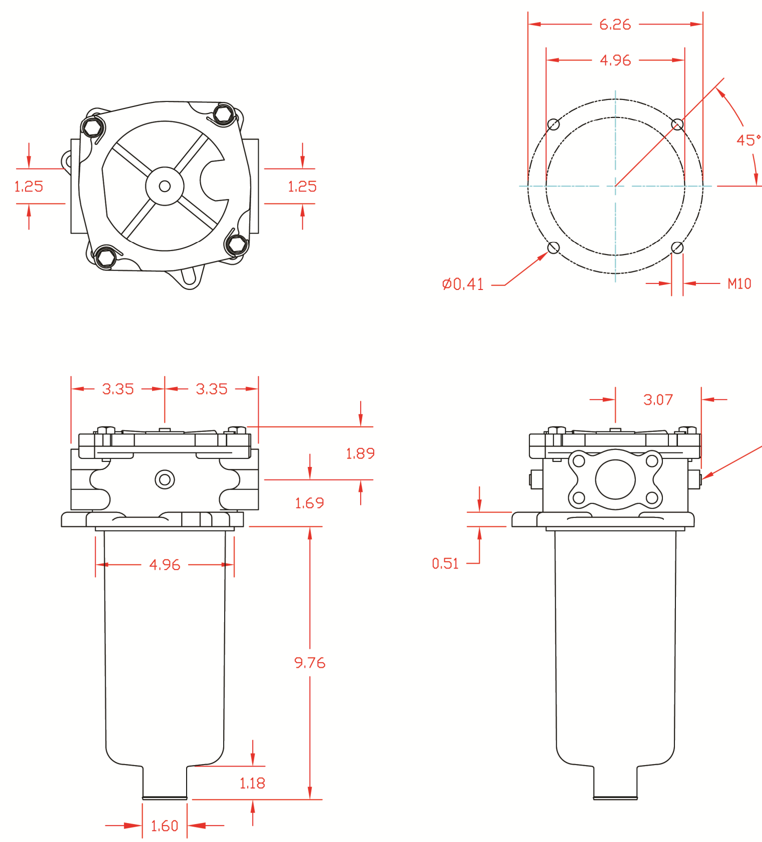
Table 6 Code	Special Options
H4	HPK series element instead of HP4C coreless. HPK conforms to AIAG HF4 automotive standard. **For element part number replace 4C with K and if -12M in place of 10M for the element p/n**

Table 7 Code	Drop Tube Option
4	4" Nominal drop tube extension
6	6" Nominal drop tube extension
8	8" Nominal drop tube extension
9	9" Nominal drop tube extension
10	10" Nominal drop tube extension
12	12" Nominal drop tube extension

Drop tube with angle cut extends by the nominal length beyond the bowl nipple.



TF4 INSTALLATION DRAWING



TF4D INSTALLATION DRAWING

HY-PRO FILTRATION

TFR In-Tank Filter Assemblies

Featuring Hy-Pro G8 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

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 Fluorocarbon 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)

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FEATURES, BENEFITS, ADVANTAGES

DFE Rated Elements	G8 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.

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 ∆p 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 ∆p at both operating and cold start viscosity:

Actual assembly clean ∆p = Flow rate x ∆p Coefficient x Assembly ∆p 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 ∆p calculation should be repeated for start-up conditions if cold starts are frequent.
- Actual assembly clean ∆p 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 ∆p 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 (i.e. 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	∆p Factor* (psid/gpm)	∆p 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

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

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)
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)	G8 Dualglass
3M	β5[c] = 1000 (β3 = 200)	G8 Dualglass
6M	β7[c] = 1000 (β6 = 200)	G8 Dualglass
10A	β12[c] = 1000 (β12 = 200)	Water removal
10M	β12[c] = 1000 (β12 = 200)	G8 Dualglass
16A	β16[c] = 1000 (β17 = 200)	Water removal
16M	β16[c] = 1000 (β17 = 200)	G8 Dualglass
25A	β22[c] = 1000 (β25 = 200)	Water removal
25M	β22[c] = 1000 (β25 = 200)	G8 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

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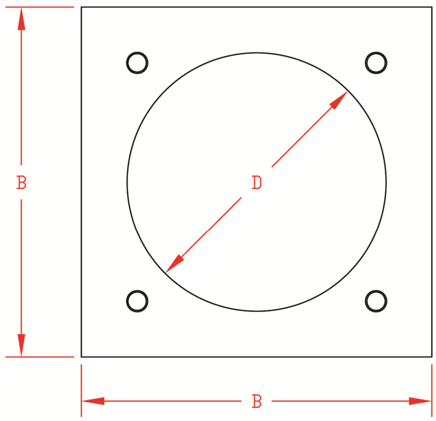
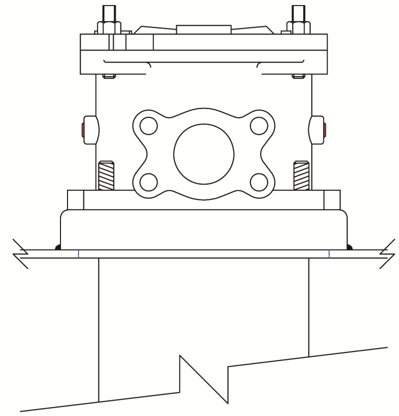
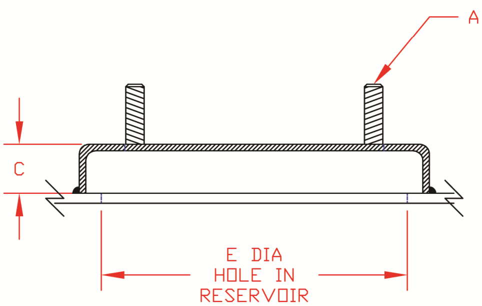
TFR MOUNTING FLANGES





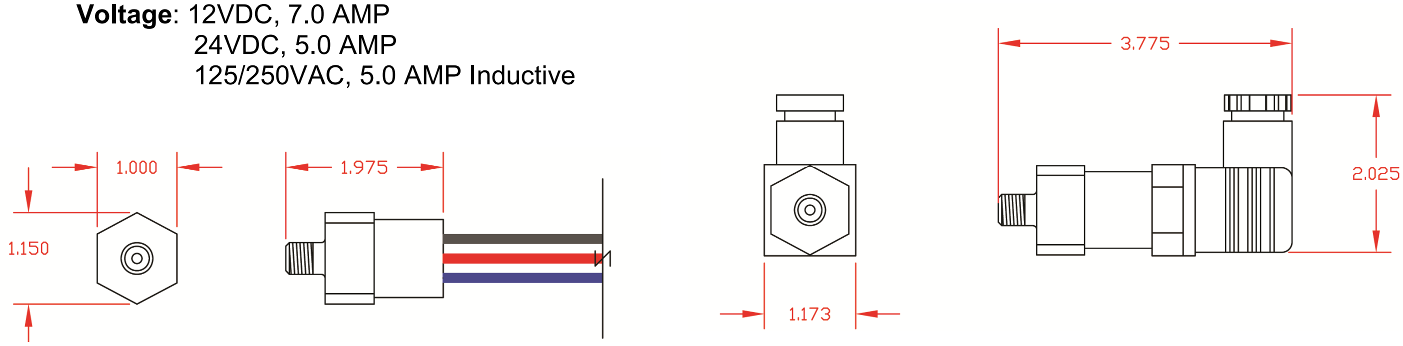


Part Num. (Series)	IN (mm) A	B	C	D	E
TFR-WF1 (TFR1)	5/16-18 UNC-2A	5.33 (135,4)	1.00 (25,4)	3.59 (91,2)	3.8 - 4.5 (96 - 114)
TFR-WF2 (TFR2)	3/8-16 UNC-2A	7.18 (182,4)	1.00 (25,4)	5.30 (134,5)	5.5 - 6.25 (140 - 158)
TFR-WF3 (TFR3)	3/8-16 UNC-2A	7.80 (194,7)	1.00 (25,4)	6.59 (167,5)	6.75 - 7.25 (171 -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

TFR PRESSURE GAGES & PRESSURE SWITCHES

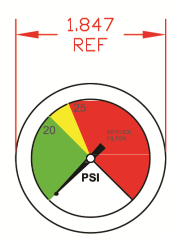
Part Number	Connection Type	N. Closed	Wiring N. Open	Common	Set Point	Stud Connection
PS25E	3 Wire	Green	Red	Black	22 psi (rising)	1/8" NPT
PS25D	DIN 43650	Green: 2	Red: 3	Black : 1	22 psi (rising)	1/8" NPT

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



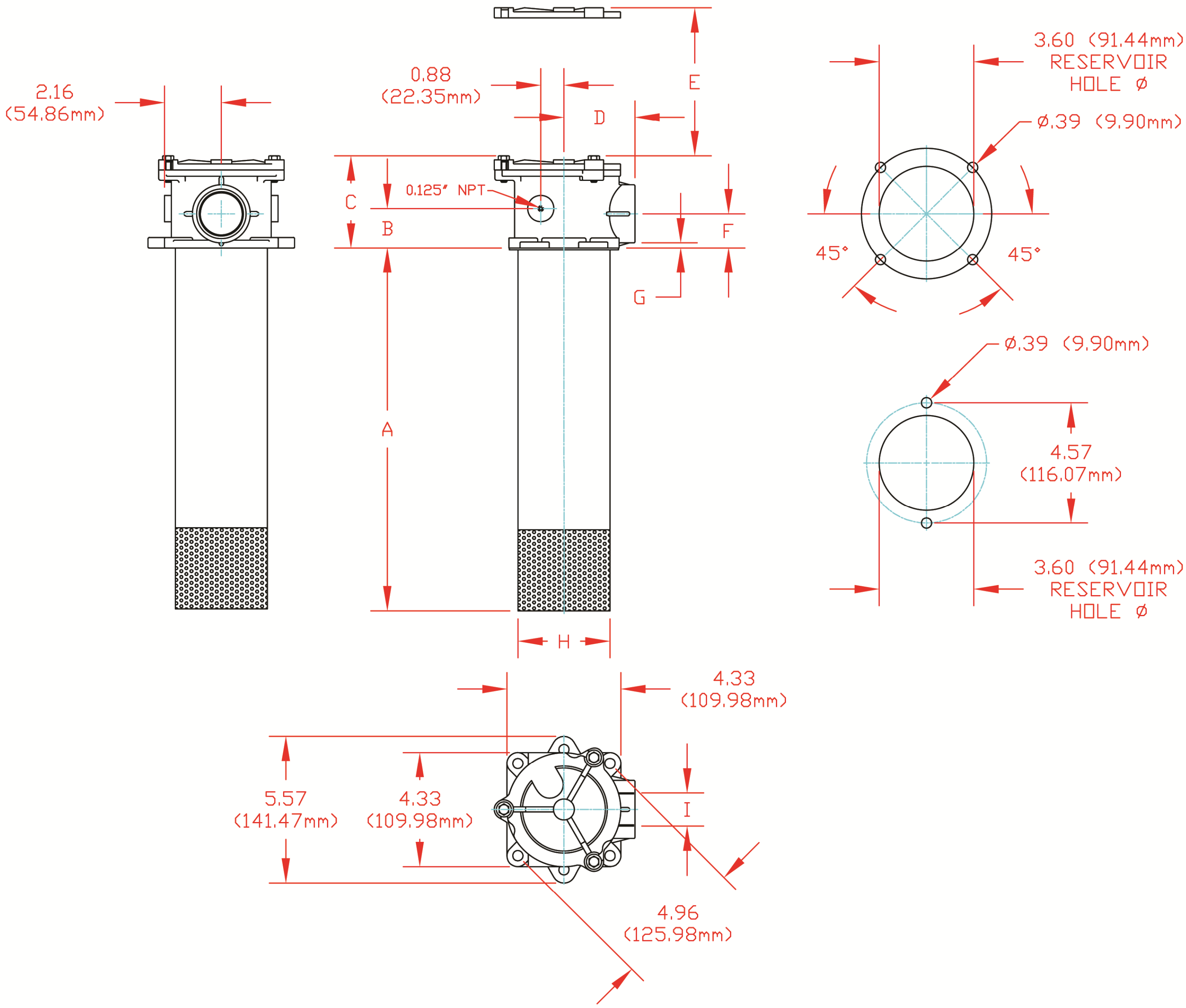
G25: Visual pressure gauge green to red at 25 psid to ensure service before Element operates in bypass.

Steel case, brass stem 1/8” NPT.



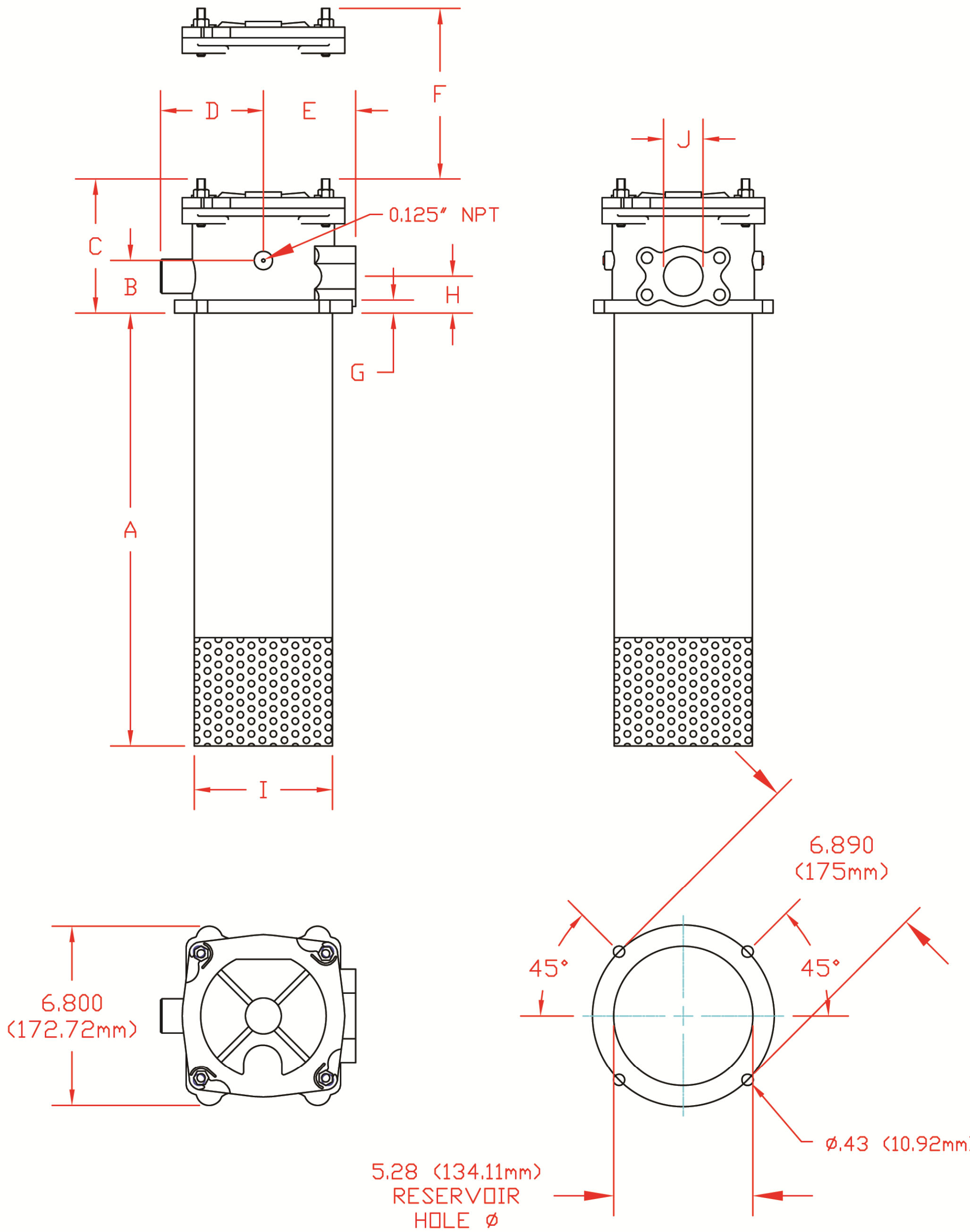
HY-PRO FILTRATION

TFR1 INSTALLATION DRAWING



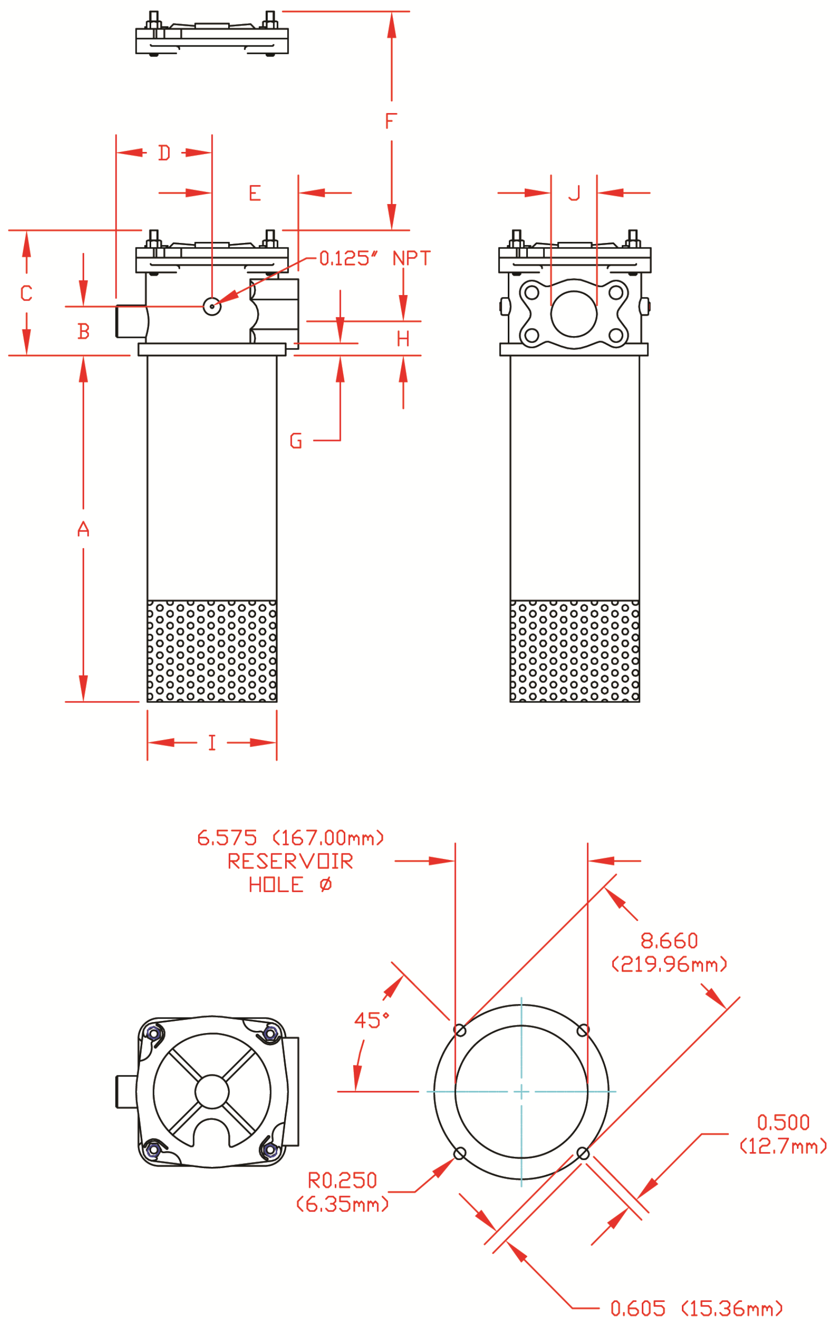
Length Code (Table 4)	Dimension IN (MM)									
	A	B	C	D	E	F	G	H	I	J
6	7.80 (198)	1.50 (38,1)	3.55 (90,2)	2.68 (68)	11.85 (301)	1.1 (28) or 1.26 (32)	0.24 (6)	3.50 (89)	1" or 1 1/4"	4.96 (126)
8	9.85 (250,2)	1.50 (38,1)	3.55 (90,2)	2.68 (68)	13.80 (350,5)	1.1 (28) ~ 1.26 (32)	0.24 (6)	3.50 (89)	1" or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

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

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.

- Carbon steel construction standard (304 & 316 stainless available).
- Duplexing option available for continuous filtration during filter element change-out.
- HP106 and HP107 standard element configurations 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
- Optional element configurations include: 8314 coreless design or industry standard 6 x 18 and 6 x 36 with gasket seals. (Must be specified with order)
- 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.

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

+Subject to longer that standard lead times

Table 4 Code	Element Configuration
5	HP105 coreless series, positive o-ring seals. Recommended change-out 45 psid (3,2 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

+Subject to longer that standard lead times

Table 5 Code	Element Length
18	Single (LF single element vessel only), element codes 5,6,7 only
36	Double, element code 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	β7[c] = 1000 (B6 = 200)
6A	β7[c] = 1000 + water removal
10M	β12[c] = 1000 (B12 = 200)
10A	β12[c] = 1000 + water removal
16M	β17[c] = 1000 (B17 = 200)
16A	β17[c] = 1000 + water removal
25M	β22[c] = 1000 (B25 = 200)
25A	β22[c] = 1000 + water removal
25W	25u nominal wire mesh
40M	β35[c] = 1000 (B40 = 200)
40W	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
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"

+Subject to longer that standard lead times.

*LF single housing only available up to 4" port size.

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
H	65 psid electrical Δp gage
J	65 psid visual Δp gage

Table 9 Code	ASME Code (Not Required)
omit	No Code (Standard)
U+	U code
M+	UM code

+Subject to longer that standard lead times

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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

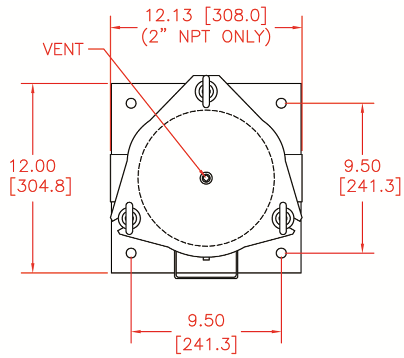
*Slip and blind flange bolt arrangement dimensions change from standard (9 bolts)

+Subject to longer that standard lead times

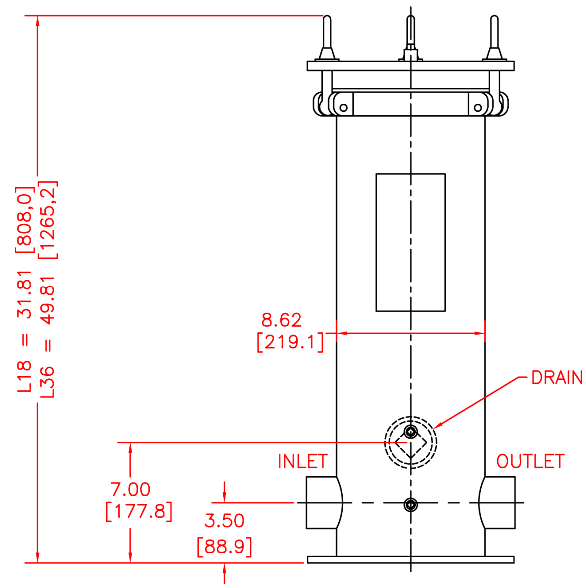
HY-PRO FILTRATION

LF - 150 PSI (10 BAR) only

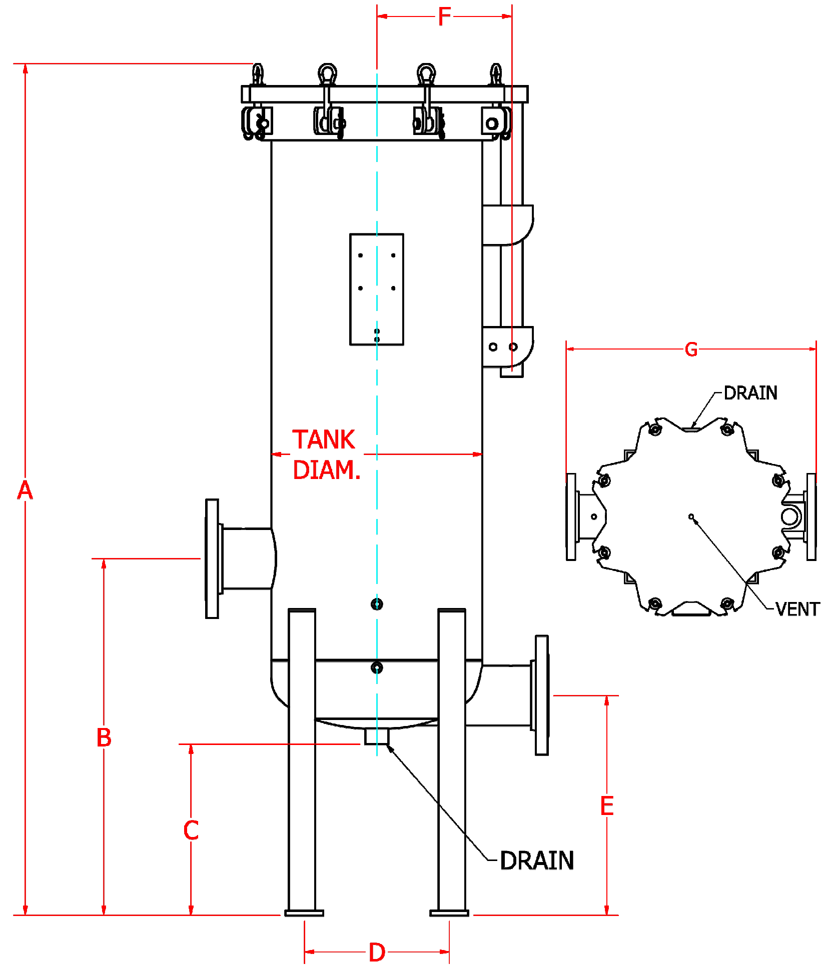
250 PSI (17 BAR), 450 PSI (30 BAR)
installation drawings next page



Length Code	Weight Lb (Kg)
18	114 (52)
36	140 (64)



LFM* - up to 450 PSI (30 BAR)

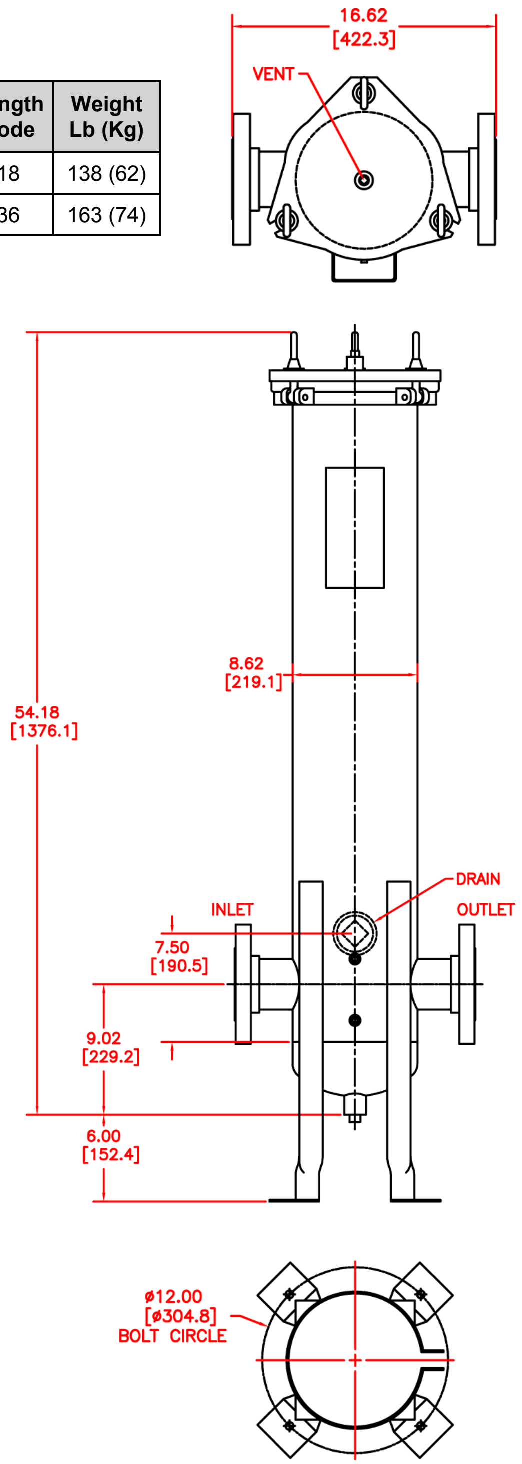


Series	Element Qty.	Tank Diam.	Port Sizes	Est. Weight	A	B	C	D*	E	F	G*
LFM3	3	16 [406,4]	2	465 Lbs 211 Kg	64.6 [1640.8]	27.0 [470,8]	13.0 [330.2]	11.0 [279.4]	27.1 [688.3]	10.2 [259.1]	26.0 [660.4]
			3		64.6 [1640.8]	27.0 [470,8]	13.0 [330.2]	11.0 [279.4]	27.1 [688.3]	10.2 [259.1]	26.0 [660.4]
			4		64.6 [1640.8]	27.0 [470,8]	13.0 [330.2]	11.0 [279.4]	27.1 [688.3]	10.2 [259.1]	26.0 [660.4]
LFM4	4	18 [457,2]	2	550 Lbs 250 Kg	76.7 [1948.2]	17.3 [439.4]	13.3 [337.8]	12.4 [315.0]	35.3 [896.6]	11.2 [284.5]	26.0 [660,4]
			3		76.7 [1948.2]	17.3 [439.4]	13.3 [337.8]	12.4 [315.0]	35.3 [896.6]	11.2 [284.5]	26.0 [660,4]
			4		76.7 [1948.2]	17.3 [439.4]	13.3 [337.8]	12.4 [315.0]	35.3 [896.6]	11.2 [284.5]	26.0 [660,4]
LFM9	9	24 [609,6]	3	645 Lbs 293 Kg	76.7 [1948.2]	23.8 [604.5]	18.8 [477.5]	16.5 [419.1]	35.3 [896.6]	15.1 [383.5]	37.3 [947.4]
			4		76.7 [1948.2]	23.8 [604.5]	18.8 [477.5]	16.5 [419.1]	35.3 [896.6]	15.1 [383.5]	37.3 [947.4]
			6		76.7 [1948.2]	23.8 [604.5]	18.8 [477.5]	16.5 [419.1]	35.3 [896.6]	15.1 [383.5]	37.3 [947.4]
LFM14*	14	30 [762]	3	710 Lbs 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]
			4		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]
			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]
LFM22*	22	36 [914,4]	4	900 Lbs 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]
			6		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]
			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]
LFM31*	31	42 [1067]	6	2080 Lbs 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]
			8		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]
			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]
LFM38*	38	48 [1219]	8	2450 Lbs 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]
			10		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]
			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]

*Dimensions are provided as reference only.

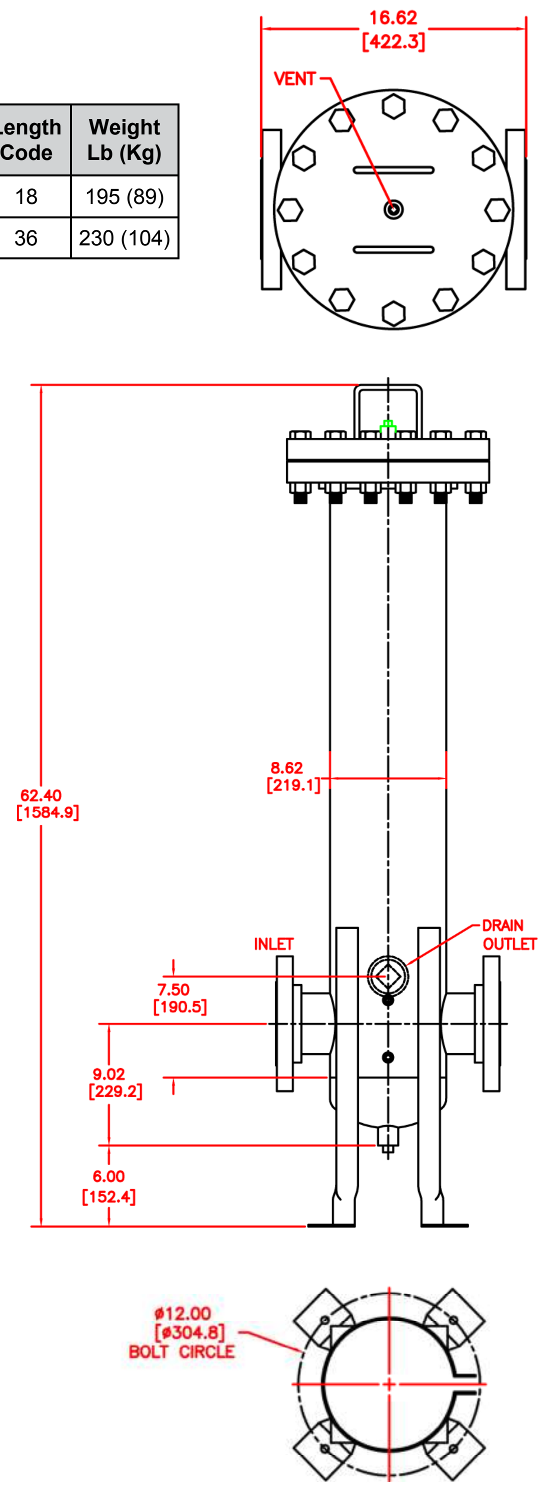
LF - 250 PSI (17 BAR)

Length Code	Weight Lb (Kg)
18	138 (62)
36	163 (74)



LF - 450 PSI (30 BAR)

Length Code	Weight Lb (Kg)
18	195 (89)
36	230 (104)



F8 High Flow Filter

500 psi, 35 bar Max Operating Pressure
G8 Dualglass Filter Element Technology

Performance

Temperature: Buna: -45°F ~ 225°F, -43°C ~ 107°C
EPR: -65°F ~ 300°F, -53°C ~ 148°C
Viton®: -20°F ~ 250°F, -29°C ~ 121°C

Standard Element Collapse: ∆P 250 psi, ∆P 17 bar

- Ideal for high viscosity lubricating fluids and high flow hydraulic applications.
- Top loading housing contains fluid during service to minimize mess.
- Full flow bypass valve located in the topside cover.
- Several element configurations available including; Hy-Pro coreless element with integral bypass, industry standard 8310 style deep pleat (core-in) and 8314 style deep pleat coreless.
- Port to port configuration matches Pall H*8300/8314 series filter assemblies.
- Mounting brackets available in the spare parts list.

Materials	
Head & top cover	Cast aluminum (anodized)
Bowl	Coated steel
Seals	Buna, EPR (skydrol) or Viton®
Media options	G8 Dualglass $\beta x_{[c]}$ > 1000 Stainless steel wire mesh G8 Glass $\beta x_{[c]}$ > 1000, H_2O removal
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 -40°F(-40°C) to 225°F(107°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

DFE rated elements (Dynamic Filter Efficiency)	G8 Dualglass media filter elements ensure fluid cleanliness In hydraulic & lube systems with high capture & retention efficiency (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	HP106/107 coreless elements Include integral bypass valve (new bypass with each element change) HP105/8314/8310 feature bypass valve integrated into the housing
Differential indicator (dirty filter)	Available with visual, electrical, or electrical with visual signal pop-up differential indicator.

HY-PRO FILTRATION

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 ∆p 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 ∆p at both operating and cold start viscosity:

Actual assembly clean ∆p = Flow rate x ∆p Coefficient x Assembly ∆p 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 ∆p calculation should be repeated for start-up conditions if cold starts are frequent.
- Actual assembly clean ∆p 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 ∆p 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.

F8 Element Assembly (housing + element) Differential Pressure Factors

Media code	Port size	L36, 39 Max flow gpm (lpm)	Length code	∆p factor* (psid/gpm)	∆p factor* (bar/lpm)	Length code	∆p factor* (psid/gpm)	∆p factor* (bar/lpm)
1M	2" Flange	100 (375)	16	0.064	0.00123	36,39	0.047	0.00090
3M		150 (560)		0.054	0.00104		0.042	0.00081
6M		150 (560)		0.052	0.00100		0.041	0.00079
10M, 12M		150 (560)		0.050	0.00094		0.040	0.00077
16M		200 (750)		0.046	0.00089		0.038	0.00073
25M		200 (750)		0.040	0.00083		0.037	0.00071
**W		300 (1125)		0.005	0.00077		0.035	0.00067
1M	2.5" Flange	150 (560)	16	0.051	0.00085	36,39	0.034	0.00065
3M		200 (750)		0.041	0.00079		0.030	0.00058
6M		200 (750)		0.039	0.00075		0.029	0.00055
10M, 12M		250 (935)		0.037	0.00072		0.028	0.00053
16M		300 (1125)		0.033	0.00065		0.026	0.00050
25M		300 (1125)		0.030	0.00058		0.024	0.00046
**W		300 (1125)		0.027	0.00051		0.022	0.00042

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

F8 FILTER ASSEMBLY PART NUMBER GUIDE

	Table 1		Table 2		Table 3	Table 4	Table 5		Table 6	Table 7		
F8	-	[ ]	[ ]	-	[ ]	[ ]	[ ]	-	[ ]	[ ]	-	Hy-Pro Code

FILTER ELEMENT PART NUMBER GUIDE

	Table 1		Table 2		Table 3	Table 4
HP	[ ]	**L**	[ ]	-	[ ]	[ ]

Table 1 code	Element Configuration
8310	Core-in deep pleat filter element Interchanges with Pall HC8310 o-ring seals
105	HP105 coreless series, positive o-ring seals.
106	HP106 element with bypass, 25 psid (1,8 bar) bypass, orings
107	HP107 element with bypass 50 psid (3,5 bar) bypass, orings
8314	Coreless filter element Interchanges with Pall HC8314, o-ring seals, max recommended

Table 2 code	Element Length
16*	Single length (table 1 codes 105, 106, 107, 8310, 8314). HP105/106/107L16 are shorter than HP105/106/107L18 elements and are not interchangeable.
36	Extended length (table 1 element codes 105, 106, 107 only)
39	Extended length (table 1 element codes 8310, 8314 only)

*Call for availability (possible longer lead times)

Table 4 code	Seals
B	Buna (Nitrile)
E-WS	EPR + stainless steel support mesh (Skydrol specific fluid applications)
V	Viton® (Fluorocarbon)

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
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	$\beta_{22[c]} = 1000$ ($\beta_{25} = 200$)
25A	$\beta_{22[c]} = 1000$ + water removal
25W	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

*For table 1 element code 8310, 8314 use 12M or 12A for respective media code (Not 10M, 10A)

Table 5 code	Porting Option
F1	**2" SAE four bolt flange (Code 61)**
F2*	2 1/2" SAE four bolt Flange (Code 61)
S1*	SAE-24 threaded 1 7/8" - 12 UN

*Call for availability (possible longer lead times)

Table 6 code	Bypass Valve Setting
X	Bypass valve integrated into filter element (table 1 element codes 106, 107 only)
25	25 psid (1,5 bar) bypass valve (table 1 element codes 105, 8310, 8314 only) **Recommend indicator V1 or L1 **
50	50 psid (3,5 bar) bypass valve (table 1 element codes 105, 8310, 8314 only) **Recommend indicator V3 or L3 **

Table 7 code	ΔP Indicator
V1	Visual only 15 psid (1 bar)
L1	Visual / Electrical 15 psid (1 bar)
V3	Visual only 35 psid (2,4 bar)
L3	Visual / Electrical 35 psid (2,4 bar)

*V1 and L1 indicator options are recommended for bypass valve setting 25 (table 6 code), HP106 element option (table 1 code) or specific applications with non-bypass. V3 and L3 indicator options are recommended for bypass valve setting 50 (table 6 code), HP107 element option (table 1 code) or specific applications with non-bypass.

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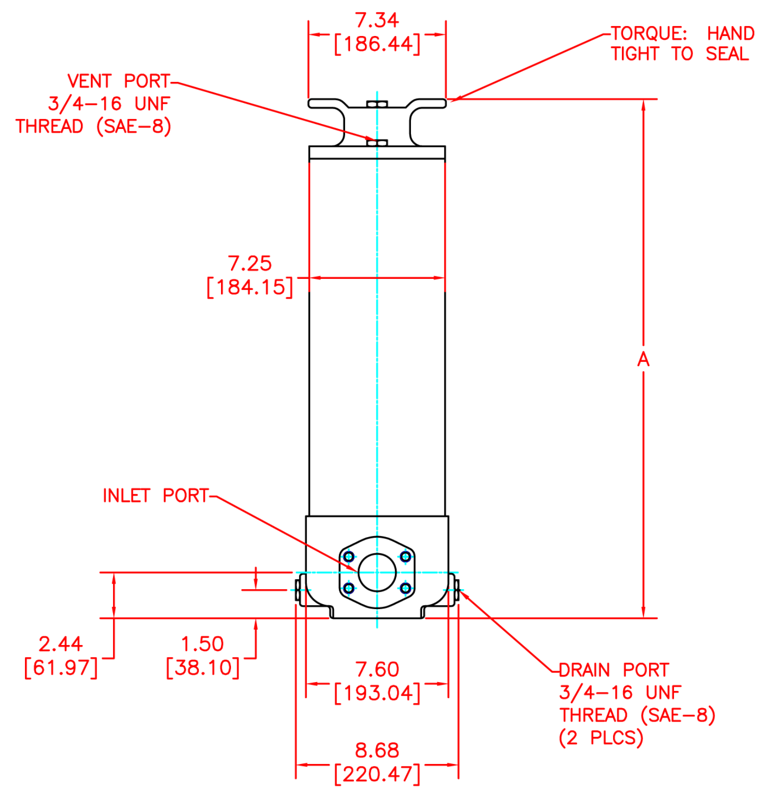
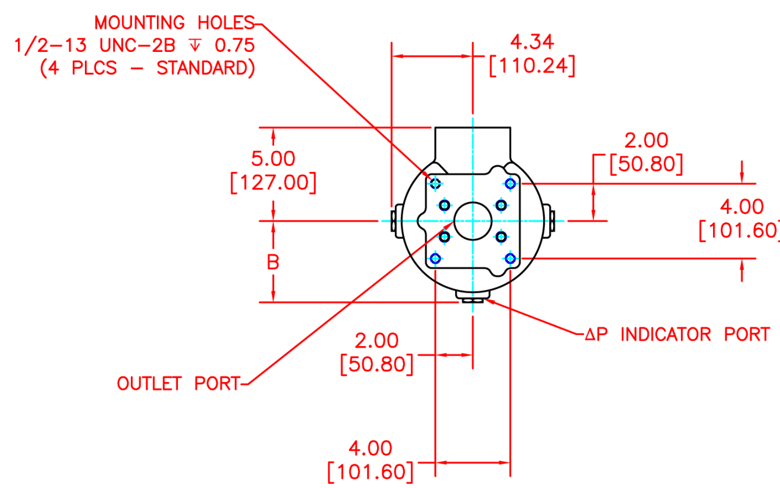
INSTALLATION DRAWING

	16 length code IN (mm)	36/39 length code IN (mm)
F1 Port Option	2" SAE four bolt flange (code 61)	2" SAE four bolt flange (code 61)
F2 Port Option	2 1/2" SAE four bolt flange (code 61)	2 1/2" SAE four bolt flange (code 61)
S1 Port Option	SAE-24 threaded 1 7/8" - 12 UN	SAE-24 threaded 1 7/8" - 12 UN
A (Length)	25.50" (648)	47.25" (1200)
B (Indicator)	Visual 5.52" (140.2) Vis/Elec 6.03" (153.2)	Visual 5.52" (140.2) Vis/Elec 6.03" (153.2)
Ele. Removal	14.90" (379)	34.70" (882)
Weight	58.5 Lb (26.6 Kg)	96.2 Lb (43.7 Kg)

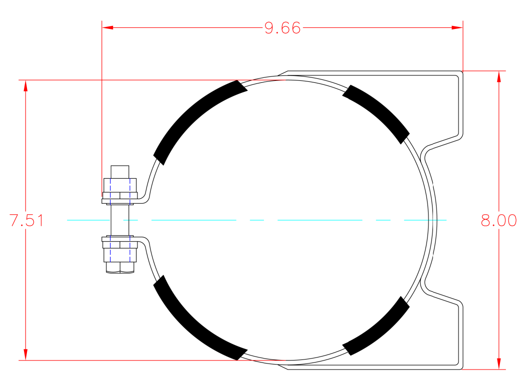


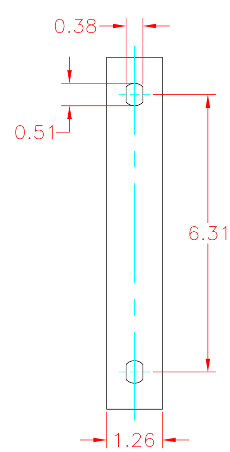


SPARE PARTS LIST

1	**Element**	**See element p/n guide**
2	**Bowl seal kit**	
	Nitrile NBR	F8SKB
	Fluorocarbon	F8SKV
3	**Replacement bowl**	
	16 length	F8B-1
	36 / 39 length	F8B-2
4	**Indicator**	
	Visual 15 psid, Buna	F8IV1B
	Visual 15 psid, Viton®	F8IV1V
	Visual 35 psid, Buna	F8IV3B
	Visual 35 psid, Viton®	F8IV3V
	Visual + Electrical 15 psid, Buna	F8IL1B
	Visual + Electrical 15 psid, Viton®	F8IL1V
	Visual + Electrical 35 psid, Buna	F8IL3B
	Visual + Electrical 35 psid, Viton®	F8IL3V
5	**Mounting bracket**	
	Housing mounting bracket	F8BR

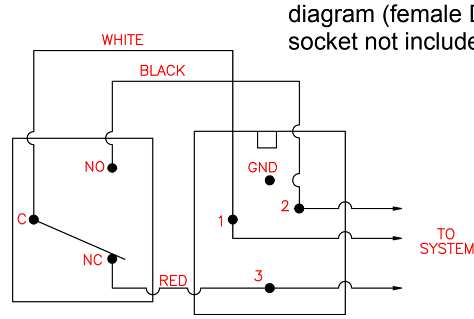
F8BR mounting bracket (use at least 2 for L36/39)





Hirschman 4-pin DIN 43650

Electrical indicator wiring diagram (female DIN socket not included)



HY-PRO FILTRATION

MF3 Medium Pressure In-Line Filter

Featuring Hy-Pro G8 Dualglass Filter element technology

APPLICATIONS

- Hydrostatic charge circuit for Mobile Equipment
- Hy-Pro 5 Star CAT service center applications
- Return-line alternative to spin-on assemblies

PRODUCT SPECIFICATIONS

Pressure Ratings	1200 psi (83 bar) max operating 3000 psi (206 bar) burst
Flow Rate	50 gpm (187 lpm) max
Design Safety Factor	3:1
Fluid Compatibility (ISO 2948)	Petroleum base fluid and specified Synthetics (contact factory)
Element Collapse	250 psid (17 bar)
Housing Materials	Head: Cast aluminum Bowl: Cast aluminum Bypass: Nylon Elements: Zinc or Tin coated Carbon steel
Filter Media	G8 Dualglass or wire mesh
Differential Pressure Indicator Trigger	45 psid (3.1 bar) standard
Bypass Valve Crack	50 psid (3.4 bar) standard
Weight (w/Element)	MF34 length bowl 6.6 Lb (3 Kg) MF38 length bowl 8.8 Lb (4 Kg)
Temperature Rating	Buna: -40°F(-40°C) ~ 225°F (107°C) Viton: -15°F(-26°C) ~ 275°F (135°C)

FEATURES, BENEFITS, ADVANTAGES

DFE Rated Elements	G8 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 leaking. (No Drips)
Low Housing Pressure Drop	Unique internal flow paths provide low resistance to flow. (Low pressure drop)
HF3 Compatible	Port to port dimension, mounting pattern, and element design meet HF3 automotive specification. (Automotive standard)
Drain Plug Standard	Bowl with drain plug comes standard. (No price adder) SAE-4

HY-PRO FILTRATION

MF3 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.

MF3 FILTER ASSEMBLY SIZING & OPERATING PRESSURE GUIDELINES

MF34* Media Code	Max Flow gpm (lpm)	Port Size	Assembly Δp Factor* psid / gpm	Assembly Δp Factor* bar / lpm	Max Operating Pressure, Fatigue Rating
1M	15 (55)	1 1/4" SAE-20	0.94	0.018	1000 psi, 68 bar 10^6 pressure cycles
3M	20 (76)		0.69	0.013	
6M	28 (107)		0.49	0.009	
12M	31 (120)		0.44	0.008	
25M	38 (146)		0.36	0.006	
**W	60 (228)		0.23	0.004	

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

MF38* Media Code	Max Flow gpm (lpm)	Port Size	Assembly Δp Factor* psid / gpm	Assembly Δp Factor* bar / lpm	Max Operating Pressure, Fatigue Rating
1M	20 (75)	1 1/4" SAE-20	0.63	0.012	1000 psi, 68 bar 10^6 pressure cycles
3M	32 (120)		0.46	0.009	
6M	38 (144)		0.38	0.007	
12M	52 (197)		0.35	0.006	
25M	71 (267)		0.29	0.005	
**W	90 (340)		0.21	0.004	

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

MF3 FILTER ASSEMBLY PART NUMBER GUIDE

	Table 1	Table 2		Table 3	Table 4	Table 5	Table 6
MF3	☐	☐	-	☐	☐	☐	☐

MF3 FILTER ELEMENT PART NUMBER GUIDE

	Table 1		Table 3	Table 4
HP60L	☐	-	☐	☐

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

Table 1 Code	Element Length
4	4” (100 mm) nominal
8	8” (200 mm) nominal

Table 2 Code	Port Type
G4	G4 1 1/4” BSPP thread
N4	NPTF 1 1/4”
N5	NPTF 1 1/2”
S4	SAE-20 (1 5/8”-12UN)
S5	SAE-24 (1 7/8”-12UN)

Table 3 Code	Media Selection
1M	G8 Dualglass $\beta_{2.5[c]}$ > 1000
3M	G8 Dualglass $\beta_{5[c]}$ > 1000
6M	G8 Dualglass $\beta_{7[c]}$ > 1000
12A	G8 Dualglass $\beta_{12[c]}$ > 1000 + water removal
12M	G8 Dualglass $\beta_{12[c]}$ > 1000
16A	G8 Dualglass $\beta_{17[c]}$ > 1000 + water removal
16M	G8 Dualglass $\beta_{17[c]}$ > 1000
25A	G8 Dualglass $\beta_{22[c]}$ > 1000 + water removal
25M	G8 Dualglass $\beta_{22[c]}$ > 1000
25W	25u nominal stainless wire mesh
40W	40u nominal stainless wire mesh
74W	74u nominal stainless wire mesh
149W	149u nominal stainless wire mesh

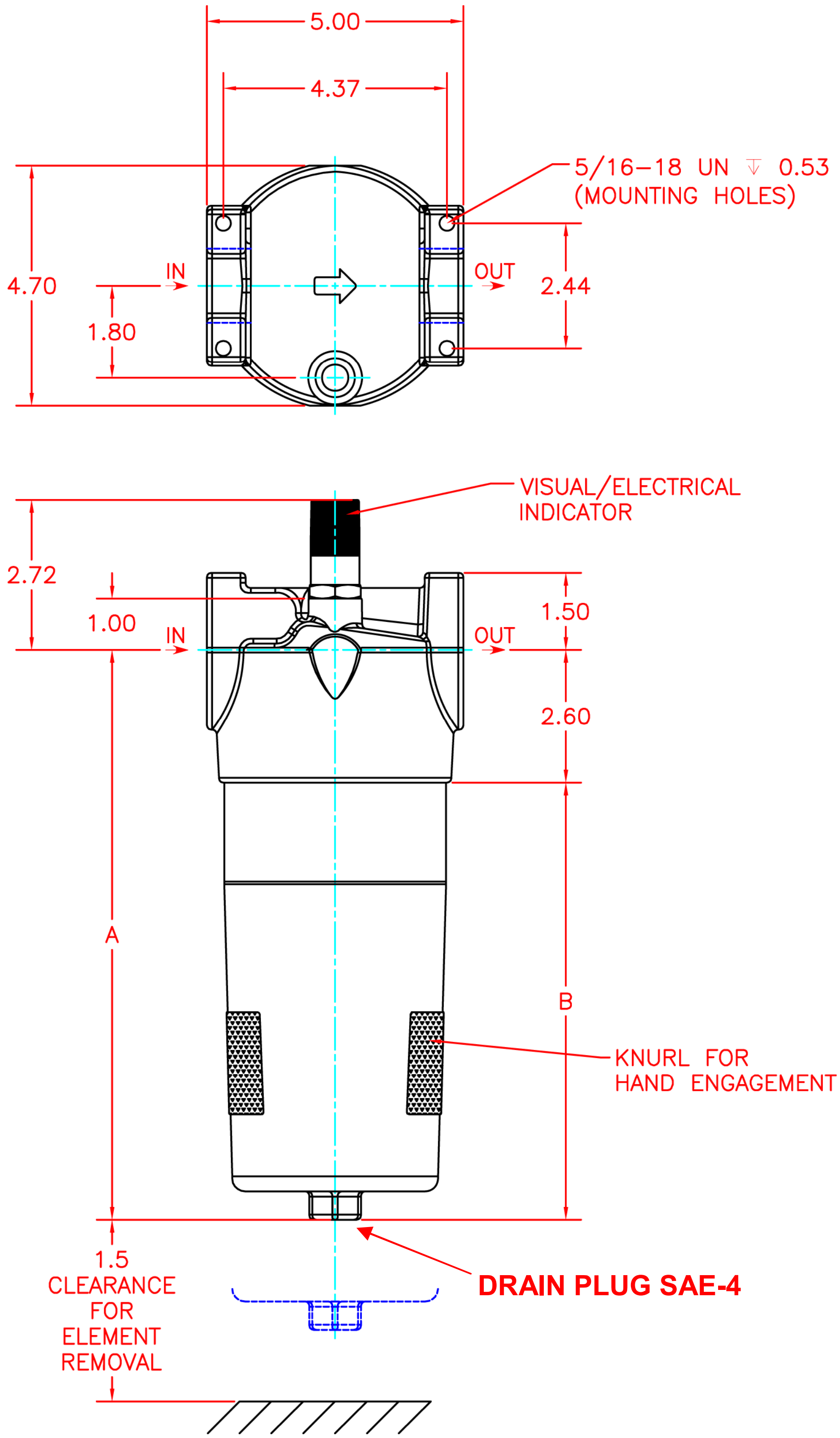
Table 4 Code	Seal
B	Buna: -40°F(-40°C) to 225°F(107°C)
V	Viton: -15°F(-26°C) to 275°F(135°C)

Table 5 Code	Bypass Valve
5	50 psid (3.4 bar)
X	No bypass

Table 6 Code	Indicator
M	Visual - mechanical
E	Visual + Electrical (DIN connector)
X	No indicator

INSTALLATION DRAWING

	Dim IN, Lb (mm, kg)	
	MF34	**MF38**
A	7.50“ (190,5)	11.1” (281,9)
B	4.9” (124,5)	8.5” (215,9)
Weight	6.6 Lb (3 Kg)	8.8 Lb (4 Kg)



SPARE PARTS LIST

Seal Kits	**P/N**
Nitrile NBR	MF3SKB
Fluorocarbon	MF3SKV
Replacement Bowl Kits	
Single length code 4	MF3B4
Double length code 8	MF3B8
ΔP Indicators	
Visual, Buna seals	MF3IVB
Visual, Viton seals	MF3IVV
Electrical, Buna seals	MF3IEB
Electrical, Viton seals	MF3IEV
Drain Plugs	
SAE-4 plug, Buna	MF3DPB
SAE-4 plug, Viton	MF3DPV

S75-S76 Low Pressure Spin-ons

Featuring Hy-Pro G8 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	G8 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 Fluorocarbon or EPR seals (call factory)
Bypass setting	25 psid (1.77 bar) standard see reverse for other options
Weight (w/element)	S75L4 5.5 lbs S75L8 12 lbs S76L4 2.3 lbs
Temperature rating	Nitrile -40°F(-40°C) ~ 225°F (107°C) Viton® -15°F(-26°C) ~ 275°F(135°C)

HY-PRO FILTRATION

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)	0.367 (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)

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	75L4 = ~6.900" 76L4 = ~5.348"
8	75L8 = ~10.900" 76L8 = ~8.961"

Table 3 Code	Porting Options (Series Availability)
N1*	BSPT 3/4" (76)
B4	BSPT 1" (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)

*Non-standard port options with Longer delivery + possible quantity requirements

Table 4 Code	Filtration Rating	Media Type
1M*	$\beta 2.5_{[c]}$ = 1000 ($\beta 1$ = 200)	G8 Dualglass
3M	$\beta 5_{[c]}$ = 1000 ($\beta 3$ = 200)	G8 Dualglass
6M	$\beta 7_{[c]}$ = 1000 ($\beta 6$ = 200)	G8 Dualglass
10C*	$\beta 12_{[c]}$ = 2 ($\beta 12$ = 2)	Cellulose
12A*	$\beta 12_{[c]}$ = 1000 ($\beta 12$ = 200)	G8+H_2O removal
12M	$\beta 12_{[c]}$ = 1000 ($\beta 12$ = 200)	G8 Dualglass
25A*	$\beta 22_{[c]}$ = 1000 ($\beta 25$ = 200)	G8+H_2O removal
25C*	$\beta 22_{[c]}$ = 2 ($\beta 25$ = 2)	Cellulose
25M	$\beta 22_{[c]}$ = 1000 ($\beta 25$ = 200)	G8 Dualglass
40W*	40u nominal	wire mesh
74W*	74u nominal	wire mesh
149W*	149u nominal	wire mesh

*These media options are most available with element sizes HP76L4 and HP75L8. For element sizes HP76L8 and HP75L4 please call for availability of these specified media options.

Table 5 Code	Indicator
M	Visual Pressure Gage
E	Electrical Pressure Switch
D*	Visual Differential Indicator on right side (75,75D only)
X	Pressure ports plugged (no gauge included)

Table 6 Code	Bypass Valve
1	3 psid, 0,21 bar (suction)
4	25 psid, 1,77 bar (standard)
5*	50 psid, 3,5 bar (S75D only)
x	No bypass

*D option ΔP indicator indicates at 25 psid even if the bypass is set for 50 psid (3,5 bar) crack on S75D series only. The D option may be selected with No bypass, 25 psid bypass, and 50 psid bypass but the indicator will always indicate at 25 psid regardless of bypass setting.

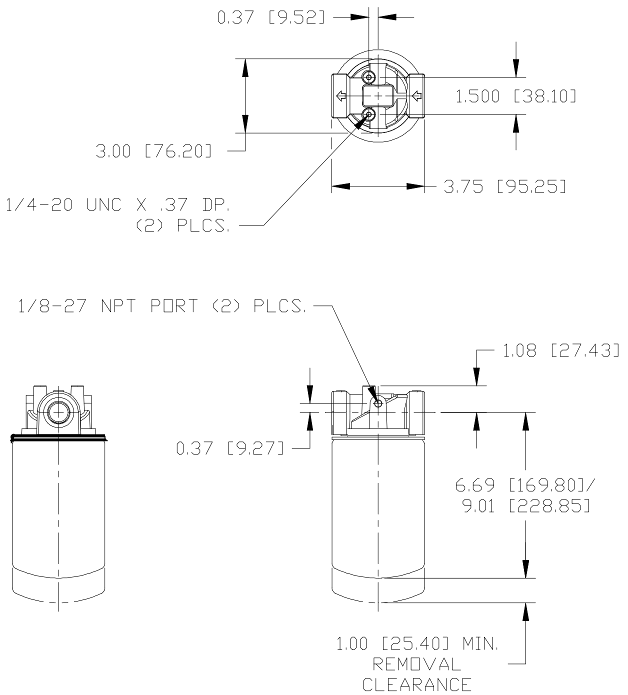
Table 7 Code	Seal Material
B	Buna-Nitrile
V	Viton®

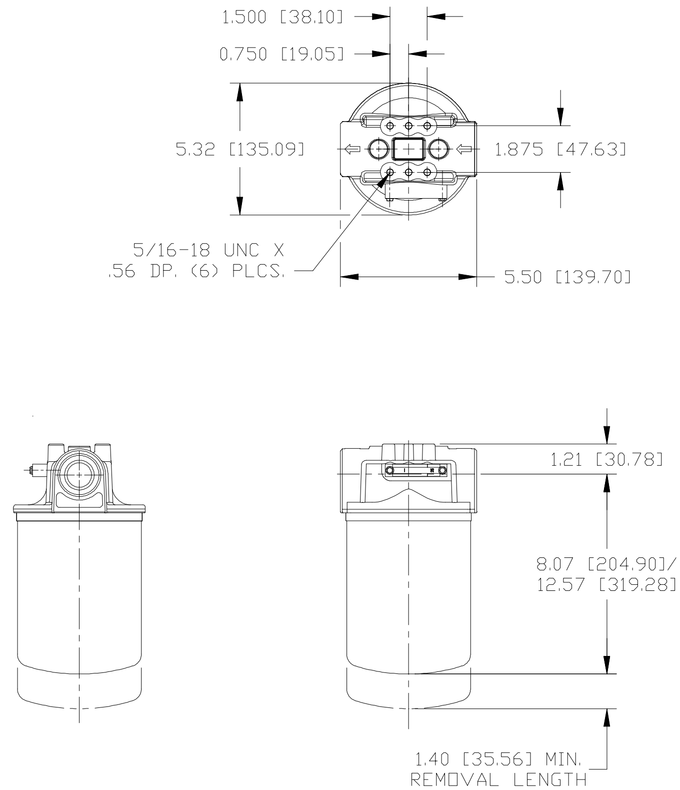
Viton® is a registered trademark of E. I. du Pont de Nemours and Company or its affiliates.

S76 INSTALLATION DRAWING

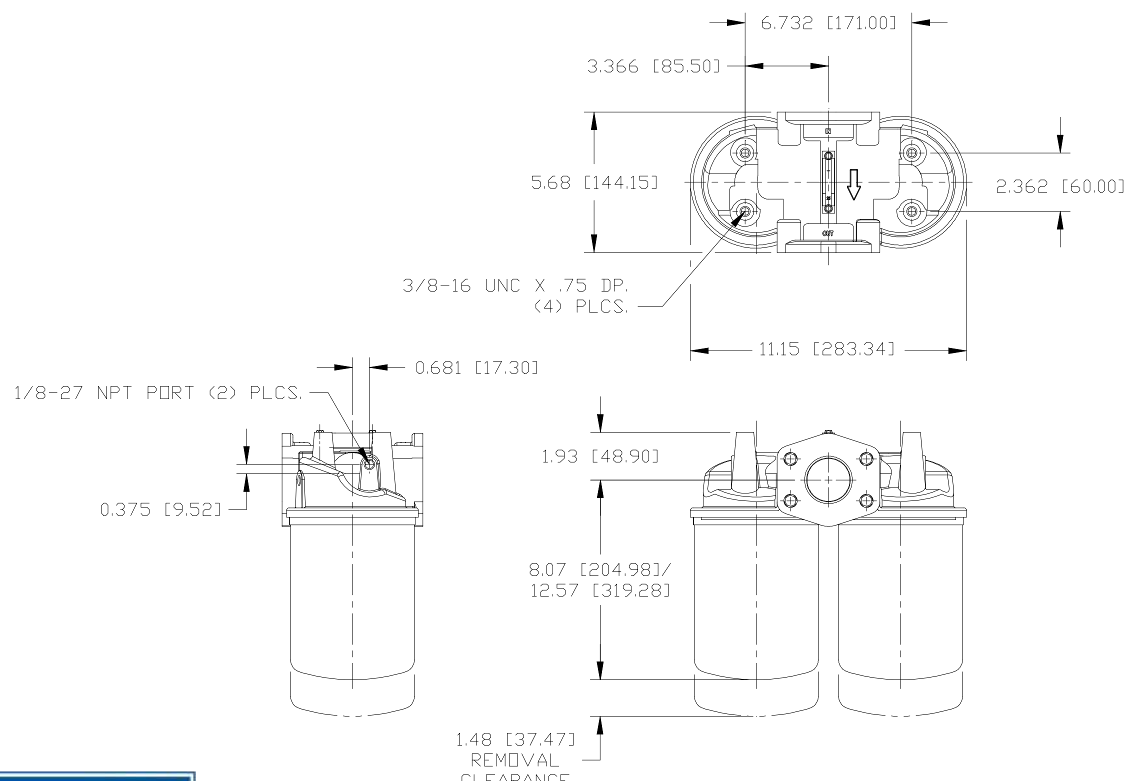
S75 INSTALLATION DRAWING

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





S75D INSTALLATION DRAWING



HY-PRO FILTRATION

S409 Spin-On Filter

G8 Dualglass Filter Element Technology

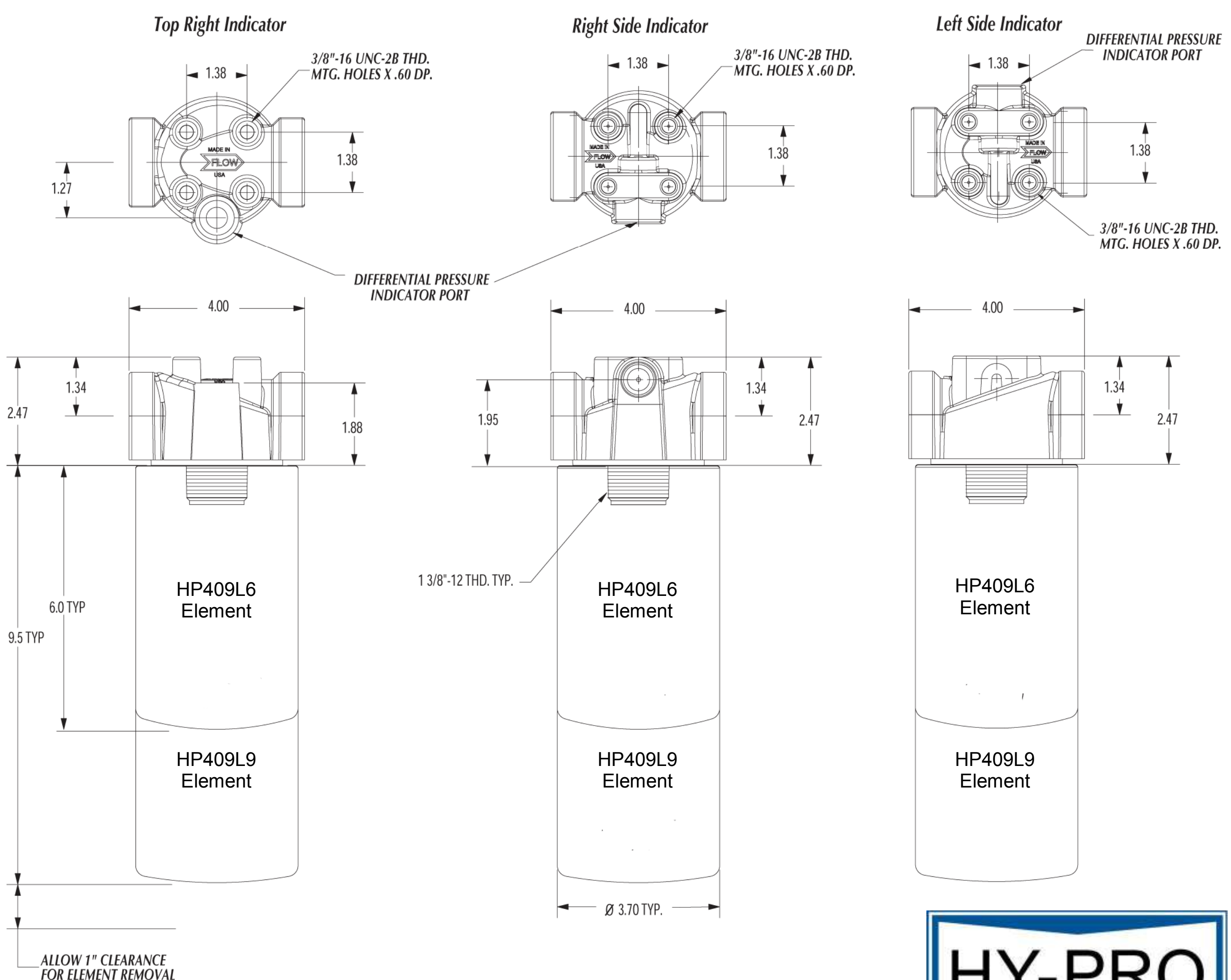
500 psi, 35 bar max operating pressure

Maximum flow rate 35 gpm, 131 lpm

Ideal for mobile equipment return-line and hydrostatic applications

Hy-Pro DFE Rated HP409 series medium pressure spin-on element

Maximum temperature 200°F, 93°C



HY-PRO FILTRATION

FILTER ASSEMBLY PART NUMBER GUIDE

S409 [Table 1] [Table 2] [Table 3] [Table 4] [Table 5] [Table 6] **-** [Table 7] [Table 8]

FILTER ELEMENT PART NUMBER GUIDE

HP409L [Table 6] **-** [Table 7] [Table 8]

Table 1 Code	Port
N12	3/4" NPTF
N16	1" NPTF
S12	1 1/16"-12 UN(SAE-12)
S16	1 5/16"-12 UN(SAE-16)

Table 2 Code	By-Pass Valve
X	No By-Pass
25	25 PSI By-Pass
50*	50 PSI By-Pass

Table 3 Code	Indicator Option
X	No Indicator
V	Visual Indicator
D*	DC Electrical Single Wire
H	Vis/Elec. w/ DIN Connector

Table 4 Code	ΔP Indicator Location
X*	No Indicator
L*	Left Side
R	Right Side
T*	Top

** Non-standard option, limited availability check with factory*

Table 5 Code	ΔP Indicator Setting
X	No Indicator
22	ΔP 22 psi
44	ΔP 44 psi

Table 6 Code	Element Length
X	No Element
6*	~6.000"
9	~9.000"

Table 7 Code	Media Selection
X	No Element
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)
25A	$\beta 22_{[c]}$ = 1000 ($\beta 25$ = 200) + Water Removal

Table 8 Code	Seal
X	No Element
B	Nitrile (Buna)
V	Fluorocarbon (Viton®)
E-WS**	EPR + Stainless Steel Support Mesh (Skydrol Specific Fluid Applications)

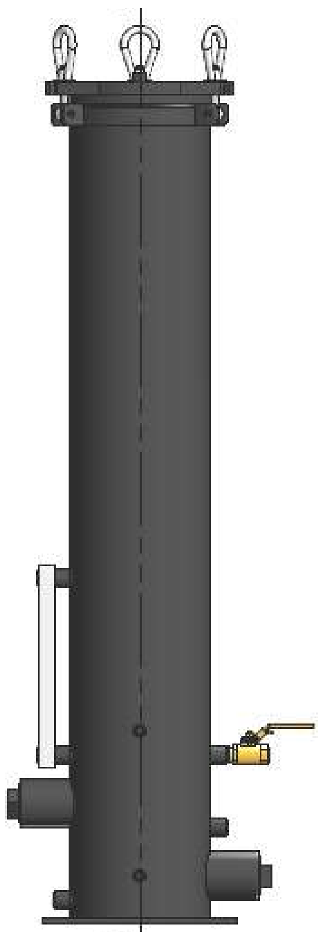
*** Only recommended for Skydrol fluid applications*

HY-PRO

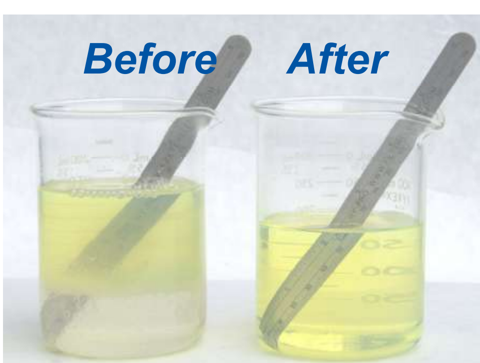
FILTRATION

CSD WATER REMOVAL FILTERS FOR DIESEL

REMOVE WATER TO EXTEND FUEL INJECTOR LIFE & INCREASE COMBUSTION ENGINE FUEL EFFICIENCY

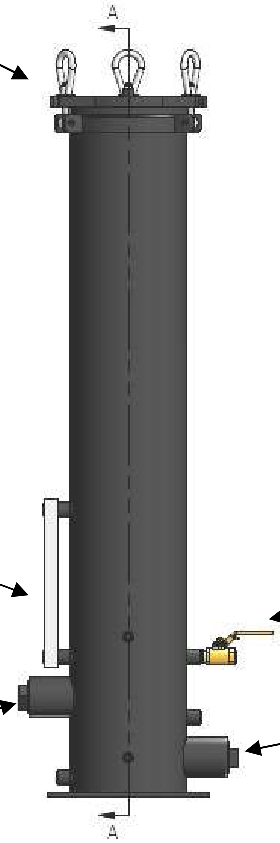


- Remove free water to saturation point with high single pass efficiency (achieve <150 ppm single pass on #2 diesel)
- Rapid removal of gross free water.
- Ideal for construction fueling depots & tank farms
- Condition fuel during bulk tank fill, service truck filling or as kidney loop (maintain clean & dry fuel)
- Install in parallel with Hy-Pro LF series high flow assemblies (high efficiency particle removal).
- Optional Automatic water drain circuit for easy 24 x 7 unattended operation



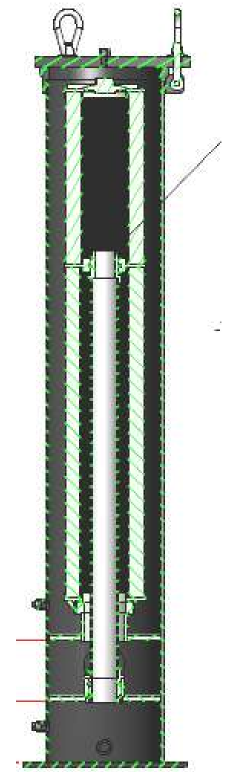
High Efficiency Coalescence Combined with High Efficiency Particulate Filtration Keep Diesel Fuel Clean & Dry for Combustion Engine Reliability

CSD40



Coalesce Vessel Equipped With True Green to Red ΔP Gauge to Monitor Element Condition

CSD40 utilizes 1 combination filter element for coalescence, separation + polishing



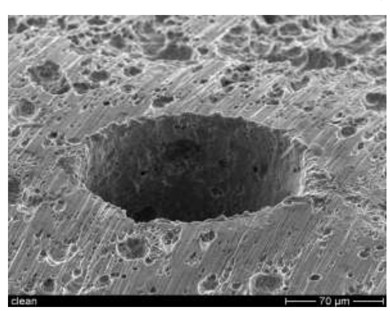
Diesel Fuel Cleanliness Requirements - What Has Changed?

- Injector pressures have increased from 3,000 psi to over 30,000 psi (electronic).
- Fuel Injectors are now a sophisticated (expensive) electronic engine component.
- Diesel fuel lubricity and fuel energy content has decreased significantly with new Ultra Low Sulfur Diesel fuels.
- Water contamination in ULSD fuels leads to accelerated microbial growth.
- Engine manufacturers have learned that ultra fine particles at higher pressures are causing premature failures (warranty).
- Fuel injector and pump life has decreased yielding more unplanned downtime and lost production.
- Water contamination is also a major cause of combustion engine failure & fuel efficiency loss.

Before CSD

After CSD

Failed Fuel Injectors



High Flow CSD Multi-Element Housings are Ideal For Enhancing Existing Fuel Delivery Systems

CSD600

Mechanical Auto Water Drain

Totalizing Water Meter

Synthetic Media Coalesce and Separator Elements

Coalesce element features 100% synthetic media (no cellulose media compatibility related failures).

Dual-stage separator and polishing filter element features water barrier and high efficiency glass media post-filtration.

HY-PRO FILTRATION

DIESEL COALESCE SKID SPECIFICATIONS & SIZING

CSD Filter Elements Utilized by Model*

Model	Maximum Flow Rate	Coalesce Elements	Separator/Polish Elements
CSD40	40 gpm (150 lpm)	1 X **HP677L39-25MV*** (Combined Element)	
CSD120	120 gpm (450 lpm)	2 x **HP731L39-CB**	1 x **HP582L30-S25MB**
CSD200	200 gpm (750 lpm)	3 x **HP731L39-CB**	2 x **HP582L30-S25MB**
CSD400	400 gpm (1,500 lpm)	6 x **HP731L39-CB**	3 x **HP582L30-S25MB**
CSD600	600 gpm (2,250 lpm)	8 x **HP731L39-CB**	5 x **HP582L30-S25MB**

*HP677L39-3MV combines coalesce and separator element functions into one element

WATER & PARTICULATE REMOVAL PERFORMANCE

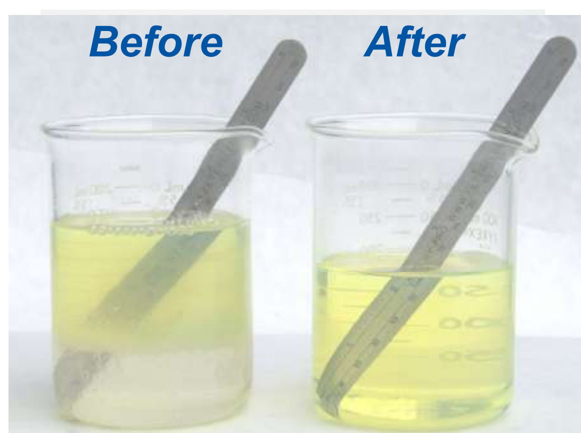
Element Synergy - CSD Housings Must Be Applied with High Efficiency Pre-Filter Housings!
DFE rated G8 Dualglass pre-filter removes particulate before entering the coalesce vessel with high efficiency $\beta 5_{[c]}$ > 1000 media which will protect the coalesce and separator elements from particulate. The fuel then enters the two stage vessel passing first through the coalesce elements where water droplets form and fall. In the second stage of the coalesce fuel passes through the combination separator/polish element where the remaining water droplets are blocked then fall to the bottom of the coalesce vessel to be ejected by the auto-water drain circuit. The separator / polish elements also feature $\beta 2.5_{[c]}$ > 1000 G8 Dualglass media creating two passes through highly efficient glass media elements.

A properly sized Hy-Pro CSD plus Hy-Pro high efficiency particulate filtration will deliver diesel fuel cleanliness codes of 15/13/10 and better. Maintain water levels at or slightly below a typical saturation level of 50 ppm.

Coalesce Elements HP731L39-CB (No Cellulose) - Hy-Pro Coalesce elements contain no cellulose media which can be attacked by high water content resulting in media migration and a loss of coalescence efficiency. Threaded end cap locks into the housing without any washers, screws, or nuts to drop into the bottom of the coalesce vessel. The pleated synthetic configuration maximizes surface area and is contained by a rigid support tube. There are no wrapped outer layers to get soggy and shed fibers into the fluid.

Separator - Polishing Elements (No Cellulose)
HP582L30-S1MB - A water separating outer wrap knocks out remaining water droplets which shed to the bottom of the reservoir. The pleated G8 Dualglass media pack downstream of the water barrier removes solid contaminant to yield super clean and dry fluid leaving the Hy-Pro coalesce skid.

The $\beta 2.5_{[c]}$ > 1000 final element also reduces the population of sub-micronic insoluble particles that contribute to microbial growth and abrasive wear.



HY-PRO FILTRATION

CSD DIESEL COALESCE HOUSING PART NUMBER GUIDE

CSD [Max Flow Rate] [Port] - [Seal] - [Options]

Table 1 Code	Max Flow Rate gpm (lpm)
40	30 (116)
120	100 (388)
200	200 (757)
400	400 (1,500)
600	600 (2,250)
Other	Call factory

Table 3 Code	Seal Material
B	Buna-N (not suitable for bio-diesel)
V	Viton®

Table 3 code	Connections	CSD Series
B2+	2" BSPP	40 ~ 120
C2+	2" SAE Code-61 Flange	40 ~ 120
C3+	3" SAE Code-61 Flange	40 ~ 120
D2+	DN50 DIN 2633 Flange	40 ~ 120
D3+	DN65 DIN 2633 Flange	40 ~ 120
D4+	DN100 DIN 2633 Flange	120 ~ 400
D5+	DN125 DIN 2633 Flange	120 ~ 400
D6+	DN150 DIN 2633 Flange	120 ~ 400
D8+	DN200 DIN 2633 Flange	200 ~ 600
D10+	DN250 DIN 2633 Flange	200 ~ 600
F2	2" ANSI Flange	40 ~ 120
F3+	3" ANSI Flange	40 ~ 120
F4+	4" ANSI Flange	120 ~ 400
F6+	6" ANSI Flange	200 ~ 600
F8+	8" ANSI Flange	200 ~ 600
F10+	10" ANSI Flange	200 ~ 600
F12+	12" ANSI Flange	200 ~ 600
N2	NPT 2"	40 ~ 120

CSD 40 only available up to 3" port size options

+Call factory for availability.

Table 4 Code	Special Options (Add Options to p/n in the Order they Appear in Table)
AX	Auto Water Drain Mechanical (no-electrical). Requires 28 psi (2 bar) minimum back pressure at housing outlet for reliable operation of mechanical auto drain valve
AE	Auto Water Drain (electrically operated solenoid valve) **120 VAC 1P 60Hz** Power Supply Requirement
AE1	Auto Water Drain (electrically operated solenoid valve) **110 VAC 1P 50Hz** Power Supply Requirement
AE2	Auto Water Drain (electrically operated solenoid valve) **230 VAC 1P 60Hz** Power Supply Requirement
AE3	Auto Water Drain (electrically operated solenoid valve) **220 VAC 1P 50Hz** Power Supply Requirement
B*	Auto air bleed valve
M	Water Discharge Totalizing Water Meter
T	Optional Drip Tray + Fork Lift Guides

*Recommended Options

PF2 High Pressure In-Line Filter

Featuring Hy-Pro G8 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, fire trucks, 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	G8 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 (275 bar) max operating 12000 psi (827 bar) burst
Flow rate	20 gpm (75 lpm) max
Design safety factor	3:1
Element collapse	code 0: 290 psid (20 bar) code 1: 3000 psid (206 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 (137 bar)
Differential pressure indicator trigger	50 psid (3.4 bar) standard
Bypass valve crack	60 psid (4.1 bar) standard
Weight (w/element)	~4” bowl 3.8lb (1.7kg) ~8” bowl 5.0lb (2.3kg)
Temperature rating	Buna = -40°F(-40°C) to 225°F(107°C) Viton® = -15°F(-26°C) to 275°F(135°C)

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 (206 bar)

Table 2 Code	Element Length
4	~ 4"/100mm
8	~ 8"/200mm

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)	G8 Dualglass	20
2M	$\beta 5_{[c]}$ = 1000 ($\beta 3$ = 200)	G8 Dualglass	21
3M	$\beta 5_{[c]}$ = 1000 ($\beta 3$ = 200)	G8 Dualglass	20
3SF	$\beta 5_{[c]}$ = 1000 ($\beta 3$ = 200)	Dynafuzz	20, 21
6M	$\beta 7_{[c]}$ = 1000 ($\beta 6$ = 200)	G8 Dualglass	20,21
10SF	$\beta 12_{[c]}$ = 1000 ($\beta 12$ = 200)	Dynafuzz	20,21
12M	$\beta 12_{[c]}$ = 1000 ($\beta 12$ = 200)	G8 Dualglass	20
15M	$\beta 17_{[c]}$ = 1000 ($\beta 15$ = 200)	G8 Dualglass	21
25M	$\beta 22_{[c]}$ = 1000 ($\beta 25$ = 200)	G8 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)
7*	90 psid (6.42 bar)
X**	No bypass

* 20 Series Only
** 21 Series Only

Table 6 Code	Indicator
M	Visual, mechanical
E	Electrical
X	No indicator port
Z	Port plugged

Table 7 Code	Seal
B	Buna -40°F(-40°C) to 225°F(107°C)
V	Viton® -15°F(-26°C) to 275°F(135°C)

Table 8 Code	Special options
V	Vent plug (S port type option only)

Viton® is a registered trademark of E. I. du Pont de Nemours and Company or its affiliates.

HY-PRO FILTRATION

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:

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

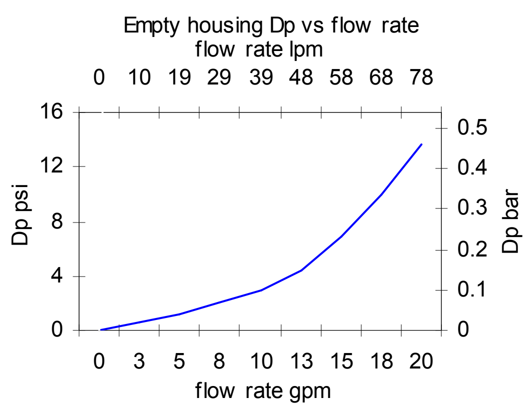
2. Calculate actual clean filter assembly Δp at both operating and cold start viscosity:

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.

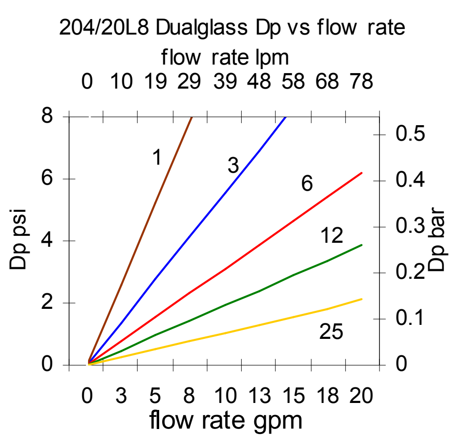
HOUSING and FILTER ELEMENT FLOW vs PRESSURE DROP and EFFICIENCY DATA

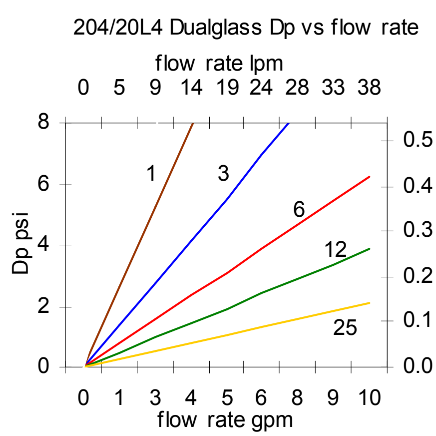


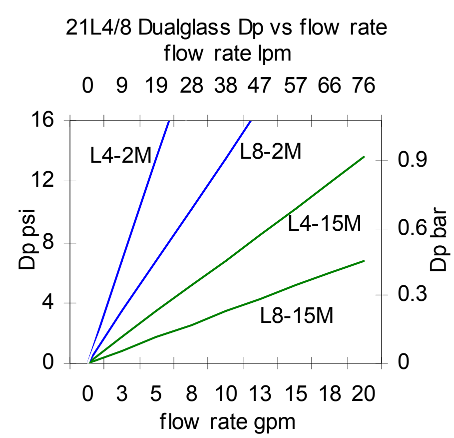
Pressure Drop Calculation

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

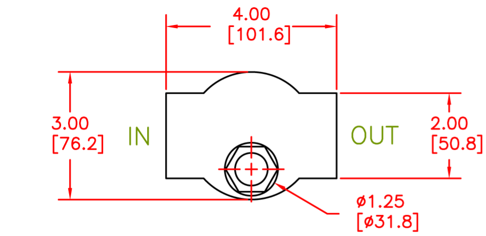




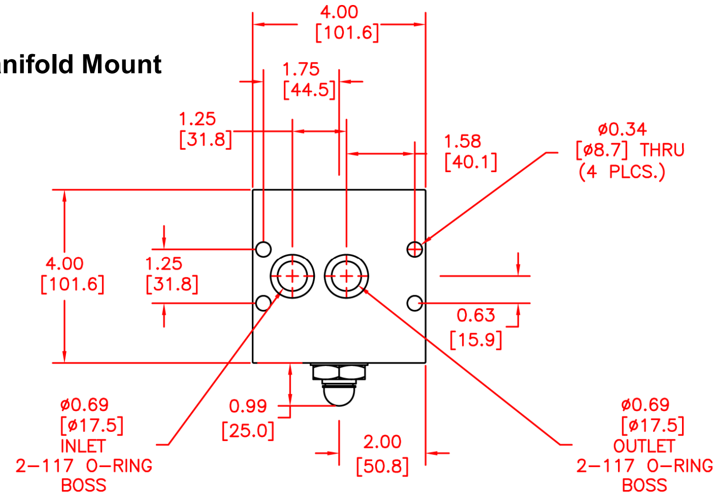


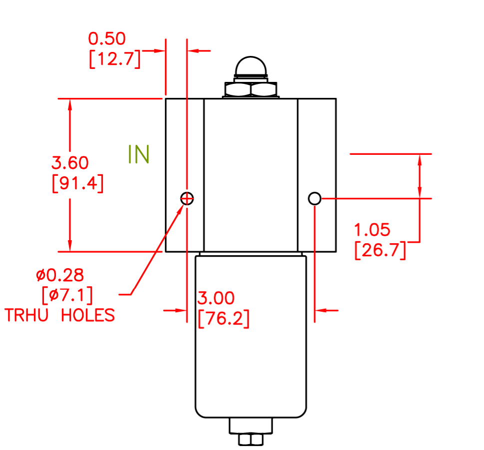
INSTALLATION DRAWING

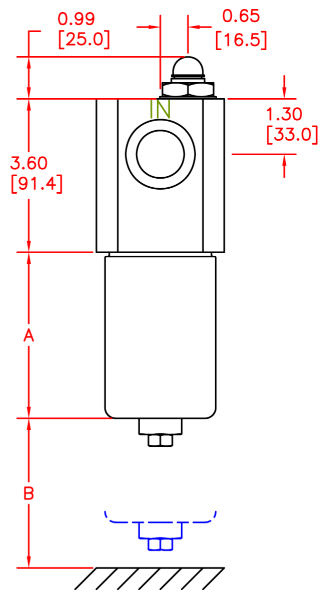
In-Line Mount



Manifold 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	4.2 (1,9)	7.3 (3,3)

SPARE PARTS LIST

1	**Head**	**P/N**
	In-line w/bypass valve, w/indicator port	PF2HLBI
	In-line w/bypass valve No indicator port	PF2HLBX
	In-line No bypass valve, w/indicator port	PF2HLXI
	In-line No bypass valve, No indicator port	PF2HLXX
	Top Manifold w/bypass valve, w/indicator port	PF2HMBI
	Top Manifold w/bypass valve, No indicator port	PF2HMBX
	Top Manifold No bypass valve, w/indicator port	PF2HMXI
	Top Manifold No bypass valve, No indicator port	PF2HMXX
2	**Element** (see Element part number guide)	
3	**Bowl seal kit** (includes teflon back up ring)	
	Nitrile Buna	PF2BSKB
	Viton® Fluorocarbon	PF2BSKV
	EPR	PF2BSKE
4	**Bowl**	
	~ 4”/100mm length w/drain port	PF2B1
	~ 8”/200mm	PF2B2

5	**Drain plug**	**P/N**
	Buna o-ring	PF2DPB
	Viton® o-ring	PF2DPV
	EPR o-ring	PF2DPE
6	**Indicator**	
	Visual, Buna o-ring	PFIVB
	Visual, Viton® o-ring	PFIVV
	Visual, EPR o-ring	PFIVE
	Electrical, Buna o-ring	PFIEB
	Electrical, Viton® o-ring	PFIEV
	Electrical, EPR o-ring	PFIEE
7	**Manifold mount kit** (includes 2 o-rings)	
	Buna o-ring	PF2SKMB
	Viton® o-ring	PF2SKMV
	EPR o-ring	PF2SKME

PFH High Pressure In-Line Filter

615 bar, 8700 psi Operating Pressure
993 lpm, 265 gpm Max Flow Rate

(See Pages 2-3 for Series Specific Operating Pressures and Flow Rates)

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).

- Power unit pump discharge filter.
- Pilot filter directly in front of valves and actuators.
- 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)	G8 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	G8 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 -40°F(-40°C) to 225°F(107°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

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 (i.e. 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.

PFH131 Series

Media code	Bowl length	Max flow rate* gpm (lpm)	Port size	Assembly Δp factor* psid / gpm	Max operating Pressure, fatigue rating
3M	~4"	5.5 (20.4)	3/4"	2.751	**psi (bar)**
6M		6.2 (23.1)		2.433	4570 psi, 315 bar
10M		9.6 (36.1)		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"	8.9 (33.5)	3/4"	1.681	**psi (bar)**
6M		12.4 (46.5)		1.210	4570 psi, 315 bar
10M		15.3 (57.4)		0.980	10^7 pressure cycles
25M		22.0 (82.5)		0.682	6500 psi, 450 bar
25W		27.3 (102.3)		0.550	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	~4	9.4 (35.4)	1"	1.59	psi (bar)
6M		11.7 (43.9)		1.28	4570 psi, 315 bar
10M		17.8 (66.8)		0.842	10^7 pressure cycles
25M		24.3 (91.0)		0.618	6500 psi, 450 bar
**W		36.6 (137.2)		0.41	10^4 pressure cycles
3M	~8"	16.8 (63.0)	1"	0.893	psi (bar)
6M		20.5 (77.1)		0.73	4570 psi, 315 bar
10M		27.4 (102.6)		0.548	10^7 pressure cycles
25M		33.9 (127.3)		0.442	6500 psi, 450 bar
**W		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	~4"	19 (71.2)	SAE-20 1 1/4"	0.809	psi (bar)
6M		23 (86.2)		0.627	6090 psi, 420 bar
10M		26 (97.5)		0.46	10^7 pressure cycles
25M		32 (120)		0.335	8700 psi, 615 bar
**W		45 (168.7)		0.185	10^4 pressure cycles
3M	~8"	37 (138.7)	SAE-20 1 1/4"	0.52	psi (bar)
6M		42 (157.5)		0.383	6090 psi, 420 bar
10M		50 (187.5)		0.28	10^7 pressure cycles
25M		58 (217.5)		0.185	8700 psi, 615 bar
**W		72 (270)		0.119	10^4 pressure cycles
3M	~13"	60 (225)	SAE-20 1 1/4" SAE-24 1 1/2"	0.42	psi (bar)
6M		66 (247.5)		0.308	6090 psi, 420 bar
10M		74 (277.5)		0.175	10^7 pressure cycles
25M		90 (337.5)		0.146	8700 psi, 615 bar
**W		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

PFH840 Series

Media code	Bowl length	Max flow rate* gpm (lpm)	Port size	Assembly Δp factor* psid / gpm	Max operating Pressure, fatigue rating
3M	~15"	99 (372)	SAE 2" Flange Code 62	0.151	psi (bar)
6M		121 (457)		0.123	4570 psi, 315 bar
10M		153 (573)		0.098	10^7 pressure cycles
25M		172 (646)		0.087	6500 psi, 450 bar
25W		200 (750)		0.051	10^4 pressure cycles
3M	~26"	117 (439)	SAE 2" Flange Code 62	0.128	psi (bar)
6M		140 (525)		0.107	4570 psi, 315 bar
10M		176 (661)		0.085	10^7 pressure cycles
25M		217 (815)		0.069	6500 psi, 450 bar
**W		265 (993)		0.041	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 PART NUMBER GUIDE

	Table 1	Table 2	Table 3	Table 4	Table 5	Table 6	Table 7	Table 8	Table 9
PFH									

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*
840	6000 psi, 450 bar*

*See sizing / pressure guidelines

Table 2 Code	Element Collapse
N	450 psid (30 bar)
H	3000 psid (200 bar)
C*	250 psid (17 bar)

Table 3 Code	Element Length
4	~4" (131,152,419)
8	~8" (131,152,419)
13	~13" (419 only)
15	~15" (840 only)
26	~26" (840 only)

Table 4 Code	Port Type	Series Availability
B1	G 1/2 BSPP threaded	131
B2	G 3/4 BSPP threaded	131-152
B3	G1 BSPP threaded	152
B4	G1 1/4 BSPP threaded	419
F1	SAE-20 Flange 1 1/4" (Code 62)	**419**
F3	SAE-32 Flange 2" (Code 62)	**840**
S1	SAE-8 threaded	131
S2	SAE-12 threaded 3/4"	**131**
S3	SAE-16 threaded 1"	**152**
S4	SAE-20 threaded 1 1/4"	**419**
S5	SAE-24 threaded 1 1/2"	419

*S2 is the most common port option for PFH131 series
*S3 is the most common port option for PFH152 series

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 -40°F(-40°C) to 225°F(107°C)
V	Viton -15°F(-26°C) to 275°F(135°C)

Table 7 Code	Bypass Valve
7	102 psid bypass
X*	No bypass

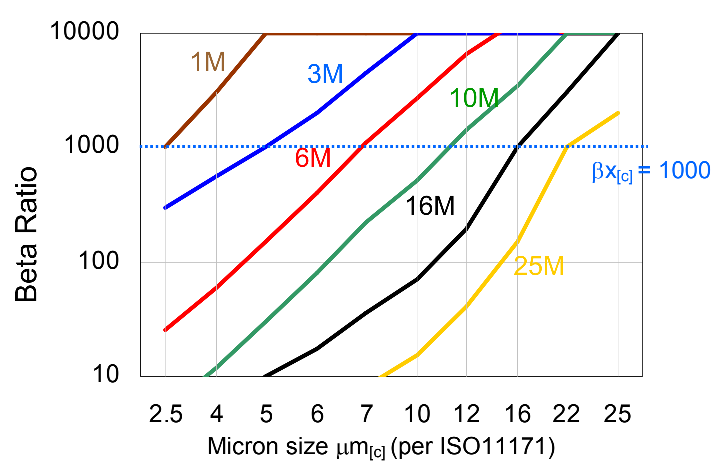
*No bypass "X" option only recommended with "H" element collapse rating (table 2)

Table 8 Code	ΔP Indicator
V	Visual, mechanical
E	Electrical
L	Electrical + LED visual
Z	Indicator port plugged

Table 9 Code	Special Options (Not Required)
D	Bowl drain w/plug

FILTER MEDIA SELECTION GUIDE

Media Code	Media Description
A	G8 Dualglass high performance media combined With water removal scrim. $\beta x_{[c]} = 1000$ ($\beta x = 200$)
M	G8 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 $\beta x_{[c]} = 2$ ($\beta x = 2$)



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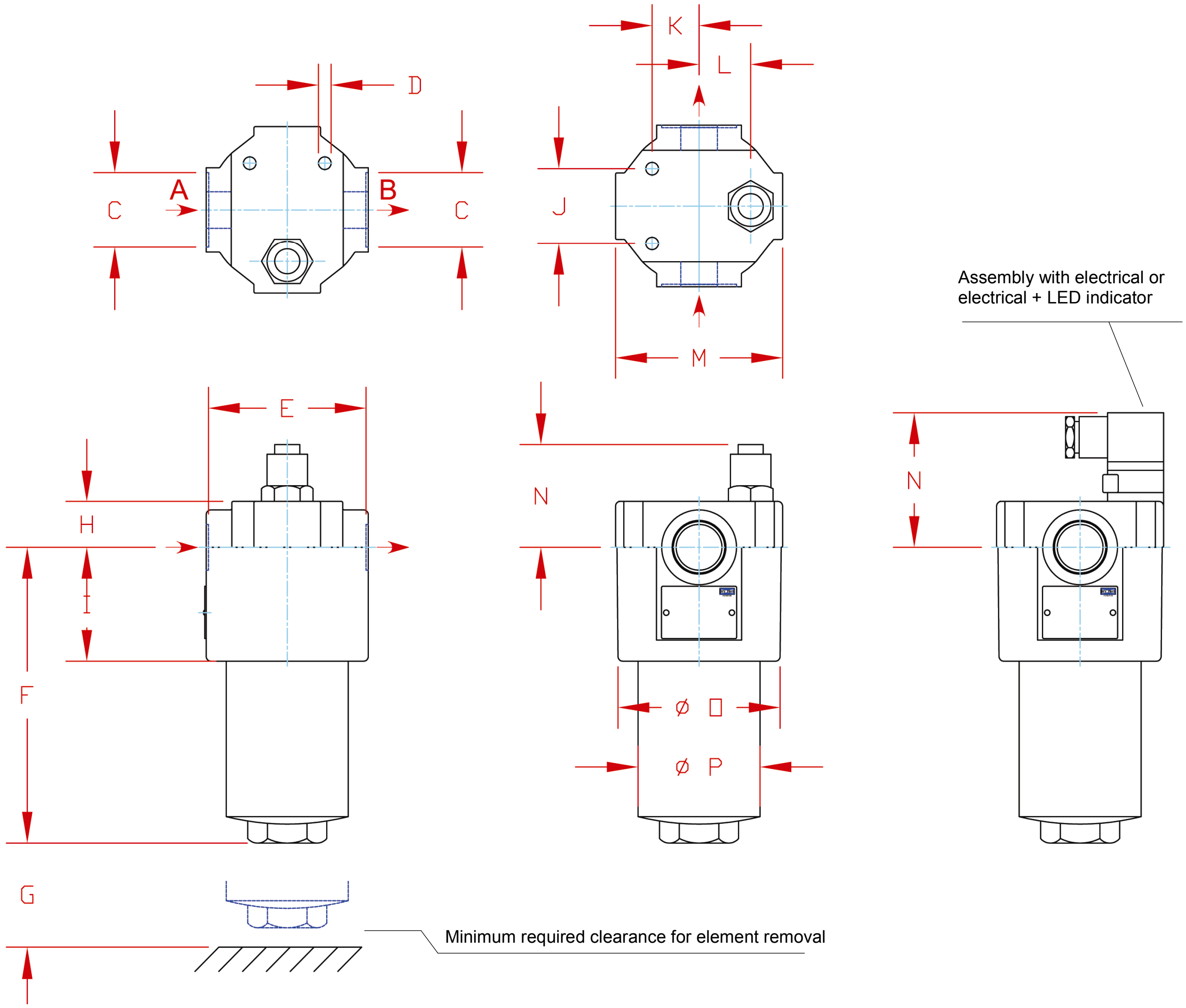
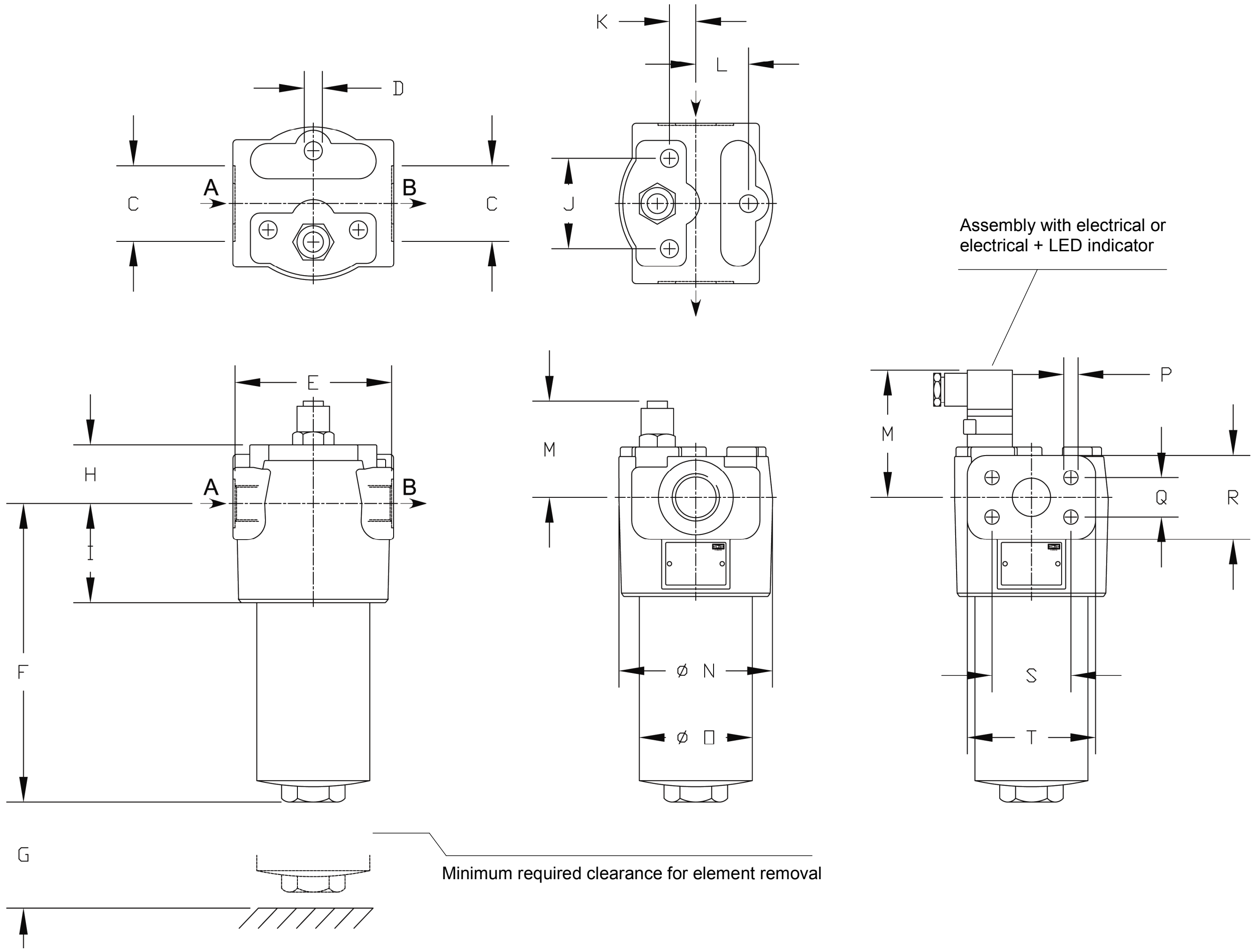


	PFH131*4 IN (mm)	PFH131*8 IN (mm)
A/B	G 1/2, G3/4, SAE-8, SAE-12 thread	G 1/2, G3/4, SAE-8, SAE-12 thread
C	1.653 (41,5)	1.653 (41,5)
D	5/16” - 18 (7,94) UNF 3/4” (19,05) depth	5/16” - 18 (7,94) UNF 3/4” (19,05) depth
E	3.310 (84,08)	3.310 (84,08)
F	6.225 (158,12)	10.008 (254,2)
G	2.167 (55,04)	2.167 (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**	
	~4” length	PFB131
	~4” length with drain port	PFB131D
	~8” length	PFB132
	~8” 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)

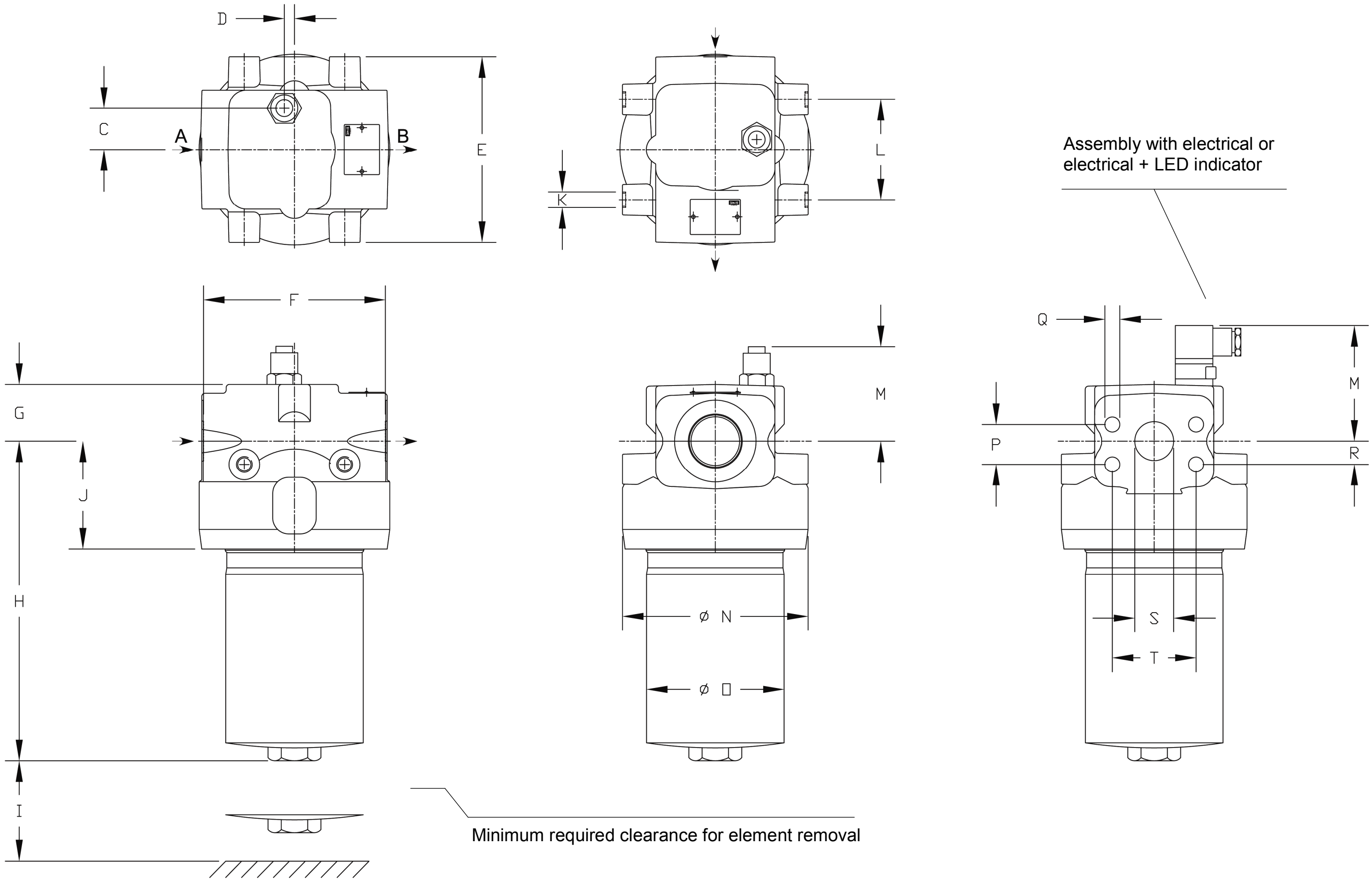


	PFH152*4 IN (mm)	PFH152*8 IN (mm)
A/B	G3/4, G1, SAE-12, SAE-16 thread, SAE-16 Code 62	G3/4, G1, SAE-12, SAE-16 thread, SAE-16 Code 62
C	1.950 (49,53)	1.950 (49,53)
D	M10 X 0.472 (11,98) depth	M10 X 0.472 (11,98) depth
E	4.094 (103,99)	4.094 (103,99)
F	8.819 (224,0)	11.220 (284,99)
G	2.756 (70,00)	2.756 (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	3/8” - 16 UNF	0.70 (17,78) Depth
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**	
	~4” length	PFB1521
	~4” length with drain port	PFB1521D
	~8” length	PFB1522
	~8” length with drain port	PFB1522D
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

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

HY-PRO FILTRATION

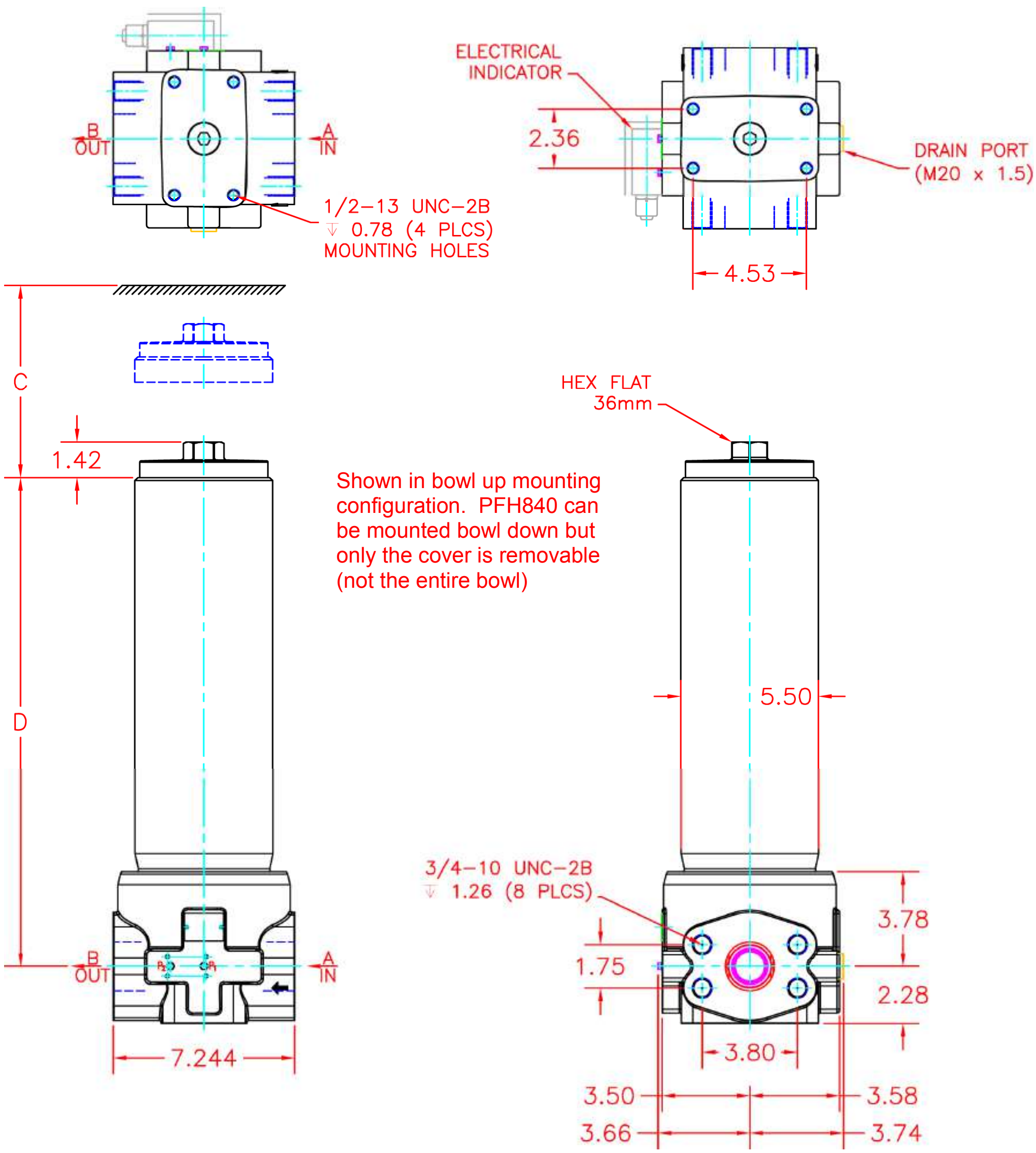


	PFH419*4 IN (mm)	PFH419*8 IN (mm)	PFH419*13 IN (mm)
A/B	G1 1/4, SAE-20, SAE-24 thread SAE-20 code 62	G1 1/4, SAE-20, SAE-24 thread SAE-20 code 62	G1 1/4, SAE-20, SAE-24 thread SAE-20 code 62
C	1.30 (33,02)	1.30 (33,02)	1.30 (33,02)
D	0.32 (8,12)	0.32 (8,12)	0.32 (8,12)
E	5.83 (148,08)	5.83 (148,08)	5.83 (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	7/16”- 14 TPI 1.00 (25,4) depth	7/16”- 14 TPI 1.00 (25,4) depth	7/16”- 14 TPI 1.00 (25,4) 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**	
	~4” length	PFB4191
	~4” length w/drain port	PFB4191D
	~8” length	PFB4192
	~8” length w/drain port	PFB4192D
	~13” length	PFB4193
	~13” 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)

PFH840 INSTALLATION DRAWING AND SPARE PARTS LIST

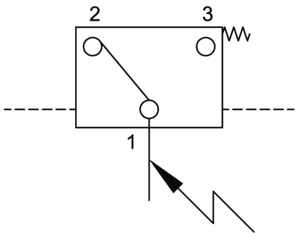


	PFH840*15 IN (mm)	PFH840*26 IN (mm)
A/B	SAE-32 2" Code 62	SAE-32 2" Code 62
C	16.95 (431)	25.25 (642)
D	19.49 (495)	27.56 (700)

	PFH840*15 Lbs (kg)	PFH840*26 Lbs (kg)
Weight	105 (47,7)	123 (55,9)

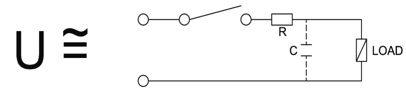
1	**Element (see Element part number guide)**	**Part number**
2	**Bowl Seal kit**	
	Buna	PFH840SKB
	Viton	PFH840SKV
3	**Bowl Cover**	
	Bowl Cover (PFH840 tubes not available)	PFH840C
4	**Indicator**	
	Visual indicator, Buna o-ring	PFH840IVB
	Visual, Viton o-ring	PFH840IVV
	Electrical, Buna o-ring	PFH840IEB
	Electrical, Viton o-ring	PFH840IEV
	Electrical + LED visual, Buna o-ring	PFH840ILB
	Electrical + LED visual, Viton o-ring	PFH840ILV

ELECTRICAL + LED, ELECTRICAL DIFFERENTIAL PRESSURE INDICATOR INFORMATION

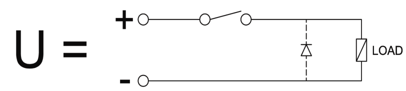


- Indication pressure - 73 psid (5.18 bar)
- Switching voltage - max 120 V AC / 175 V DC
- Switching current - max 0,17 A AC / 0,25 A DC
- Switching power - max 3,5 VA AC / 5 W DC
- Contact type - Change-over
- Electrical protection - IP 65

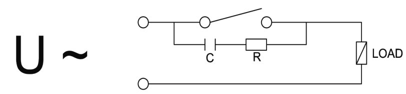
- Current limiter for DC and AC voltage. If loads are connected over long distances a protective resistor should be connected in series in order to limit the current.



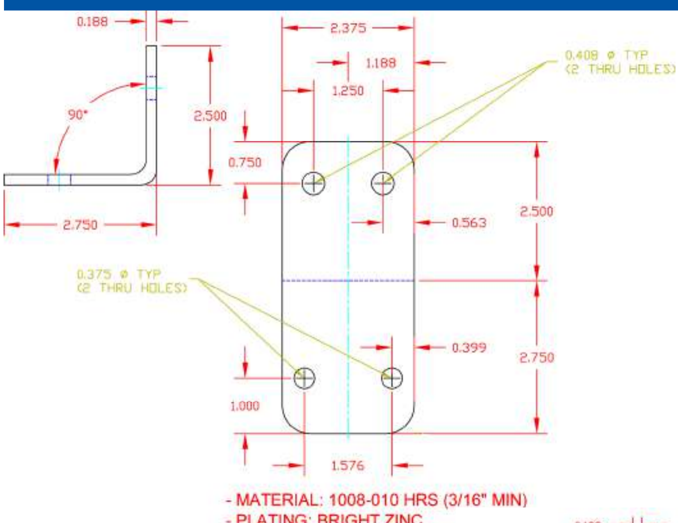
- Spark suppression in DC applications. The contacts of reed switches open very fast which causes voltage peaks to be induced when switching off inductive loads (relays, lifting magnets, solenoids). The self-induction currents are short-circuited by connecting a diode in parallel to the inductive load



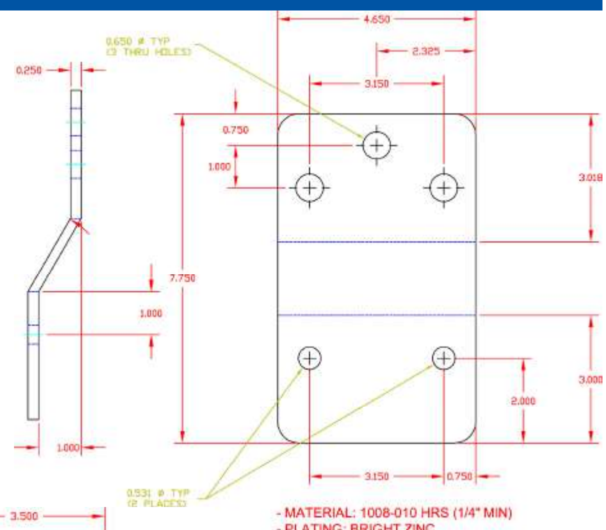
- Spark suppression in AC applications. In AC applications a diode connected in parallel to the load is not sufficient. RC elements should be connected in parallel to the reed switch.



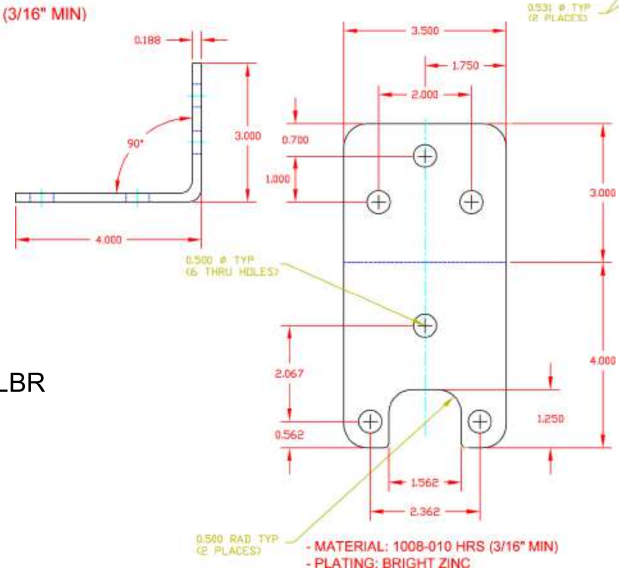
MOUNTING BRACKET SPECIFICATIONS



PFH131LBR



PFH419LBR



PFH152LBR

HY-PRO FILTRATION

PF4 High Pressure Base Mounted Filter

Hy-Pro G8 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	G8 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 F 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 Fluorocarbon 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 psid (3.5 bar) standard.
Weight (no element)	~9” length bowl 60 lbs (27 kg) ~18” length bowl 83 lbs (38 kg) ~27” 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**	
	~9" length code 9	PF4B9
	~18" length code 18	PF4B18
	~27" 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:

$$\text{Actual assembly clean } \Delta p = \text{Flow rate} \times \Delta p \text{ Coefficient} \times (\text{Empty filter housing } \Delta p \text{ factor} + \text{Element } \Delta p \text{ factor})$$

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 ∆ Pressure Factor

Media code	Element Length	*Max recommended flow rate gpm (lpm)	*Empty Housing ∆P by port factor psid / gpm (bar / lpm)	*Filter Element ∆p factor psid / gpm	*Filter Element ∆p factor bar / lpm
1M	9	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	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	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 ∆p factor assumes υ = 150 sus, 32 Centistokes. See ∆p viscosity conversion formula for viscosity

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

Media code	Element Length	Max recommended flow rate* gpm (lpm)	*Empty Housing ∆P by port factor psid / gpm (bar / lpm)	*Filter Element ∆p factor psid / gpm	*Filter Element ∆p factor bar / lpm
1M	9	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	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	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 ∆p factor assumes υ = 150 sus, 32 Centistokes. See ∆p viscosity conversion formula for viscosity

PF4 FILTER ASSEMBLY PART NUMBER GUIDE

	Table 1	Table 2		Table 3	Table 4	Table 5	Table 6	Table 7
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 2 Code	Element Length
9	~9"
18	~18"
27	~27"

Table 6 Code	Bypass Valve Setting
X	Non-Bypass (K3 element collapse only, table 1)
5*	50 psid (3.5 bar)

*Contact factory for higher cracking pressure

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 40W	$\beta 35_{[c]}$ = 1000 ($\beta 40$ = 200) or 40u nominal wire mesh
74W	74u nominal wire mesh
149W	149u nominal wire mesh
250W	250u nominal wire mesh

Table 4 Code	Porting Option
C1	1 1/2" SAE 4-bolt Flange (code 61)
F1	1 1/2" SAE 4-bolt Flange (code 62)
G5	G 1 1/2" BSPP Thread
M1	Manifold mount (see installation detail)
N1	NPTF 1 1/2"
S1	SAE-24 (1 7/8"-12 UN straight thread)

Table 5 Code	Seal Material
B	Buna (Nitrile)
E-WS	EPR + stainless steel support mesh (Skydrol fluid)
V	Viton® (Fluorocarbon)

Table 7 Code	Δp Indicator Type & Set-Point ΔPSI (ΔBAR)
XD*	Electrical/visual 35 (2,2)
HE*	Electrical/visual 100 (7)
XJ	Indicator port plugged
XL	Visual only 35 (2,5)
XO	Visual only 100 (7)
HR*	Electrical switch only 35 (2,5)

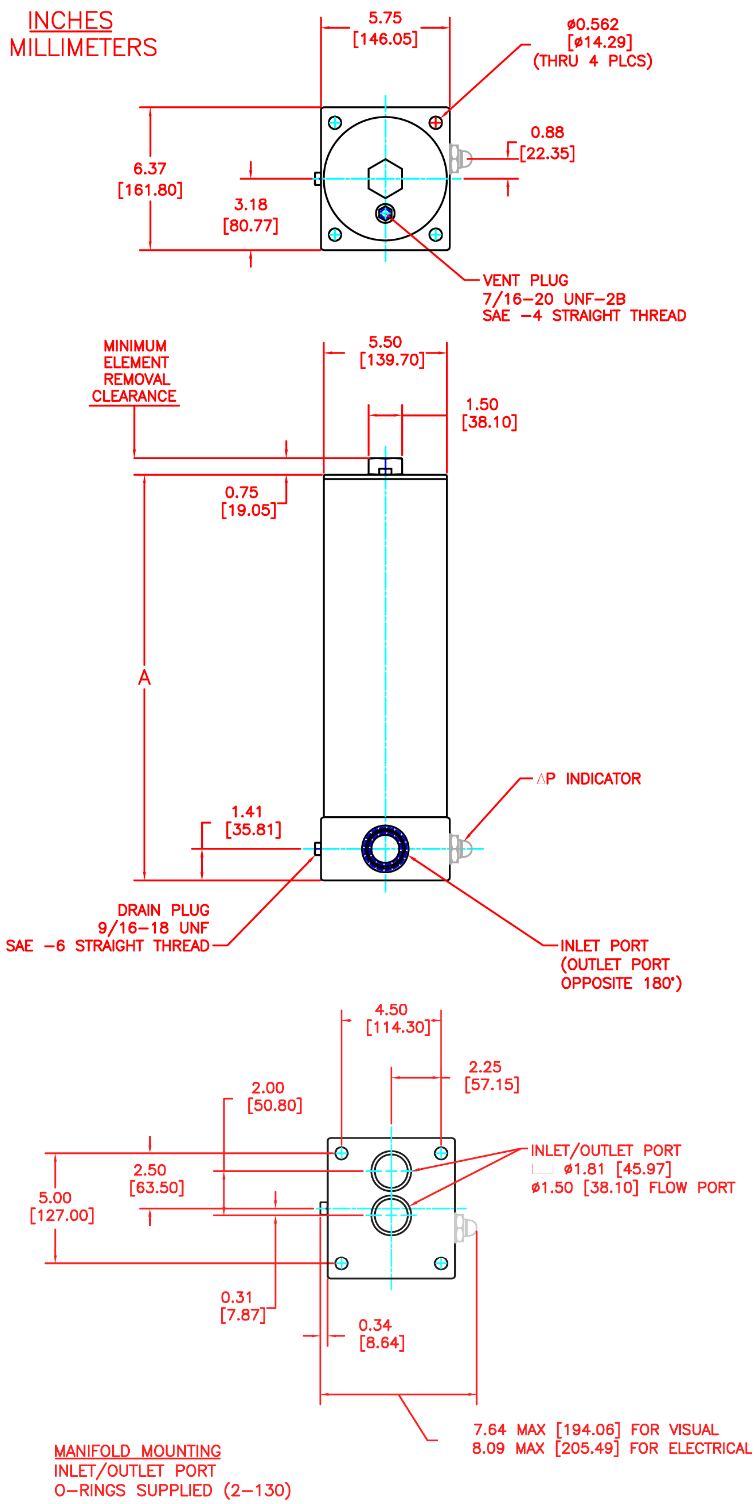
Electrical indicator voltage: 115VAC / 28VDC. Standard electrical connection is Hirschmann 4 pin DIN 43650 denoted by H in Table 7. 5 pin 41512 Harrison connections are available upon request.

ΔP 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 ΔP condition must be inspected while the system is running.

Recommended bypass valve setting / ΔP indicator combinations

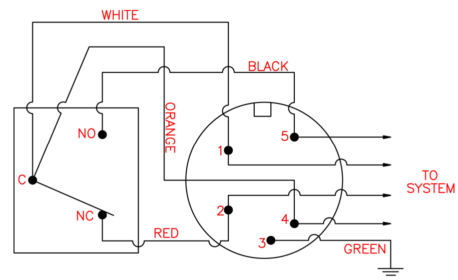
Bypass valve setting (code)	X	5
Recommended Indicator selection	HE, XO	XD, XL, HR

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

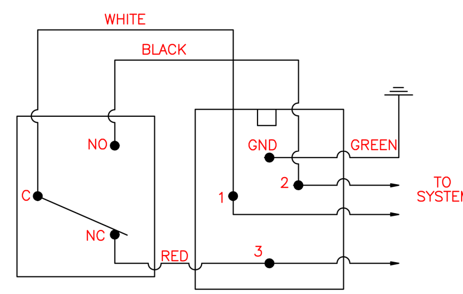


Dimension	L9	L18	L27
A (overall length)	15.31 (389)	24.7 (628)	34.0 (864)
Element removal	9.0 (229)	18.0 (457)	27.0 (686)

Electrical indicator wiring diagrams (Aluminum housing + thermal lockout)

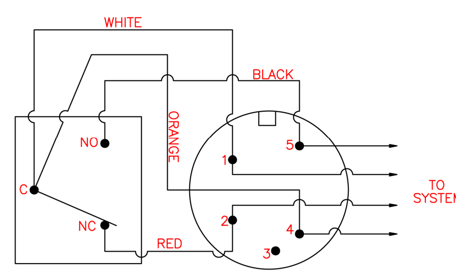


Brad Harrison 5-pin receptacle 41512

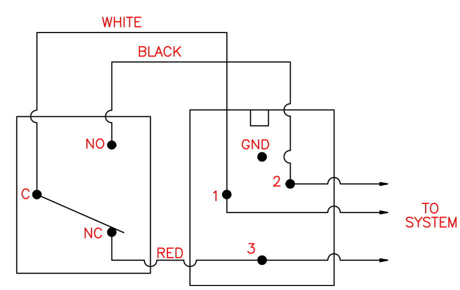


Hirschman 4-pin DIN 43650

Electrical indicator wiring diagrams (Plastic housing NO thermal lockout)



Brad Harrison 5-pin receptacle 41512



Hirschman 4-pin DIN 43650

HY-PRO FILTRATION

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.

- Large cylinders remotely located from valve manifold. Protect both components and clean fluid that typically does not return to the reservoir.
- Steel mills, Board plants, Scrap yards, concrete mixers.
- Any line where flow can reverse direction.
- Hydrostatic loop circuit applications.

PRODUCT FEATURES

DFE rated elements (Dynamic Filter Efficiency)	G8 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.

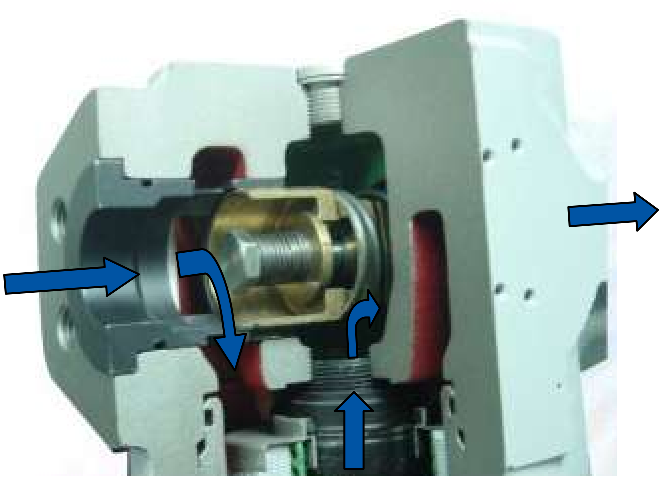
PRODUCT SPECIFICATIONS

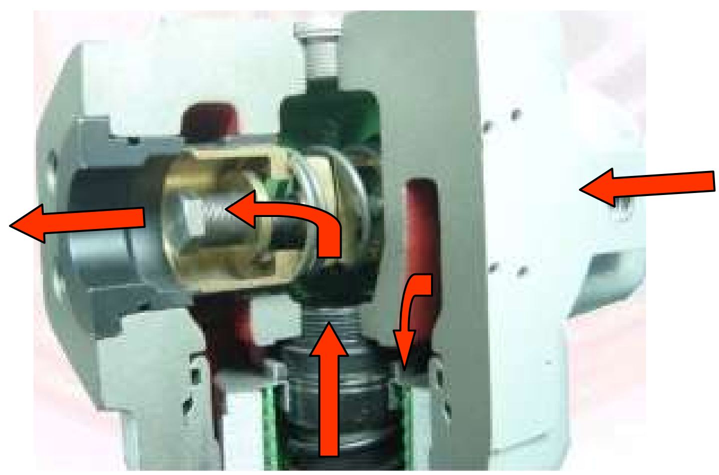
Materials	
Head	Cast steel
Bowl	Extruded steel
Seals	Buna or Viton®
Media options	G8 Dualglass, Stainless mesh
Interior coating	Phosphate coating
Exterior coating	Power paint coated
ISO standards	
ISO 2941	Collapse and burst resistance
ISO 2942	Fabrication and integrity test
ISO 2943	Material compatibility 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 -40°F(-40°C) to 225°F(107°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

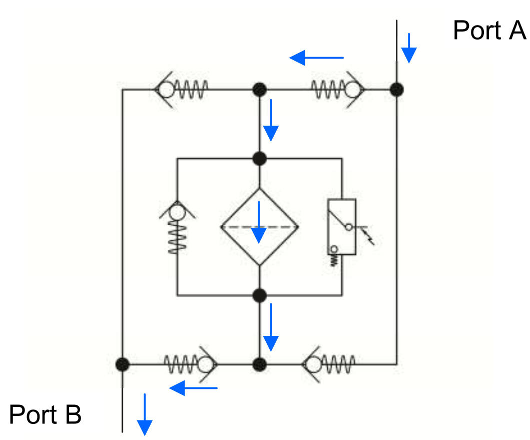
PFHB Series

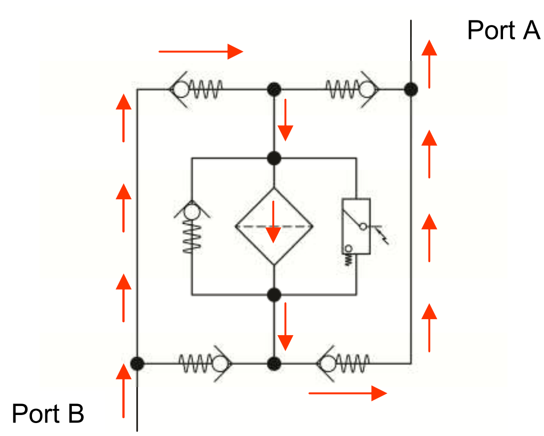
Media Code	Bowl Code Length	Max Flow Rate* gpm (lpm)	Port Size	Assembly Δp Factor* psid / gpm	Max Operating Pressure, Fatigue Rating
3M	~8"	37 (138.7)	SAE-20 1 1/4" Flange Code 62	0.52	**psi (bar)**
6M		42 (157.5)		0.383	6090 psi, 420 bar
10M		50 (187.5)		0.28	10^7 pressure cycles
25M		58 (217.5)		0.185	8700 psi, 615 bar
**W (mesh)		72 (270)		0.119	10^4 pressure cycles
3M	~13"	60 (225)	SAE-24 1 1/2" Flange Code 62	0.42	**psi (bar)**
6M		66 (247.5)		0.308	6090 psi, 420 bar
10M		74 (277.5)		0.175	10^7 pressure cycles
25M		90 (337.5)		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:

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

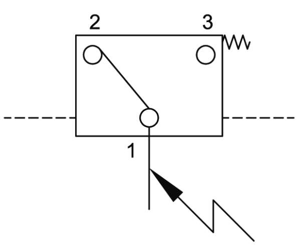
2. Calculate actual clean filter assembly Δp at both operating and cold start viscosity:

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:

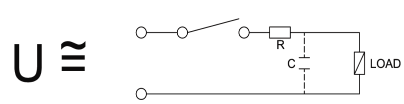
- To avoid or minimize bypass during cold start the actual assembly clean Δp calculation should be repeated for start-up conditions if cold starts are frequent.
- Actual assembly clean Δp should not exceed 15 psid at normal operating viscosity.
- If suitable assembly size is approaching the upper limit 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

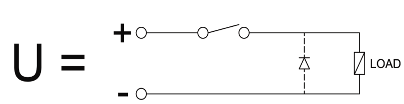


- Indication pressure - 73 psid (5.18 bar)
- Switching voltage - max 120 V AC / 175 V DC
- Switching current - max 0,17 A AC / 0,25 A DC
- Switching power - max 3,5 VA AC / 5 W DC
- Contact type - Change-over
- Electrical protection - IP 65

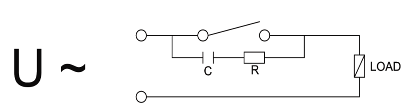
- Current limiter for DC and AC voltage. If loads are connected over long distances a protective resistor should be connected in series in order to limit the current.



- 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.



PFHB FILTER ASSEMBLY PART NUMBER GUIDE

	Table 1	Table 2	Table 3	Table 4	Table 5	Table 6	Table 7	Table 8
PFHB								

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	~9.180"
13	~13.110"

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 -40°F(-40°C) to 225°F(107°C)
V	Viton® -15°F(-26°C) to 275°F(135°C)

Table 6 Code	Bypass Valve
7	102 psid bypass
X*	No bypass

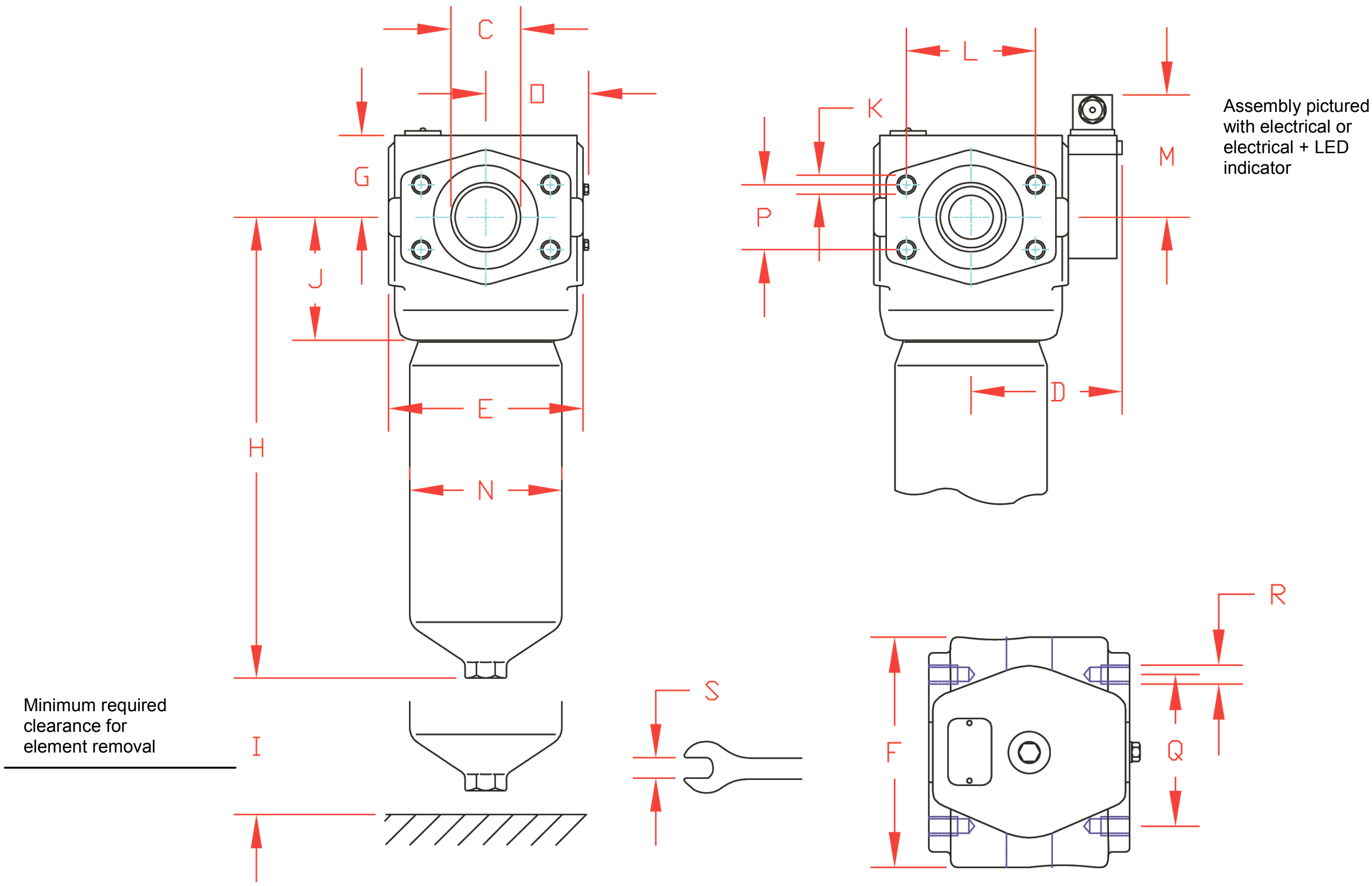
*No bypass "X" option only recommended with "H" element collapse rating (table 2)

Table 7 Code	Δp Indicator
V	Visual, mechanical
E	Electrical
L	Electrical + LED visual
Z	Indicator port plugged

Table 8 Code	Special Options (Not Required)
D	Bowl drain w/plug
N*	Nickel coated for water (deionized, demineralized or river water) applications (call factory)

*Nickel option is standard with drain port in bowl and stainless steel plug.

PFHB INSTALLATION DRAWING AND SPARE PARTS LIST



	PFHB*8 IN (mm)	PFHB*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)

	PFHB*8 lbs (kg)	PFHB*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**	
	~8” Length	PFB4192
	~8” Length w/drain port	PFB4192D
	~13” Length	PFB4193
	~13” Length w/drain port	PFB4193D
4	**Indicator**	
	Visual indicator, Buna seal	PFH840IVB
	Visual, Viton® seal	PFH840IVV
	Electrical, Buna seal	PFH840IEB
	Electrical, Viton® seal	PFH840IEV
	Electrical + LED, Nitrile seal	PFH840ILB
	Electrical + LED, Fluoro seal	PFH840ILV

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 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.

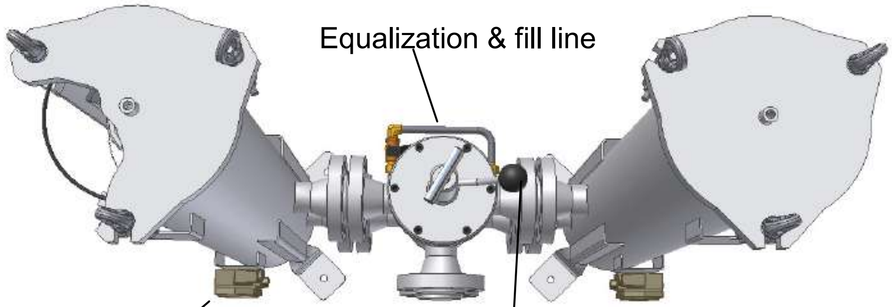
ASME U & UM CODE REQUIREMENTS

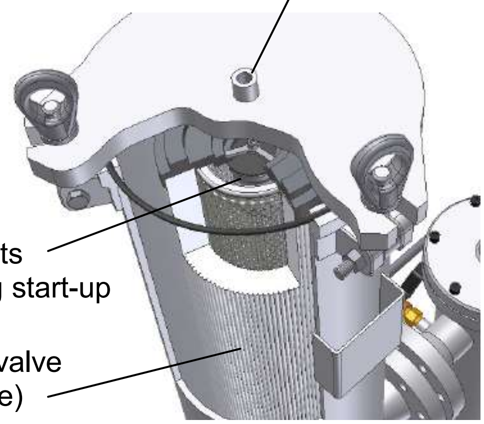
Standard vessels are manufactured to ASME code standards, but not certified. ASME U and UM code certification is available as an option. See table 11 under the duplex assembly housing selection ordering detail.

Top loading housing minimizes mess

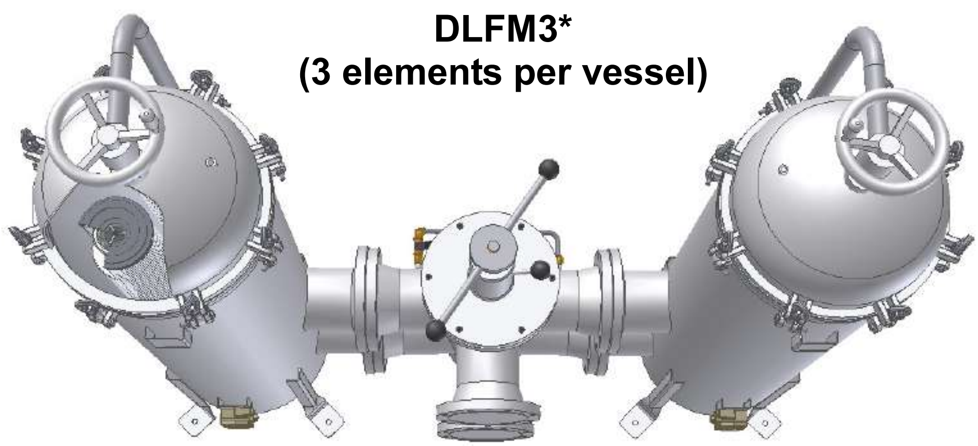
No tools required for cover removal
150psi (10 bar) & 250 psi (17 bar)

DLF* (single element)





DLFM3*
(3 elements per vessel)



HY-PRO FILTRATION

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

	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
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

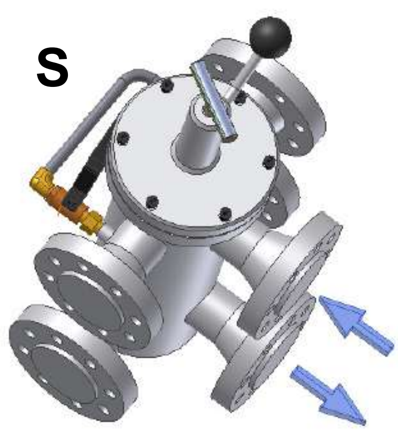
Table 4 Code	Max Operating Pressure
omit	150 psi, 10 bar max ANSI 150#, DIN PN10
V	250 psi, 17 bar max ANSI 300#, DIN PN16
W*	450 psi, 30 bar max

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

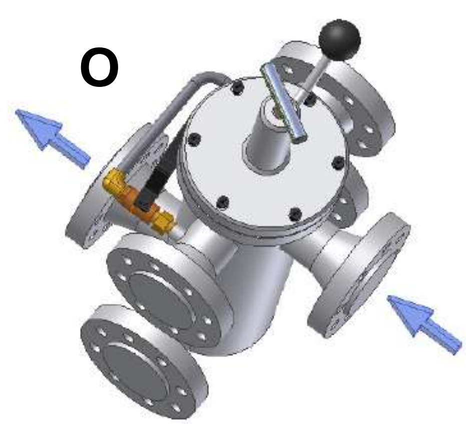
VALVE PORTING OPTIONS (SAME SIDE OR OPPOSITE SIDE)

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.

S



O



HY-PRO FILTRATION

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 6 Code	Element Configuration
5	HP105 coreless series, positive o-ring seals. Recommended change-out 45 psid (3,2 bar) **NON-BYPASS**
6	HP106 element w/integral bypass, 25 psid (1,8 bar) bypass, orings change-out 22 psid (1,5 bar)
7	HP107 element w/ integral 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, **NON-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	$\beta 22_{(c)}$ = 1000 ($\beta 25$ = 200)
25A	$\beta 22_{(c)}$ = 1000 + water removal
25W	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 8 Code	Seals
B	Buna
E-WS	EPR + stainless steel support mesh for Skydrol compatibility
V	Viton®

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 hardware

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

DLFM3

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

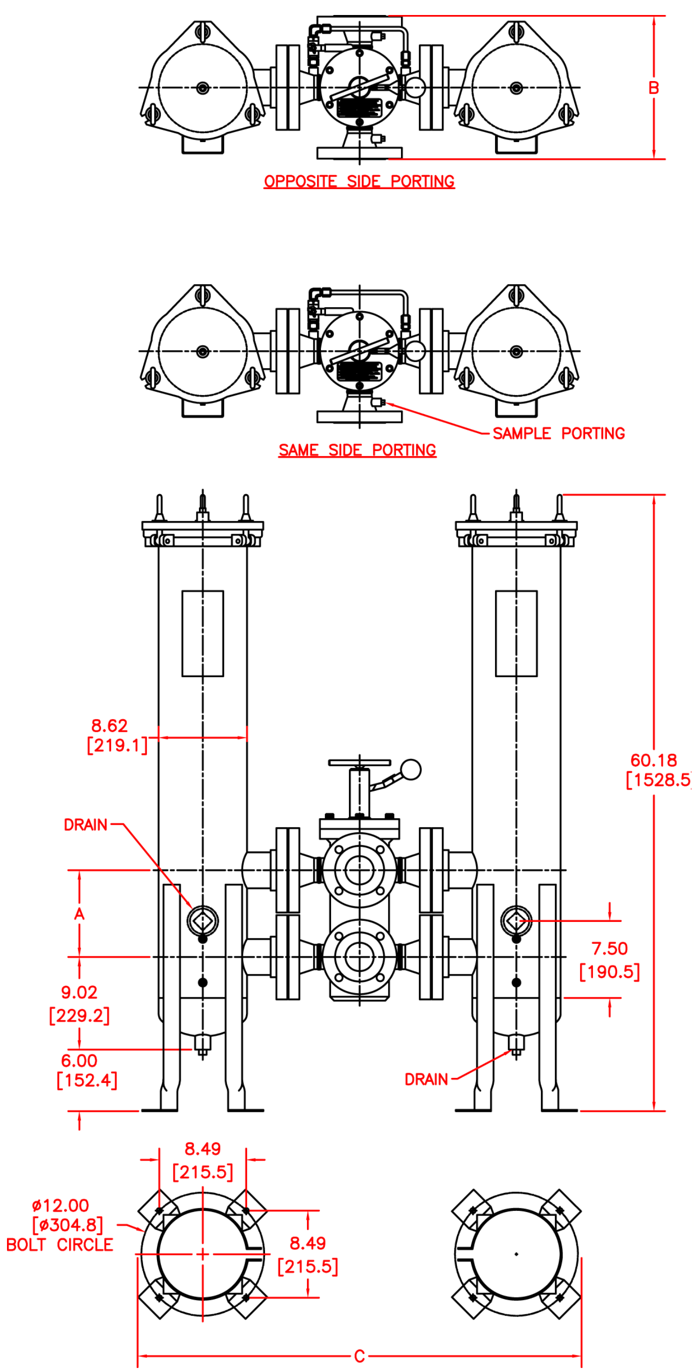
DLFM4

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

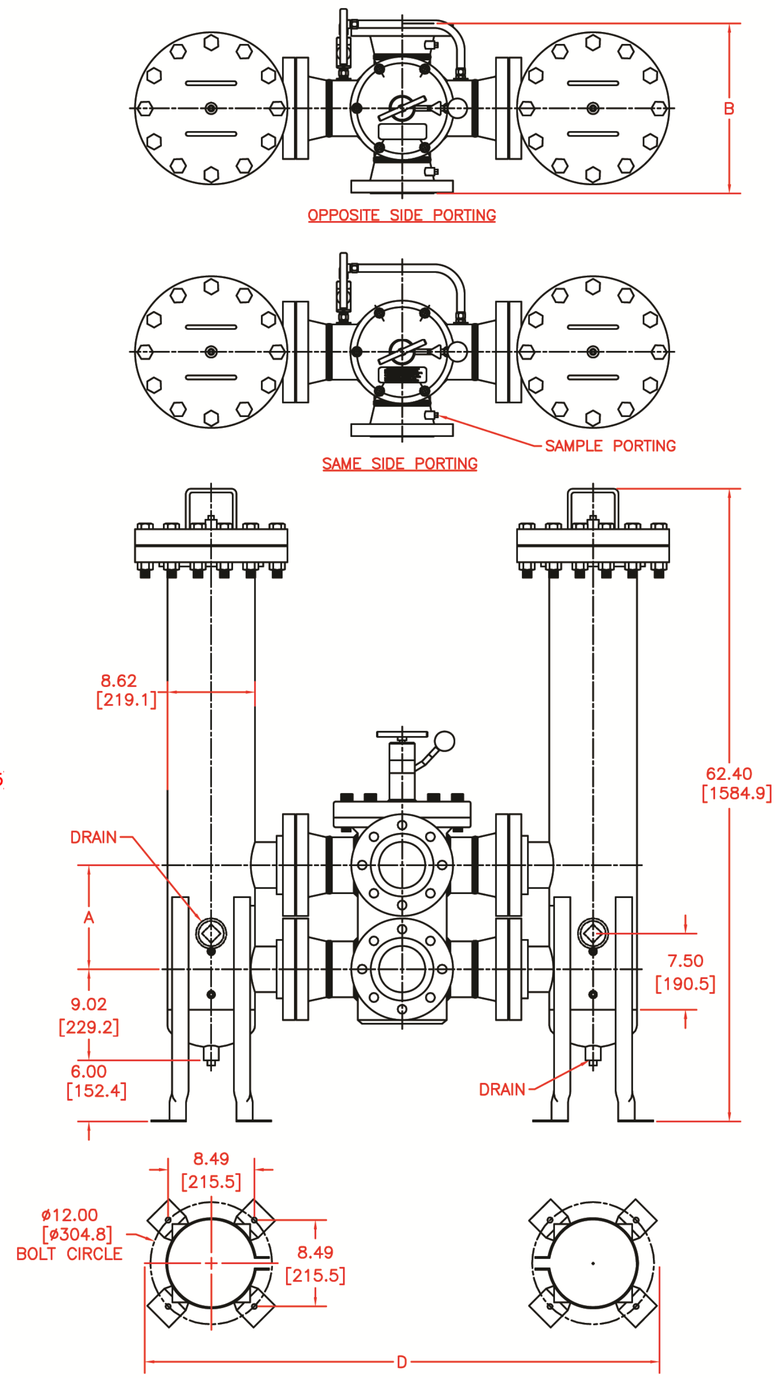
DLFM9

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	0.0034	0.000067
3M		800 (3000)		0.0025	0.000047
6M		1000 (3750)		0.0022	0.000043
10M		1300 (4500)		0.0020	0.000040
16M		1400 (5250)		0.0019	0.000036
25M		1500 (6560)		0.0016	0.000031
**W		1500 (5625)		0.0013	0.000024
1M	36, 39	600 (2250)	6" (DIN 150) Flange	0.0032	0.000061
3M		800 (3000)		0.0022	0.000043
6M		900 (3375)		0.0020	0.000039
10M		1300 (4875)		0.0017	0.000033
16M		1300 (4875)		0.0016	0.000030
25M		1500 (5625)		0.0013	0.000026
**W		1500 (5625)		0.0010	0.000019

DLF - up to 250 PSI (17 BAR)



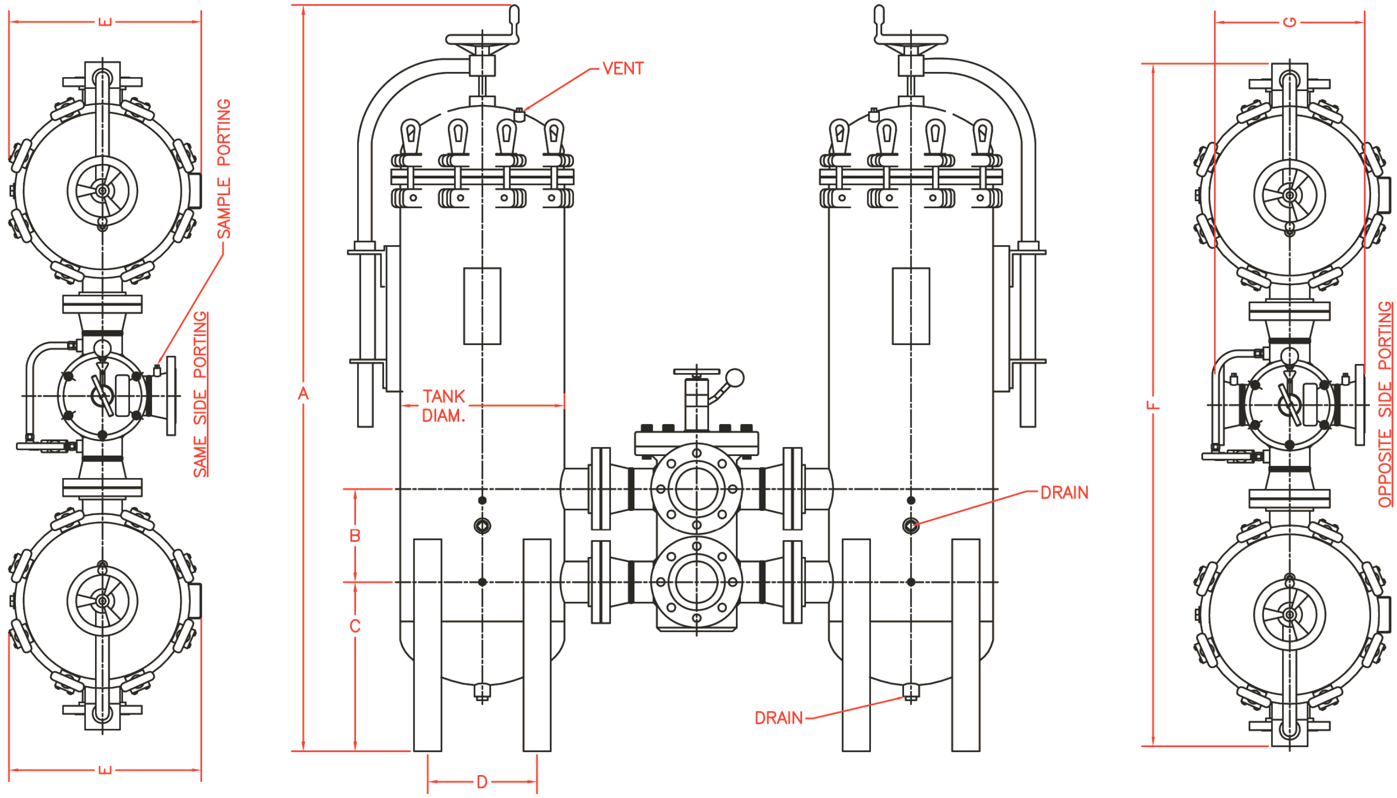
DLF - 450 PSI (30 BAR)



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)

HY-PRO FILTRATION

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)	66.3 (1682.8)	6.8 (171,5)	16.9 (428.6)	11.0 (279.4)	20.5 (520.7)	59.5 (1511.3)	14.0 (355,6)
			3 (150 Lb)	1251 (568)	66.3 (1682.8)	7.8 (196,9)	16.9 (428.6)	11.0 (279.4)	20.5 (520.7)	61.5 (1562.1)	14.0 (355,6)
			3 (300 Lb)	1290 (586)	66.3 (1682.8)	8.5 (215,9)	16.9 (428.6)	11.0 (279.4)	20.5 (520.7)	61.5 (1562.1)	14.0 (355,6)
			4	1344 (611)	66.3 (1682.8)	10.3 (260,4)	16.9 (428.6)	11.0 (279.4)	20.5 (520.7)	68.5 (1739.9)	16.8 (425,5)
DLFM4	4	18	2	1360 (618)	76.7 (1948.2)	6.8 (171,5)	17.3 (439.4)	12.4 (315.0)	22.5 (571.5)	65.5 (1663.7)	14.0 (355,6)
			3 (150 Lb)	1421 (646)	76.7 (1948.2)	7.8 (196,9)	17.3 (439.4)	12.4 (315.0)	22.5 (571.5)	67.5 (1714.5)	14.0 (355,6)
			3 (300 Lb)	1460 (664)	76.7 (1948.2)	8.5 (215,9)	17.3 (439.4)	12.4 (315.0)	22.5 (571.5)	67.5 (1714.5)	14.0 (355,6)
			4	1514 (688)	76.7 (1948.2)	10.3 (260,4)	17.3 (439.4)	12.4 (315.0)	22.5 (571.5)	74.5 (1892.3)	16.8 (425,5)
DLFM9	9	24	3 (150Lb)	1811 (823)	76.7 (1948.2)	7.8 (196,9)	23.8 (604.5)	16.5 (419.1)	29.3 (743,9)	86.3 (2192.0)	14.0 (355,6)
			3 (300 Lb)	1850 (841)	76.7 (1948.2)	8.5 (215,9)	23.8 (604.5)	16.5 (419.1)	29.3 (743,9)	86.3 (2192.0)	14.0 (355,6)
			4	1904 (865)	76.7 (1948.2)	10.3 (260,4)	23.8 (604.5)	16.5 (419.1)	29.3 (743,9)	93.3 (2369.8)	16.8 (425,5)
			6 (150 Lb)	2081 (946)	76.7 (1948.2)	11.5 (292,1)	23.8 (604.5)	16.5 (419.1)	29.3 (743,9)	98.3 (2496.8)	19.8 (501,7)
			6 (300 Lb)	2195 (998)	76.7 (1948.2)	13.0 (330,2)	23.8 (604.5)	16.5 (419.1)	29.6 (751.8)	98.3 (2496.8)	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

*Dimensions provided as reference only.

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	G8 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

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.

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:

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

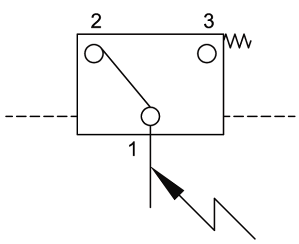
2. Calculate actual clean filter assembly Δp at both operating and cold start viscosity:

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:

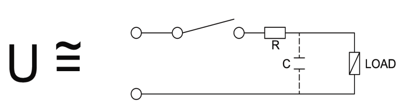
- To avoid or minimize bypass during cold start the actual assembly clean Δp calculation should be repeated for start-up conditions if cold starts are frequent.
- Actual assembly clean Δp should not exceed 15 psid at normal operating viscosity.
- If suitable assembly size is approaching the upper limit 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

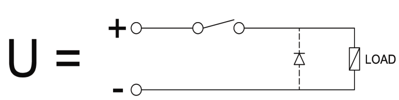


- Indication pressure - 32 psid, 2,2 bar
- Switching voltage - max 230 V ~/=
- Switching current - max 2,5 A
- Switching power - max 3,5 VA AC / 5 W DC
- Contact load - max 60 VA / 40 W
- Inrush current - 70 VA
- Electrical protection - IP 65
- Cable connection - PG11 0 6-10
- Contact type - Bistable

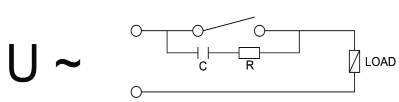
- Current limiter for DC and AC voltage. If loads are connected over long distances a protective resistor should be connected in series in order to limit the current.



- 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.



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

* 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 ∆Bar, 450 ∆PSI.

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)

* Long lead time. Call for availability.

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)

*Expect Long lead time length codes 4, 6, and DFN39N 10 code. Call for availability.

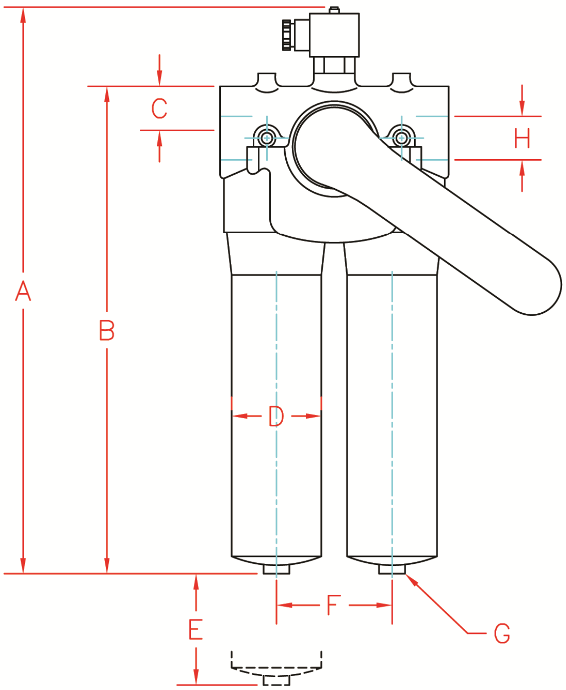
Table 5 Code	∆P Indicator
V	Visual pop-up indicator only (manual reset) Indication: 2.2 bar∆, 32 psi∆
L	Visual indicator with electrical alarm Indication: 2.2 bar∆, 32 psi∆

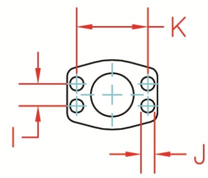
Table 6 Code	Media Selection
1M	$\beta 2.5_{[c]}$ = 1000, $\beta 1$ = 200
3M	$\beta 5_{[c]}$ = 1000, $\beta 3$ = 200
6M	$\beta 7_{[c]}$ = 1000, $\beta 6$ = 200
10M	$\beta 12_{[c]}$ = 1000, $\beta 12$ = 200
25M	$\beta 22_{[c]}$ = 1000, $\beta 25$ = 200
25W	25u nominal mesh media
40W	40u nominal mesh media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

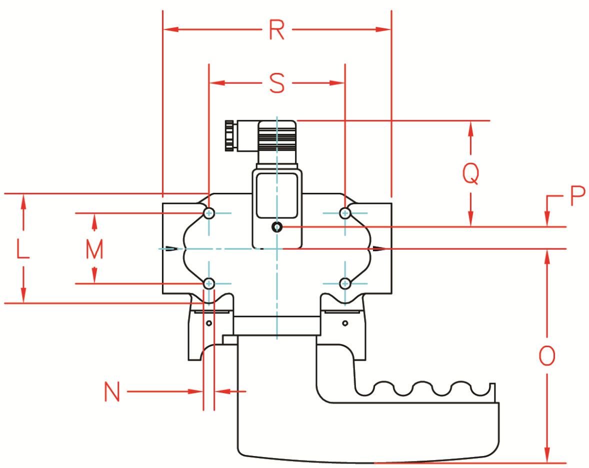
Table 7 Code	Seal Material
B	Buna -40°F(-40°C) to 225°F(120°C)
V	Viton® -15°F(-26°C) to 275°F(135°C)

Viton® is a registered trademark of E. I. du Pont de Nemours and Company or its affiliates.

DFN19N INSTALLATION DRAWING AND SPARE PARTS LIST



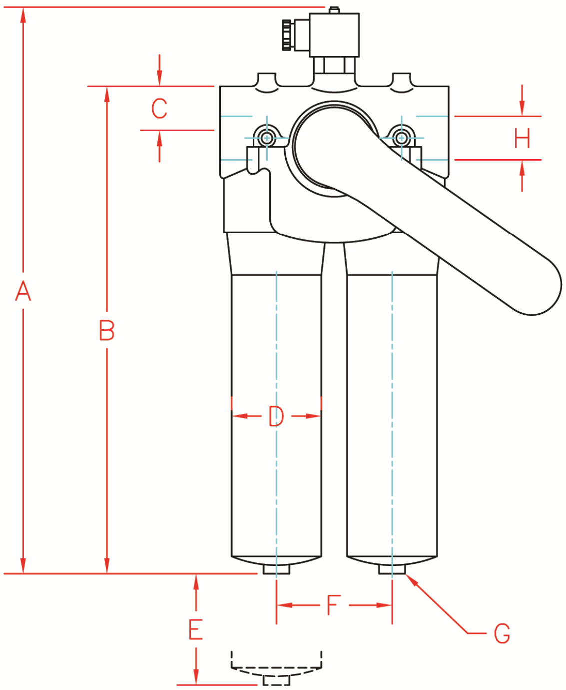


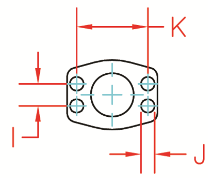


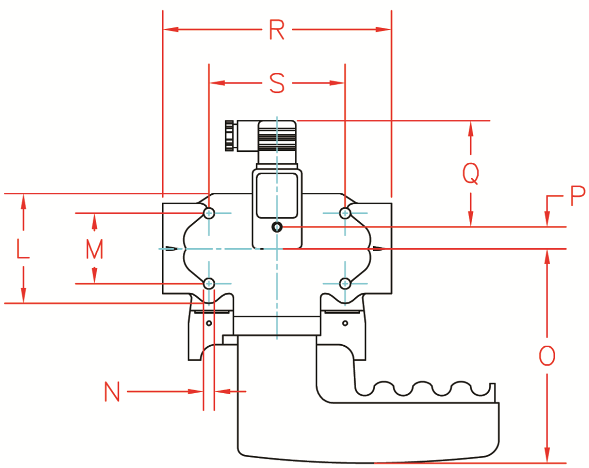
	DFN19N*-* 4 IN (mm)	DFN19*-* 6 IN (mm)	DFN19N*-* 10 IN (mm)
A	10.35 (263)	12.72 (323)	16.38 (416)
B	8.07 (205)	10.43 (265)	14.1 (358)
C	1.50 (38)	1.50 (38)	1.50 (38)
D	2.60 (66)	2.60 (66)	2.60 (66)
E	3.15 (80)	3.15 (80)	3.15 (80)
F	3.34 (85)	3.34 (85)	3.34 (85)
G	SW27	SW27	SW27
H	G1 BSPP or 1" SAE Flange 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

HY-PRO FILTRATION





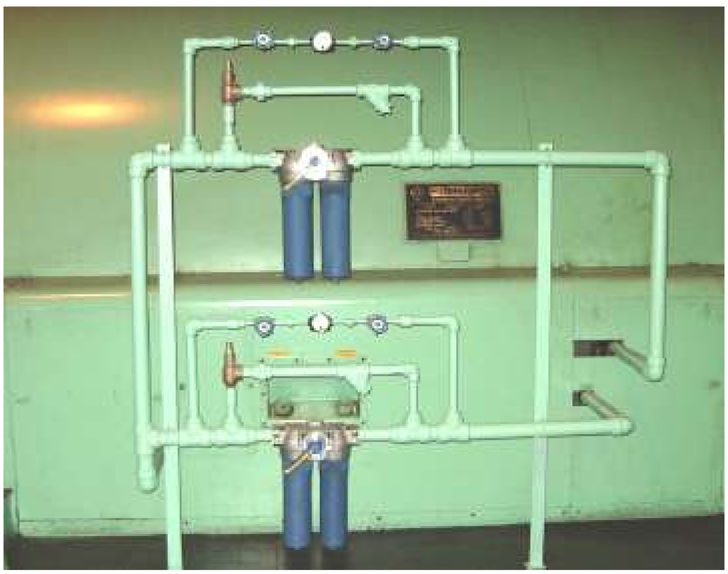


	DFN39N*-* 6 IN (mm)	DFN39N*-* 10 IN (mm)	DFN39N*-* 15 IN (mm)
A	13.74 (349)	17.48 (444)	23.15 (588)
B	11.45 (291)	15.20 (386)	20.87 (530)
C	1.58 (40)	1.58 (40)	1.58 (40)
D	4.29 (109)	4.29 (109)	4.29 (109)
E	4.33 (110)	4.33 (110)	4.33 (110)
F	5.51 (140)	5.51 (140)	5.51 (140)
G	SW32	SW32	SW32
H	G1 1/2” 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 6	DFN39B6
	Double length code 10	DFN39B10
	Triple length code 15	DFN39B15

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 ∆p 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 ∆p 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 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

PRODUCT SPECIFICATIONS

Materials	
Head	Steel
Bowl	Forged Steel
Seals	Nitrile (buna) or Fluoro (Viton®)
Media options	G8 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

HY-PRO FILTRATION

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	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	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	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.

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 ∆p coefficient at both operating and cold start viscosity:

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

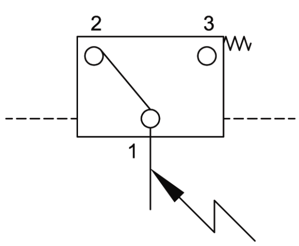
2. Calculate actual clean filter assembly ∆p at both operating and cold start viscosity:

Actual assembly clean ∆p = Flow rate x ∆p Coefficient x Assembly ∆p 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 ∆p calculation should be repeated for start-up conditions if cold starts are frequent.
- Actual assembly clean ∆p 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 ∆p 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 (i.e. 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.

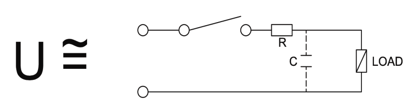
ELECTRICAL + LED, ELECTRICAL DIFFERENTIAL PRESSURE INDICATOR INFORMATION



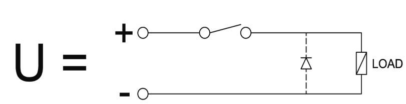
- Indication pressure - 32 psid, 2,2 bar
- Switching voltage - max 230 V ~/=
- Switching current - max 2,5 A
- Switching power - max 3,5 VA AC / 5 W DC
- Contact load - max 60 VA / 40 W
- Inrush current - 70 VA

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

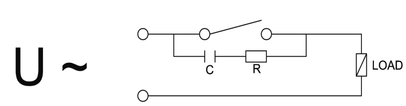
- Current limiter for DC and AC voltage. If loads are connected over long distances a protective resistor should be connected in series in order to limit the current.



- 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.



DFH FILTER ASSEMBLY PART NUMBER GUIDE

	Table 1	Table 2		Table 3	Table 4	Table 5	Table 6	Table 7
DFH			-					

DFH 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**
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)

* Long lead time port codes B1 and B2. Call for availability.

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)

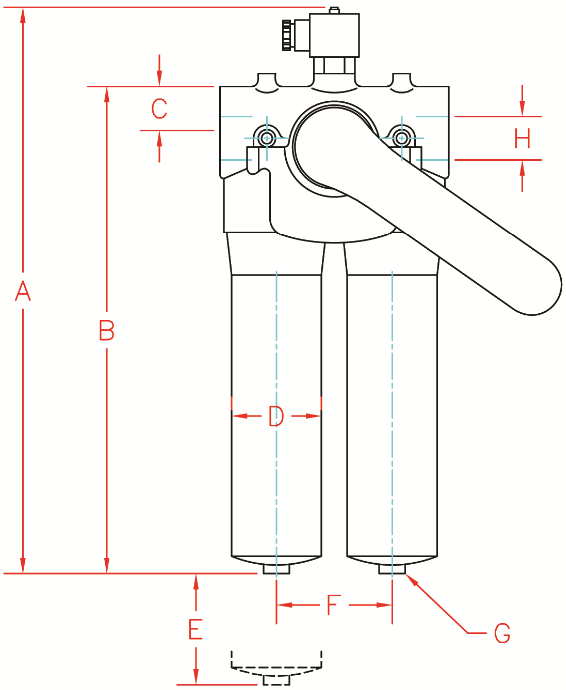
*Expect Long lead time length codes 4, 6, and DFN39H 10 code. Call for availability.

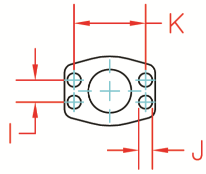
Table 5 Code	**ΔP Indicator**
V	Visual pop-up indicator only (manual reset) Indication: 5 barΔ, 72 psiΔ
L	Visual indicator with electrical alarm Indication: 5 barΔ, 72 psiΔ

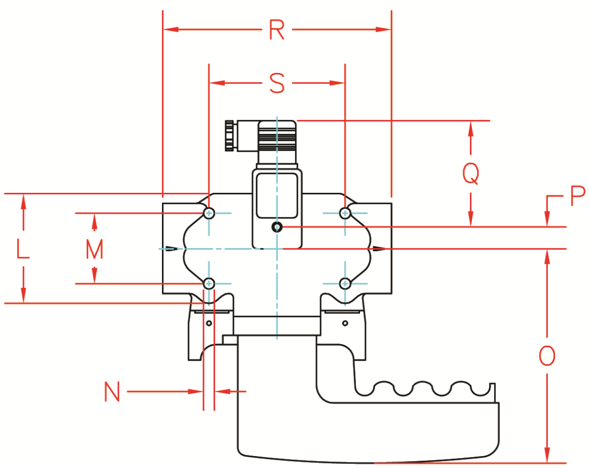
Table 6 Code	**Media Selection**
1M	$\beta 2.5_{[c]} = 1000$, $\beta 1 = 200$
3M	$\beta 5_{[c]} = 1000$, $\beta 3 = 200$
6M	$\beta 7_{[c]} = 1000$, $\beta 6 = 200$
10M	$\beta 12_{[c]} = 1000$, $\beta 12 = 200$
25M	$\beta 22_{[c]} = 1000$, $\beta 25 = 200$
25W	25u nominal mesh media
40W	40u nominal mesh 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



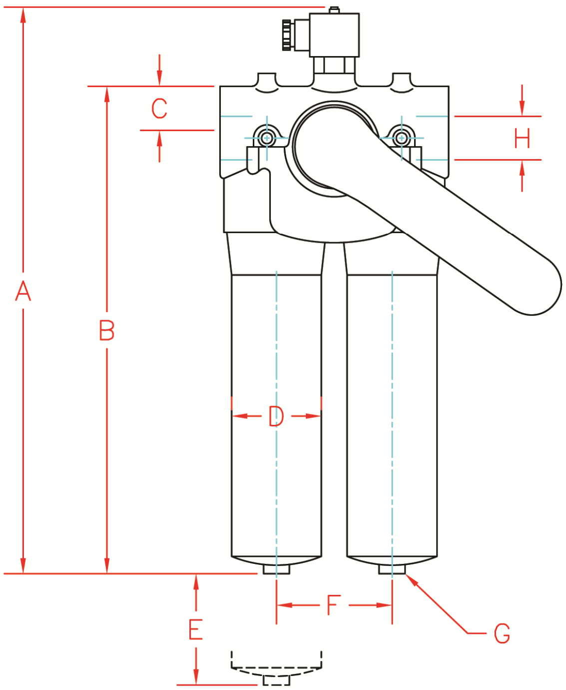


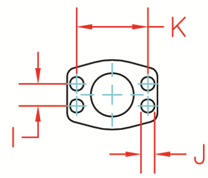


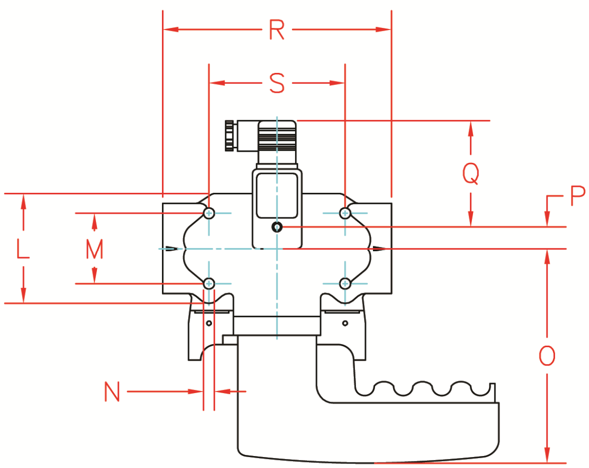
	DFH19**-* 4 IN (mm)	DFH19**-* 6 IN (mm)	DFH19**-* 10 IN (mm)
A	10.35 (263)	12.72 (323)	16.38 (416)
B	8.07 (205)	10.43 (265)	14.1 (358)
C	1.50 (38)	1.50 (38)	1.50 (38)
D	2.60 (66)	2.60 (66)	2.60 (66)
E	3.15 (80)	3.15 (80)	3.15 (80)
F	3.34 (85)	3.34 (85)	3.34 (85)
G	SW27	SW27	SW27
H	G1 BSPP or 1” SAE Flange 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	33 Lbs (15 kg)	35 Lbs (15,9 kg)	38 Lbs (17,2 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	82 Lbs (37,2 kg)	84 Lbs (38,1 kg)	103 Lbs (46,7 kg)

1	**Element (see Element number guide)**	**p/n**
2	**Seal Kit**	
	Nitrile NBR	DFH39SKB
	Fluorocarbon	DFH39SKV
3	**Replacement Bowl Kits**	
	Single length code 6	DFH39B6
	Double length code 10	DFH39B10
	Triple length code 15	DFH39B15

HY-PRO FILTRATION

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.

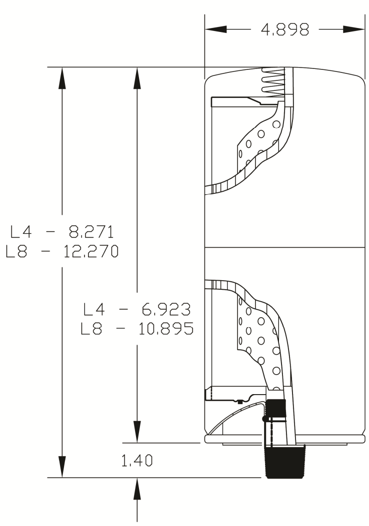
PRODUCT SPECIFICATIONS

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)

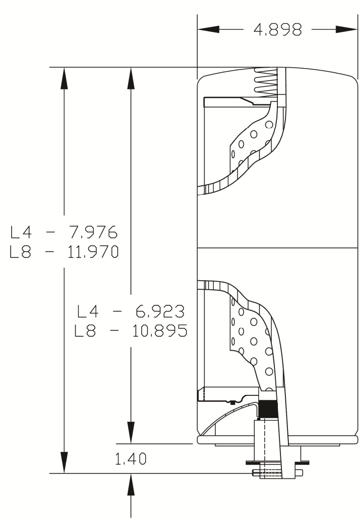
SPIN-ON BREATHER APPLICATIONS

- 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.

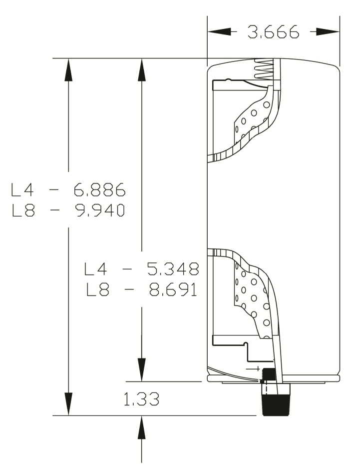
SPIN-ON BREATHER + ADAPTOR ASSEMBLY INSTALLATION DRAWINGS



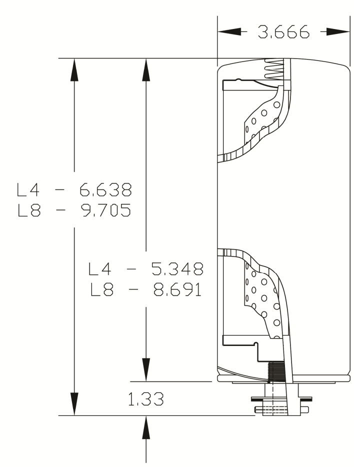
HP75L* -** + ADTB-75



HP75L*-** + ADBB-75



HP76L*-** + ADTB-76



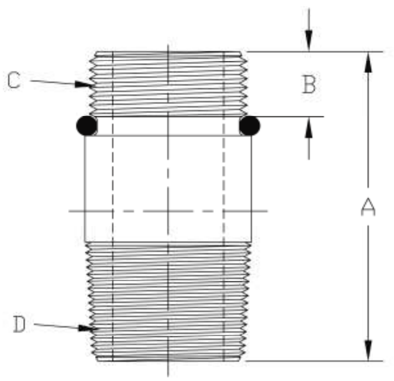
HP76L*-** + ADBB-76

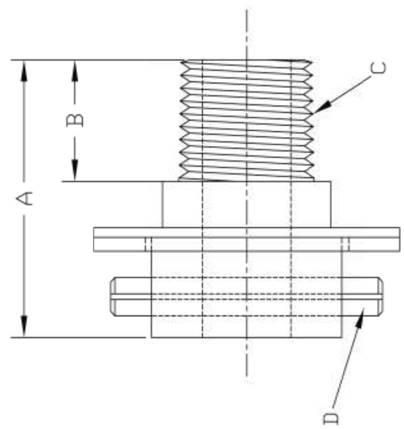
HY-PRO
FILTRATION

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

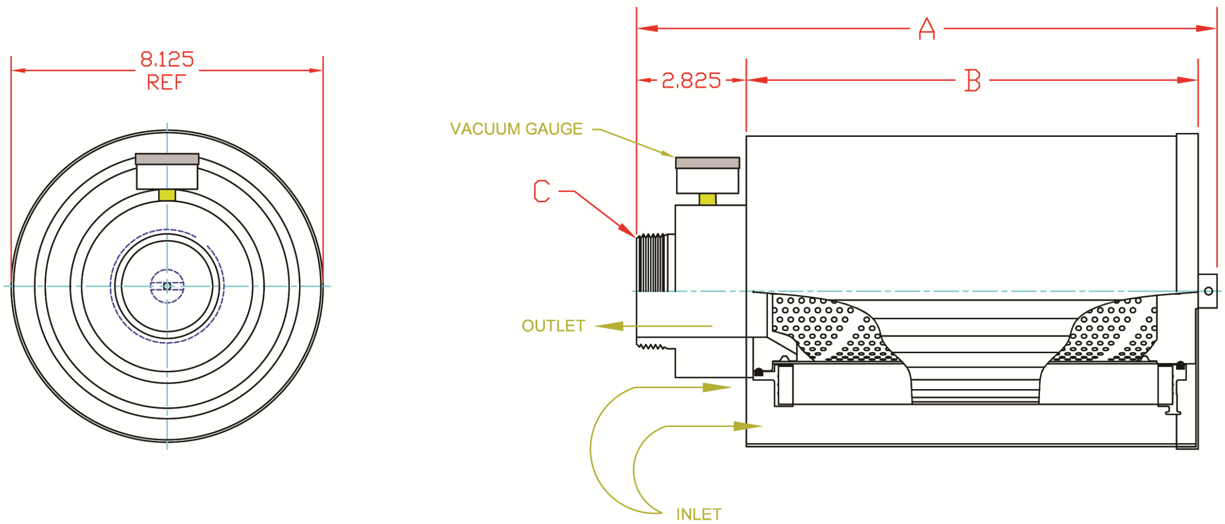
Construction Materials	Tube assembly & Shroud: Plated steel Element: Synthetic end-caps, handle (element will incinerate at 1100°F)
Filtration Efficiency	Media code -3M: 0.3µ absolute Media code-6M: 0.6µ absolute Media code-10M: 1.0µ absolute Media code-25M: 2.5µ absolute
Weight	BF25*11, BF30*11 23.5 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
N15	15.95 (406)	NA	11.64 (296)	NA	1.5" Male NPT

BF BREATHER ASSEMBLY PART NUMBER GUIDE

Table 1 | Table 2 | Table 3 | Table 4

BF [Table 1] [Table 2] - [Table 3] [Table 4] G

REPLACEMENT FILTER ELEMENT PART NUMBER GUIDE

Table 2 | Table 3 | Table 4

HPBF30L [Table 2] - [Table 3] [Table 4]

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
N15	1.5" Male NPT

Table 2 Code	Element Length
11	Single length
17	Double length

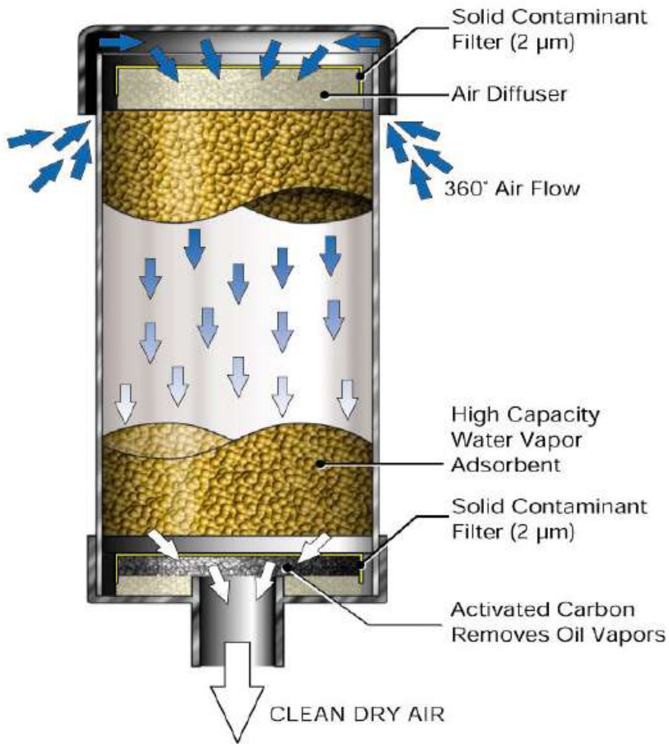
Table 3 Code	Filtration Rating	Media Type
3M	0.3μ absolute	G8 Dualglass
6M	0.6μ absolute	G8 Dualglass
10M	1.0μ absolute	G8 Dualglass
25M	2.5μ absolute	G8 Dualglass

Table 4 Code	Seal Material
B	Nitrile-Buna
V	Fluorocarbon-Viton®

Viton® is a registered trademark of E. I. du Pont de Nemours and Company or its affiliates.

+Contact factory for availability.
Longer lead time.

HY-PRO FILTRATION



Hy-Dry Breathers

Disposable Air Purifying Breathers

- Fluid contamination is the root cause of most hydraulic system failures.
- Controlling airborne contamination is critical.
- Combine Hy-Dry Breathers with Hy-Pro Filter Elements for complete fluid conditioning.

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)

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-103	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	

HY-PRO FILTRATION

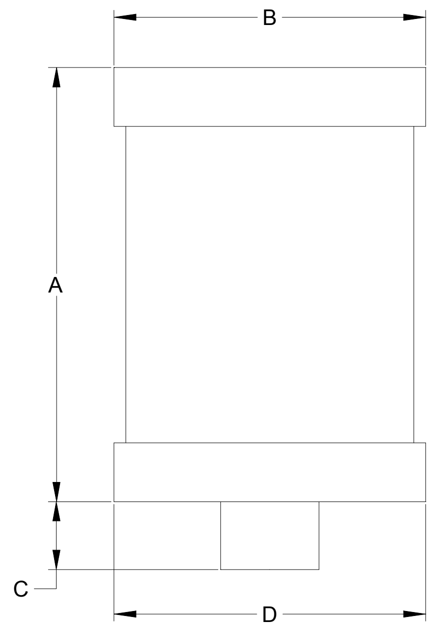
HY-DRY DISPOSAL CARTRIDGE ORDER GUIDE

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-103	8.0" (20,5cm)	5.0" (12,8cm)	1.25" (3,2cm)	5.0" (12,8cm)	3.3lb (1.5kg)	35	262	1" MNPT
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	1" MNPT
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

*scd 40 is slip-on connection (No Threads)

C SERIES BREATHERS HIGH HUMIDITY APPLICATIONS

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.

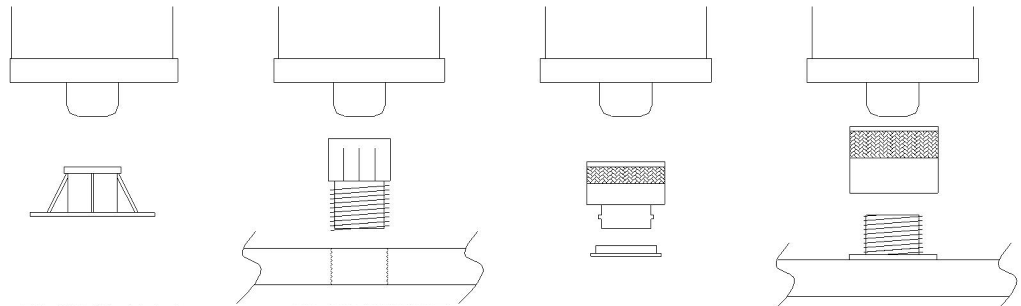


Hy-Dry Number	Check valve psi (bar)	A	B	C	Replacement Element	Weight	CFM (gpm,lpm)	Hy-Dry Stem
HPBC-101	0.3 (0,02) IN 2.1 (0,15) OUT	5.0" (12,8cm)	5.0" (12,8cm)	1.25" (3,2cm)	HPB-341	0.8lb (1,7kg)	35 (262,990)	1" schd 40*
HPBC-102	0.3 (0,02) IN 2.1 (0,15) OUT	8.0" (20cm)	5.0" (12,8cm)	1.25" (3,2cm)	HPB-342	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

RESERVOIR ADAPTORS

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

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)

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.

HPB-103

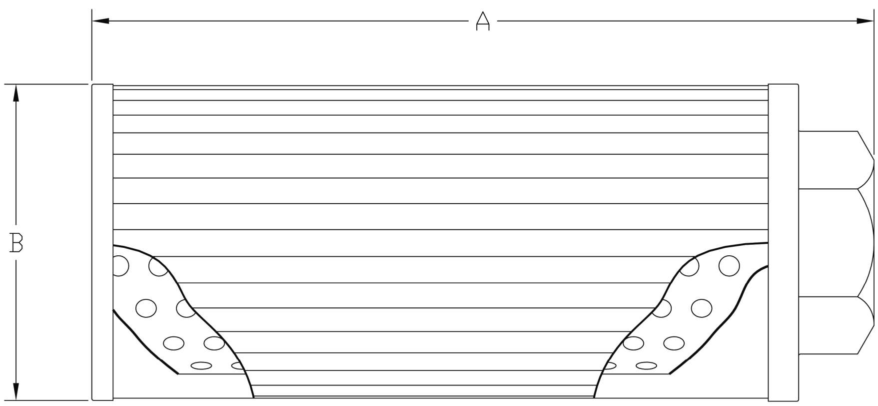
HPBR-102 FOR MOBILE AND HEAVY DUTY APPLICATIONS

*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 by special request only.
- 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

Table 1 Table 2 Table 3 Table 4

__ __ - 100 - __

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
100	**100 mesh (149μ nominal)**
-	-

Table 4 Code	Bypass Valve Setting
Omit	No Bypass
B3	**3 psid Bypass**

HY-PRO

FILTRATION

Application Tools

HY-PRO FILTRATION

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

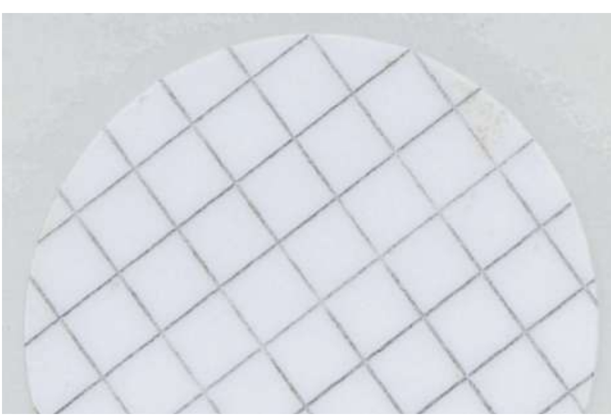
Monitoring fluid cleanliness in hydraulic and lubrication systems is a common practice. When the pressure is on waiting weeks for bottle samples from an independent lab might not be an option. Oil analysis practices vary from lab to lab and once the sample is shipped off you no longer have control of the sample or how it is processed.

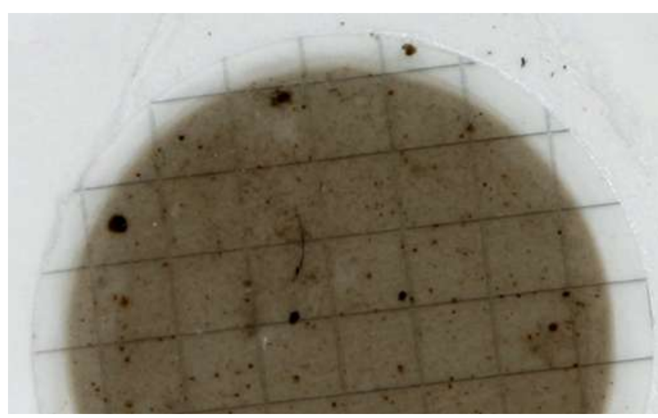
See The Difference, Control The Process

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

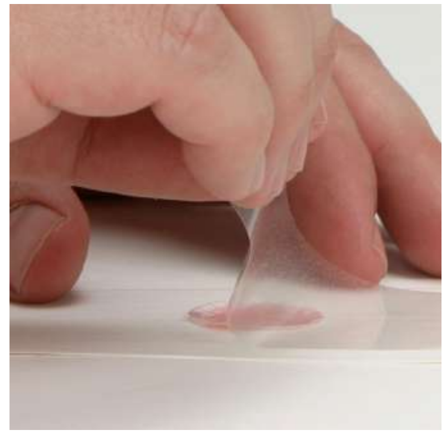




HY-PRO FILTRATION

Draw the sample fluid through the patch by pulling on the vacuum pump handle. Confirm that the waste bottle and funnel-patch assembly are sealed.

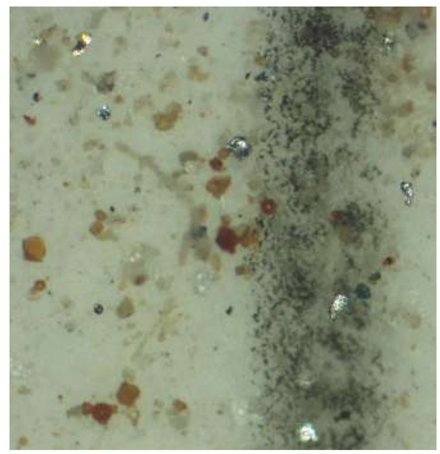
Once the entire sample has passed through the patch rinse the funnel with filtered solvent and draw through the patch. Then separate the funnel from the patch supporter and remove



Place the sample (ink/dirty side up) on a clean index card and cover it immediately with a plastic laminate patch cover.

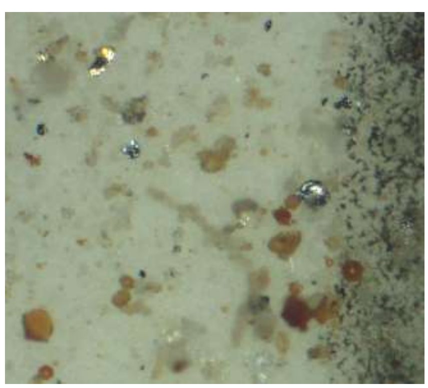
Analyze the sample with the 100x magnification field microscope. For best results in might be necessary to hold the light source closer to the sample

Analyze the sample with the 100x magnification field microscope. For best results hold the light source closer to the sample



Use the reference manual photos to make approximate ISO code correlation and identify contaminant types.

Bright metal particle typically from internal contaminant generation.



Combination bright metal, silica, rust, gel and fiber materials.

Rust or gel

HY-PRO FILTRATION

Varnish Test Kits

Membrane Patch Colorimetric test kits for lube oil varnish potential (MPC ΔE) per ASTM D02.C0.01 WK13070

Monitor & trend varnish potential on-site

Portable field kit or permanent site lab kits available for varnish potential testing.

Reference manual includes details on sample patch preparation, spectrometer operation, sample result interpretation and varnish solutions.

Lube Oil Varnish

Turbine lube oil is susceptible to fluid degradation from oxidation and thermal degradation leading to varnish deposit formation. Condition monitoring is critical in staying ahead of lube oil degradation issues and the Membrane Patch Colorimetric (MPC) testing method is one of the key pieces in predicting potential varnish problems before unit trip or fail to start conditions occur.

New Oil Formulations (Group I vs Group II)

Group I base stocks are giving way to group II based turbine lube oils with greater antioxidant response and thermal stability. One compromise with group II base stocks is lower solubility which can lead to more rapid varnish deposit formation. That's one more reason that monitoring varnish potential is reliability critical.

Varnish Potential Patch Test Kits

Include everything you need to properly prepare a filter patch and analyze it for varnish potential on site.

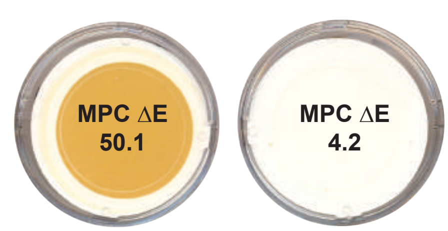
MPC ΔE Condition Scale

Normal	Monitor	Abnormal	Critical
<15	15-29	30-40	>40

The Proven Lube Oil Varnish Solution To Make Varnish Vanish

When combustion turbines fall casualty to unit trip or fail-to-start conditions, lube oil varnish is the usual suspect! The **SVR (Soluble Varnish Removal)** system featuring **ICB (ION Charge Bonding)** element technology attacks the root cause of varnish deposit formation by removing the by-products of oxidation while they are still in solution (dissolved). By removing the soluble (dissolved) oxidation by-products SVR takes away the feedstock for varnish deposit formation to stop varnish before it stops you!

Hy-Pro **NSD (Non-Spark) Filter Elements** prevent fluid thermal degradation related to element sparking and extend the life of anti-oxidant additive packages. NSD elements are available for all lube and hydraulic control applications in a variety of micron ratings.



Note: After drawing sample allow fluid to sit for 7 days prior to testing to prevent an artificially low MPC value.

VARNISH TEST KIT ORDER GUIDE & SPECIFICATIONS

V [Table 1 Model] **TK-** [Table 2 Options]

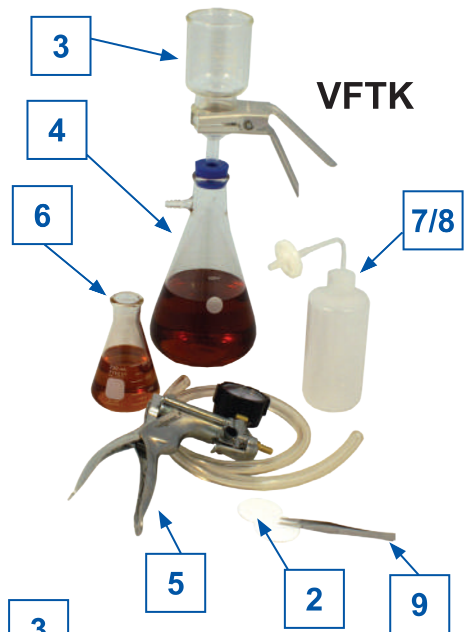
Table 1 Code	Model
F	Field test kit with hand vacuum pump and multi-use / disposable filter patch funnel assembly
L	Lab test kit with electrical piston type vacuum pump and glass filter patch funnel assembly

Table 2 Code	Special Options
E1	220 VAC 1P 50Hz vacuum pump electrical (VLTK only)
X	Excludes spectrometer to obtain sample patch MPC ∆E value

WHAT'S INCLUDED?

Item	VFTK Spare Parts Description	Qty
1	Spectrometer calibrated for MPC ∆E	1
2	Membrane filter patches (disposable) box of 100	1
3	Glass filter funnel / filter holder top assembly	3
4	Glass filter funnel flask + vacuum pump tube port	1
5	Hand operated vacuum pump (with tubing)	1
6	Glass mixing flask (sample oil & solvent) 150 ml	1
7	Solvent dispenser with cap and squirt nozzle	1
8	Solvent dispenser syringe filter	3
9	Forceps (metal tipped)	1
10	Instruction, reference and solutions manual	1

*filter funnels (item 3) for VFTK are multi-use for mineral based oils. If used on phosphate ester they are only suitable for a single sample or concurrent batch samples (discard after batch). Base is polystyrene and not compatible for extended exposure to phosphate ester fluids.



Item	VLTK Spare Parts Description	Qty
1	Spectrometer calibrated for MPC ∆E	1
2	Membrane filter patches (disposable) box of 100	1
3	Glass filter funnel / filter holder top assembly	1
4	Glass filter funnel flask + vacuum pump tube port	1
5	Bench piston vacuum pump VLTK is 120 VAC 1P 60Hz VLTK-E1 is 220 VAC 1P 50Hz	1
6	Glass mixing flask (sample oil & solvent) 150 ml	1
7	Solvent dispenser with cap and squirt nozzle	1
8	Solvent dispenser syringe filter	3
9	Forceps (metal tipped)	1
10	Instruction, reference and solutions manual	1

PM-1 Particle Monitor

Install on hydraulic & lube oil systems to monitor ISO Fluid Cleanliness Code

Eliminate bottle & dirty sampling port error with on-line particle monitoring

Ideal for dedicated in-line installations

Optional case & hose kit for field use

Large illuminated ISO Code display

Specifications

Display	ISO Cleanliness Code (per ISO4406:1999) particle counts 4, 6, 14, 21 µm[c], SAE AS4059
Voltage	9 - 33 V
Operating Pressure	Up to 6,090 PSI / 420 BAR Dynamic
Protection Class	IP67
Flow rate	50 - 500 ml/min (require for operation)
Electric Connection	M12 x 1 (8 Pole)
Data memory	On-board 4MB storage capacity
Fluid Compatibility	Mineral oils and specified synthetics (phosphate ester by special option only)
Temperature Range	Oil: 14°F / -10°C to +176°F / 80°C Air: 14°F / -10°C to +140°F / 60°C (Storage: -4°F / -20°C to +176°F / 80°C)
Interface	RS-232, Analog output 4-20 mA configurable, Digitaler digital alarm output, Digital input to start and stop readings

Be Proactive Monitor Contamination

PM-1 allows you to recognize contamination level changes in hydraulic and lube oil systems. Monitoring on-line provides quick results and eliminates delay, error or potential doubt associated with bottle samples & oil analysis lab results.

Increasing ISO codes can indicate accelerated component or bearing wear, or symptomatic of some other issue such as insufficient filtration or breathers & worn seals.

Communication & Data Acquisition

PM-1 exports data to serial interface or optionally to a CAN-Bus (CANopen). In parallel, the configurable 4-20 mA interface can be connected. PM-1 operation based on time interval or start/stop with manual or digital input. PM-1 also has integrated data memory.

PM-1 Principle of Operation

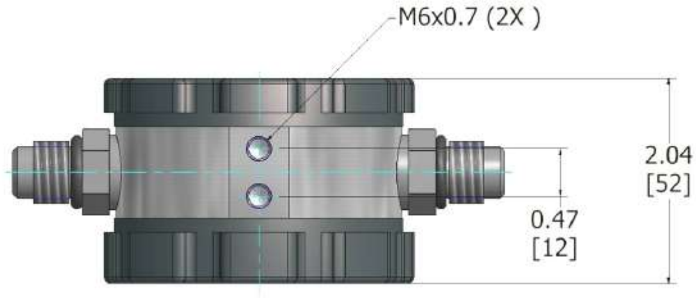
PM-1 uses a laser to measure particle sizes and quantity by light extinction. A measuring cell is used to calculate corresponding voltage drop from the particles passing through the PM-1.

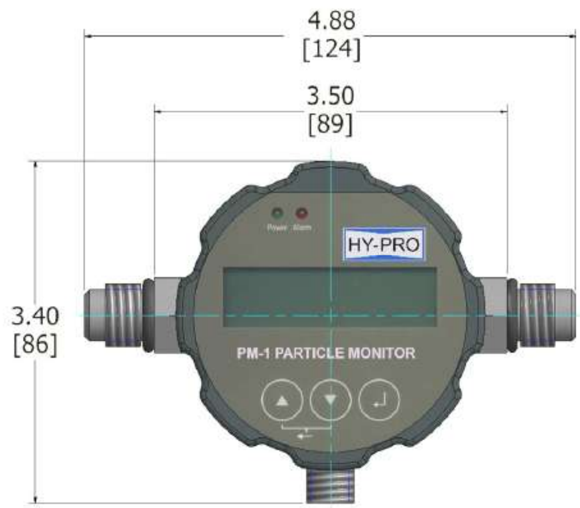
Pressure Range

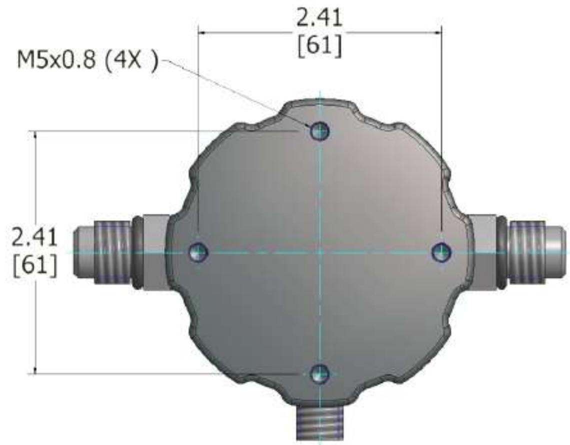
PM-1 is designed for operating pressure up to 6,090 PSI / 420 BAR. For lower pressure lube oil systems alternative inlet & outlet fittings are available if the Minimess® standard connections are too restrictive.

Minimess is a registered trademark of Hydrotechnik GMBH.

PM-1 DIMENSIONS & INSTALLATION DRAWING







ORDERING INFORMATION

Part Number	Description
PM-1	PM-1 particle monitor
*PM-1-PWRSUP-60	PM-1 electrical power supply for portable use (120vAC 1P 60Hz to 24 vDC)
*PM-1-PWRSUP-50	PM-1 electrical power supply for portable use (120vAC 1P 50Hz to 24 vDC)
PM-1-PWRCAB	PM-1 9-33 V power cable with M-12 x 1 (8 pole) connection 15 Feet / 5 Meter (power cable plus 1 x 8 pole connection for PM-1)
PM-1-HKIT-60	Portability kit for PM-1 (includes pelican case, sampling hoses for high pressure Minimess & low pressure lube application adapters, outlet line flow control attachment, PM-1-PWRSUP-60 power supply (60Hz power) and PM-1-DAT data/ power adapter.
PM-1-HKIT-50	Portability kit for PM-1 (includes pelican case, sampling hoses for high pressure Minimess & low pressure lube application adapters, outlet line flow control attachment, PM-1-PWRSUP-50 power supply (50Hz power) and PM-1-DAT data/ power adapter.
PM-1-BR	PM-1 back mounting bracket with rubber vibration suppression
PM-1-USB	USB adapter - RS232 serial
*PM-1-DAT	Data cable with open ends (5m length)
PM-1-FITLOW	Low pressure lube system fittings to replace standard Minimess® inlet & outlet connections. Suitable for low pressure systems (< 29 PSI / 2 BAR) where achieving minimum flow index 50000 reading (50ml/min) is not possible.

*For PM-1 portable counting you must purchase the PM-1-DAT **AND** either the PM-1-PWRSUP-60 (for 60Hz) or the PM-1-PWRSUP-50 (50 Hz) to power the unit. The unit cannot be powered just with the PM-1-PWRSUP-50 or -60. The PM-1-DAT allows for connection to RS232 data port for data acquisition and download.

OA-PATLKF (Replaces OA-1)

Bottle Sample Oil Analysis Kits

ISO4406:1999 particle count (4/6/14)

Spectroscopy, FTIR, Wear Metals

AN (acid number) mg KOH/g

Water Content by KF (ppm)

Hy-Pro qualified objective lab results

Prepaid tests in 10 pack cartons

Benefits of Fluid Monitoring

Fluid conditioning monitoring is critical for making proper condition based contamination solution recommendations. With a complete snapshot of the fluid condition from oil analysis Hy-Pro can help diagnose any problems caused by contamination or fluid degradation and craft a solution to yield optimum system reliability and yield maximum useful fluid life.

When used in a routine sampling program the OA1 oil analysis kit results provide all the information needed to trend changes in fluid condition and identify types of contamination to catch component or fluid problems before they result in unplanned downtime or premature fluid replacement.

Sampling Procedure Requirements

- Sample must be representative of the system
- Sample should be taken during system operation
- Fluid should be at operating temperature
- Sampling method must not introduce contamination
- Only use sampling bottles pre-cleaned per ISO3722

Obtaining Representative Sample

For oil analysis data to be most effective the sample must be acquired properly so that it is representative of the fluid that is going to sensitive bearings hydraulic components. Select a position of maximum turbulence and constant flow.

- If general system cleanliness is required, sample from a main flow line upstream of a filter or from an active reservoir
- If the cleanliness of the fluid entering a sensitive component is required, sample in a main flow line upstream of the component
- Identify best sample port location and type
- Completely purge sample port
- Rinse sample bottle 3 times with oil from sample port oil before collecting the sample
- Develop a procedure to ensure consistency
- Sample port must be properly flushed to prevent introduction of background contamination

Testing, interpretation, fluid reliability strategies from the experts who know oil!

TESTOIL
INDUSTRIAL ANALYSIS

Machine Condition: **MARGINAL**
Lubricant Condition: **NORMAL**
Techno Drill

Analysis Report

Lube Type: CASTROL Gun Drill Oil 2190
Machine MFG: UNKNOWN
Machine MOD:
MachineType: Unknown
Problems: *** HIGH IRON.

Received:
Report:
Sample No:
Analyst:

ATTN:

Customer Notes: *

Elevated wear metals may indicate accelerated machine wear. Inspect unit for abnormal noise, vibration and high temperature.

	Reference	9/19/2011
Lab No		757064
Oil Chng / Mach / Lube		N / M / N
SPECTROSCOPIC ANALYSIS (ppm) ASTM D 5185		
Iron		584
Copper		0
Lead		0
Aluminum		0
Tin		0
Nickel		0
Chromium		1
Titanium		0
Vanadium		0
Silver		0
Silicon		1
Boron		2
Calcium		85
Magnesium		0
Phosphorus		0
Zinc		9
Barium		0
Molybdenum		0
Sodium		0
Potassium		3
VISCOSITY (centistokes) ASTM D 445		
Vis 40		12.7
FTIR SPECTROSCOPY (indexing numbers) JOAP Method		
Anti Wear		14
Nitration		2
Other Fluid		57
Oxidation		58
PARTICLE COUNT (particles per ml) ISO 4406:99		
ISO Code		17/ 16/ 12
>4 Micron		1281
>6 Micron		498
>14 Micron		38
>50 Micron		1
>100 Micron		0
SINGLE COMPONENT TESTS		
Acid # mg KOH/g		2.36
Water %		0.039

Machine Condition: **MARGINAL**
Lubricant Condition: **NORMAL**
Techno Drill

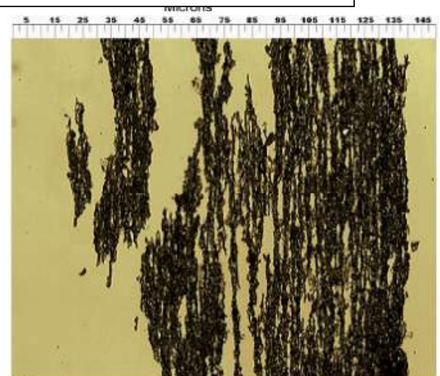
Received:
Report:
Sample No:
Analyst:

ATTN:

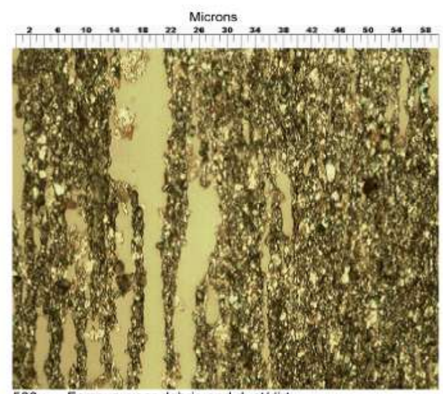
Wear Particle Analysis Report

Moderate	Heavy	Max. Size	Particle Composition
		5-15	Ferrous,White Non-Ferrous

les for this sample.



200x Ferrous wear debris and dust/dirt.



500x Ferrous wear debris and dust/dirt.

Tests Included	Description
Metals	Spetroscopic Analysis (ppm) per ASTM D 5185
Viscosity	Centistokes per ASTM D 445
FTIR	Spetroscopy (index number) JOAP
Particle Count	ISO 4406:99 (particles per ml)
Acid Number	Reported in mg KOH/g
Water in oil	Reported ppm by KF
Wear Metals	Detected size range & composition
Ferrous Metals	200x & 500x magnified photos & ferrous metal composition

HY-PRO FILTRATION

OA-TO & OA-MPC Kits

Turbine Oil Analysis; MPC only for trending varnish potential monthly & a deeper analysis for periodic monitoring

- MPC (membrane patch Colourimetry)
- MPC patch weight (mg)
- RULER (remaining anti-oxidant level)
- ICP spectrometric element analysis ppm
- Water Content by KF (ppm)
- ISO4406:1999 particle count (4/6/14)
- AN (acid number)

MPC (membrane patch colourimetry)

ASTM developed standard for quantifying the amount of oil degradation byproducts in the oil that can lead to the formation of varnish deposits. We recommend monitoring MPC monthly on older fluids that may depleted anti-oxidant additive levels and quarterly for newer fluids.

RULER (Remaining Useful Life Evaluation Routine, trending anti-oxidant levels)

Newer generation group II based turbine oils typically have an anti-oxidant (AO) additives made up of sacrificial amines and / or phenols that are depleted as oxidation and oil degradation occurs. The RULER test compares remaining levels of anti-oxidant additive versus the levels found in new oil.

This is a critical piece of periodic turbine oil condition monitoring because once anti-oxidant additive levels drop below 20% of new varnish deposit formation will increase at a much more rapid rate yielding unit trip and fail-to-start conditions. We recommend RULER testing annually for newer fluids and twice annually for aged fluids that might have 50% of new anti-oxidant levels.

SVR (Soluble Varnish Removal) Stops Varnish Before it Stops You!

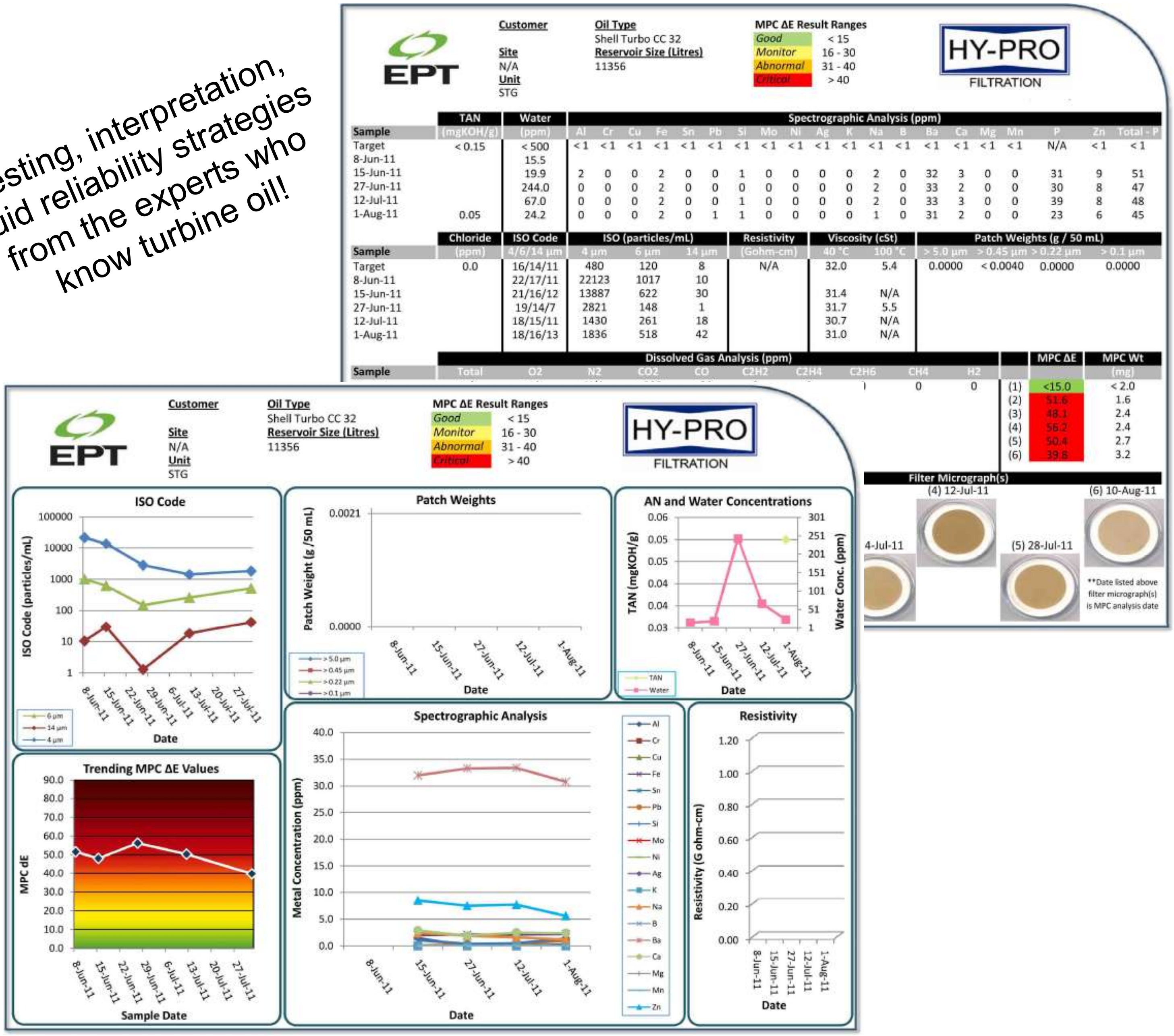
Turbine lube oil varnish has manifested into a problem for operators of combustion and steam turbines with the change to Group II base stock oils (reduced solubility). The issue is especially prolific in CTs that cycle frequently and utilize a combined reservoir for lube and hydraulic oil.

The SVR removes the polar oxides (free radicals) that are the molecular building blocks of varnish deposit formation. The SVR is unique for it removes the polar oxides while they are still dissolved in the oil (in solution) preventing deposit formation that occurs in unprotected turbine hydraulic & lube oil systems when oil temperature drops.

Systems with extensive varnish deposits can be restored to a varnish free condition by installing the SVR1200 for steam or combustion lube oil reservoirs. Varnish deposit formation is a chemical process that can be reversed by fitting the SVR1200 to the lube oil reservoir. No more varnish related unit trips or fail-to-start conditions!

Users of the SVR1200 have also experienced an extension of the AO additive package life. Remaining AO levels are an important factor in the formula to determine when the oil must be changed. Extending the life of the AO additives equates to an overall extension of the useful oil life.

Testing, interpretation, fluid reliability strategies from the experts who know turbine oil!



Part Number	Test Description
OA-MPC601311	**Mineral oil / Turbine oil MPC varnish potential test ONLY** MPC colourimetry patch test and photop per ASTM D02.C0.01 WK13070, recommended monthly to varnish potential & ICB element condition (sample form &100 ml fluid sample bottle included).
OA-TO601368	**Mineral oil / Turbine oil full analysis** package Includes: TAN, metals analysis ppm, Water % KF, Viscosity 40C, MPC varnish potential, MPC patch weight, ISO particle count, RULER. Recommended bi-annually for overall lube oil condition (sample form & 250 ml fluid sample bottle included).

HY-PRO FILTRATION

VAC-U-Dry Application Questionnaire

From	To	Date

System Questions

Oil Volume	Liters	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 Temperature				
Low Temperature				
Utility Services Available	Electrical	Volts	Hz	Amps
	Process	Yes/No		Temp
General Environment	Dry/wet/dust etc			
Unit - Mobile or Fixed in Position			Negative / Positive Head?	
Plant Application	EG. Turbine/Paper Mach			

Information & Respond

Reply Required	in Days

CUSTOMER OBJECTIVES

CONTACT INFORMATION	
Company Address	
NAME	POSITION
Tel No	
Email	
Fax	

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/Tradename:		ISO VG:
	Viscosity cTs:	Viscosity SUS:	S.G:
	Emulsion mix:	Water content (PPM)	

Operating Temperature Range	FROM: ℉	TO: ° F
	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

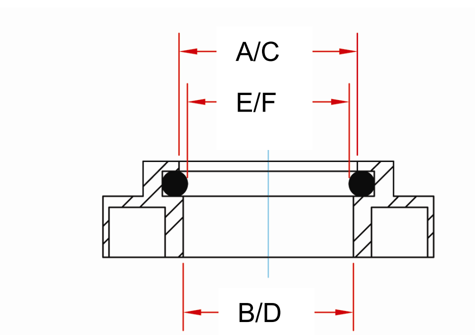
Mounting Arrangement (bowl down, top loading, etc)	
Port Configuration (in-line 180°, 90°, dual inlet, etc)	
Other Requirements (Duplex, Reverse flow, Bi-Directional, etc)	
Space Restrictions (overhead)	
Quantity and Required Delivery	
Notes:	

HY-PRO FILTRATION

Non-Standard Filter Element Worksheet

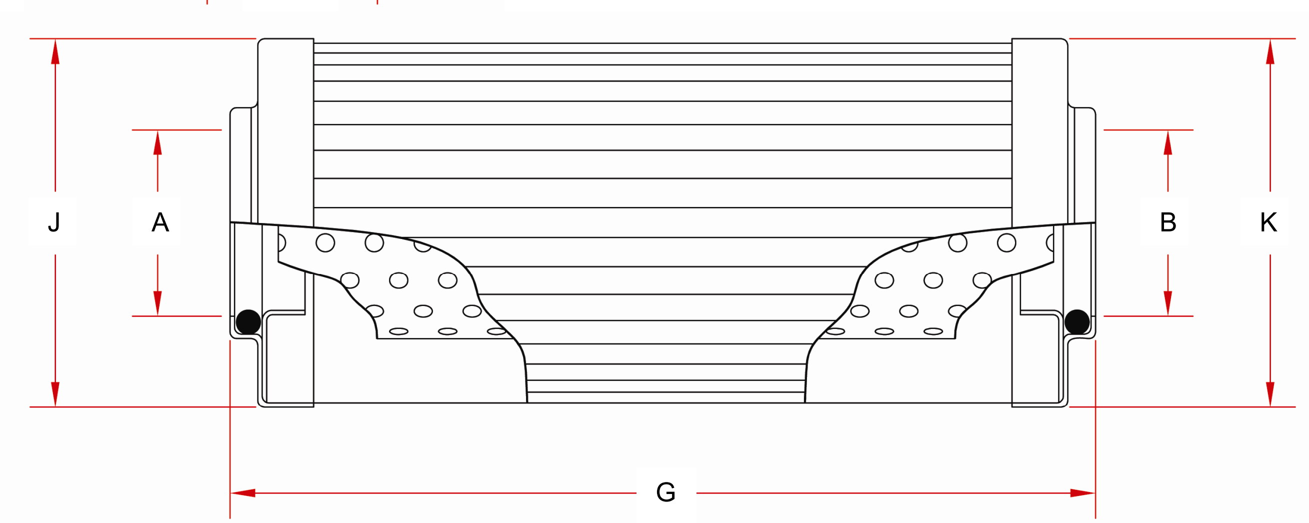
NAME		**Company**		
Phone		**Email**		
Part No.		**Element OEM**		
Element Style*	(select from grid pg2)	**Quantity required**		
End cap material	(plated steel, stainless steel, plastic molded)			
Support tube	(no-coreless, inner only, outer only, inner + outer)			
Bypass valve	(yes/no)	**Bypass setting**	(psid/bar)	
Media type	(cellulose, poly, glass, wire mesh, stainless fiber)			
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, 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



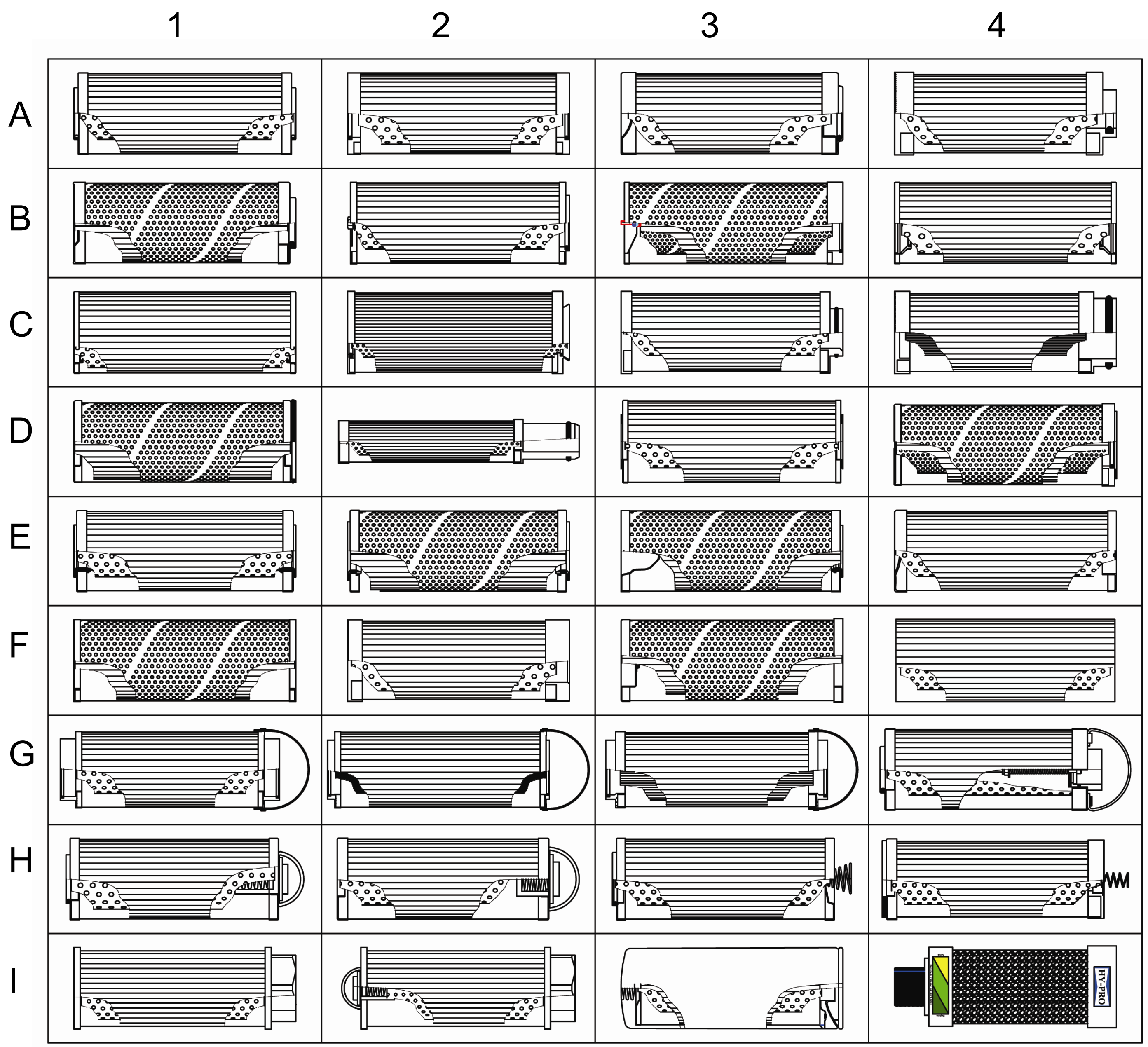
Dimension boxes H, I, L have been left blank for use in a sketch or other features that need to be added to the drawing. When measuring for dimensions E and F (o-ring touch-off) be sure that the o-ring is still installed and that the caliper blade makes only very light contact with the o-ring. Do not 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.



HY-PRO FILTRATION

Non-Standard Filter Element Worksheet



HY-PRO
FILTRATION

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.

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
1704 64th Ave Suite B
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 deter mine 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 re pair 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.

HY-PRO FILTRATION

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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