Cleaner Fluids for More Efficient Systems
**Hydraulic Filtration Product Families:**

- **Hydraulic & Lubrication Systems**
- **Hydraulic & Lubrication Filters**
- **Condition Monitoring**
- **Hydraulic Filter Accessories**

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**Hydraulic System Cleanliness**

Cleanliness is the measure of solid and liquid contamination found in hydraulic systems. Contamination is defined as any substance not part of a hydraulic system’s working fluid.

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**The Importance of Cleanliness**

- Provides maximum efficient productivity
- Improves control of spare parts through preventive maintenance and monitoring
- Reduces equipment downtime through scheduled inspections
- Minimizes safety hazards and prevents contamination-related failure
- Increases the life expectancy of system components, which both increases operating profitability and decreases maintenance costs
- Reduces repair costs and system downtime

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**The Occurrence of Contamination**

There are three principal means through which contamination can occur in a typical hydraulic system. It can be:

- Incorporated during system assembly
- Generated during system operation
- Ingested by the system during operation

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**Eaton Filtration Services**

- State-of-the-art testing lab facilities
- Equipment rentals
- Field service—inspections, field trials, start-up, repair, replacement, and maintenance
- Extensive network of sales/service representatives
- Worldwide technical support
- Product specialists dedicated to providing application engineering

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**Eaton Sustainability Commitment**

Eaton is unwavering in our commitment to being sustainable by design—in the way we operate, through the design of our products, and through the energy and climate saving benefits our products deliver. Eaton issues a Sustainability Report as part of its Annual Report, available on www.eaton.com.
**Interpor Fleece (VG) Glass Fiber**

**Features:**
- Deep filtration
- High particle holding capacity
- Best micron rating at high $\Delta p$
- Usable for mineral oils, emulsions, and for most synthetic hydraulic fluids and lubrication oils
- Filter fineness based on filtration quotient $\beta_{x,\Delta p} \approx 200$:
  + $4 \mu m(c)$, $5 \mu m(c)$, $7 \mu m(c)$, $10 \mu m(c)$, $15 \mu m(c)$, and $20 \mu m(c)$

**Paper Matting (P)**

**Features:**
- Deep filtration
- Constructed of paper and polyester fiber
- High material stability and strength
- Available in 10 $\mu m$ and 25 $\mu m$ fineness

**Stainless Steel Mesh (G)**

**Features:**
- Surface filtration
- Provides high resistance filter elements (irrespective of the hydraulic fluid used)
- Partially cleanable
- Available in 25 $\mu m$, 40 $\mu m$, and 80 $\mu m$ finenesses (other micron ratings on request)
Series TEF, DTEF, TEFB, RF, TRW

**Application:** Mounted on top of the reservoir with the outlet port returning to the reservoir

**Port size:** up to -24 SAE (G 1-½), up to SAE 5", up to ANSI flange 8" (DN 200)

**Operating pressure:** 145 psi (10 bar)

**Flow rates:** TEF up to 1902 gpm (7200 l/min), TRW up to 79 gpm (300 l/min)

**Filtration materials:** Paper, Interpor fleece, or stainless steel wire mesh

**Benefits:** Lightweight, easy to change, minimizes chance of oil spillage during element change and the resulting environmental concern

- **TEF** - Removable bowl that prevents contamination from entering the reservoir during filter element change; multiple inlet ports are possible
- **TEFB** - No additional breather port needed in the tank
- **TRW** - Horizontal tank-mounted return line filters

### Return Line Filters with Suction Connection

#### Series TRS, TNRS

**Application:** Tank-mounted return line filters with suction connection for mobile hydraulic applications having a minimum of two, independent hydraulic circuits

**Port size:** up to 3x20 SAE (G 1-¼), up to SAE 2"

**Operating pressure:** 145 psi (10 bar)

**Flow rate:** up to 119 gpm (450 l/min)

**Filtration materials:** Paper, Interpor fleece, or stainless steel wire mesh

**Benefits:** Tank-top-mounted in-line filters supply clean suction flow and prevent cavitation; custom designs possible

#### Stainless Steel Pressure Filters

##### Series ELF

**Application:** For mounting in suction, pressure, and return lines

**Port size:** up to ANSI 10” (DN 250)

**Operating pressure:** 232 psi (16 bar)

**Series EH**

**Application:** Mounted in pressure lines

**Port size:** up to -24 SAE (G 1-½), up to SAE 2"

**Operating pressure:** up to 6090 (420 bar)

### Series BEHD

**Application:** High filter efficiency at high volume flows; stainless steel filter battery

**Port size:** up to Avit 3”

**Operating pressure:** up to 4567.5 psi (315 bar)

#### Series EHD, EDU, EDA, EDSF

**Application:** Mount in suction, pressure, or return lines. The filter flow path can be changed to either of the two chambers

**Port size:** up to -16 SAE (G 1), up to SAE 4”, ANSI 10”

**Operating pressure:** up to 4567.5 psi (315 bar)

**Benefits:** For continuous filtration without system shutdown, an internally-mounted, changeover ball valve makes it possible to switch from one filter to the other for servicing or changing filter while in the “off” position

- **EDA** - Filters according to ASME

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Tank-mounted Return Line Filters

Return Line Filters with Suction Connection

Stainless Steel Pressure Filters
Change-over Pressure Filters

**Series MDD, HDD**

*Application:* For continuous operation. Mount in suction, pressure, or return lines

*Port size:* up to -16 SAE (G 1), up to SAE 2", Avit 2"

*Operating pressure:* up to 4567.5 psi (315 bar)

*Flow rates:* MDD up to 25 gpm (95 l/min), HDD up to 356 gpm (1350 l/min)

*Filtration materials:* Paper, Interpor fleece, or stainless steel wire mesh

*Benefits:* For continuous filtration without system shutdown, the duplex design is equipped with a three-way change over valve. This makes it possible for the user to divert the flow to the second filter for servicing or changing

**Series DU, DUV**

*Application:* For continuous operation. Mount in suction, pressure, or return lines

*Port size:* up to -12 SAE (G ¾), up to SAE 5"

*Operating pressure:* 464 psi (32 bar)

*Flow rates:* DU up to 1056 gpm (4000 l/min), DUV up to 528 gpm (2000 l/min)

*Filtration materials:* Paper, Interpor fleece, or stainless steel wire mesh

*Benefits:* For continuous filtration without system shutdown, a rotary slide or ball valve is internally mounted. This makes it possible to switch from one filter to the other for servicing or changing filter while in the “off” position

**Series DSF, DNR**

*Application:* For continuous operation. Mount in suction, pressure, or return lines

*Port size:* SAE 5", ANSI flanges up to 10"

*Operating pressures:* 363 psi (25 bar), 232 psi (16 bar)

*Flow rates:* DSF up to 2642 gpm (10,000 l/min), DNR up to 2113 gpm (8000 l/min)

*Filtration materials:* Paper, Interpor fleece, or stainless steel wire mesh

*Benefits:* For continuous filtration without system shutdown, the duplex design is equipped with a three-way change over valve. This makes it possible for the user to divert the flow to the second filter for servicing or changing

**Series DA, DNA**

Filters according to ASME

*Application:* For continuous operation. Mount in suction, pressure, or return lines

*Port size:* up to SAE 2", ANSI flange 4"

*Operating pressure:* 232 psi (16 bar), 580 psi (40 bar)

*Flow rates:* DA up to 264 gpm (1000 l/min), DNA up to 542 gpm (2050 l/min)

*Filtration materials:* Paper, Interpor fleece, or stainless steel wire mesh

*Benefits:* For continuous filtration without system shutdown, the duplex design is equipped with a three-way change over valve. This makes it possible for the user to divert the flow to the second filter for servicing or changing
Pressure Filters

**Series LF, RF**

**Application:** Mounted in suction, pressure, and return lines

**Port size:** from -12 SAE (G ¾) up to ANSI flange 10”

**Operating pressure:** 145 psi (10 bar), 232 psi (16 bar), 363 psi (25 bar), 464 psi (32 bar)

**Flow rate:** up to 2642 gpm (10,000 l/min)

**Filtration materials:** Paper, Interpor fleece, or stainless steel wire mesh

**Benefits:** RF-series filters have side inlets and bottom outlets on the same level

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Pressure Filters, Pn > 1450 psi (100 Bar)

**Series ML, MNL**

**Application:** Mounted in pressure lines; threaded design

**Port size:** up to -24 SAE (G 1)

**Operating pressure:** up to 2320 psi (160 bar)

**Flow rate:** up to 119 gpm (450 l/min)

**Filtration materials:** Interpor fleece or stainless steel wire mesh

**Benefits:** Economical, lightweight filter for low to medium pressure applications. Requires minimal clearance during element change, saving valuable space

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**Series HP 31, 450**

**Application:** Mounted in pressure lines; threaded design

**Port size:** up to -24 SAE (G 1-½), up to SAE 2”

**Operating pressure:** up to 6000 psi (420 bar)

**Flow rate:** up to 357 gpm (1350 l/min)

**Filtration materials:** Paper, Interpor fleece, or stainless steel wire mesh

**Benefits:** In-line or flange mounting; various port and Δp indicator options. Possible to accommodate very high flow rates with a single housing
Manifold Mounted Pressure Filters, Pn > 1450 psi (100 Bar)

### Series MNU, HNU, HPU, HPP

**Application:** Flange or manifold mounted in pressure lines  
**Port size:** 1-1/4” (DN 32)  
**Operating pressure:** 2320 psi (160 bar), 4568 psi (315 bar)  
**Flow rates:** HPP up to 357 gpm (1350 l/min)  
**Filtration materials:** Paper, Interpor fleece, or stainless steel wire mesh  
**Benefits:** Simplified mounting saves valuable space and provides filtration directly at the point needed. Prevents contaminants from passing downstream during element changes.

### Series HP 170, 1351

**Application:** Flange mounted in pressure lines  
**Port size:** up to SAE 2”  
**Operating pressure:** up to 6000 psi (420 bar)  
**Flow rates:** up to 357 gpm (1350 l/min)  
**Filtration materials:** Paper, Interpor fleece, or stainless steel wire mesh  
**Benefits:** In-line or flange mounting; various port and Δp indicator options. Possible to accommodate very high flow rates with a single housing.

### Series HPW

**Application:** Flange or threaded mounting pressure filters for reversible filtration  
**Port size:** up to -24 SAE (G 1-½), up to flange 2” (DN 50)  
**Operating pressure:** up to 4568 psi (315 bar)  
**Flow rate:** up to 106 gpm (400 l/min)  
**Filtration materials:** Paper, Interpor fleece, or stainless steel wire mesh  
**Benefits:** For use where filtration can occur in both directions.

### Series HPV, MDV

**Application:** In-line pressure filters with cold start differential pressure valve  
**Port size:** HPV up to -24 SAE (G 1-½), MDV up to -12 SAE (G ¾)  
**Operating pressure:** HPV up to 6000 psi (420 bar), MDV up to 2901 psi (200 bar)  
**Flow rates:** HPV up to 119 gpm (450 l/min), MDV up to 40 gpm (150 l/min)  
**Filtration materials:** Paper, Interpor fleece, or stainless steel wire mesh  
**Benefits:** Guarantees permanent supply of clean oil. If the element clogs, change is forced, which means no damage is possible to the downstream components. Third port forces return to the reservoir.
Manifold Mounted Pressure Filters, Pn > 1450 psi (100 Bar)

**Series HPF, HPX, HPY**

**Application:** Manifold mounted in pressure lines

**Port size:** up to 1-1/4" (DN 36)

**Operating pressure:** up to 4568 psi (315 bar)

**Flow rates:** HPF up to 357 gpm (1350 l/min)

**Filtration materials:** Paper, Interpor fleece, or stainless steel wire mesh

**Benefits:** Simplified mounting saves valuable space and provides filtration directly at the point needed. Prevents contaminants from passing downstream during element changes.

Tank Mounted Suction Filters

**Series AS, TS, TSW, ASF**

**Application:** Mounted to the side of the reservoir below oil levels. It is positioned vertically in the TS series or horizontally in the TSW series. The suction side faces the reservoir; a check valve prevents oil from draining from the reservoir during servicing.

**Port size:** up to -24 SAE (G 1-½), up to SAE 3-½"

**Flow rate:** up to 185 gpm (700 l/min)

**Filtration materials:** Paper, Interpor fleece, or stainless steel wire mesh

**Benefits:** Suction filters can be serviced from the outside of the reservoir with no additional check valve needed.

Off-line Filters

**Series NF**

**Application:** Partial flow filter for fine filtration of hydraulic and lubrication circuits; supplements the main filter

**Port size:** up to SAE 2-¼"

**Operating pressure:** 232 psi (16 bar)

**Flow rate:** up to 264 gpm (1000 l/min)

**Filtration materials:** Paper, Interpor fleece, or stainless steel wire mesh.

**Water absorption elements are also available**

**Benefits:** Offers a large filtration area in a compact size allowing for high dirt-retaining capacity even with a small filter fineness. Filter element can be changed quickly and without tools.
Tank Breathers

**Series NBF, EBF, BFD, BF**

**Application:** Assures that no contamination reaches the tank through air exchange or water condensation in the reservoir

**Port size:** up to BS PP 3 (G 3)

**Flow rates:** up to 925 gpm (3500 l/min)

**Filtration materials:**
- **NBF** - Paper, Interpor fleece
- **EBF** - Paper
- **TBF** - Paper
- **BF, WP** - Paper, Interpor fleece
- **BFD** - Silica gel, Interpor fleece

**Benefits:** Protects system from airborne debris and/or moisture

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Spin-on Filters

**Series WPL**

**Application:** In-line filter; mounted into pressure and return lines for all hydraulic systems

**Port size:** up to NPT 1-½” (G 1-½)

**Flow rate:** up to 69 gpm (260 l/min)

**Filtration materials:** Paper or Interpor fleece

**Benefits:** Easy maintenance. Die-cast aluminum construction saves overall weight. Use as suction or return filter

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Clogging Indicators

**Series AE, OE, O, E, VS**

**Application:** Wide range of clogging indicators for hydraulic and lubrication systems

**Types:** Optical, electrical, optical-electrical, electronic. Available variations include: block execution, explosion-proof, thread execution, with reset function, and with control function

**Benefits:** Easy integration into automatic control systems, allows for continuous contamination control and pressure differential measuring, early identification of increased contamination, and optimal utilization of filter elements
Filter Efficiency Data

Multi-Pass Performance
According to ISO 16889

Filtration Quotient $\beta_x(c)$ Interpor Glass Fiber

Calculation of the filtration quotient $\beta_x(c)$

\[
\beta_x(c) = \frac{\text{amount of particles of the size } \geq x \, \mu m(c) \text{ before the filter}}{\text{amount of particles of the size } \geq x \, \mu m(c) \text{ after the filter}}
\]

Conversion of filtration quotient $\beta_x(c)$ into filtration efficiency (in %)

\[
\text{efficiency} = \left(1 - \frac{\beta_x(c) - 1}{\beta_x(c)}\right) \times 100 \%
\]

e.g. $\beta_{10}(c) = 200 \rightarrow \left(\frac{200 - 1}{200}\right) \times 100 = 99.5\%$

Dirt Holding Capacity According to ISO 16889

Dirt holding capacity according to ISO 16889 (test dust: ISO-MTD) of different filter media and filtration grades. Dirt holding capacities at 29, 58, 87, 116 psi (2, 4, 6, 8 bar) pressure differential.
**Systems Sensitivity and Optimal Cleanliness Class**

The cleanliness of the oil in a hydraulic system is determined by the micron rating of the filter element, the specific contaminant, and the size and distribution of the particles in the fluid. This table presents standard data values. To determine the quality of a particular oil, it should be analyzed using established procedures.

<table>
<thead>
<tr>
<th>System types Application case</th>
<th>Req. class acc. to ISO 4406:99</th>
<th>Req. class acc. to NAS 1638</th>
<th>Recommended Eaton’s Internormen filter material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Against fine soiling and gumming up of sensitive systems</td>
<td>16/12/8 2-3</td>
<td>1 VG</td>
<td></td>
</tr>
<tr>
<td></td>
<td>17/13/9 3-4</td>
<td>3 VG</td>
<td></td>
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<tr>
<td>Heavy-duty servo motor systems; high pressure systems with long service life</td>
<td>19/15/11 4-6</td>
<td>6 VG</td>
<td></td>
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<tr>
<td>Proportional valves; industrial hydraulics with high operating safety</td>
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<tr>
<td>Mobile hydraulics; common mechanical engineering, medium pressure systems</td>
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<td>16 VG</td>
<td></td>
</tr>
<tr>
<td>Heavy industries; low pressure systems; mobile hydraulics</td>
<td>23/19/15 9-11</td>
<td>25 VG</td>
<td></td>
</tr>
</tbody>
</table>

In addition to proprietary tests developed by Eaton Internormen Products, we test our filter elements according to the following ISO standards:

- **ISO 2941**: Verification of collapse/burst resistance
- **ISO 2942**: Verification of fabrication integrity
- **ISO 2943**: Verification of material compatibility with fluids
- **ISO 3723**: Method for end load testing
- **ISO 3724**: Verification of flow fatigue characteristics
- **ISO 3968**: Evaluation of pressure drop versus flow characteristics
- **ISO 16889**: Multi-pass method for evaluating filtration performance

Customer-specific filter solutions in-lab and on-site, are based on the work of research and development and design teams. These services are supported by computer analysis, measurement methods, the availability of necessary test stands according to ISO standards, and continuous production control of all filter elements.

The beta ratio of the filter element and its permanent efficiency are guaranteed for high pressure differentials. Filter materials, bonding and processing are regularly controlled by means of bubble-point tests; on our test stand, according to ISO 2942.

Eaton’s Internormen elements can be supplied with 100% bubble-point tests and corresponding certificates on request.
For more information, please e-mail us at filtrationinfo@eaton.com

Visit us online at eaton.com/filtration for a complete list of Eaton’s filtration products

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