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# INDEX

## FILTERS

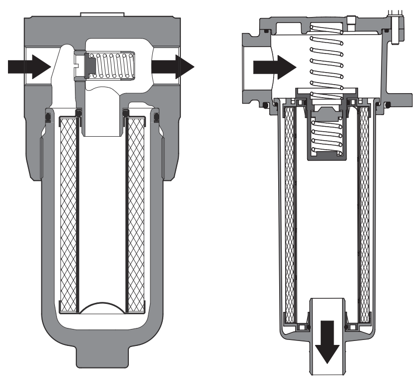
# Fluid contamination

**Fluid contamination** defines the presence of foreign particles and substances into the hydraulic fluid, classified in 3 families (solid, water and air contamination), which produce different effects on hydraulic components.
This aspect is a main issue for all hydraulic systems, being responsible for failures and increased machine downtime with consequent heavy costs for end users.

**The purpose of this document is to provide general information about type, sources and effects of fluid contamination on hydraulic components.**
**In particular it is focused on the solid contamination, most commonly present in hydraulic systems, with a description of international methods for its measurement and classification.**

## 1 SOLID CONTAMINATION

It is responsible for wearing and damages of hydraulic components causing approximately 80% of hydraulic systems failures.
Solid contaminants can enter into the hydraulic system from the external environment or they can be generated during the system operation. A detailed analysis about the potential causes of fluid contamination is described in section 4



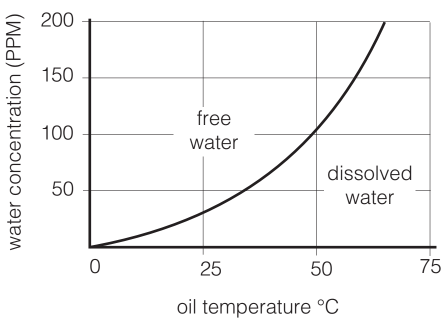

**Effects**: solid contamination causes accelerated wear and sticking phenomena, with consequent increased internal leakages and inaccurate regulation of hydraulic components. In the worst cases it may lead to the components breakage.
A detailed analysis of the effects of solid contamination on hydraulic components is described in section 5

**Removal methods**: the solid contamination cannot be completely removed but it can be consistently reduced at acceptable levels by means **of hydraulic filters (in line and return line type)**.
Contamination coming from external environment can be also prevented using specific air filters and pressurized tanks.

**An extensive description of filter types, contamination classes and suggested filtration circuits is described in the technical table LF020**

## 2 WATER CONTAMINATION

Water can be present into the hydraulic fluid as dissolved water (emulsion) or free water, depending to its concentration and fluid temperature.
Water can enter into the hydraulic system during oil filling operations, through the tank cover or by the air moisture present in the ambient.




**Effects**: water contamination causes oxidation and corrosion of metal parts, plus alteration of chemical proprieties of the hydraulic fluid.

**Removal methods**: sealed tanks are normally used in case of system out-doors installation to prevent water dropping.

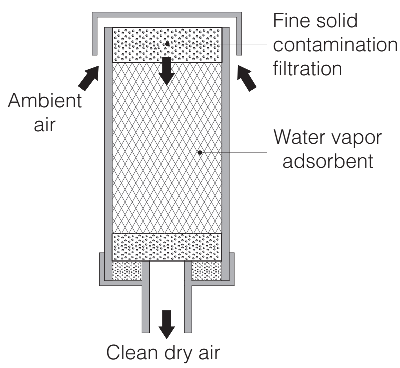
Centrifugal separators are a valid solution to remove the water emulsion from the hydraulic fluid.

Breather filters are normally used to remove the humidity form the air entering the oil tank.

**Note**: consult Atos Technical Office for detailed information about water contamination removal

## 3 AIR CONTAMINATION

Air is always present into the hydraulic system before its commissioning, or it can be introduced during maintenance.




**Effects**: the presence of air may cause pumps damage due to cavitation, inaccurate valve regulation and vibrations.

**Removal methods**: air bleeding points are normally present in the upper side of the hydraulic system and in hydraulic components. The complete air bleeding procedure must be performed at the system commissioning of after maintenance operations.

**Note**: consult Atos Technical Office for detailed information about air bleeding procedures. See also , tech. table P002 for system commissioning

## 4 SOURCES OF SOLID CONTAMINATION

The solid contamination has two main sources:

- **Fluid original contamination**, caused by poor quality hydraulic fluids, or fluids stored in dirty tanks
- **System progressive contamination**, generated during the system working and caused by wearing of metal parts and rubber pipes

In a more detailed analysis, following causes of contamination can be identified:

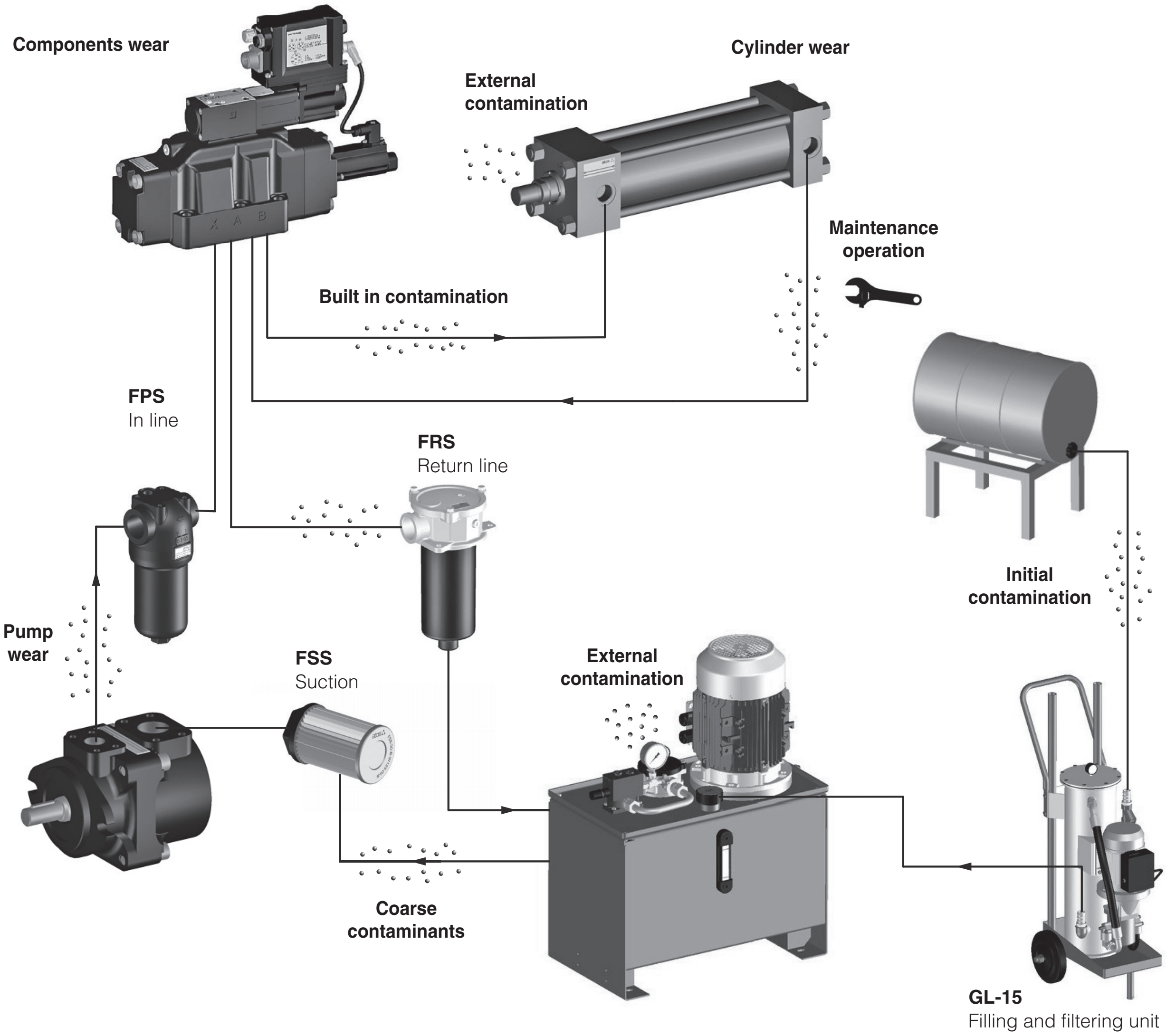
**4.1 First fluid filling**
Oil coming from shipping containers usually has a contamination level higher than the standards acceptable for most hydraulic systems: oil cannot be assumed to be clean unless it has been carefully filtered.

**4.2 Built-in contamination**
Different contaminants can be found in new systems and they can be directly related to manufacturing and assembling operations.

**4.3 Self-generated contamination**
The major source of contamination directly comes from the normal hydraulic system operation. Most of contaminant are due to rubber released from the inner walls of flexible hoses, some from with moving parts of hydraulic components, like pumps and valves

**4.4 External contamination**
Contaminants coming from the surrounding environment can enter the hydraulic fluid through reservoir breather caps and worn cylinder rod seals.

**4.5 Maintenance-induced contamination**
Contaminants coming from the surrounding environment can enter the system during maintenance operations. Inaccurate cleaning of the pipes after the replacement of failed components can be the source of further contamination.



## 5 EFFECTS OF SOLID CONTAMINATION

The presence of solid contaminants into the hydraulic fluid have harmful effects on the correct operation and service life of hydraulic components as pumps, valves and actuators.

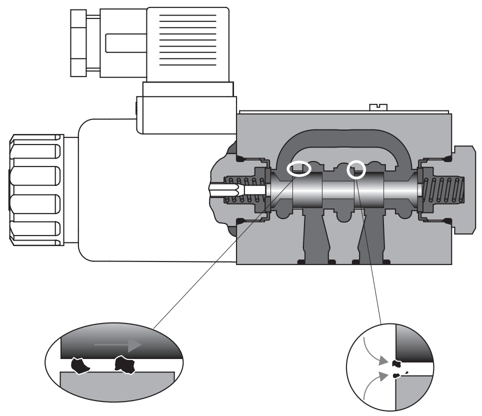
They mainly cause abrasion, erosion and fatigue effects on components surface with following main consequences:

- increased internal leakages
- sticking effects
- permanent wear of moving parts

Typical failures produced by solid contamination can be classified as:

- **Transitory failures**, when particles enter components causing its temporarily malfunction. The components returns to correctly operate as soon the particles are removed by the oil flow.
- **Progressive deterioration**, when particles cause micro-erosion and abrasion of the component surfaces. This failure causes a progressive degra dation of performances until the functionality of the component is definitively compromised.
- **Irreparable failure**, when particles enter the gap between mobile parts causing the sudden sticking. This failure could be solved by cleaning the internal parts of the component, in the worst cases the whole components must be replaced

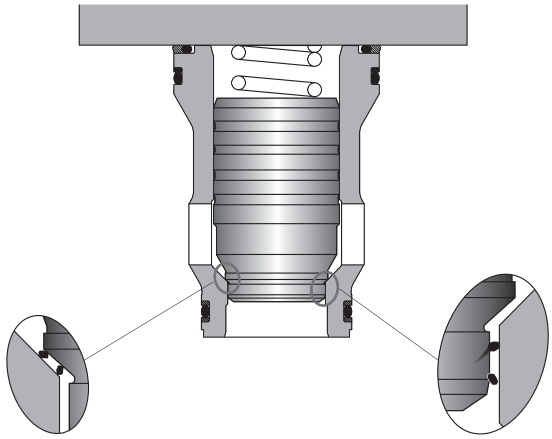
**Typical failures in spool valve**



**Transitory failure:** sticking effects (control inaccuracy)

**Progressive degradation:** erosion of the spool, leakages

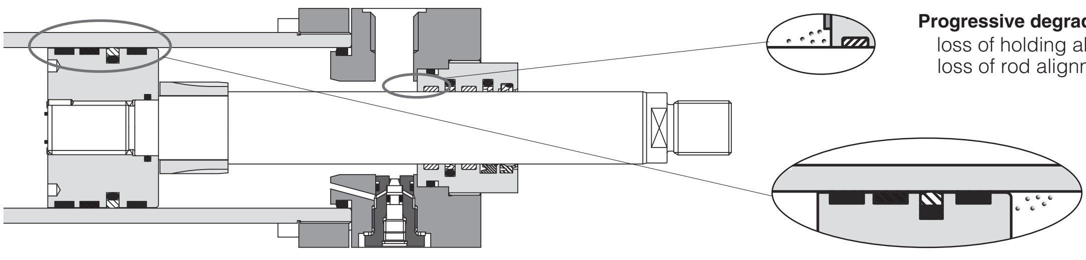
**Typical failures in poppet cartridges**



**Transitory failure:** leakages

**Progressive degradation:** erosion of the poppet

**Typical failures in cylinders**



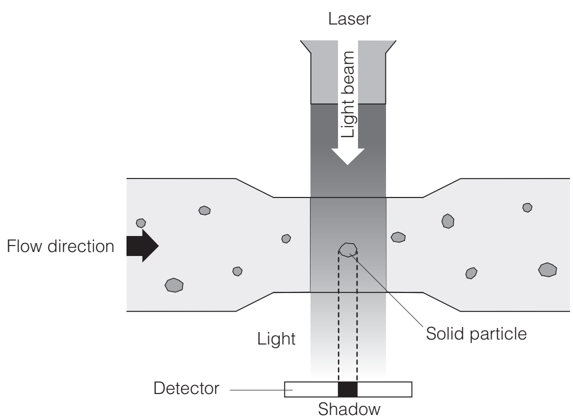
**Progressive degradation:** loss of holding ability loss of rod alignment

**Transitory failure:** sticking effect

## 6 MEASUREMENT OF SOLID CONTAMINATION

One of the most common methods used by the industry for solid contamination analysis is the Automatic Particles Counter (APC). It is based on the principle of a light beam projected through the sample of fluid to be analyzed.

As a solid particle passes through the light beam, it results in a measurable energy drop that is proportional to the size of the particle.
This method permits to measure the quantity and dimensions of solid particles present in the fluid and it is used for the classification of the fluid contamination level, as described in section 5



## 7 CLASSIFICATION OF CONTAMINATION LEVEL

The contamination level identifies the quantity and dimensions of solid particles present into the hydraulic fluid.
It is classified according to the European standard ISO 4406/1999, while for North America it is classified by SAE AS 4059 or NAS 1638 standards.

### 7.1 ISO 4406 classification

ISO 4406 is the European standard being used extensively within the industrial hydraulics to measure and classify the fluid contamination.
The contamination level is measured by counting the number of particles of a certain dimension present into a 100 ml of fluid.
It is expressed by a combination of 3 codes, i.e: **20 / 18 / 15**, respectively identifying the quantity of contaminants with dimension > 4 $\mu m_{(c)}$, > 6 $\mu m_{(c)}$ and > 14 $\mu m_{(c)}$, as per following table

| ISO CODE (to ISO 4406) | Particle quantity / 100 ml from | to |
|---|---|---|
| **5** | 16 | 32 |
| **6** | 32 | 64 |
| **7** | 64 | 130 |
| **8** | 130 | 250 |
| **9** | 250 | 500 |
| **10** | 500 | 1.000 |
| **11** | 1.000 | 2.000 |
| **12** | 2.000 | 4.000 |
| **13** | 4.000 | 8.000 |
| **14** | 8.000 | 16.000 |
| **15** | 16.000 | 32.000 |
| **16** | 32.000 | 64.000 |
| **17** | 64.000 | 130.000 |
| **18** | 130.000 | 260.000 |
| **19** | 260.000 | 500.000 |
| **20** | 500.000 | 1.000.000 |
| **21** | 1.000.000 | 2.000.000 |
| **22** | 2.000.000 | 4.000.000 |
| **23** | 4.000.000 | 8.000.000 |
| **24** | 8.000.000 | 16.000.000 |
| **25** | 16.000.000 | 32.000.000 |
| **26** | 32.000.000 | 64.000.000 |
| **27** | 64.000.000 | 130.000.000 |
| **28** | 130.000.000 | 250.000.000 |

**20 / 18 / 15**
>4$\mu m_{(c)}$ >6$\mu m_{(c)}$ >14$\mu m_{(c)}$

Example of contamination classification

HIGHER FILTRATION

### 7.2 SAE AS 4059 classification

This classification is normally adopted in North America, particularly in aerospace industry.The contamination level is classified by a combination of 3 codes, i.e. **7B/6C/5D** identifying the quantity of contaminants of a certain dimension present into 100 ml of fluid

| **Dimensions code** | | A | B | C | D | E | F |
|---|---|---|---|---|---|---|---|
| **Particle dimensions** | | > 4 $\mu m_{(c)}$ | > 6 $\mu m_{(c)}$ | > 14 $\mu m_{(c)}$ | > 21 $\mu m_{(c)}$ | > 38 $\mu m_{(c)}$ | > 70 $\mu m_{(c)}$ |
| | | **Particle quantity /100 ml** | | | | | |
| **Contamination classes** | **000** | 195 | 76 | 14 | 3 | 1 | 0 |
| | **00** | 390 | 152 | 27 | 5 | 1 | 0 |
| | **0** | 780 | 304 | 54 | 10 | 2 | 0 |
| | **1** | 1.560 | 609 | 109 | 20 | 4 | 1 |
| | **2** | 3.120 | 1.220 | 217 | 39 | 7 | 1 |
| | **3** | 6.250 | 2.430 | 432 | 76 | 13 | 2 |
| | **4** | 12.500 | 4.860 | 864 | 152 | 26 | 4 |
| | **5** | 25.000 | 9.730 | 1.730 | 306 | 53 | 8 |
| | **6** | 50.000 | 19.500 | 3.460 | 612 | 106 | 16 |
| | **7** | 100.000 | 38.900 | 6.920 | 1.220 | 212 | 32 |
| | **8** | 200.000 | 77.900 | 13.900 | 2.450 | 424 | 64 |
| | **9** | 400.000 | 156.000 | 27.700 | 4.900 | 848 | 128 |
| | **10** | 800.000 | 311.000 | 55.400 | 9.800 | 1.700 | 256 |
| | **11** | 1.600.000 | 623.000 | 111.000 | 19.600 | 3.390 | 1.020 |
| | **12** | 3.200.000 | 1.250.000 | 222.000 | 39.200 | 6.780 | |

HIGHER FILTRATION

### 7.3 NAS 1638 classification

NAS 1638 (National Aerospace Standard) is a type of classification used in North America.

It divides the dimensional distribution of the particles into intervals (5-15 µm, 15-25 µm, etc.) and assigns a code to each interval, according to the following table in which is reported also a comparison with ISO 4406 and SAE AS 4059 standards.

| ISO 4406 | SAE AS 4059 | NAS 1638 |
|---|---|---|
| 14/12/09 | 4A/3B/3C | 3 |
| 15/13/10 | 5A/4B/4C | 4 |
| 16/14/11 | 6A/5B/5C | 5 |
| 17/15/12 | 7A/6B/6C | 6 |
| 18/16/13 | 8A/7B/7C | 7 |
| 19/17/14 | 9A/8B/8C | 8 |
| 20/18/15 | 10A/9B/9C | 9 |
| 21/19/16 | 11A/10B/10C | 10 |
| 22/20/17 | 12A/11B/11C | 11 |
| 23/21/18 | 13A/12B/12C | 12 |

HIGHER FILTRATION

# Filtration guidelines

**Cleanliness of hydraulic fluid is a priority aspect in the design of all hydraulic systems as approximately 80% of failures are caused by the presence of solid contamination.**

The solid contamination cannot be completely removed, but it can be consistently reduced and controlled by means of hydraulic filters (in line and return line type, see section 2) so that the quantity and dimensions of particles present into the fluid (contamination class) are acceptable for the specific type of system.

**The purpose of this document is to provide information on the different types of filters and suggestions for their correct use. Through an optimized filtration system it is possible to obtain appropriate fluid cleanliness and thus reduce the damages caused by contamination, extending the life of the machines and preventing production downtime.**


## 1 RECOMMENDED CONTAMINATION CLASSES

The **recommended fluid contamination class** is the max level of contamination acceptable for a certain hydraulic system and it depends to the filtration system architecture.

The fluid contamination class must be evaluated taking into account several parameters as:

- type of hydraulic components installed in the system: the required cleanliness level has to be determined according to the most sensitive component, i.e. presence of servoproportional valves
- type of application and surrounding environment: particular dusty environments , i.e. ceramic presses, require specific filtration circuits and methods to prevent that the solid contamination enters the system tank (pressurized tank)
- duty cycle: heavy duties and high pressure values require better contamination classes
- expected system lifetime
- typical operation and start-up temperatures

The fluid contamination level of a specific hydraulic system corresponds to the contaminant level measured in the tank.

The following table provides the suggested contamination classes, depending on the hydraulic components and their expected operating life.

The contamination class has to be selected according to the most sensitive component installed in the system.

| **Standard** | **Typical contamination classes** | | | | | | |
|---|---|---|---|---|---|---|---|
| ISO 4406 | 15/13/10 | 16/14/11 | 17/15/12 | 18/16/13 | 19/17/14 | 20/18/15 | 21/19/16 |
| NAS 1638 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| SAE 5049 | 5A/4B/4C | 6A/5B/5C | 7A/6B/6C | 8A/7B/7C | 9A/8B/8C | 10A/9B/9C | 11A/10B/10C |
| Recomended filter element | F03 | F03<br>F06 | F06 | F06<br>F10 | F10<br>F20 | F20<br>F25 | |
| **Component** | | | | | | | |
| Proportional valves | | longer life | | normal operation | | | |
| Solenoid & conventional valves | | | | | longer life | normal operation | |
| Variable displacement pumps | | | | longer life | | normal operation | |
| Fixed displacement pumps | | | | | longer life | | normal operation |
| Cylinders | | | | | longer life | normal operation | |

## 2 HYDRAULIC FILTERS TYPE

The architecture of a filtration system involves the use of different type of hydraulic filters with specific characteristics; typically they are “in line” and “return line” filters.

The type of fluid used in the hydraulic system influences the choice of filter.

It is always recommended to verify the compatibility of the fluid characteristics with the selected filter.

### 2.1 In line filters

FPS

In line filters are normally installed in the system main line, immediately after the pump or before valve’s manifold, in order to protect all downstream components from contamination.

They have to be sized in accordance with the maximum system pressure and flow rate.

Atos in line filters **FPS** (threaded ports) and **FPH** (SAE 6000 flanged ports) are suitable for max operating pressure up to 420 bar.

In line filters are provided with or without by-pass valve:

- filters with by-pass valve are used to permit the flow passage in case of clogged filtering element. This is an extreme condition to be always avoided by a correct maintenance
- filters without by-pass valves are used to protect critical components like servoproportional valves; in this execution the filter element can withstand a higher differential pressure (collapse pressure)

In line filters can be provided with a clogging indicator, notifying the status of the filter element and allowing its replacement before the filter by-pass opening (if present), see section 6.

FPH

### 2.2 Return line filters

They perform the **filtration of the fluid returning back to the tank from the hydraulic circuit**, ensuring that all the contaminants generated by components wear do not enter the tank and will not be recirculated into the system.

They have to be sized considering the maximum flow on return line during the whole machine cycle; particularly, in case of differential cylinders the return flow could be greater than the pump flow.

Return line filters can be installed in line or on the top of the hydraulic tank and have to be selected considering return line pressure.

Atos return line filters type **FRS** are designed for tank top mounting and to withstand max operating pressure up to 8 bar.

Return line filters are provided with a by-pass valve to prevent dangerous excessive back-pressure in the return line caused by the clogged filer element.

The filter outlet must be always located below the fluid level, in all operating conditions, to prevent possible foaming of the fluid in the tank.

FRS

### 2.3 Suction filters

These filters are used to **protect the pump from ingestion of coarse contamination**. Atos suction filters type **FSS** are designed to be directly fit on the pumps suction line.

To avoid the risk of pump cavitation, suction filters are generously sized, with high filtration ratings and low differential pressures.

Suction filters have to be sized also considering cold start-up operations, because low oil temperatures could boost up cavitation phenomenon.

Due to cavitation reasons they are normally avoided for variable displacement piston pumps.

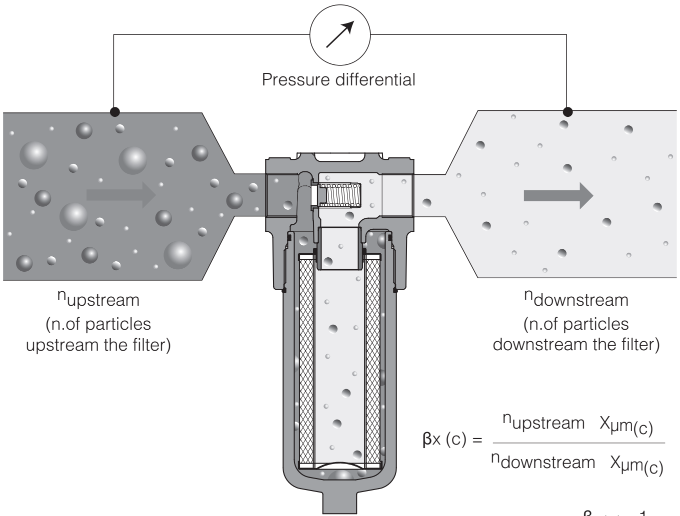
FSS

## 3 FILTER EFFICIENCY AND BETA RATIO

The filter efficiency is the capability of the filter to block a certain quantity of particles equal or greater than a defined dimension.

The most commonly used rating in the industry is the **Beta ratio** $\beta x\ (c)$, defined as the number of particles of a given size upstream the filter, divided by the number of particles of the same size counted downstream the filter. The higher the Beta Ratio, the higher is the filter efficiency.

| n. of particles upstream the filter | n. of particles downstream the filter | Beta ratio $\beta_{x(c)}$ | Efficiency % |
|---|---|---|---|
| 1.000.000 | 500.000 | 2 | 50 |
| | 100.000 | 10 | 90 |
| | 50.000 | 20 | 95 |
| | 13.000 | 75 | 98,7 |
| | 5.000 | 200 | 99,5 |
| | 1.000 | 1.000 | 99,9 |




$$\beta x\ (c) = \frac{n_{upstream}\ \ X\mu m_{(c)}}{n_{downstream}\ \ X\mu m_{(c)}}$$

$$\text{Efficiency\%} = 100\ \frac{\beta_{X(c)} - 1}{\beta_{X(c)}}$$

### 3.1 Standards for Beta ratio determination

Since 1999 the **ISO16889** has been introduced as international standard to regulate the execution of Multi-Pass Tests to assess the Beta value of a filter element, replacing old ISO 4578.

ISO16889 considers the filter efficiency = 99,9% (β ratio > 1000), while for old ISO4572 the efficiency was lower = 99,5% (βratio > 200),

To avoid misunderstandings, particles measured to ISO16889 are identified as **μm$_{(c)}$**

The table below reports the Beta values of Atos filter elements, according to the considered standard.

| Microfibre filter element | $\beta_{x(c)} > 1000$ (ISO16889) | $\beta_x > 200$ (ISO4572) |
|---|---|---|
| **F03** | 4.5 μm$_{(c)}$ | 3 μm |
| **F06** | 7 μm$_{(c)}$ | 6 μm |
| **F10** | 12 μm$_{(c)}$ | 10 μm |
| **F20** | 22 μm$_{(c)}$ | 20 μm |
| **F25** | 27 μm$_{(c)}$ | 25 μm |

| Cellulose filter element | $\beta_{x(c)} > 2$ (ISO16889) | $\beta_x > 2$ (ISO4572) |
|---|---|---|
| **C10** | 10 μm$_{(c)}$ | 10 μm |
| **C25** | 25 μm$_{(c)}$ | 25 μm |

**Contamination classes and pressure drop values remain unchanged between ISO4572 and ISO16889**

## 4 DIRT-HOLDING CAPACITY

The Beta ratio does not give any indication about the total amount of contaminant that can be trapped by the filter during its life.

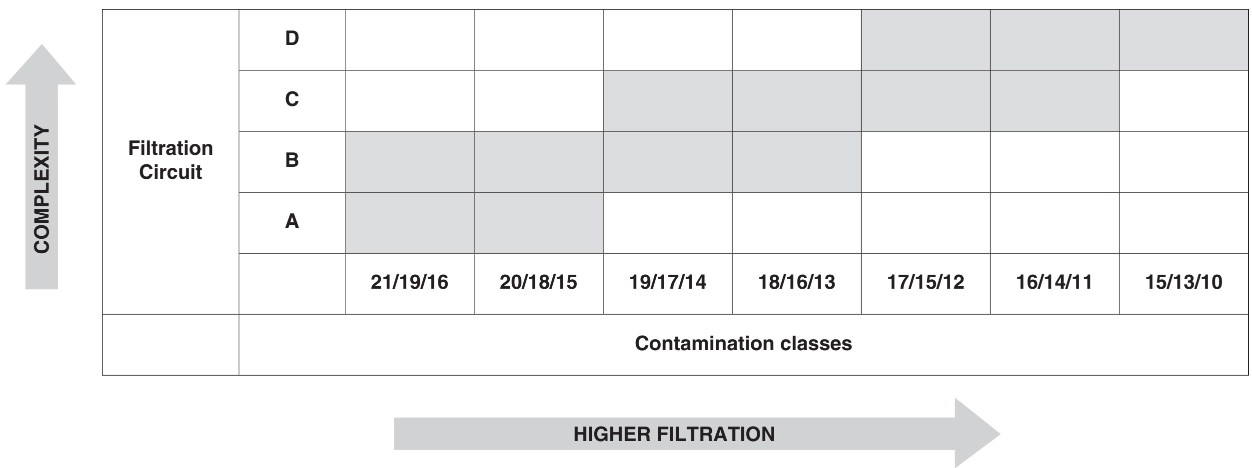
This parameter is defined **DIRT-HOLDING CAPACITY (DHC)** and it defines the quantity of contaminant that the filter element can trap and hold before the maximum allowable back pressure or delta P level is reached.

Generally, a filter element with a larger effective filtration surface has a greater dirty holding capacity and therefore a longer service life.

## 5 FILTRATION CIRCUIT

The solid contamination caused by normal component's wear is the main source of fluid contamination.
To avoid malfunctioning and progressive deterioration of the components installed in the hydraulic system, a proper filtration circuit has to be designed.

The following recommendations support the user in designing of an optimized filtration circuit.
The table below suggests the selection of a filtration circuit according to the targeted contamination class, see section 1 for recommended contamination classes.




General rules to be followed to ensure optimal operating conditions for the hydraulic systems:

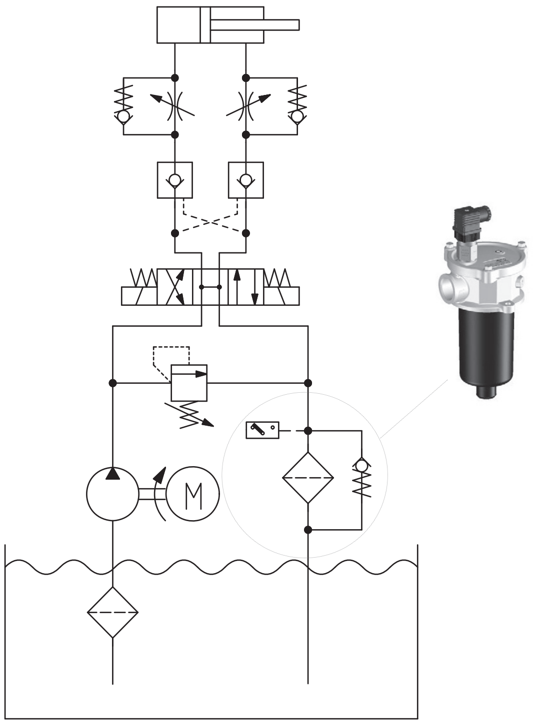
- the hydraulic tank has to be properly designed to limit the ingress of external contamination
- maintenance operations must be performed to avoid the ingress of contamination.

Consult Atos technical office for additional support for proper design of filtration circuits.

**CIRCUIT A**

**Return line filter** ensures that all the contaminants generated during system operations are correctly filtered before entering the tank.
It is a cost effective solution mainly used in systems with on-off valves.

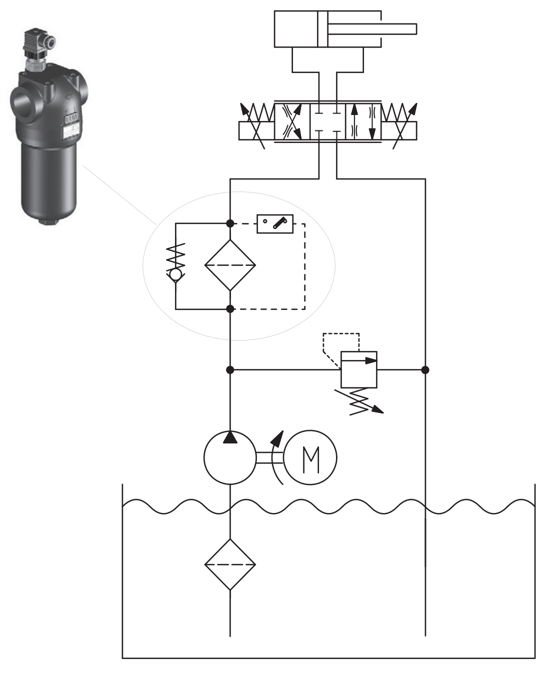
This configuration can't ensure protection of hydraulic components from wear generated by the pump.



**CIRCUIT B**

**In line filter** is normally installed immediately after the pump, to guarantee a correct filtration of the fluid before it reaches the hydraulic components.
It is a solution particularly used to protect proportional and servoproportional valves.

This configuration can't ensure protection of hydraulic components from contaminants generated further downstream and of the pump from dirt returned to the tank.

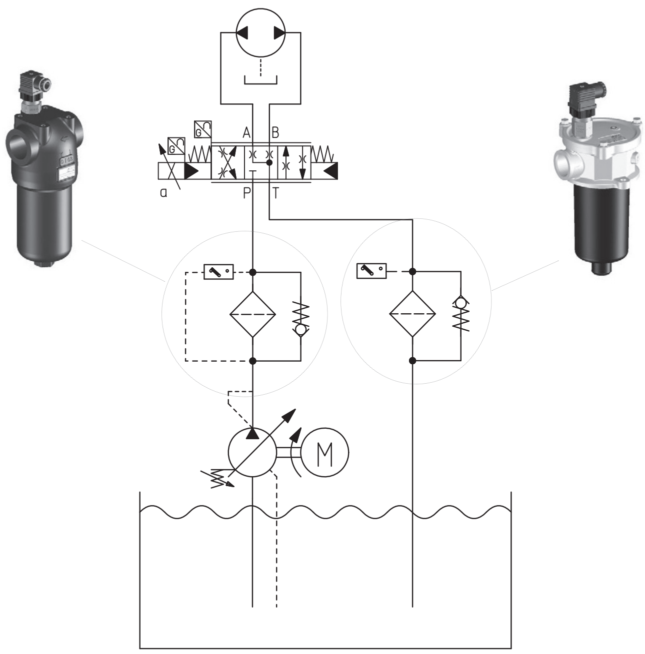


**CIRCUIT C**

This example shows a circuit with **both in line and return line filters.**
It is an ideal solution to enhance the whole system efficiency.

This system configuration will ensure:
- correct protection of components from wear generated by the pump
- correct filtration of the fluid flowing back to the tank, removing all the contamination entered in the system as consequence of components wear.

An efficient contamination control is guaranteed if the whole pump flow is passing through the filters.
As consequence, this system configuration is not indicated for circuits with variable displacement pumps operating for long time in null flow.

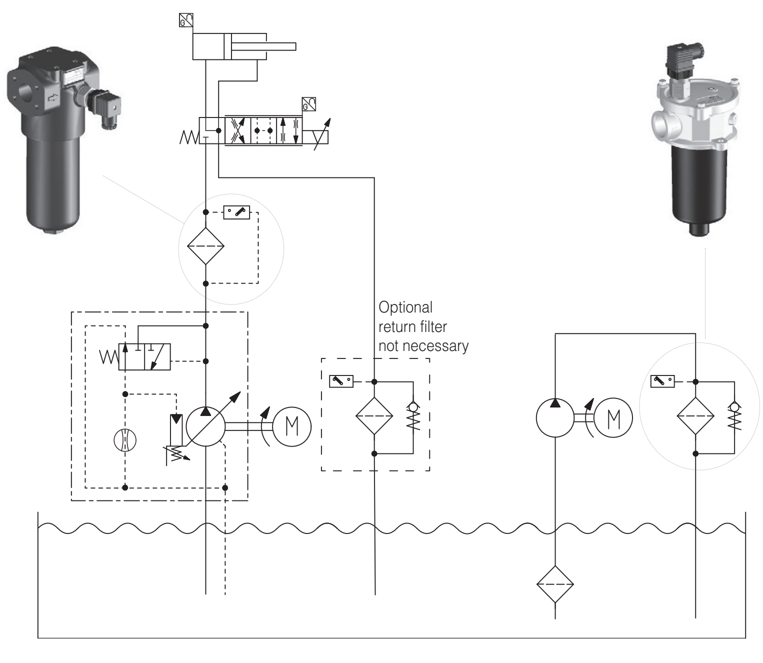



**CIRCUIT D**

This example is similar to circuit C but implemented with an **additional off-line filtration system.**
It is an ideal solution when wide change in system flow rates are expected or for systems equipped with variable displacement pumps operating for long time in null flow.
The additional off-line filtration system allows to maintain a constant filtration of the fluid in the tank, avoiding the accumulation of contamination particles

This system configuration will ensure:
- excellent cleanliness level, independently of the operating cycles of the main circuit
- higher dirt-holding capacity along with higher filtration efficiency
- easier maintenance operations thanks to the possibility of replacing the filter element without stopping the machine.

To protect critical components like servoproportional valves, in line filter without by-pass valves is suggested.



## 6 CLOGGING INDICATORS

They notify to the operator when the filter element is near to be clogged and then it must be replaced.
Their use is recommended for in line and return line filters to avoid that the high pressure caused by the clogged filter element causes the filter by-pass opening and the consequent release of contaminants into the hydraulic circuit.

Depending on the type of hydraulic filter, different clogging indicators are used:

- **Visual indicator**, Atos type **CIA-V**, normally used with **return line filters**
  It is a pressure gauge which measures the pressure before the filer element and indicates the clogged condition by means of coloured sectors:
  **Green** (range 0 to 3 bar) = filter element in good condition;
  **Red** (> 3 ) = filter element to be immediately replaced
  It requires a constant visual inspection by the operator to verify the filter condition

**CIA-V**

- **Electrical indicator**, Atos type **CIA-E**, normally used with **return line filters**
  It is a pressure switch which measures the pressure before the filer element and it indicates the clogged condition by means of switching contact (NO or NC)
  The switching pressure if factory set at 2 bar corresponding to 70% of the by-pass valve cracking pressure
  The electric contact is normally interfaced with the machine CNC for the automatic monitoring of the filter condition

**CIA-E**

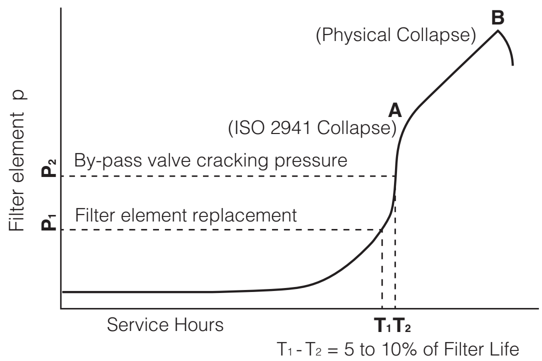
- **Visual differential indicator**, Atos type **CID-V**, normally used with **in line filters**
  It is a pressure switch which measures the Δp across the filer element and it indicates the clogged condition by means of coloured bands:
  **Green** = filter element in good condition;
  **Red** = filter element to be immediately replaced
  The switching pressure if factory set at 5 bar corresponding to 80% of the by-pass valve cracking pressure
  For filters without by-pass valve the switching pressure if factory set at 8 bar
  It requires a constant visual inspection by the operator to verify the filter condition

**CID-V**

- **Electrical differential indicator**, Atos type **CID-M**, normally used with **in line filters**
  It is a pressure switch which measures the Δp across the filer element and it indicates the clogged condition by means of switching contact (NO or NC)
  The switching pressure if factory set at 5 bar corresponding to 80% of the by-pass valve cracking pressure
  For filters without by-pass valve the switching pressure if factory set at 8 bar
  The electric contact is normally interfaced with the machine CNC for the automatic monitoring of the filter condition
  Optional version, Atos code **CID-L**, is provided with additional LED to indicate the filer clogged condition

**CID-E**

**Notes about Electrical differential indicator function**
The electrical differential clogging indicator switches at pressure P1, signalling the necessity to replace the filter element, before the by-pass valve cracking pressure P2.
To protect the system from contamination, the set value P1 of the clogging indicator is always lower than the cracking pressure P2 of the by-pass valve.
For in line filters without by-pass valve, the continued operation at higher Δp can cause the degradation of the filtration performances (point A in the diagram). In the worst case the filter element may collapse, losing its integrity (point B in the below diagram).
For this reason, in line filters without by-pass valves are usually provided with filter element having high collapse pressure value.




## 7 ISO STANDARDS

The following lists is intended to provide a documentation of the actual ISO norms relevant to hydraulic filtration

**ISO 2941** Hydraulic fluid power – Filter element – verification of collapse/burst pressure rating

**ISO 2942** Hydraulic fluid power – Filter element – verification of fabrication integrity and determination of the first bubble point

**ISO 2943** Hydraulic fluid power – Filter element – verification of material compatibility with fluids

**ISO 3723** Hydraulic fluid power – Filter element – method for end load test

**ISO 3724** Hydraulic fluid power – Filter element – determination of resistance to flow fatigue using particulate contaminant

**ISO 3968** Hydraulic fluid power – Filters – evaluation of differential pressure versus flow characteristics

**ISO 4406** Hydraulic fluid power – Fluids – method for coding the level of contamination by solid

**ISO 16889** Hydraulic fluid power – Filters – multi-pass method for evaluating filtration performance of a filter element

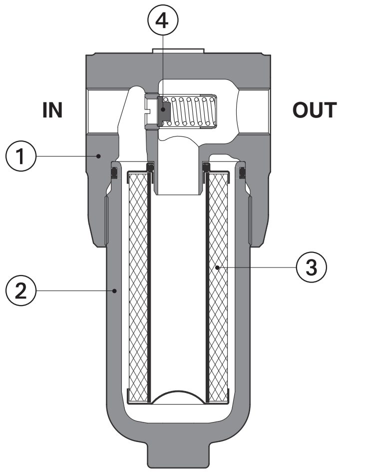
**ISO 23181** Hydraulic fluid power – Filter element – determination of resistance to flow fatigue using high viscosity fluid

**ISO 11170** Hydraulic fluid power – sequence of tests for verifying performance characteristics of filter elements

**ISO 10771-1** Hydraulic fluid power – fatigue pressure testing of metal pressure-containing envelopes – test method

# In line filters, high pressure type FPS

Threaded ports




(1) Filter head
(2) Filter bowl
(3) Filter element
(4) By-pass valve

**FPS-10-*R-***

**FPS**

In line filters are designed for installation on the pressure line downstream the pump, to ensure a high cleanliness of the fluid circulating into the hydraulic system. They protect sensible components from contamination present in the working fluid and they are particularly recommended for systems with proportional valves.

- three head sizes
- threaded port sizes: G1/2" to G1 1/2" SAE-16, SAE-20, SAE-24
- high efficiency microfiber elements. Collapse pressure 21 bar for filters equipped with by-pass valve or 210 bar for filters without by-pass
- filtration rating 4,5 - 7 - 12 - 22 μm(c) (βx (c) >1000, ISO 16889).
- versions without or with by-pass valve with cracking pressure 6 bar.
- without or with differential clogging indicator

Max flow **440 l/min**
Max working pressure **420 bar**

## 1 MODEL CODE OF COMPLETE FILTERS

**FPS** - **10** - **A** - **F10** - **01** - **R** - ***** - **W** ***** / *****

**FPS**: In line filter, high pressure

**Series number** (*)

**Seals material:**
- = NBR
**PE** = FKM

**Filter size**:
**10** = ports size 1/2" ÷ 1"
**20** = ports size 1" ÷ 1 1/4"
**30** = ports size 1 1/4" ÷ 1 1/2"

| Filter lenght: | Max flow [l/min] (1) FPS-10 | FPS-20 | FPS-30 |
|---|---|---|---|
| **A** = | 110 | 191 | 240 |
| **B** = | 133 | 205 | 349 |
| **C** = | - | 226 | 390 |
| **D** = | - | - | 440 |

**Filter element:**
**SN** = only body, without filter element
**Microfibre filter element** βx(c) >1000 - ISO 16889:
**F03** = 4,5 μm (c); **F10** = 12 μm (c);
**F06** = 7 μm (c) **F20** = 22 μm (c)

**Ports size**:

| | FPS-10 | FPS-20 | FPS-30 |
|---|---|---|---|
| BSPP threaded: | **00** = G 1/2"<br>**01** = G 3/4"<br>**02** = G 1" | **02** = G 1"<br>**03** = G 1 1/4" | **03** = G 1 1/4"<br>**04** = G 1 1/2" |
| SAE J1926-1 threaded: | **42** = SAE-16 (1") | **43** = SAE-20 (1 1/4") | **44** = SAE-24 (1 1/2") |

**Differential clogging indicator** see sect. 14:
**W** = without, indicator port with plastic plug **(2)**
**P** = without, indicator port with steel plug
**L** = electrical indicator with LED **(3)**
**M** = electrical indicator without LED **(3)**
**V** = visual indicator **(3)**
**see also note (4)**

**Options** see sect. 10:
**-** = none
**AR** = anti-back flow valve and reverse valve

**By-pass valve** see sect. 9:
**R** = by-pass valve with cracking pressure 6 bar (filter element PSH-*-R with collapse pressure 21 bar)
**N** = without by-pass (filter element PSH-*-N with collapse pressure 210 bar)

**Note:** filters for use in potentially explosive atmosphere are available on request, contact Atos Technical Office

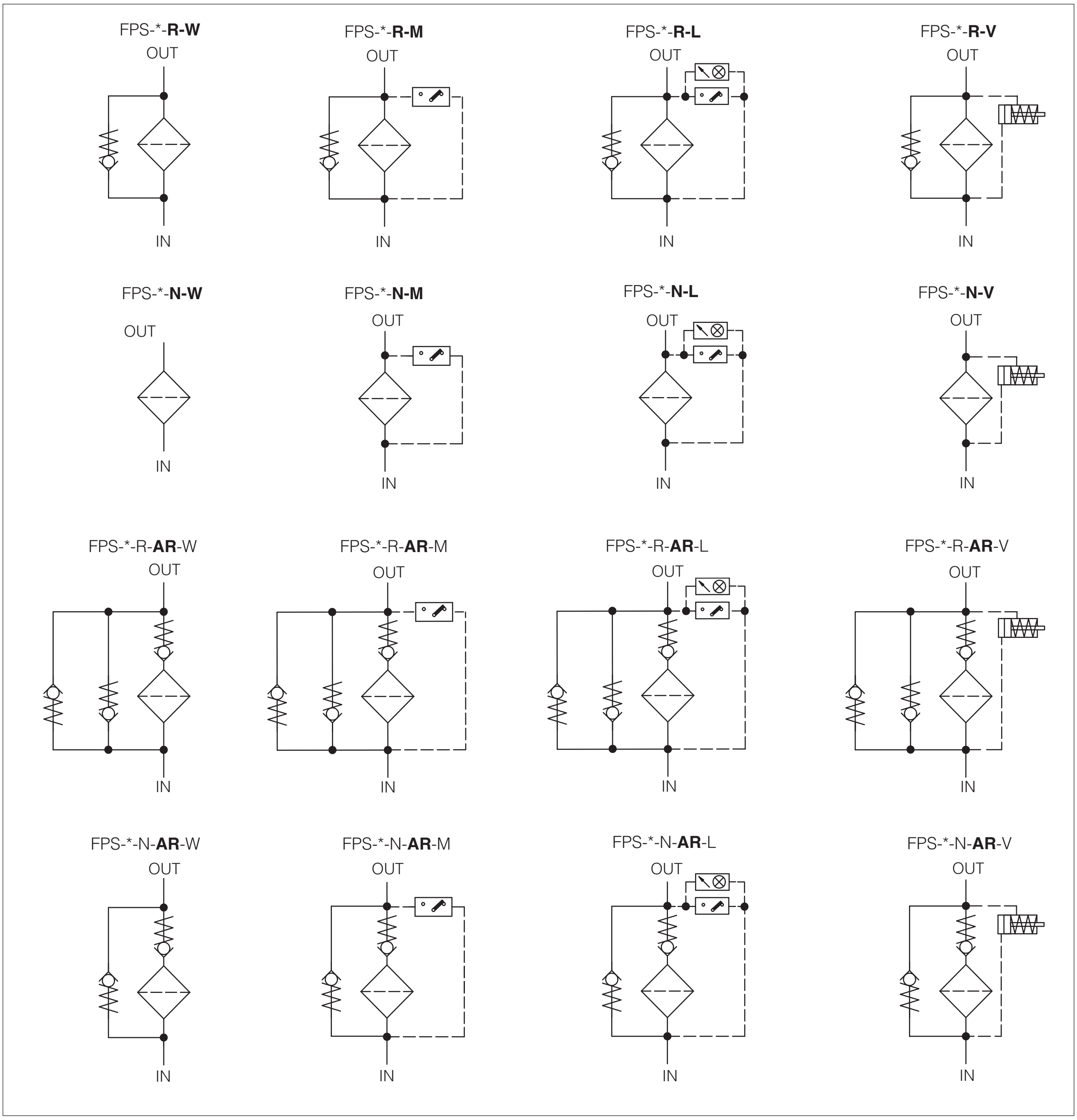
**(1)** Max flow rates are measured with: Δp 1 bar, filter element F20, largest port size, option -R, oil viscosity 32 $mm^2$/s - see also section 6
In case of different conditions see section 11 for filter sizing

**(2)** The plastic plug (option W) is only intended to prevent impurities from entering the filter through the clogging indicator port.
A clogging indicator must be fitted on the filter before commissioning. Do not install the filter with the plastic cap on the hydraulic system

**(3)** The clogging indicator is supplied disassembled from the filter. The indicator port on filter head is plugged with plastic plug

**(4)** Differential thermostated indicator CID-T and differential electronic transmitter CID-Z are available on request, see section 4

## 2 HYDRAULIC SYMBOLS (representation according to ISO 1219-1)




## 3 MODEL CODE OF FILTER ELEMENTS - only for spare (1)

| PSH | - | 10 | - | A | - | F10 | - | R | * | / | * |
|---|---|---|---|---|---|---|---|---|---|---|---|

**PSH**: Spare filter element for in line filter type FPS

**Filter element size**:

**10** = for FPS-10
**20** = for FPS-20
**30** = for FPS-30

**Filter element lenght**:

| for FPS-10 | for FPS-20 | for FPS-30 |
|---|---|---|
| **A** | **A** | **A** |
| **B** | **B** | **B** |
| | **C** | **C** |
| | | **D** |

**Microfibre filter element**, βx(c) >1000 - ISO 16889:

**F03** = 4,5 μm (c)
**F06** = 7 μm (c)
**F10** = 12 μm (c)
**F20** = 22 μm (c)

**R** = filter element with collapse pressure 21 bar, for filter FPS-*-R with by-pass valve
**N** = filter element with collapse pressure 210 bar, for filter FPS-*-N without by-pass valve

*: Series number

Seals material:
- = NBR
**PE** = FKM

**(1)** Select the filter element according to the model code reported on the filter nameplate, see section 17.2

## 4 MODEL CODE OF DIFFERENTIAL CLOGGING INDICATORS - only for spare - see section 14 and 15

| CID | - | E | 05 | - | M | * | / | * |
|---|---|---|---|---|---|---|---|---|

**CID**: Spare differential clogging indicator for in line filter

**Type of indicator**:
- **E** = electrical
- **V** = visual
- **T** = thermostated (available on request)
- **Z** = electronic transmitter (available on request)

**Differential switching pressure** (only for CID-E and CID-V):
- **05** = 5 bar for filters with by-pass valve
- **08** = 8 bar for filters without by-pass valve

**Optional LED** - only for CID-E
- **L** = with LED
- **M** = without LED

Series number

Seals material:
- \- = NBR
- **PE** = FKM

## 5 GENERAL CHARACTERISTICS

| | | |
|---|---|---|
| Assembly position / location | | Vertical position with the bowl downward |
| Ambient temperature range | | **Standard** = -20°C ÷ +70°C **/PE** option = -20°C ÷ +70°C |
| Storage temperature range | | **Standard** = -20°C ÷ +80°C **/PE** option = -20°C ÷ +80°C |
| Materials | Filter head | Cast iron |
| | Filter bowl | Carbon steel |
| Surface protection | | Zinc coating with black passivation |
| Corrosion resistance | | Salt spray test (EN ISO 9227) > 600 h |
| Fatigue strength | | min. 1 x $10^6$ cycles at 420 bar |
| Compliance | | RoHS Directive 2011/65/EU as last update by 2015/863/EU<br>REACH Regulation (EC) n°1907/2006 |

## 6 HYDRAULICS CHARACTERISTICS - based on mineral oil ISO VG 46 at 50 °C (viscosity 32mm²/s)

| Filter size | | FPS-10 | | | | FPS-20 | | | FPS-30 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Ports size code | | **00** | **01** | **02** | **42** | **02** | **03** | **43** | **03** | **04** | **44** |
| Ports dimension | | G1/2" | G3/4 | G1" | SAE-16 | G1" | G1"1/4 | SAE-20 | G1"1/4 | G1/"1/2 | SAE-24 |
| Filter lenght | | **A ÷ B** | **A ÷ B** | **A ÷ B** | | **A ÷ C** | **A ÷ C** | | **A ÷ D** | **A ÷ D** | |
| Max flow (l/min) at Δp= 1 bar Filter with by-pass **-R** (see note) | **F03** | 28÷45 | 30÷50 | 34÷56 | | 55-82 | 59÷90 | | 64÷200 | 66÷210 | |
| | **F06** | 48÷66 | 53÷75 | 60÷92 | | 100÷135 | 112÷154 | | 110÷284 | 113÷305 | |
| | **F10** | 60÷77 | 68÷89 | 80÷114 | | 135÷170 | 154÷195 | | 175÷342 | 183÷370 | |
| | **F20** | 75÷85 | 87÷99 | 110÷133 | | 166÷196 | 191÷226 | | 227÷323 | 240÷440 | |
| Max flow (l/min) at Δp= 1 bar Filter without by-pass **-N** (see note) | **F03** | 25-42 | 25÷46 | 29÷51 | | 44÷67 | 47÷73 | | 57÷167 | 58÷175 | |
| | **F06** | 35÷55 | 38÷68 | 41÷80 | | 83÷116 | 91÷131 | | 77÷228 | 80÷243 | |
| | **F10** | 55÷70 | 60÷81 | 71÷102 | | 117÷153 | 133÷176 | | 153÷267 | 160÷286 | |
| | **F20** | 69÷83 | 79÷96 | 98÷127 | | 154÷187 | 177÷215 | | 197÷372 | 208÷405 | |
| Max operating pressure | [bar] | **420** | | | | | | | | | |
| Burst pressure | [bar] | **> 1260** | | | | | | | | | |

**Note:** Max flow rates are measured with min and max filter length. In case of different conditions see section 11 for filter sizing

## 7 FILTER ELEMENTS

| Material | | Inorganic microfibre |
|---|---|---|
| Filtation rating as per ISO16889 | **F03** | $\beta_{4,5\mu m\,(c)} \geq 1000$ |
| | **F06** | $\beta_{7\mu m\,(c)} \geq 1000$ |
| | **F10** | $\beta_{12\mu m\,(c)} \geq 1000$ |
| | **F20** | $\beta_{22\mu m\,(c)} \geq 1000$ |
| Filter element collapse pressure | **R** = for filter with by-pass valve | 21 bar |
| | **N** = for filter without by-pass valve | 210 bar |

8 **SEALS AND HYDRAULIC FLUIDS** - for other fluids not included in below table, consult our technical office

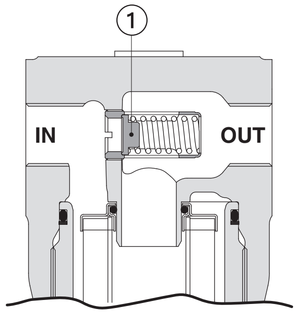
| | | | |
|---|---|---|---|
| Seals, recommended fluid temperature | NBR seals (standard) = -30°C ÷ +100°C, with HFC hydraulic fluids = +10°C ÷ +50°C<br>FKM seals (/PE option) = -25°C ÷ +120°C | | |
| Recommended viscosity | 15 ÷ 100 mm²/s - max allowed range 2.8 ÷ 500 mm²/s | | |
| **Hydraulic fluid** | **Suitable seals type** | **Classification** | **Ref. Standard** |
| Mineral oils | NBR, FKM | HL, HLP, HLPD, HVLP, HVLPD | DIN 51524 |
| Flame resistant without water | FKM | HFDU, HFDR | ISO 12922 |
| Flame resistant with water | NBR | HFC | |

9 **BY-PASS VALVE**

**Filter with by-pass valve** - version **-R**

The filter with by-pass valve (1) is used in combination with filter elements PSH-*-R with collapse pressure 21 bar.
The by-pass valve allows the oil flow to by-pass the filter element in particular conditions:

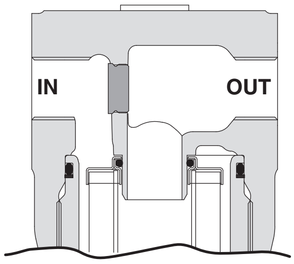
- it protects the filter element from pressure peaks that could be generated, especially at the cold system start-up. In these cases the valve opens only for the instant necessary to discharge the pressure peak, limiting the quantity of oil that bypasses the filter.
- it allows the free passage of the oil flow in case of completely clogged filter element (Δp > 6 bar). This situation should be carefully avoided, by means of a scheduled maintenance, otherwise the contaminated oil will pass to the clean side of the filter and then it will circulate in the hydraulic system. The filter element must be replaced before the clogging condition, at this purpose the use of a differential clogging indicator CID-V (visual, option V) or CID-E (electrical, options L or M) is highly recommended.



FPS-*-R

**Filter without by-pass valve** - version **-N**

The filter version without by-pass is recommended when the hydraulic system must be absolutely protected by contamination, then avoiding the risk that the contaminant passes though the by-pass valve.
The filter without by pass must be used in combination with filter elements PSH-N with high collapse pressure 210 bar



FPS-*-N

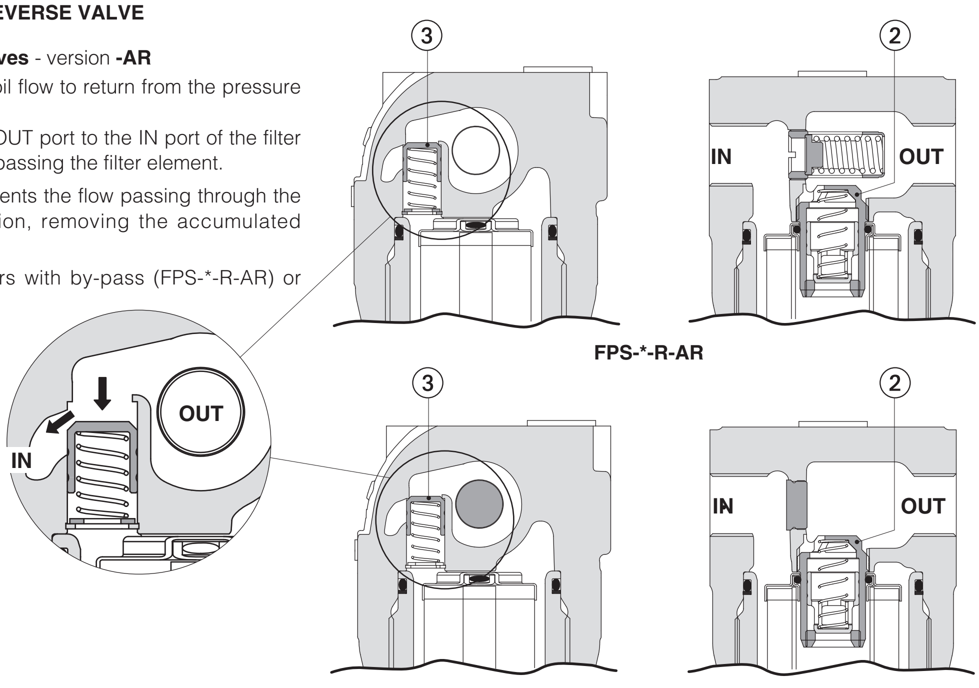
10 **ANTI BACK-FLOW AND REVERSE VALVE**

**Anti-back flow and Reverse valves** - version **-AR**

The filter version -AR allows the oil flow to return from the pressure line back to the pump.
The return flow passes from the OUT port to the IN port of the filter through the reverse valve (3), bypassing the filter element.

The anti-back flow valve (2) prevents the flow passing through the filter element in reverse direction, removing the accumulated contaminant.

Version **AR** is available for filters with by-pass (FPS-*-R-AR) or without by-pass (FPS-*-N-AR)



FPS-*-R-AR

FPS-*-N-AR

## 11 FILTERS SIZING

For the filter sizing it is necessary to consider the Total Δp at the maximum flow at which the filter must work.
The Total Δp is given by the sum of filter head Δp plus the filter element Δp:

**Total Δp = filter head Δp + filter element Δp**

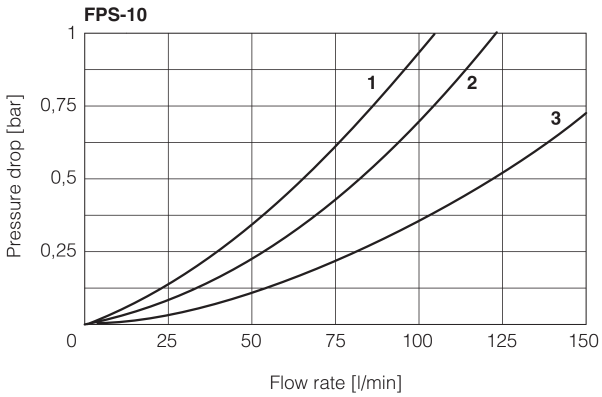
In the best conditions the total Δp should not exceed 1,0 bar
See below sections to calculate the Δp of filter head and Δp of the filter element

### 11.1 Q/Δp DIAGRAMS OF FILTER HEAD

The pressure drop of filter head mainly depends on the ports size and fluid density
In the following diagrams are reported the Δp characteristics of filter head based on mineral oil with density 0,86 kg/dm³ and viscosity 30 mm²/s

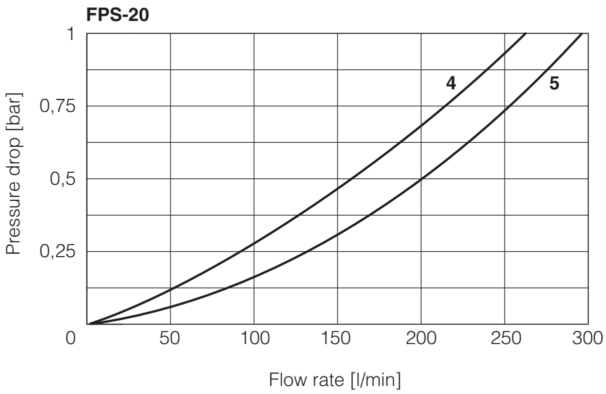
**FPS-10**

**1** = FPS-10*** 00 (G 1/2")
**2** = FPS-10*** 01 (G 3/4")
**3** = FPS-10*** 02 (G 1")
FPS-10*** 42 (SAE-16)



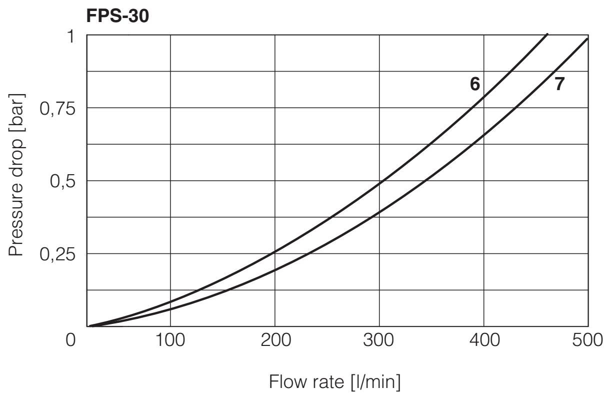

**FPS-20**

**4** = FPS-20*** 02 (G 1")
**5** = FPS-20*** 03 (G 1¼")
FPS-20*** 43 (SAE-20)




**FPS-30**

**6** = FPS-30*** 03 (G 1¼")
**7** = FPS-30*** 04 (G 1½")
FPS-30*** 44 (SAE-24)



### 11.2 FILTER ELEMENT Δp

The pressure drop through the filter depends to:
- size of filter element
- filtration rating
- fluid viscosity

The Δp of filter element is given by the formula:

$$\Delta p \text{ of filter element} = Q \times \frac{Gc}{1000} \times \frac{Viscosity}{32}$$

**Q** = working flow (l/min)

**Gc** = Gradient coefficient (mbar/(l/min)).
The Gc values are reported in the following table

**Viscosity** = effective fluid viscosity in the working conditions ($mm^2/s$)

**Gradient coefficent Gc of PSH filter elements**

| Filter element size | | 10 | | 20 | | | 30 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Filter element lenght | | **A** | **B** | **A** | **B** | **C** | **A** | **B** | **C** | **D** |
| Filter element type | Filtration rating | **Gc** Gradient coefficient | | | | | | | | |
| **R** for filter with bypass valve | **F03** | 27.75 | 15.25 | 15.82 | 13.19 | 9.63 | 14 | 7.13 | 4.7 | 3.62 |
| | **F06** | 15.12 | 7.58 | 7.27 | 6.06 | 4.43 | 8.03 | 3.37 | 2.2 | 1.89 |
| | **F10** | 9.37 | 4.91 | 4.45 | 3.71 | 2.71 | 4.43 | 2.33 | 1.5 | 1.12 |
| | **F20** | 5.31 | 3.25 | 2.87 | 2.39 | 1.75 | 2.95 | 1.34 | 0.92 | 0.44 |
| **N** for filter without bypass valve | **F03** | 32.2 | 17.32 | 20.27 | 16.90 | 12.35 | 16.48 | 8.13 | 5.5 | 4.71 |
| | **F06** | 22.38 | 9.41 | 9.50 | 7.92 | 5.79 | 11.88 | 4.18 | 3.28 | 2.91 |
| | **F10** | 11.2 | 6.27 | 5.66 | 4.72 | 3.45 | 5.27 | 3.45 | 2.36 | 2.15 |
| | **F20** | 6.81 | 3.71 | 3.41 | 2.84 | 2.07 | 3.70 | 1.60 | 0.86 | 0.78 |

**Example**:

Calculation of Total Δp for filter type FPS-10-B-F10-02-R at Q = 80 l/min and viscosity 46 $mm^2/s$ (filter element PSH-10-B-F10-R)

**Dp** of filter head + filter bowl = 0,24 bar

**Gc** = 4,91 mbar/(l/min)

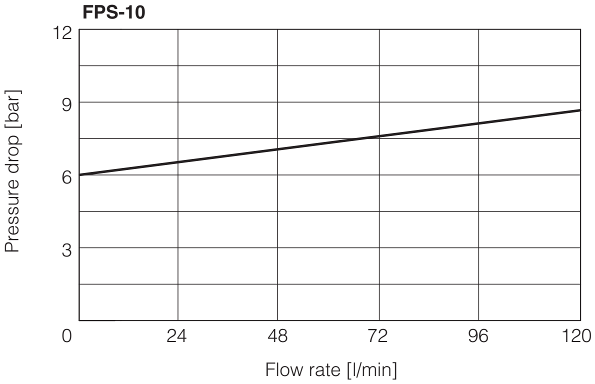
**Filter element Δp** = $80 \times \frac{4{,}91}{1000} \times \frac{46}{32} = 0{,}60$ bar

**Total Δp** = 0,24 + 0,60 = **0,84 bar**

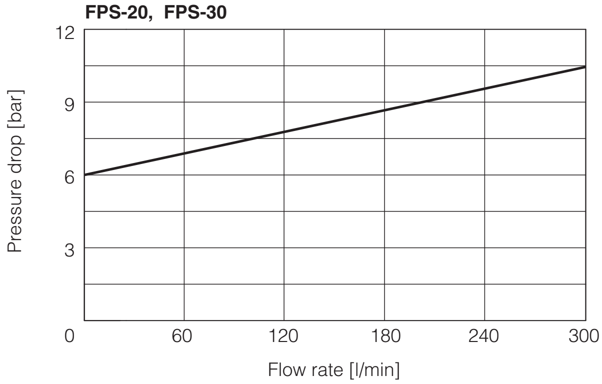
## 12 BY-PASS VALVE - based on mineral oil ISO VG46 at 50°C (viscosity = 32 $mm^2/s$)

Q/Δp diagrams of flow through the by-pass valve

**FPS-10**

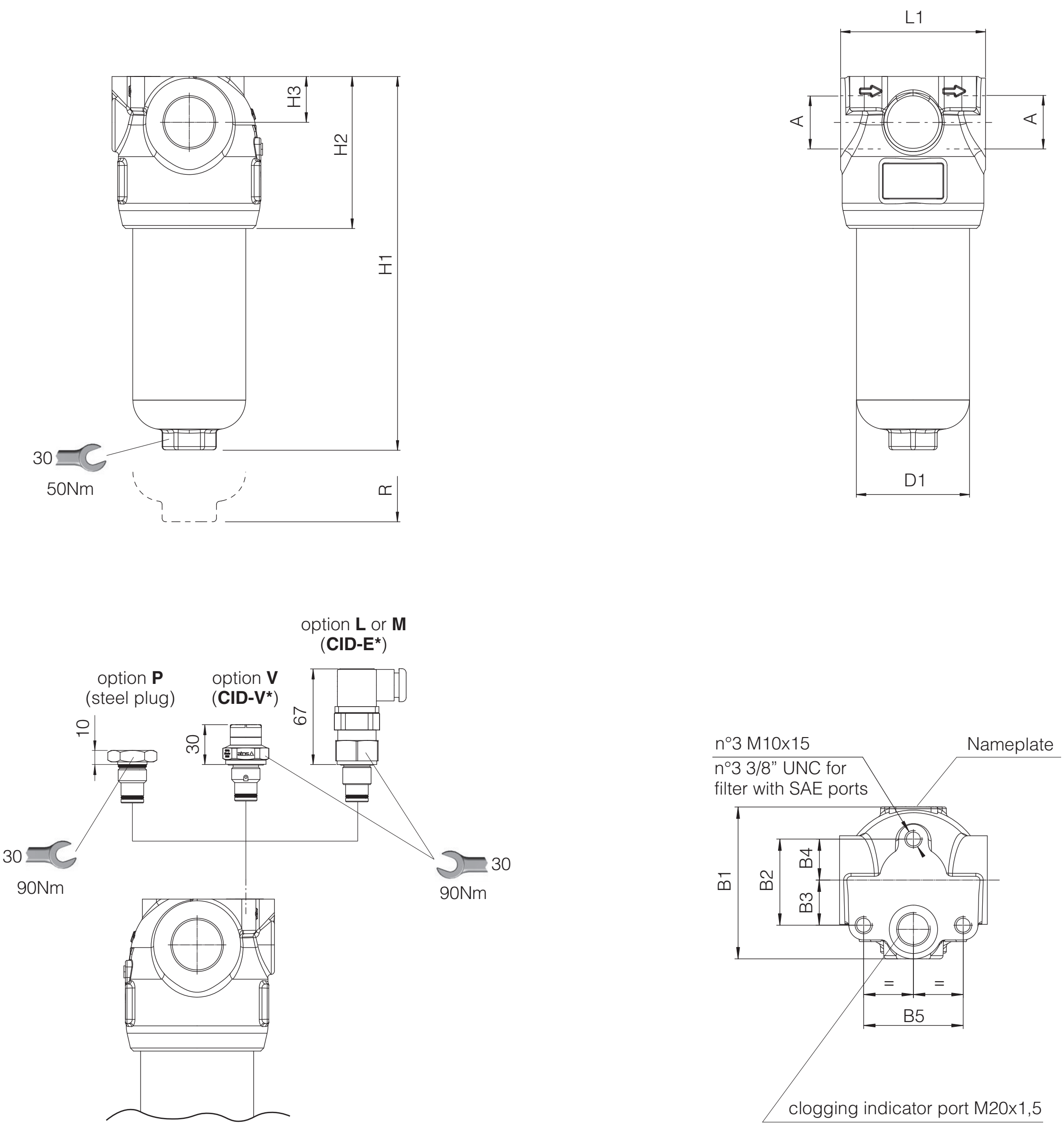



**FPS-20, FPS-30**



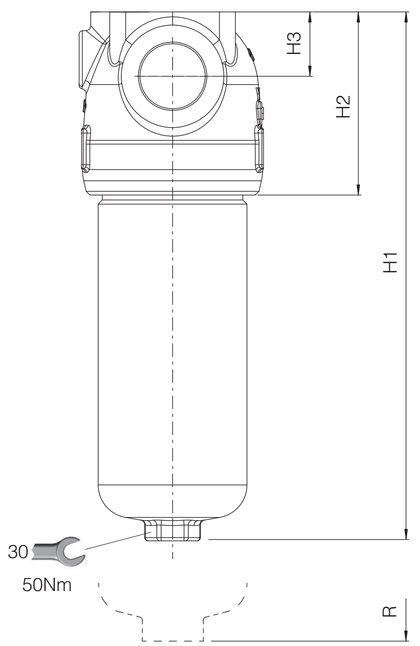
## 13 INSTALLATION DIMENSIONS OF FPS FILTERS [mm]

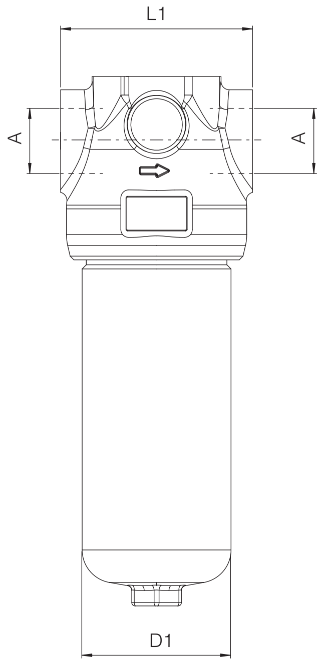
### FPS -10

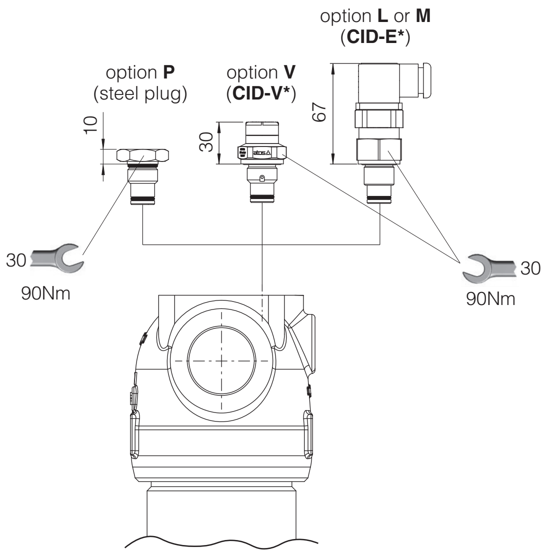


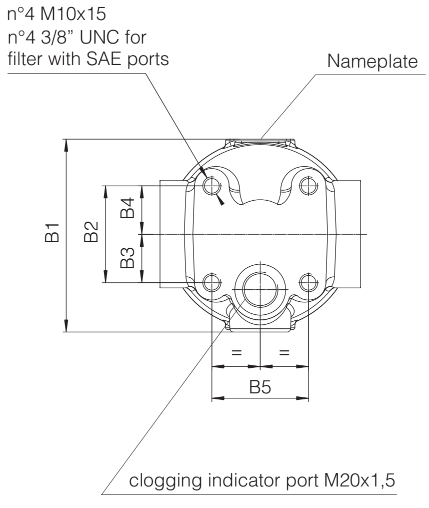

| Code | A | B1 | B2 | B3 | B4 | B5 | D1 | H1 | H2 | H3 | L1 | R (element removal) | Mass (Kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FPS-10-A | 1/2" BSPP<br>3/4" BSPP<br>1" BSPP<br>SAE-16 | 93.5 | 52.5 | 27.5 | 25 | 60.6 | 70 | 203 | 93 | 28 | 90 | 110 | 4 |
| FPS-10-B | | | | | | | | 296 | | | | | 5 |

# FPS -20



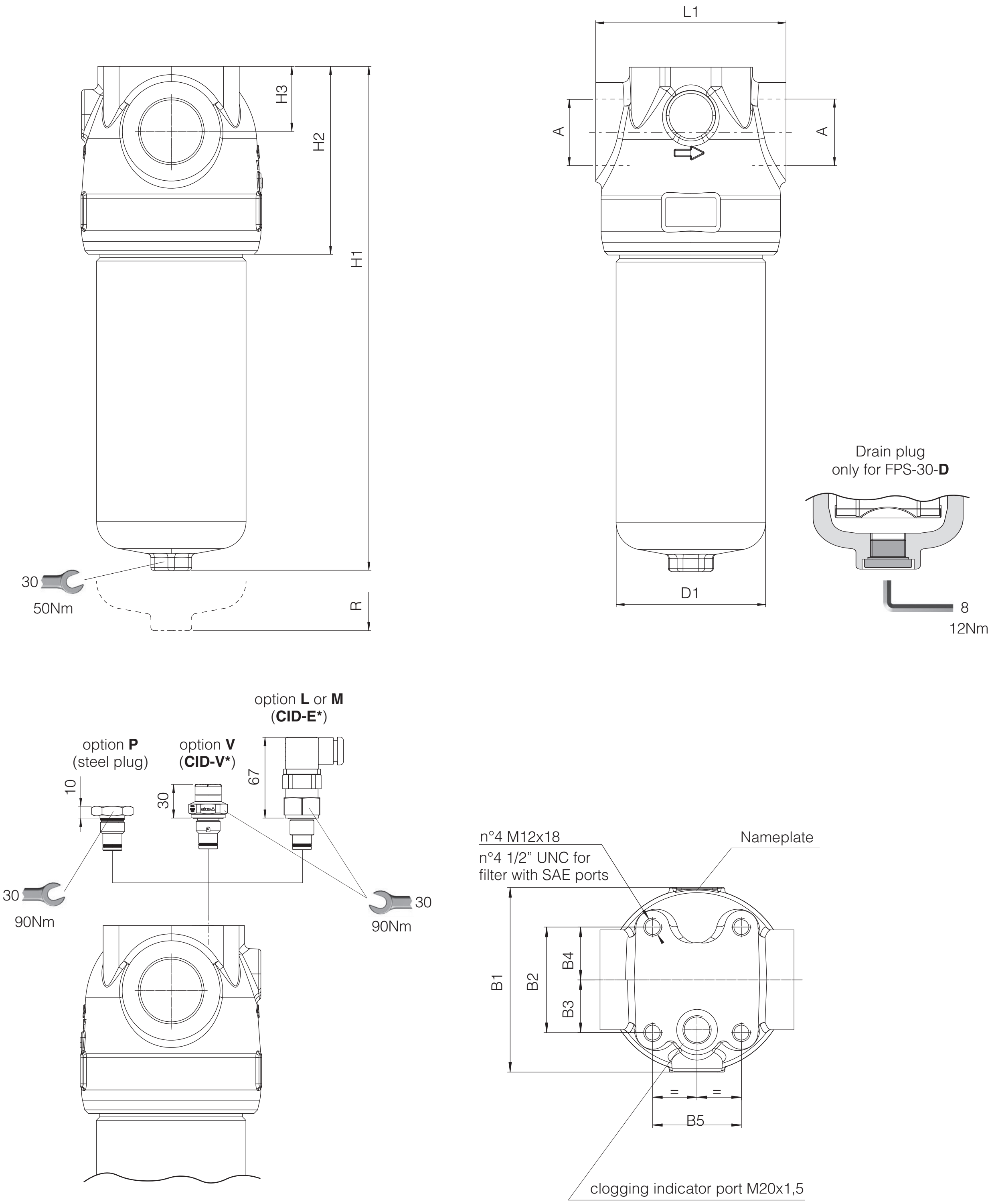



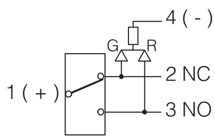
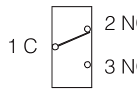
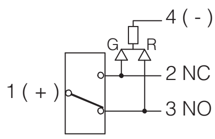
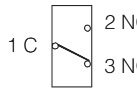

| Code | A | B1 | B2 | B3 | B4 | B5 | D1 | H1 | H2 | H3 | L1 | R<br>(element removal) | Mass (Kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FPS-20-A | | | | | | | | 261 | | | | | 7.4 |
| FPS-20-B | 1" BSPP<br>1 1/4" BSPP<br>SAE-20 | 111.5 | 56 | 28 | 28 | 56 | 90 | 320 | 111 | 39 | 116 | 120 | 8.5 |
| FPS-20-C | | | | | | | | 390 | | | | | 9.9 |

# FPS -30




| Code | A | B1 | B2 | B3 | B4 | B5 | D1 | H1 | H2 | H3 | L1 | R (element removal) | Mass (Kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FPS-30-A | 1 1/4" BSPP<br>1 1/2 BSPP<br>SAE-24 | 133.5 | 76 | 38 | 38 | 64 | 110 | 240.5 | 136 | 47 | 140 | 130 | 10.5 |
| FPS-30-B | | | | | | | | 333.5 | | | | | 13 |
| FPS-30-C | | | | | | | | 453.5 | | | | | 16.4 |
| FPS-30-D | | | | | | | | 552.5 | | | | | 19 |

## 14 CHARACTERISTICS OF DIFFERENTIAL CLOGGING INDICATORS

| Model code | | CID-E* ELECTRICAL | | CID-V* VISUAL |
|---|---|---|---|---|
| Differential switching pressure | CID-E05, CID-V05 | 5 bar ± 10% | | 5 bar ± 15% |
| | CID-E08, CID-V08 | 8 bar ± 10% | | 8 bar ± 10% |
| Max pressure | | 450 bar | | 420 bar |
| Max differential pressure | | 200 bar | | |
| Ambient temperature | | -25°C ÷ +100°C | | -25°C ÷ +80°C |
| Hydraulic connection | | M20x1,5 | | |
| Duty factor | | 100% | | |
| Mechanical life | | 1 x $10^6$ operations | | |
| Mass (Kg) | | 0,16 | | 0,11 |
| Electric connection | | Electric plug connection as per DIN 43650 with cable gland type PG7 | | - |
| Power supply | CID-E05-L, CID-E08-L | 24 $V_{DC}$ ± 10% | | - |
| | CID-E05-M, CID-E08-M | 14 $V_{DC}$ ÷ 30 $V_{DC}$ | 125 $V_{AC}$ ÷ 250 $V_{AC}$ | - |
| Max current - resistive (inductive) | | 5 A (4 A) ÷ 4 A (3 A) | 5 A (3 A) ÷ 3 A (2 A) | - |
| Protection degree to DIN EN 60529 | | IP65 with mathing connector | | - |
| Switching scheme | | CID-*-L | CID-*-M | |
| | clean filter element |   |   | GREEN |
| | clogged filter element |   |   | RED |

## 15 DIMENSIONS OF DIFFERENTIAL CLOGGING INDICATORS

**ELECTRICAL INDICATOR**

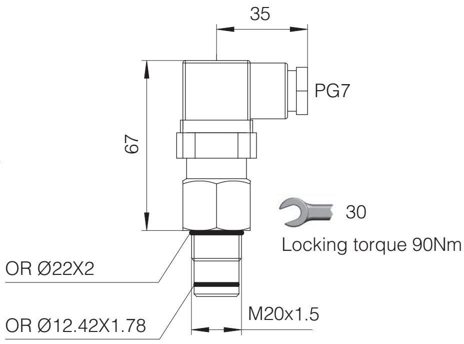
**CID-E05-L**
**CID-E08-L**

Electric connector
DIN 43650
Trasparent
**with internal Led**

**CID-E05-M**
**CID-E08-M**

Electric connector
DIN 43650
Black color

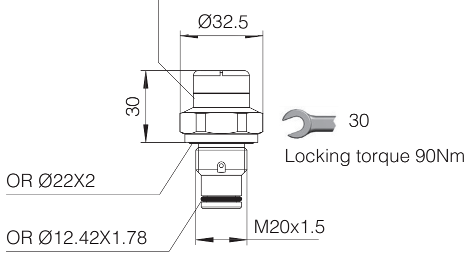
**Led signal:**
**Green** = clean filter element
**Red** = clogged filter element
(filter elements to be replaced)




**VISUAL INDICATOR**

**CID-V05**
**CID-V08**

**Visual signal:**
**Green** = clean filter element
**Red** = clogged filter element
(filter elements to be replaced)



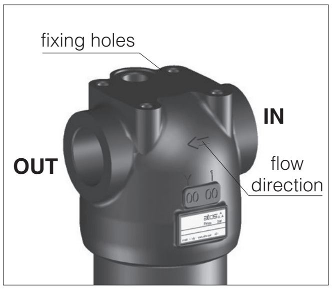

Note: the electrical connector can be oriented at steps of 90°

**NOTE**: Differential thermostated indicator CID-T and differential electronic transmitter CID-Z are available on request

## 16 INSTALLATION AND COMMISSIONING

The max operating pressure of the system must not exceed the max working pressure of the filter.
During the filter installation, pay attention to respect the flow direction, shown by the arrow on the filter head.
The filter should be preferably mounted with the bowl downward.
The filter should be properly secured using the threaded fixing holes on the filter head.
Make sure that there is enough space for the replacement of the filter element.
Never run the system without the filter element.
For filters ordered with clogging indicator:
- remove the plastic plug from the indicator port on the filter head
- install the clogging indicator and lock it at the specified torque

During the cold start up (fluid temperature lower than 30°C), a false clogging indicator signal can be given due to the high fluid viscosity.




## 17 MAINTENANCE

The filter element must be replaced as soon as the clogging indicator switches to highlight the filter clogged condition.
For filters without clogging indicator, the filter element must be replaced according to the system manufacturer's recommendations.
Select the new filter element according to the model code reported on the filter nameplate, see section 17.2

For the replacement of the filter element, proceed as follow:
- releases the system pressure; the filter has no pressure bleeding device
- pay attention to the fluid and filter surface temperature. Always use suitable gloves and protection glasses
- unscrew the bowl ② from the filter head ① by turning counterclockwise (view from bottom side)
- remove the dirty filter element ③ pulling it carefully
- lubricate the seal of new filter element and insert it over the spigot in the filter head
- clean the bowl internally, lubricate the threads and screw by hand the bowl to the filter head by turning clockwise (view from bottom side). Tighten at the recommended torque.


⚠ **WARNING**: The dirty filter elements cannot be cleaned and re-used. They are classified as "dangerous waste material", then they must be disposed of by authorized Companies, according to the local laws.

### 17.1 SEALS KIT

| Filter type | Seal kit code | Seal kit compositon |
|---|---|---|
| FPS-10 | GUARN FPS-10 | ④+⑤+⑥+⑦ |
| FPS-20 | GUARN FPS-20 | ④+⑤+⑥+⑦ |
| FPS-30 | GUARN FPS-30 | ④+⑤+⑥+⑦+⑧ |

### 17.2 FILTER IDENTIFICATION NAMEPLATE

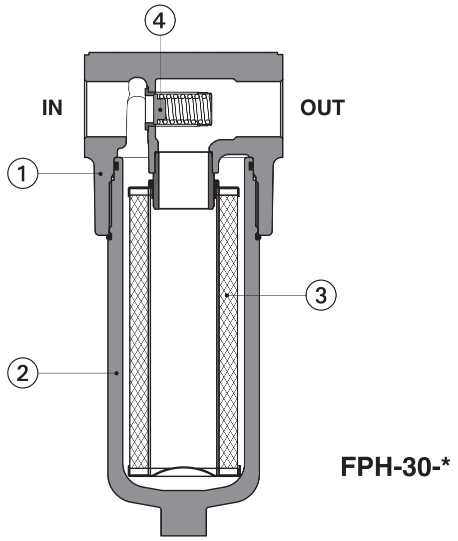

① Model code of complete filter
② Model code of filter element
③ Max working pressure
④ Filter matrix code

## 18 RELATED DOCUMENTATION

| | |
|---|---|
| **LF010** | Fluid contamination |
| **LF020** | Filtration guidelines |

# In line filters, high pressure type FPH

SAE flanged ports




(1) Filter head
(2) Filter bowl
(3) Filter element
(4) By-pass valve

**FPH**

In line filters are designed for installation on the pressure line downstream the pump, to ensure a high cleanliness of the fluid circulating into the hydraulic system. They protect sensible components from contamination present in the working fluid and they are particularly recommended for systems with proportional valve.

- two head sizes
- SAE 6000 flanged ports, from 3/4” to 1 1/2”
- high efficiency microfiber elements. Collapse pressure 21 bar for filters equipped with by-pass valve or 210 bar for filters without by-pass
- filtration rating 4,5 - 7 - 12 - 22 μm(c) (βx (c) >1000, ISO 16889).
- versions without or with by-pass valve with cracking pressure 6 bar.
- without or with differential clogging indicator

Max flow **400 l/min**
Max working pressure **420 bar**

## 1 MODEL CODE OF COMPLETE FILTERS

| FPH | - | 10 | - | A | - | F10 | - | 21 | - | R | - | W | | ** | / | * |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

**FPH**: In line filter, high pressure

**Filter size**:
**10** = ports size 3/4” ÷ 1” SAE6000 flange
**30** = ports size 1 1/4” ÷ 1 1/2 SAE6000 flange

| **Filter lenght**: | | Max flow [l/min] **(1)** FPH-10 | FPH-30 |
|---|---|---|---|
| **A** | = | 95 | 230 |
| **B** | = | 115 | 320 |
| **C** | = | - | 350 |
| **D** | = | - | 400 |

**Filter element:**
**SN** = only body, without filter element
**Microfibre filter element** βx(c) >1000 - ISO 16889:
**F03** = 4,5 μm (c); **F10** = 12 μm (c);
**F06** = 7 μm (c) **F20** = 22 μm (c)

**Ports size**:
SAE 6000 flange with metric bolts:

| FPH-10 | FPH-30 |
|---|---|
| **21** = 3/4” | **23** = 1 1/4” |
| **22** = 1” | **24** = 1 1/2” |

**By-pass**:
**R** = by-pass valve with cracking pressure 6 bar (filter element with collapse pressure 21 bar)
**N** = without by-pass (filter element with collapse pressure 210 bar)

**Differential clogging indicator** see sect. 9 :
**W** = without, indicator port with plastic plug **(2)**
**P** = without, indicator port with steel plug
**L** = electrical indicator with LED **(3)**
**M** = electrical indicator without LED **(3)**
**V** = visual indicator **(3)**
See also note **(4)**

**Series number** (**)

**Seals material**:
- = NBR
**PE** = FKM **(4)**

**Note:** filters for use in potentially explosive atmosphere are available on request, contact Atos Technical Office

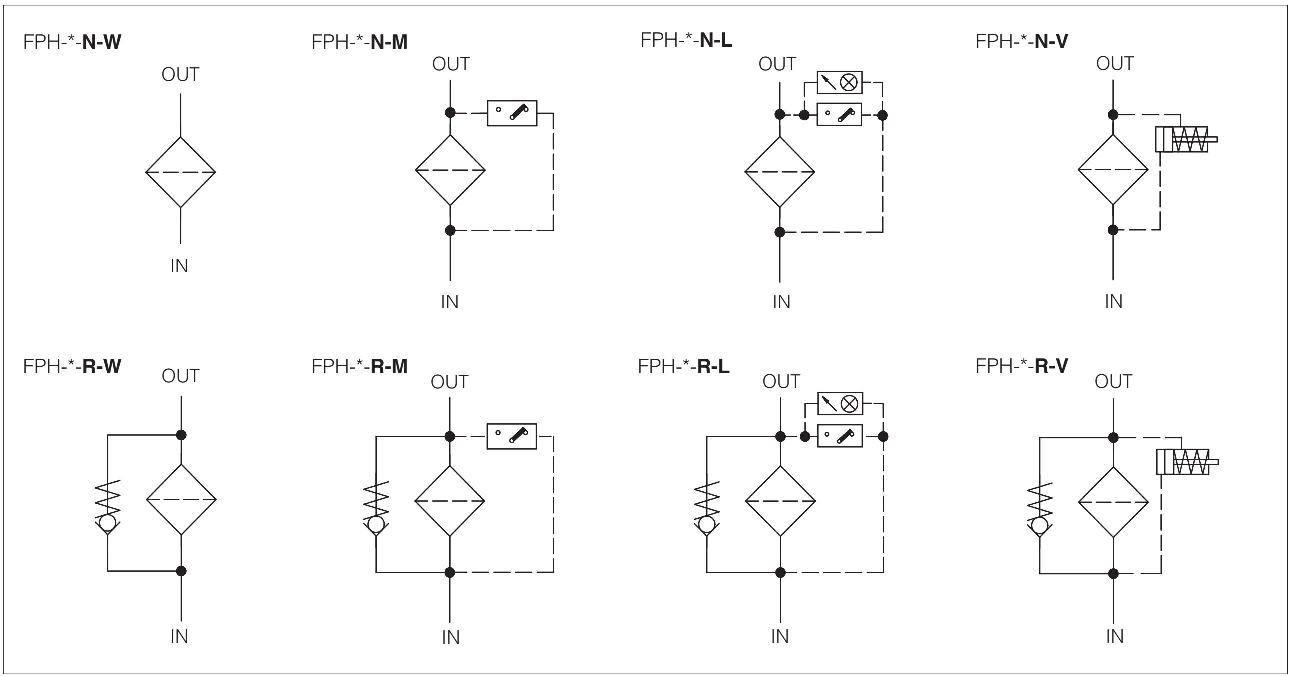
**(1)** Max flow rates are measured with: Δp 1 bar, filter element F20, largest port size, option -R, oil viscosity 32 $mm^2/s$ - see also section 6
In case of different conditions see section 11 for filter sizing

**(2)** The plastic plug (option W) is only intended to prevent impurities from entering the filter through the clogging indicator port.
A clogging indicator must be fitted on the filter before commissioning. Do not install the filter with the plastic cap on the hydraulic system

**(3)** The clogging indicator is supplied disassembled from the filter. The indicator port on filter head is plugged with plastic plug

**(4)** Differential thermostated indicator CID-T and differential electronic transmitter CID-Z are available on request, see section 4

## 2 HYDRAULIC SYMBOLS (representation according to ISO 1219-1)




## 3 MODEL CODE OF FILTER ELEMENTS - only for spare (1)

| PSH | - | 10 | - | A | - | F10 | - | R | * | / | * |
|---|---|---|---|---|---|---|---|---|---|---|---|

**PSH**: Spare filter element for in line filter type FPH

**Series number**: *

**Seals material** (*):
- `-` = NBR
- **PE** = FKM

**Filter element size**:
- **10** = for FPH-10
- **30** = for FPH-30

**R** = filter element with collapse pressure 21 bar, for filter FPH-*-R with by-pass valve

**N** = filter element with collapse pressure 210 bar, for filter FPH-*-N without by-pass valve

**Filter element lenght**:

| for FPH-10 | for FPH-30 |
|---|---|
| **A** | **A** |
| **B** | **B** |
| | **C** |
| | **D** |

**Microfibre filter element**, βx(c) >1000 - ISO 16889:
- **F03** = 4,5 μm (c)
- **F06** = 7 μm (c)
- **F10** = 12 μm (c)
- **F20** = 22 μm (c)

**(1)** Select the filter element according to the model code reported on the filter nameplate, see section 16.2

## 4 MODEL CODE OF DIFFERENTIAL CLOGGING INDICATORS - only for spare - see section 13 and 14

| CID | - | E | 05 | - | M | * | / | * |
|---|---|---|---|---|---|---|---|---|

**CID**: Spare differential clogging indicator for in line filter

**Series number**: *

**Seals material** (*):
- `-` = NBR
- **PE** = FKM

**Type of indicator**:
- **E** = electrical
- **V** = visual
- **T** = thermostated (available on request)
- **Z** = electronic transmitter (available on request)

**Differential switching pressure** (only for CID-E and CID-V):
- **05** = 5 bar for filters with by-pass valve
- **08** = 8 bar for filters without by-pass valve

**Optional LED** - only for CID-E
- **L** = with LED
- **M** = without LED

## 5 GENERAL CHARACTERISTICS

| | | |
|---|---|---|
| Assembly position / location | | Vertical position with the bowl downward |
| Ambient temperature range | | **Standard** = -20°C ÷ +70°C **/PE** option = -20°C ÷ +70°C |
| Storage temperature range | | **Standard** = -20°C ÷ +80°C **/PE** option = -20°C ÷ +80°C |
| Materials | Filter head | Cast iron |
| | Filter bowl | Carbon steel |
| Surface protection | | Phosphatized |
| Fatigue strength | | min. 1 x $10^6$ cycles at 420 bar |
| Compliance | | RoHS Directive 2011/65/EU as last update by 2015/863/EU<br>REACH Regulation (EC) n°1907/2006 |

## 6 HYDRAULICS CHARACTERISTICS - based on mineral oil ISO VG 46 at 50 °C (viscosity 32mm²/s)

| | | | | | |
|---|---|---|---|---|---|
| Filter size | | **FPH-10** | | **FPH-30** | |
| Ports size code | | **21** | **22** | **23** | **24** |
| Ports dimension | SAE 6000 flange | 3/4" | 1" | 1 1/4" | 1 1/2" |
| Filter lenght | | **A ÷ B** | | **A ÷ D** | |
| Max flow (l/min) at Δp= 1 bar<br>Filter with by-pass **-R**<br>(see note) | **F03** | 30÷47 | 31÷51 | 63÷192 | 65÷200 |
| | **F06** | 47÷69 | 52÷82 | 105÷269 | 108÷285 |
| | **F10** | 62÷81 | 72÷100 | 168÷318 | 174÷340 |
| | **F20** | 79÷90 | 95÷115 | 217÷374 | 230÷400 |
| | | | | | |
| Max flow (l/min) at Δp= 1 bar<br>Filter without by-pass **-N**<br>(see note) | **F03** | 26÷43 | 27÷47 | 54÷160 | 55÷167 |
| | **F06** | 35÷62 | 38÷72 | 74÷218 | 75÷230 |
| | **F10** | 57÷75 | 64÷90 | 148÷254 | 153÷270 |
| | **F20** | 72÷88 | 86÷110 | 190÷345 | 198÷370 |
| Max operating pressure | [bar] | **420** | | | |
| Burst pressure | [bar] | **> 1260** | | | |

**Note:** Max flow rates are measured with min and max filter length. In case of different conditions see section 11 for filter sizing

## 7 FILTER ELEMENTS

| | | |
|---|---|---|
| Material | | Inorganic microfibre |
| Filtation rating as per ISO16889 | **F03** | $\beta_{4,5\mu m\,(c)} \geq 1000$ |
| | **F06** | $\beta_{7\mu m\,(c)} \geq 1000$ |
| | **F10** | $\beta_{12\mu m\,(c)} \geq 1000$ |
| | **F20** | $\beta_{22\mu m\,(c)} \geq 1000$ |
| Filter element collapse pressure | **R** = for filter with by-pass valve | 21 bar |
| | **N** = for filter without by-pass valve | 210 bar |

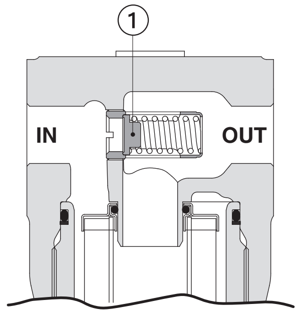
## 8 SEALS AND HYDRAULIC FLUIDS - for other fluids not included in below table, consult our technical office

| | | | |
|---|---|---|---|
| Seals, recommended fluid temperature | NBR seals (standard) = -25°C ÷ +100°C, with HFC hydraulic fluids = +10°C ÷ +50°C<br>FKM seals (/PE option) = -25°C ÷ +100°C | | |
| Recommended viscosity | 15 ÷ 100 mm²/s - max allowed range 2.8 ÷ 500 mm²/s | | |
| **Hydraulic fluid** | **Suitable seals type** | **Classification** | **Ref. Standard** |
| Mineral oils | NBR, FKM | HL, HLP, HLPD, HVLP, HVLPD | DIN 51524 |
| Flame resistant without water | FKM | HFDU, HFDR | ISO 12922 |
| Flame resistant with water | NBR | HFC | |

## 9 BY-PASS VALVE

**Filter with by-pass valve** - version **-R**

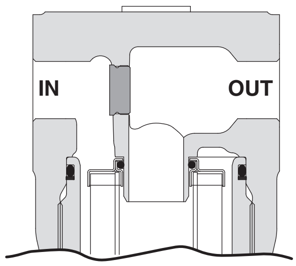
The filter with by-pass valve (1) is used in combination with filter elements PSH-*-R with collapse pressure 21 bar.
The by-pass valve allows the oil flow to by-pass the filter element in particular conditions:
- it protects the filter element from pressure peaks that could be generated, especially at the cold system start-up. In these cases the valve opens only for the instant necessary to discharge the pressure peak, limiting the quantity of oil that bypasses the filter.
- it allows the free passage of the oil flow in case of completely clogged filter element (Δp > 6 bar).
  This situation should be carefully avoided, by means of a scheduled maintenance, otherwise the contaminated oil will pass to the clean side of the filter and then it will circulate in the hydraulic system.
  The filter element must be replaced before the clogging condition, at this purpose the use of a differential clogging indicator CID-V (visual, option V) or CID-E (electrical, options L or M) is highly recommended.



FPH-*-R

**Filter without by-pass valve** - version **-N**

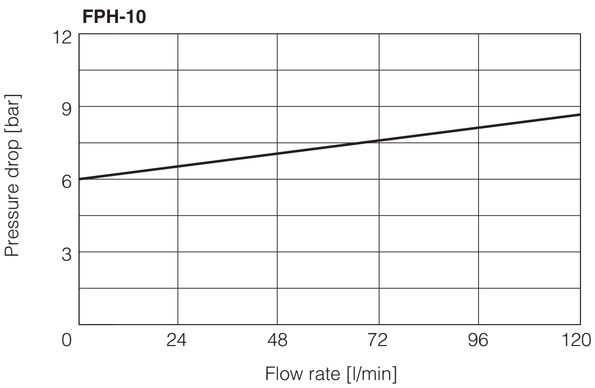
The filter version without by-pass is recommended when the hydraulic system must be absolutely protected by contamination, then avoiding the risk that the contaminant passes though the by-pass valve.
The filter without by pass must be used in combination with filter elements PSH-N with high collapse pressure 210 bar.

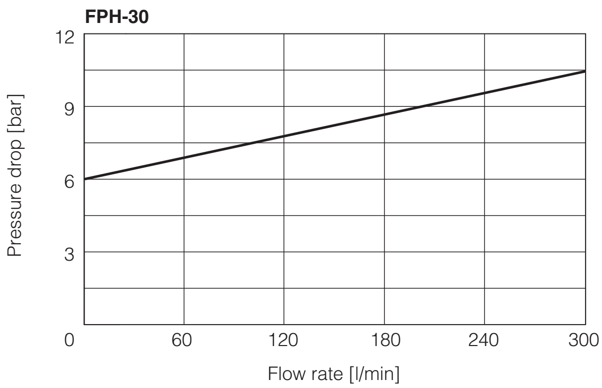


FPH-*-N

## 10 BY-PASS VALVE - based on mineral oil ISO VG46 at 50°C (viscosity = 32 $mm^2/s$)

Q/Δp diagrams of flow through the by-pass valve



## 11 FILTERS SIZING

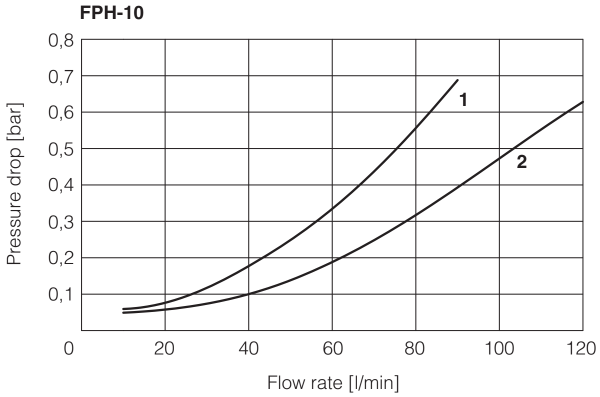
For the filter sizing it is necessary to consider the Total Δp at the maximum flow at which the filter must work.
The Total Δp is given by the sum of filter head Δp plus the filter element Δp:

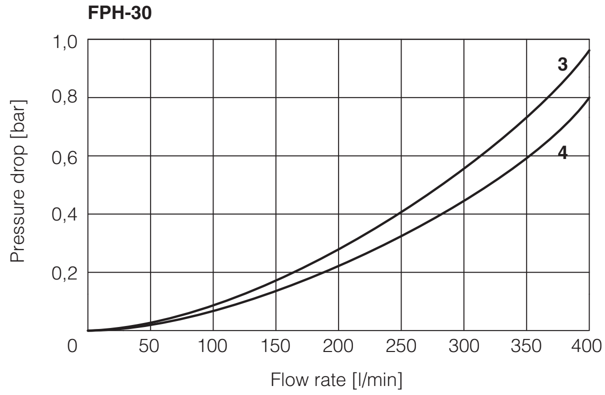
**Total Δp = filter head Δp + filter element Δp**

In the best conditions the total Δp should not exceed 1,0 bar
See below sections to calculate the Δp of filter head and Δp of the filter element

### 11.1 Q/Δp DIAGRAMS OF FILTER HEAD

The pressure drop of filter head mainly depends on the ports size and fluid density
In the following diagrams are reported the Δp characteristics of filter head based on mineral oil with density 0,86 kg/dm$^3$ and viscosity 30 mm$^2$/s




**1** = FPH-10*** 21 (3/4" SAE 6000) **2** = FPH-10*** 22 (1" SAE 6000) **3** = FPH-30*** 23 (1 1/4"SAE 6000) **4** = FPH-30*** 24 (G 1 1/2"SAE 6000)

### 11.2 FILTER ELEMENT Δp

The pressure drop through the filter depends to:
- size of filter element
- filtration rating
- fluid viscosity

The Δp of filter element is given by the formula:

$$\textbf{Δp of filter element} = \mathbf{Q} \times \frac{\mathbf{Gc}}{\mathbf{1000}} \times \frac{\mathbf{Viscosity}}{\mathbf{30}}$$

**Q** = working flow (l/min)
**Gc** = Gradient coefficient (mbar/(l/min)). The Gc values are reported in the following table
**Viscosity** = effective fluid viscosity in the working conditions ( mm$^2$/s)

**Gradient coefficent Gc of PSH filter elements**

| Filter element size | | 10 | | 30 | | | |
|---|---|---|---|---|---|---|---|
| Filter element lenght | | A | B | A | B | C | D |
| Filter element type | Filtration rating | **Gc** Gradient coefficient | | | | | |
| **R** for filter with bypass valve | **F03** | 27.75 | 15.25 | 14 | 7.13 | 4.7 | 3.62 |
| | **F06** | 15.12 | 7.58 | 8.03 | 3.37 | 2.2 | 1.89 |
| | **F10** | 9.37 | 4.91 | 4.43 | 2.33 | 1.5 | 1.12 |
| | **F20** | 5.31 | 3.25 | 2.95 | 1.34 | 0.92 | 0.44 |
| **N** for filter without bypass valve | **F03** | 32.2 | 17.32 | 16.48 | 8.13 | 5.5 | 4.71 |
| | **F06** | 22.38 | 9.41 | 11.88 | 4.18 | 3.28 | 2.91 |
| | **F10** | 11.2 | 6.27 | 5.27 | 3.45 | 2.36 | 2.15 |
| | **F20** | 6.81 | 3.71 | 3.70 | 1.60 | 0.86 | 0.78 |

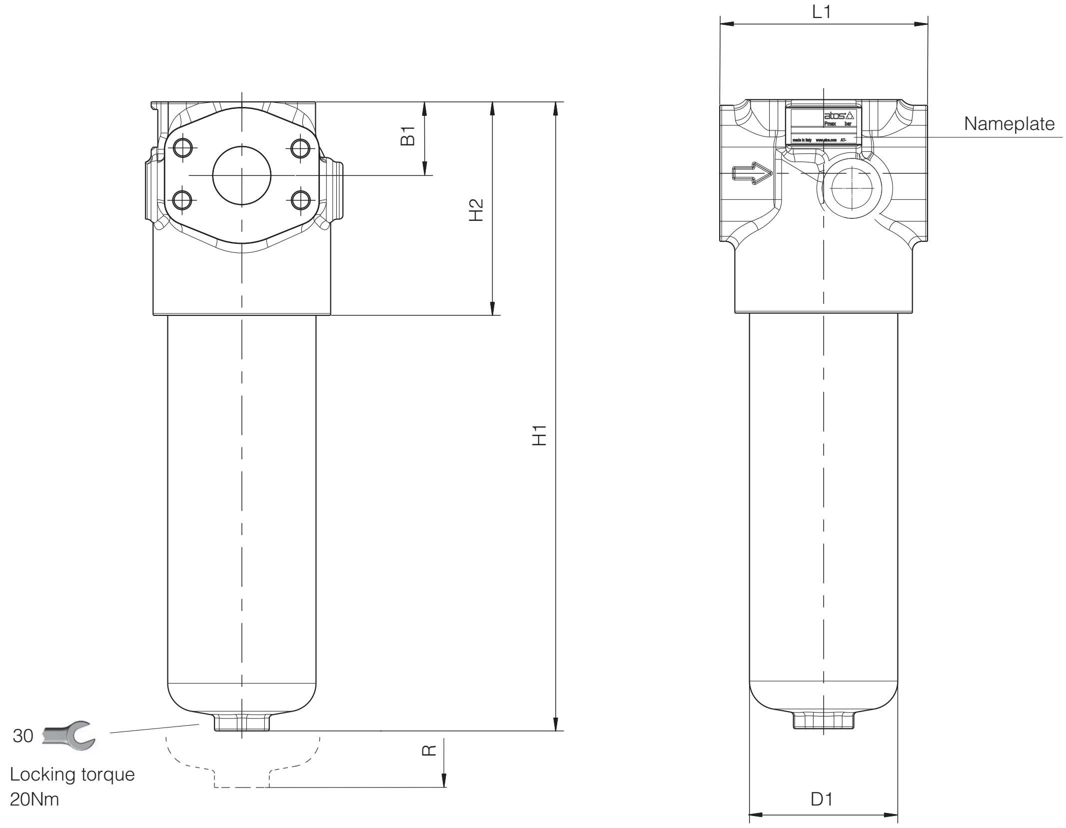
**Example**:
calculation of Total Δp for filter type FPH-30-C-F06-04-R at Q = 200 l/min and viscosity 46 mm$^2$/s (filter element PSH-30-C-F06-R)
**Δp** of filter head + filter bowl = 0,22 bar
**Gc** = 2,2 mbar/(l/min)

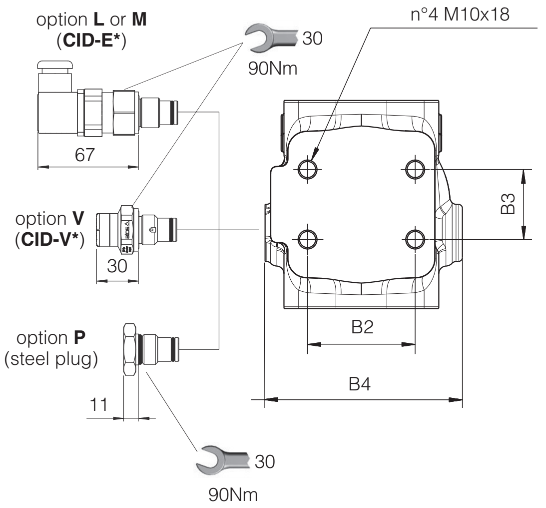
$$\textbf{Filter element Δp} = 200 \times \frac{2,2}{1000} \times \frac{46}{30} = 0,68 \text{ bar}$$

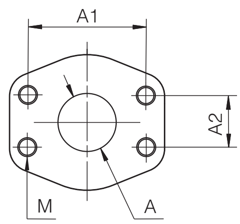
**Total Δp** = 0,22 + 0,68 = **0,90 bar**

 **INSTALLATION DIMENSIONS OF FPH FILTERS** [mm]

# FPH -10



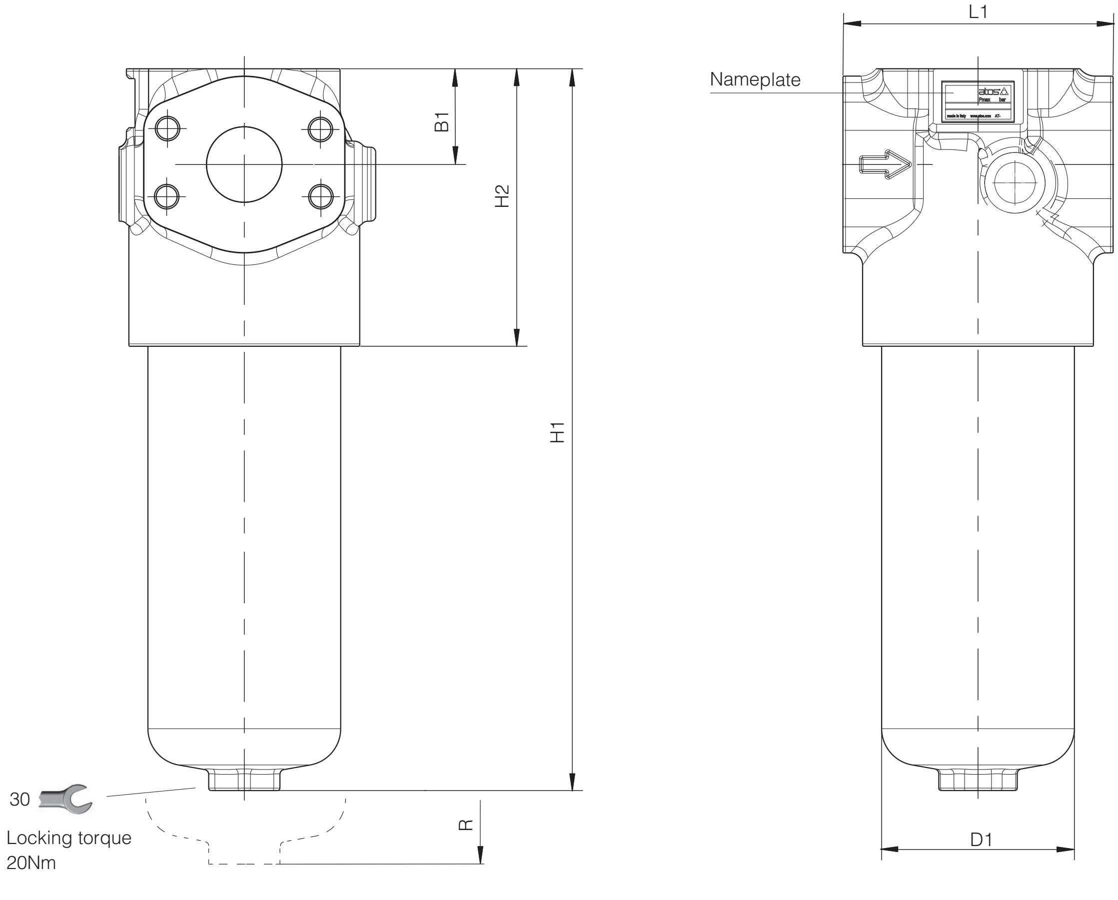



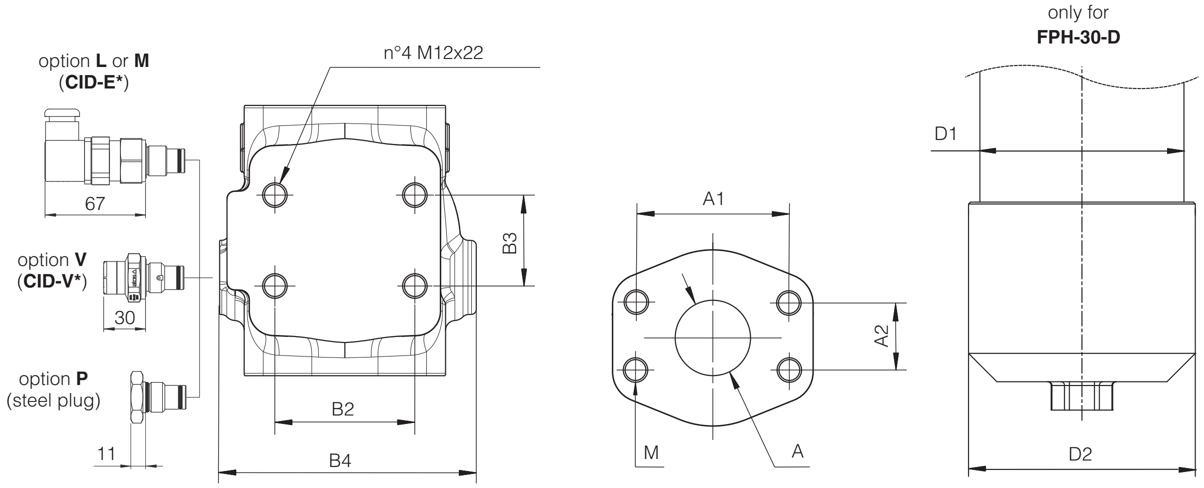




| SAE J518-6000 FLANGE | A | A1 | A2 | M |
|---|---|---|---|---|
| 3/4" | 19 | 50.8 | 23.8 | M10 |
| 1" | 22 | 57.2 | 27.8 | M12 |

| Code | B1 | B2 | B3 | B4 | D1 | D2 | F | H1 | H2 | L1 | R (element removal) | Mass (Kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FPH-10-A | 39 | 57 | 37 | 105 | 78,5 | - | 68 | 222 | 113 | 110 | 130 | 6,7 |
| FPH-10-B | | | | | | | | 333 | | | | 8,4 |

# FPH -30

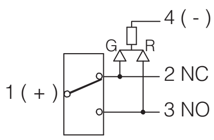
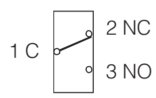
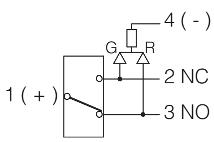
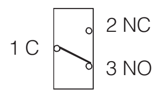



| SAE J518-6000 FLANGE | A | A1 | A2 | M |
|---|---|---|---|---|
| 1 1/4" | 32 | 66.7 | 31.8 | M14 |
| 1 1/2" | 38 | 79.4 | 36.5 | M16 |

<table>
<tr><th>Code</th><th>B1</th><th>B2</th><th>B3</th><th>B4</th><th>D1</th><th>D2</th><th>F</th><th>H1</th><th>H2</th><th>L1</th><th>R<br>(element removal)</th><th>Mass (Kg)</th></tr>
<tr><td>FPH-30-A</td><td rowspan="4">47</td><td rowspan="4">76</td><td rowspan="4">64</td><td rowspan="4">140</td><td rowspan="4">107</td><td rowspan="3">-</td><td rowspan="4">68</td><td>262</td><td rowspan="4">145</td><td rowspan="4">140</td><td rowspan="4">140</td><td>13,2</td></tr>
<tr><td>FPH-30-B</td><td>355</td><td>15,5</td></tr>
<tr><td>FPH-30-C</td><td>475</td><td>18,4</td></tr>
<tr><td>FPH-30-D</td><td>120</td><td>568</td><td>22,8</td></tr>
</table>

## 13 CHARACTERISTICS OF DIFFERENTIAL CLOGGING INDICATORS

| Model code | | CID-E* ELECTRICAL | | CID-V* VISUAL |
|---|---|---|---|---|
| Differential switching pressure | CID-E05, CID-V05 | 5 bar ± 10% | | 5 bar ± 15% |
| | CID-E08, CID-V08 | 8 bar ± 10% | | 8 bar ± 10% |
| Max pressure | | 450 bar | | 420 bar |
| Max differential pressure | | 200 bar | | |
| Ambient temperature | | -25°C ÷ +100°C | | -25°C ÷ +80°C |
| Hydraulic connection | | M20x1,5 | | |
| Duty factor | | 100% | | |
| Mechanical life | | 1 x $10^6$ operations | | |
| Mass (Kg) | | 0,16 | | 0,11 |
| Electric connection | | Electric plug connection as per DIN 43650 with cable gland type PG7 | | - |
| Power supply | CID-E05-L, CID-E08-L | 24 $V_{DC}$ ± 10% | | - |
| | CID-E05-M, CID-E08-M | 14 $V_{DC}$ ÷ 30 $V_{DC}$ | 125 $V_{AC}$ ÷ 250 $V_{AC}$ | - |
| Max current - resistive (inductive) | | 5 A (4 A) ÷ 4 A (3 A) | 5 A (3 A) ÷ 3 A (2 A) | - |
| Protection degree to DIN EN 60529 | | IP65 with mathing connector | | - |
| Switching scheme | | **CID-*-L** | **CID-*-M** | |
| | clean filter element |  |  | GREEN |
| | clogged filter element |  |  | RED |

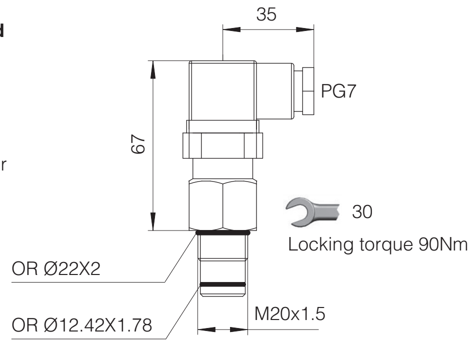
## 14 DIMENSIONS OF DIFFERENTIAL CLOGGING INDICATORS

### ELECTRICAL INDICATOR

**CID-E05-L**
**CID-E08-L**
Electric connector
DIN 43650
Trasparent
**with internal Led**

**CID-E05-M**
**CID-E08-M**
Electric connector
DIN 43650
Black color

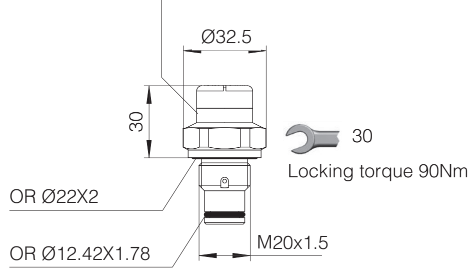
**Led signal:**
**Green** = clean filter element
**Red** = clogged filter element
(filter elements to be replaced)




### VISUAL INDICATOR

**CID-V05**
**CID-V08**

**Visual signal:**
**Green** = clean filter element
**Red** = clogged filter element
(filter elements to be replaced)




Note: the electrical connector can be oriented at steps of 90°

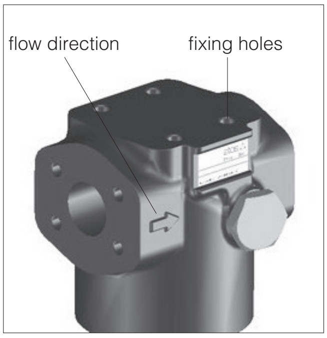
**NOTE**: Differential thermostated indicator CID-T and differential electronic transmitter CID-Z are available on request

## 15 INSTALLATION AND COMMISSIONING

The max operating pressure of the system must not exceed the max working pressure of the filter.
During the filter installation, pay attention to respect the flow direction, shown by the arrow on the filter head.
The filter should be preferably mounted with the housing downward.
The filter should be properly secured using the threaded fixing holes on the filter head.
Make sure that there is enough space for the replacement of the filter element.
Never run the system without the filter element.
For filters ordered with clogging indicator:

- remove the plastic plug from the indicator port on the filter head
- install the clogging indicator and lock it at the specified torque

During the cold start up (fluid temperature lower than 30°C), a false clogging indicator signal can be given due to the high fluid viscosity.

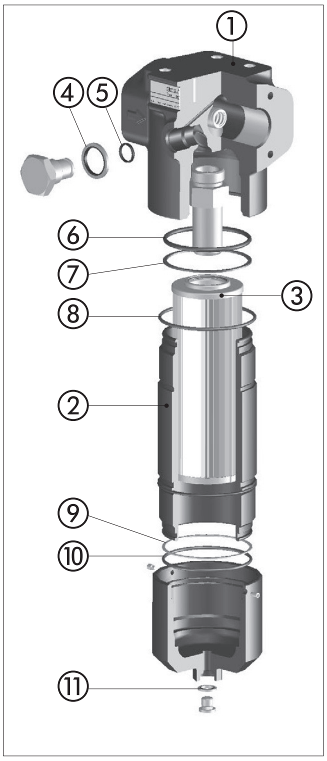



## 16 MAINTENANCE

The filter element must be replaced as soon as the clogging indicator switches to highlight the filter clogged condition
For filters without clogging indicator, the filter element must be replaced according to the system manufacturer's recommendations.
Select the new filter element according to the model code reported on the filter nameplate, see section 14.1

For the replacement of the filter element, proceed as follow:

- releases the system pressure; the filter has no pressure bleeding device
- pay attention to the fluid and filter surface temperature. Always use suitable gloves and protection glasses
- unscrew the bowl ② from the filter head ① by turning counterclockwise (view from bottom side)
- remove the dirty filter element ③ pulling it carefully
- lubricate the seal of new filter element and insert it over the spigot in the filter head
- clean the bowl internally, lubricate the threads and screw by hand the bowl to the filter head by turning clockwise (view from bottom side). Tighten at the recommended torque.




⚠ **WARNING**: The dirty filter elements cannot be cleaned and re-used. They are classified as "dangerous waste material", then they must be disposed of by authorized Companies, according to the local laws.

### 16.1 SEALS KIT

| Filter type | Seal kit code | Seal kit compositon |
|---|---|---|
| FPH-10 | GUARN FPH-10 | ④+⑤+⑥+⑦+⑧ |
| FPH-30 | GUARN FPH-30 | ④+⑤+⑥+⑦+⑧ |
| FPH-30-D | GUARN FPH-30-D | ④+⑤+⑥+⑦+⑧+⑨+⑩+⑪ |

### 16.2 FILTER IDENTIFICATION NAMEPLATE

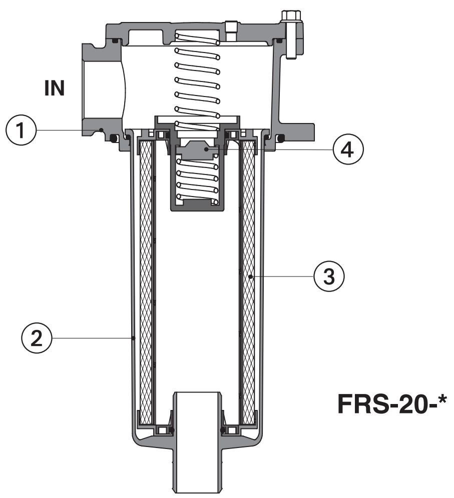

① Model code of complete filter
② Model code of filter element
③ Max working pressure
④ Filter matrix code

## 17 RELATED DOCUMENTATION

| | |
|---|---|
| **LF010** | Fluid contamination |
| **LF020** | Filtration guidelines |

# Return line filters, tank-top type FRS

Threaded ports




① Filter head
② Filter bowl
③ Filter element
④ By-pass valve

**FRS**

Return filters are designed to ensure cleanliness of fluid back to the tank from contamination collected downstream of the hydraulic circuit.

They are specific for installation on the top of the hydraulic tank.

- four head sizes
- threaded ports size from G1/2" to G2" or SAE-12 to SAE-32
- by-pass valve with cracking pressure 3 bar
- high efficency microfibre filter element with filtration rating 7 - 12 - 27 μm(c) (βx (c) >1000, ISO 16889)
- cellulose filter elements with filtration rating 10 or 25 μm (βx (c) >2, ISO 16889)
- without or with electrical or visual clogging indicators

Max flow **600 l/min**
Max working pressure **8 bar**

## 1 MODEL CODE OF COMPLETE FILTERS

| FRS | - | 10 | - | A | - | F10 | - | 00 | - | R | - | W | ** | / | * |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

Return line filter

Series number

Seals material:
- = NBR
**PE** = FKM

**Filter size**:
**10** = ports size 1/2" ÷ 3/4"
**20** = ports size 1/2" ÷ 1 1/4"
**30** = ports size 1" ÷ 1 1/2"
**40** = ports size 1 1/4" ÷ 2"

**Clogging indicator** see sect. 12:
**W** = without, indicator port plugged with steel plug
**E** = electrical indicator **(5)**
**V** = visual indicator **(5)**

| **Filter lenght**: | Max flow [l/min] **(1)** FRS-10 | FRS-20 | FRS-30 | FRS-40 |
|---|---|---|---|---|
| **A** = | 45 | 65 | 275 | 355 |
| **B** = | 55 | 110 | 300 | 480 |
| **C** = | - | 175 | - | 550 |
| **D** = | - | 200 | - | 430 **(2) (3)** |
| **E** = | - | - | - | 600 **(2)** |

**By-pass**:
**R** = by-pass valve with cracking pressure 3 bar

**SN** = only body, without filter element

**Microfibre filter element**, βx(c) >1000 - ISO 16889:
**F06** = 7 μm (c)
**F10** = 12 μm (c)
**F25** = 27 μm (c)

**Cellulose filter element**, βx (c) >2 - ISO 16889:
**C10** = 10 μm (c)
**C25** = 25 μm (c)

**Ports size**:
BSPP threaded:

| FRS-10 | FRS-20 | FRS-30 | FRS-40 |
|---|---|---|---|
| **00** = G 1/2" | **00** = G 1/2" | **02** = G 1" | **03** = G 1 1/4" |
| **01** = G 3/4" | **01** = G 3/4" | **03** = G 1 1/4" | **04** = G 1 1/2" |
| | **02** = G 1" | **04** = G 1 1/2" | **05** = G 2" |
| | **03** = G 1 1/4" | | |

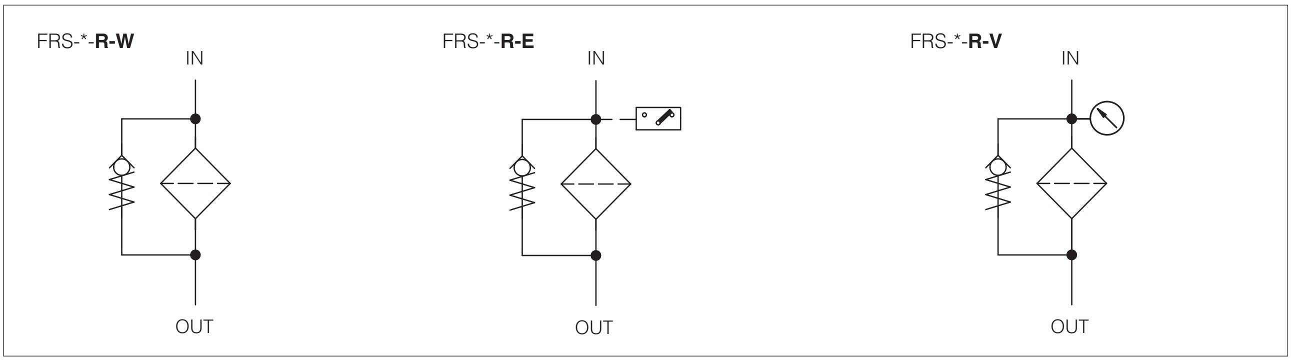
SAE J1926-1 threaded **(4)**:

| FRS-10 | FRS-20 | FRS-30 | FRS-40 |
|---|---|---|---|
| **41** = SAE-12 (3/4") | **42** = SAE-16 (1") | **44** = SAE-24 (1 1/2") | **45** = SAE-32 (2") |

**Note:** filters for use in potentially explosive atmosphere are available on request, contact Atos Technical Office

**(1)** Max flow rates are measured with: Δp 0,5 bar, filter element F25, largest port size, oil viscosity 32 $mm^2/s$ - see also section 6
In case of different conditions see section 9 for filter sizing
**(2)** Available only for FRS-40 series 11, on request
**(3)** Filters type FRS-40-D is similar to FRS-40-B but it uses filter elements with smaller internal diameter
**(4)** Filters with SAE threaded ports are available on request
**(5)** The clogging indicator is supplied disassembled from the filter. The indicator port on filter head is plugged with steel plug

## 2 HYDRAULIC SYMBOLS (representation according to ISO 1219-1)




## 3 MODEL CODE OF FILTER ELEMENTS - only for spare **(1)**

| PRS | - | 10 | - | A | - | F10 | ** | / | * |
|---|---|---|---|---|---|---|---|---|---|

**PRS**: Spare filter element for return line filter type FRS

**Filter element size**:

**10** = for FRS-10
**20** = for FRS-20
**30** = for FRS-30
**40** = for FRS-40

**Filter element lenght**:

| for FRS-10 | for FRS-20 | for FRS-30 | for FRS-40 |
|---|---|---|---|
| **A** | **A** | **A** | **A** |
| **B** | **B** | **B** | **B** |
| | **C** | | **C** |
| | **D** | | **D** |
| | | | **E** |

**Microfibre filter element**, βx(c) >1000 - ISO 16889:

**F06** = 7 µm (c)
**F10** = 12 µm (c)
**F25** = 27 µm (c)

**Cellulose filter element**, βx (c) >2 - ISO 16889:

**C10** = 10 µm
**C25** = 25 µm

******: Series number

Seals material:

\- = NBR
**PE** = FKM **(2)**

**(1)** Select the filter element according to the model code reported on the filter nameplate, see section 14.1
**(2)** Filters with FKM seals are available on request
note: the spare filter element includes the by-pass valve

## 4 MODEL CODE OF CLOGGING INDICATORS - only for spare - see section 13 and 14

| CIA | - | V | ** |
|---|---|---|---|

**CIA**: Clogging indicator for return line filter type FRS

**Type of indicator**:

**E** = Electrical - pressure switch, switching pressure 2 bar
**V** = Visual - pressure gauge, range 0 ÷ 10 bar **(1)**

******: Series number

**(1)** Visual clogging indicator with rear side connection **CIA-V/P** available on request

## 5 GENERAL CHARACTERISTICS

| | | |
|---|---|---|
| Assembly position / location | | Vertical position with the bowl downward |
| Ambient temperature range | | **Standard** = -20°C ÷ +70°C **/PE** option = -20°C ÷ +70°C |
| Storage temperature range | | **Standard** = -20°C ÷ +80°C **/PE** option = -20°C ÷ +80°C |
| Materials | Filter head | Alluminium alloy |
| | Filter bowl | Nylon PA6 reinforced (FRS-10, FRS-20, FRS-30) |
| | | Steel (FRS-40 series 10), nylon PA6 reinforced (FRS-40 series 11) |
| Compliance | | RoHS Directive 2011/65/EU as last update by 2015/863/EU<br>REACH Regulation (EC) n°1907/2006 |

## 6 HYDRAULICS CHARACTERISTICS

### FRS-10, FRS-20

| Filter size | | 10 | | | 20 | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Port size code | | **00** | **01** | **41** | **00** | **01** | **02** | **42** | **03** |
| Ports dimension | | G1/2" | G3/4" | SAE 12 | G1/2" | G3/4" | G1" | SAE 16 | G1 1/4" |
| Filter lenght | | A ÷ B | | | A ÷ D | | | | |
| Max flow at Δp 0,5 bar (l/min) -see note- | **F06** | 13÷17 | 13÷17 | | 30÷90 | 31÷95 | 31÷122 | | 32÷123 |
| | **F10** | 24÷42 | 25÷44 | | 40÷110 | 43÷118 | 44÷176 | | 45÷180 |
| | **F25** | 40÷50 | 45÷55 | | 56÷114 | 61÷127 | 65÷200 | | 70÷210 |
| | **C10** | 70÷87 | 76÷97 | | 75÷130 | 90÷146 | 92÷263 | | 113÷277 |
| | **C25** | 75÷94 | 82÷105 | | 85÷140 | 115÷163 | 118÷300 | | 168÷300 |
| Max operating pressure | | 8 bar | | | | | | | |
| Direction of filtration | | See the arrow on the filter head | | | | | | | |

### FRS-30, FRS-40

| Filter size | | 30 | | | | 40 | | | |
|---|---|---|---|---|---|---|---|---|---|
| Port size code | | **02** | **03** | **04** | **44** | **03** | **04** | **05** | **45** |
| Ports dimension | | G1" | G1 1/4" | G1 1/2" | SAE 24 | G1 1/4" | G1 1/2" | G2" | SAE 32 |
| Filter lenght | | A ÷ B | | | | A ÷ E | | | |
| Max flow at Δp 0,5 bar (l/min) -see note- | **F06** | 150÷165 | 162÷172 | 166÷176 | | 187÷430 | 191÷480 | 194÷500 | |
| | **F10** | 210÷240 | 230÷256 | 238÷266 | | 283÷540 | 295÷600 | 303÷600 | |
| | **F25** | 240÷270 | 271÷293 | 275÷300 | | 336÷585 | 354÷600 **(1)** | 355÷600 **(1)** | |
| | **C10** | 270÷290 | 311÷315 | 326÷330 | | 365÷600 **(1)** | 387÷600 **(1)** | 400÷600 **(1)** | |
| | **C25** | 330÷355 | 380÷390 | 400÷409 | | 473÷600 **(1)** | 514÷600 **(1)** | 536÷600 **(1)** | |
| Max operating pressure | | 8 bar | | | | | | | |
| Direction of filtration | | See the arrow on the filter head | | | | | | | |

**Note:** Max flow rates are measured with min and max filter lenght. In case of different conditions see section 11
**(1)** Max flow limited by the max flow speed allowed in connecting pipes.

## 7 FILTER ELEMENTS

| Material | | Inorganic microfibre | Cellulose |
|---|---|---|---|
| Filtation rating as per ISO16889 | **F06** | $\beta_{06\mu m (c)} \geq 1000$ | - |
| | **F10** | $\beta_{12\mu m (c)} \geq 1000$ | - |
| | **F25** | $\beta_{27\mu m (c)} \geq 1000$ | - |
| | **C10** | - | $\beta_{10\mu m (c)} \geq 2$ |
| | **C25** | - | $\beta_{25\mu m (c)} \geq 2$ |

## 8 SEALS AND HYDRAULIC FLUIDS - for other fluids not included in below table, consult our technical office

| Seals, recommended fluid temperature | NBR seals (standard) = -25°C ÷ +100°C, with HFC hydraulic fluids = +10°C ÷ +50°C<br>FKM seals (/PE option) = -25°C ÷ +100°C | | |
|---|---|---|---|
| Recommended viscosity | 15 ÷ 100 $mm^2/s$ - max allowed range 2.8 ÷ 500 $mm^2/s$ | | |
| **Hydraulic fluid** | **Suitable seals type** | **Classification** | **Ref. Standard** |
| Mineral oils | NBR, FKM | HL, HLP, HLPD, HVLP, HVLPD | DIN 51524 |
| Flame resistant without water | FKM | HFDU, HFDR | ISO 12922 |
| Flame resistant with water | NBR | HFC | |

## 9 FILTERS SIZING

For the filter sizing it is necessary to consider the Total Δp at the maximum flow at which the filter must work.
The Total Δp is given by the sum of filter head Δp plus plus filter bowl Δp plus the filter element Δp:

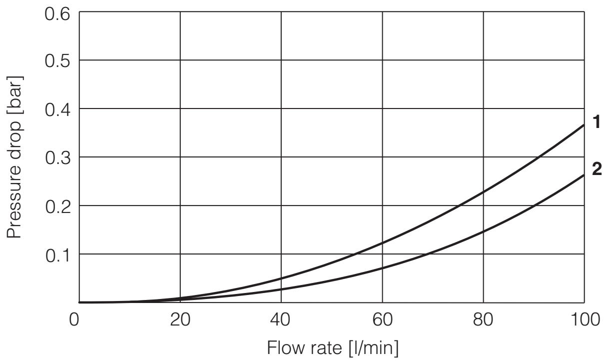
**Total Δp = filter head Δp + filter bowl Δp + filter element Δp**

In the best conditions the total Δp should not exceed 0,5 bar
See below sections to calculate the Δp of filter head and Δp of the filter element

### 9.1 Q/Δp DIAGRAMS OF FILTER HEAD + FILTER BOWL

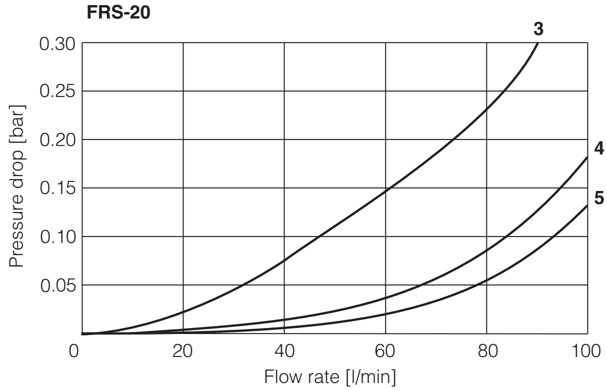
The pressure drop mainly depends on the ports size and fluid density
In the following diagrams are reported the Δp characteristics based on mineral oil with density 0,86 kg/dm$^3$ and viscosity 32 mm$^2$/s

**FRS-10**



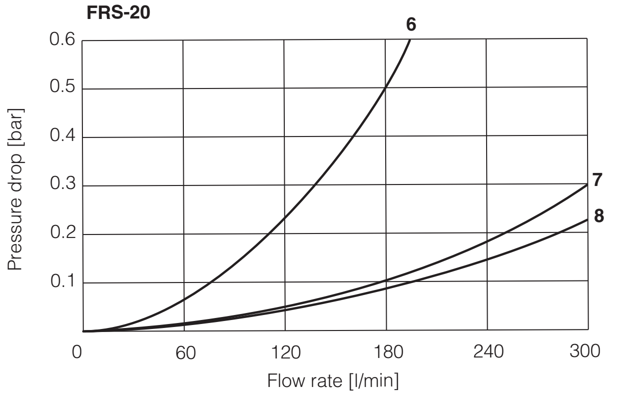

**1** = FRS-10-*-00 (G 1/2")
**2** = FRS-10-*-01 (G 3/4")
FRS-10-*-41 (SAE-12)

**FRS-20**



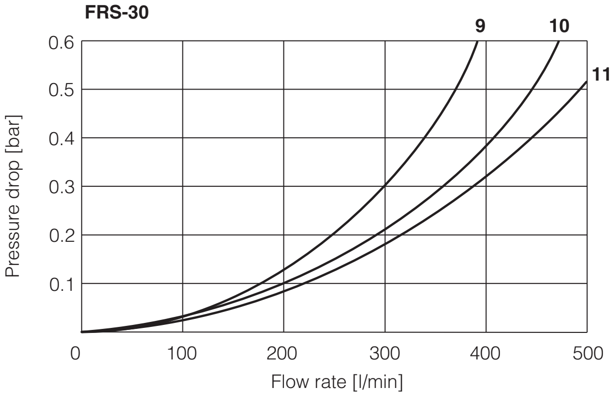

**3** = FRS-20-*-00 (G 1/2")
**4** = FRS-20-A-01 (G 3/4")
FRS-20-B-01 (G 3/4")
**5** = FRS-20-A-02 (G 1")
FRS-20-B-02 (G 1")
FRS-20-A-42 (SAE-16)
FRS-20-B-42 (SAE-16)

**FRS-20**



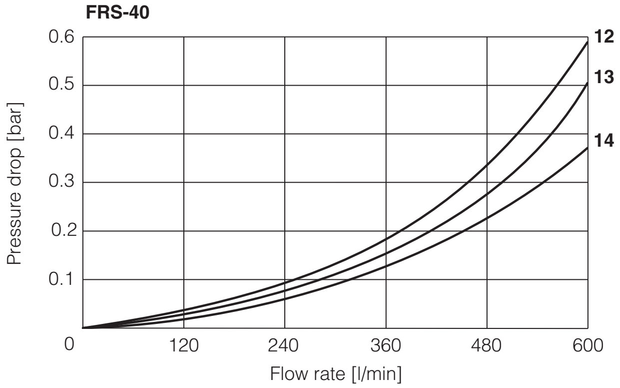

**6** = FRS-20-C-01 (G 3/4")
FRS-20-D-01 (G 3/4")
**8** = FRS-20-*-03 (G 1 1/4")
**7** = FRS-20-C-02 (G 1")
FRS-20-D-02 (G 1")
FRS-20-C-42 (SAE-16)
FRS-20-D-42 (SAE-16)

**FRS-30**



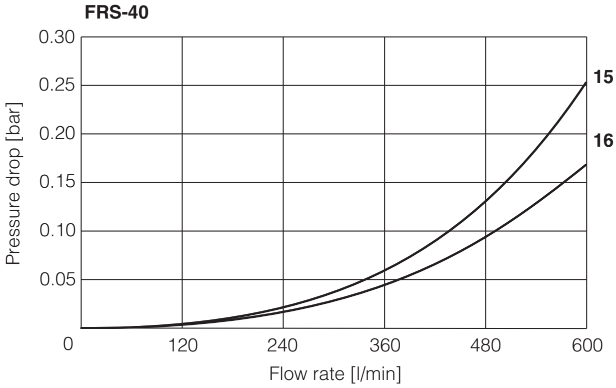

**9** = FRS-30-*-02 (G 1")
**10** = FRS-30-*-03 (G 1 1/4")
**11** = FRS-30-*-04 (G 1 1/2")
FRS-30-*-44 (SAE-24)

**FRS-40**




**12** = FRS-40-A-03 (G 1 1/4")
FRS-40-D-03 (G 1 1/4")
**13** = FRS-40-A-04 (G 1 1/2")
FRS-40-D-04 (G 1 1/2")
**14** = FRS-40-A-05 (G 2")
FRS-40-D-45 (G 2")
FRS-40-A-45 (SAE-32)
FRS-40-D-45 (SAE-32)

**FRS-40**




**15** = FRS-40-B-04 (G 1 1/2")
FRS-40-C-04 (G 1 1/2")
FRS-40-E-04 (G 1 1/2")
**16** = FRS-40-B-05 (G 2")
FRS-40-C-05 (G 2")
FRS-40-E-05 (G 2")
FRS-40-B-45 (SAE-32)
FRS-40-C-45 (SAE-32)
FRS-40-E-45 (SAE-32)

### 9.2 FILTER ELEMENT Δp

The pressure drop through the filter depends to:
• size of filter element
• filtration rating
• fluid viscosity
The Δp of filter element is given by the formula:

$$\Delta p \text{ of filter element} = Q \times \frac{Gc}{1000} \times \frac{Viscosity}{30}$$

**Q** = working flow (l/min)
**Gc** = Gradient coefficient (mbar/(l/min)). The Gc values are reported in the following table
**Viscosity** = effective fluid viscosity in the working conditions (mm²/s)

**Gradient coefficent Gc of FRS filter elements**

| Filter element size | **10** | | **20** | | | | **30** | | **40** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Filter element lenght | **A** | **B** | **A** | **B** | **C** | **D** | **A** | **B** | **A** | **B** | **C** | **D** | **E** |
| Filtration rating | **Gc** Gradient coefficient | | | | | | | | | | | | |
| **F06** | 37.60 | 28.90 | 15.39 | 8.67 | 5.66 | 3.71 | 2.70 | 2.50 | 2.40 | 1.66 | 1.47 | 2.00 | 0.74 |
| **F10** | 19.80 | 10.40 | 10.77 | 5.86 | 3.54 | 2.29 | 1.62 | 1.34 | 1.34 | 0.84 | 0.61 | 0.98 | 0.37 |
| **F25** | 9.22 | 7.18 | 7.14 | 3.92 | 2.25 | 1.88 | 1.19 | 1.00 | 0.98 | 0.52 | 0.43 | 0.71 | 0.25 |
| **C10** | 4.83 | 2.74 | 4.09 | 2.70 | 1.64 | 1.06 | 0.85 | 0.83 | 0.82 | 0.45 | 0.36 | 0.64 | 0.22 |
| **C25** | 4.13 | 2.06 | 2.52 | 1.41 | 0.82 | 0.42 | 0.39 | 0.35 | 0.34 | 0.23 | 0.12 | 0.26 | 0.16 |

**Examples**:
1) calculation of Total Δp for filter type FRS-20-B-F10-02-R at Q = 50 l/min and viscosity 46 mm²/s (filter element PRS-20-B-F10)
   **Δp** of filter head + filter bowl = 0,02 bar
   **Gc** = 5,86 mbar/(l/min)

**Filter element Δp** = $50 \times \frac{5,86}{1000} \times \frac{46}{30} = 0,45$ bar

**Total Δp** = 0,02 + 0,45 = **0,47 bar**

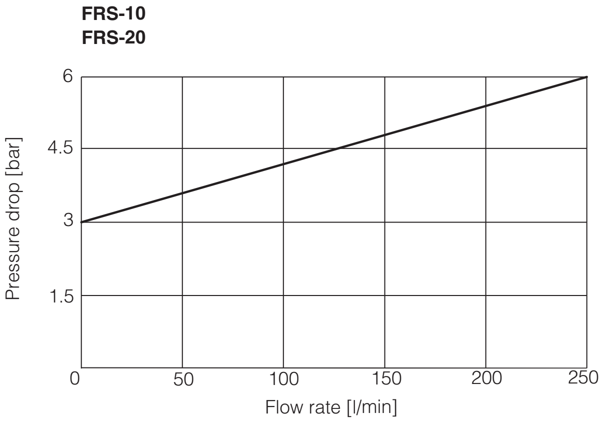
2) calculation of Total Δp of filter type FRS-40-C-F25-05-R at Q = 500 l/min and viscosity 46 mm²/s (filter element PRS-40-C-F25)
   **Δp** of filter head + filter bowl = 0,13 bar
   **Gc** = 0,43 mbar/(l/min)

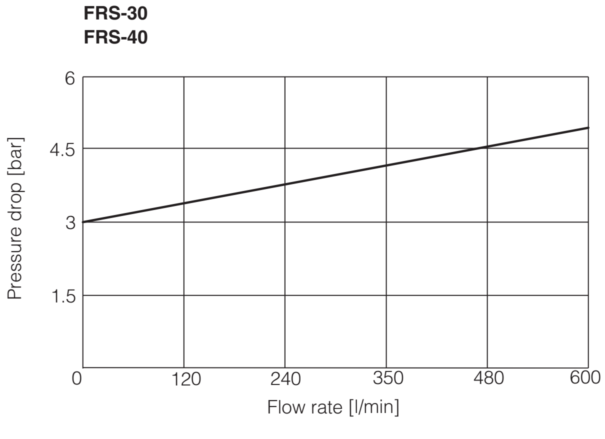
**Filter element Δp** = $500 \times \frac{0,43}{100} \times \frac{46}{30} = 0,33$ bar

**Total Δp** = 0,13 + 0,33 = **0,46 bar**

**10** **BY -PASS VALVE** - based on mineral oil ISO VG46 at 50°C (viscosity = 32 mm²/s)

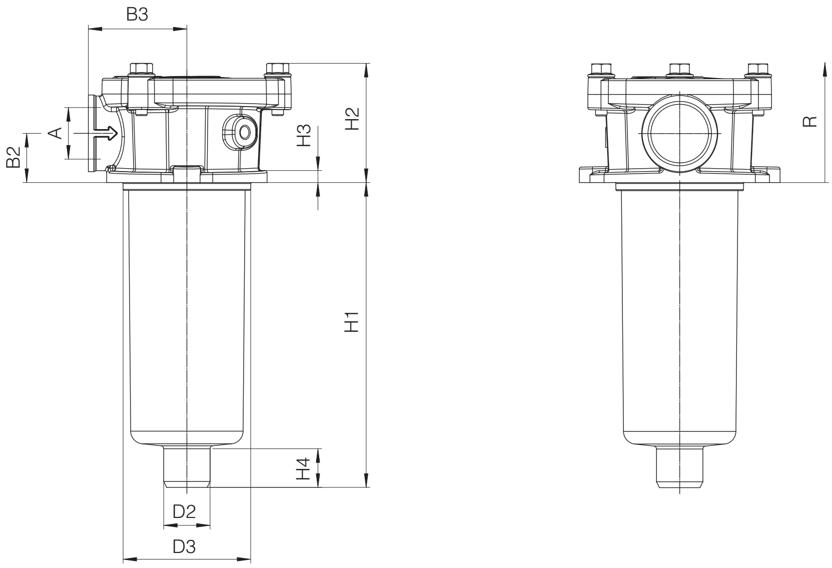
Q/Δp diagrams of flow trough the by pass valve

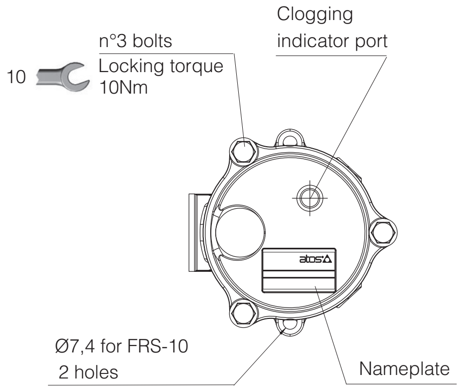


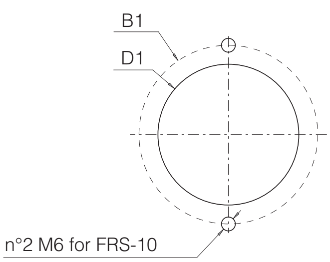
## 11 INSTALLATION DIMENSIONS OF FRS FILTERS [mm]

### FRS-10



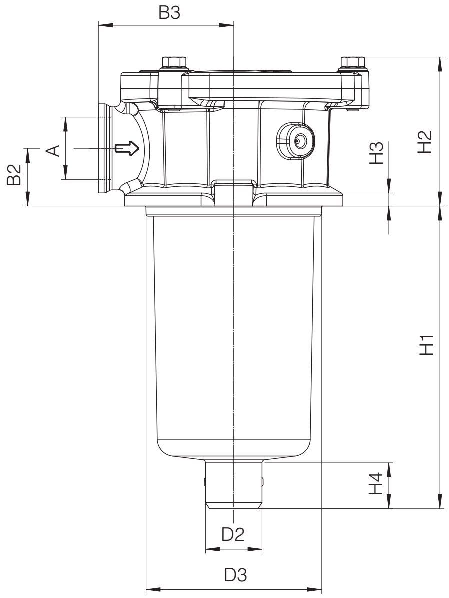



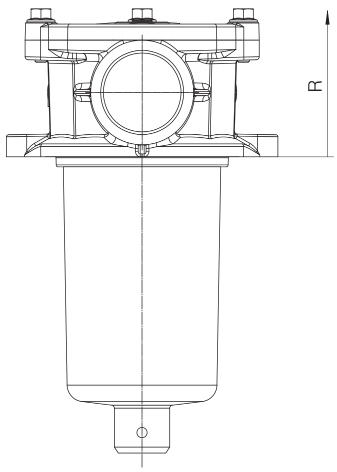

FILTER MOUNTING SURFACE

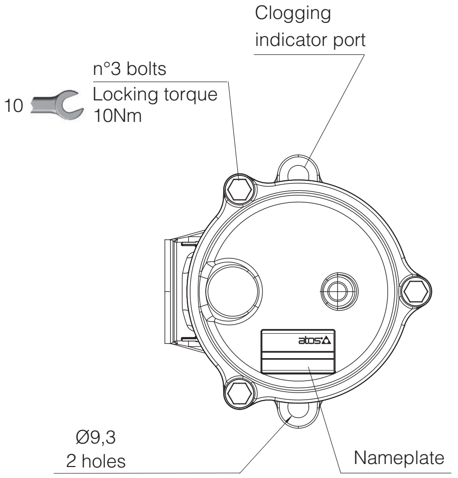


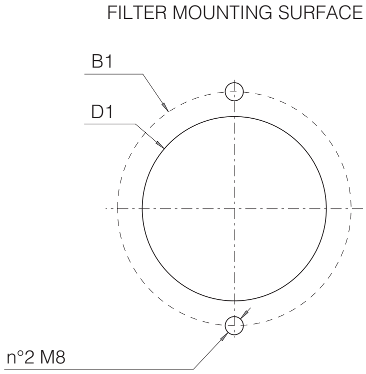

| Code | A | B1 | B2 | B3 | D1 | D2 | D3 | H1 | H2 | H3 | H4 | R (element removal) | Mass (Kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FRS-10-A | 1/2" BSPP<br>3/4" BSPP<br>SAE-12 | 89 | 25 | 51 | 67,5 | 24 | 67 | 82 | 60 | 8 | 22 | 150 | 0,45 |
| FRS-10-B | | | | | | | | 155 | | | | 220 | 0,60 |

# FRS-20



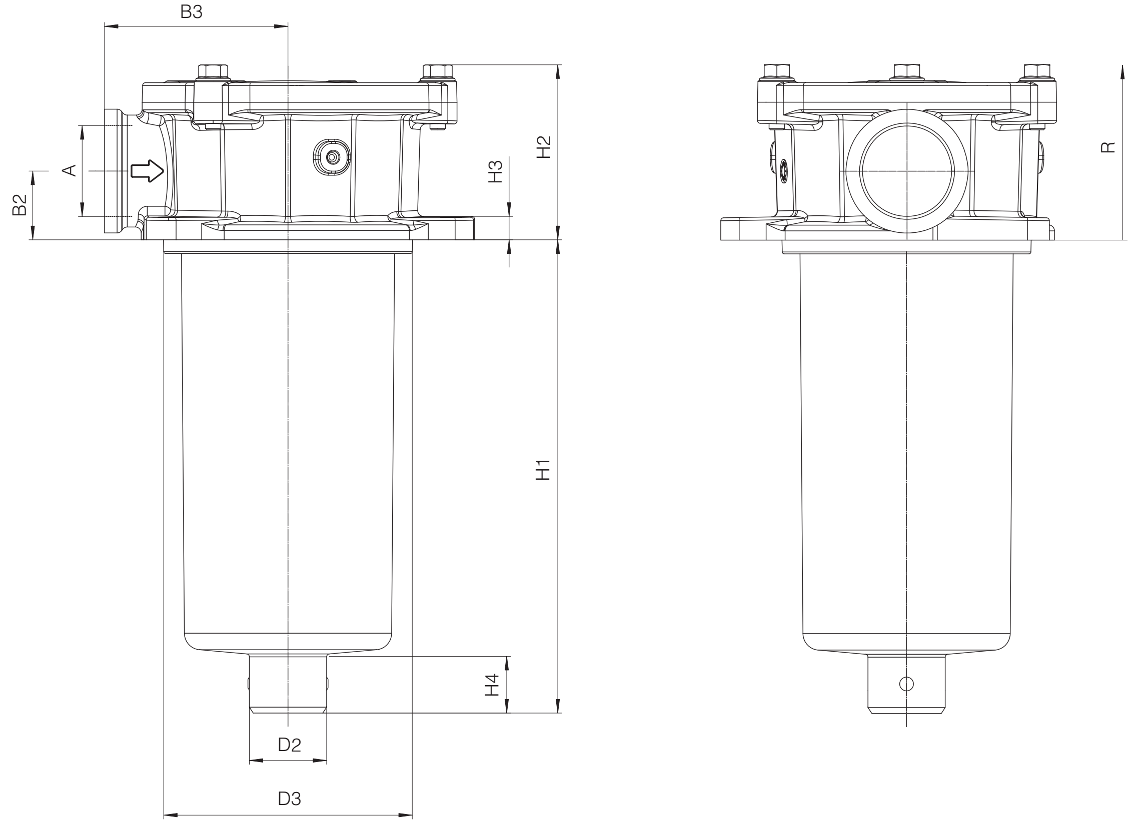



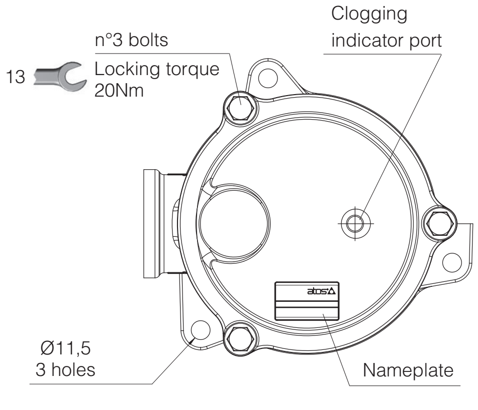

| Code | A | B1 | B2 | B3 | D1 | D2 | D3 | H1 | H2 | H3 | H4 | R (element removal) | Mass (Kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FRS-20-A | 1/2" BSPP<br>3/4" BSPP<br>1" BSPP<br>1 1/4" BSPP<br>SAE-16 | 115 | 28,5 **(1)** | 67 | 88,5 | 40 | 87 | 92 | 73 | 11 | 24 | 170 | 0,80 |
| FRS-20-B | | | | | | | | 139 | | | | 220 | 0,90 |
| FRS-20-C | | | 32 **(2)** | | | | | 219 | | | | 295 | 1,10 |
| FRS-20-D | | | | | | | | 323 | | | | 400 | 1,30 |

**(1)** For port size 3/4", 1" and SAE-16

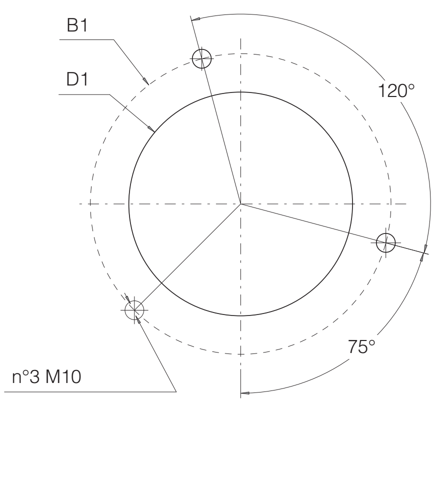
**(2)** For port size 1 1/4"

# FRS-30



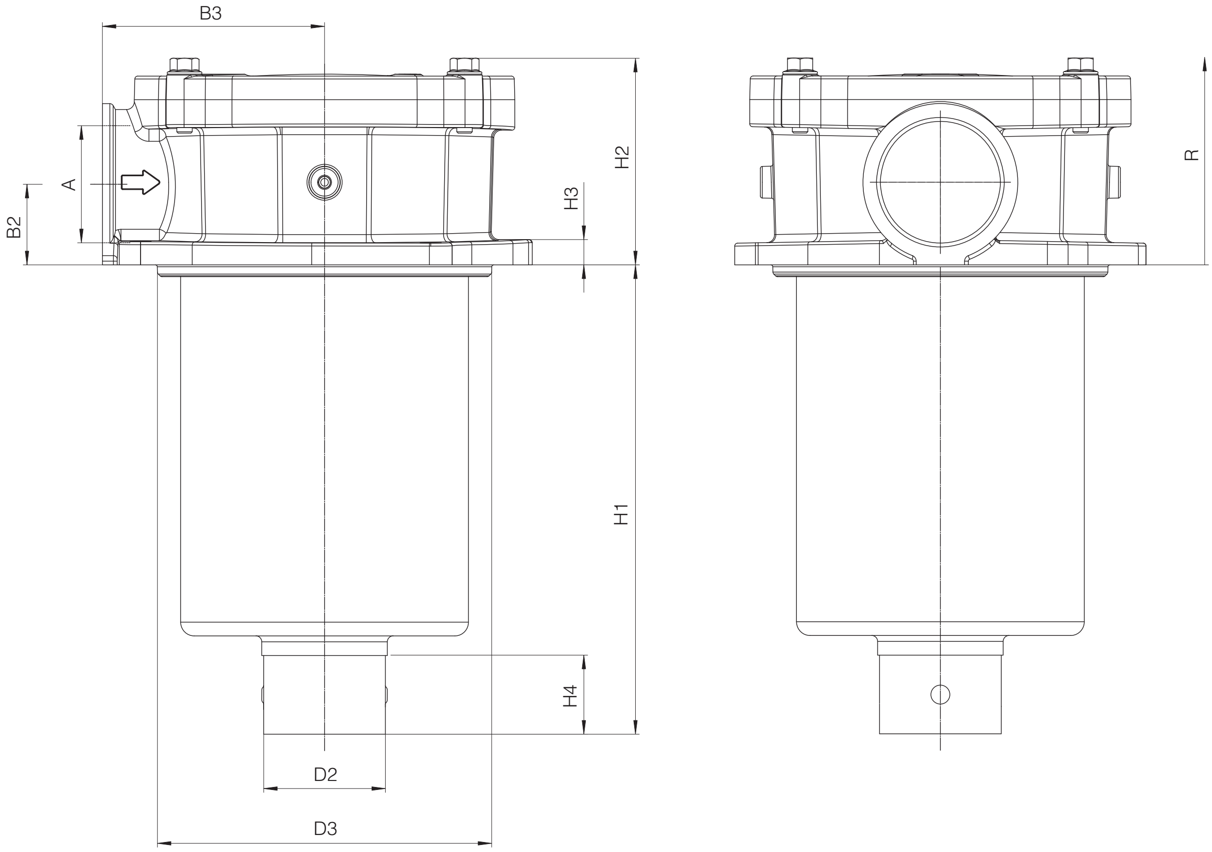



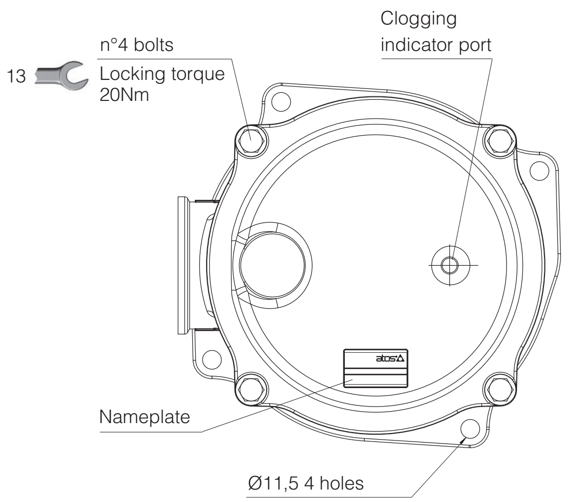

FILTER MOUNTING SURFACE

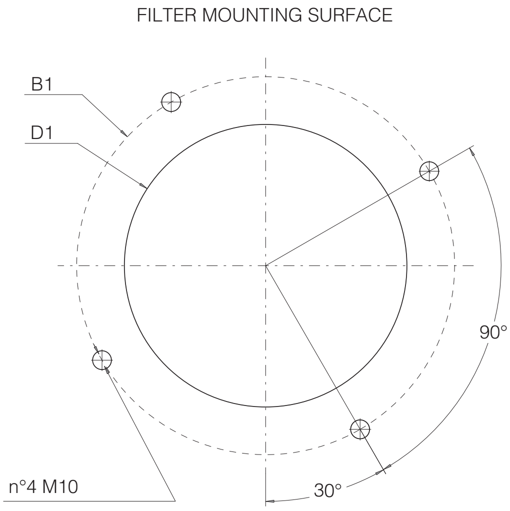



| Code | A | B1 | B2 | B3 | D1 | D2 | D3 | H1 | H2 | H3 | H4 | R (element removal) | Mass (Kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FRS-30-A | 1" BSPP<br>1 1/4" BSPP<br>1 1/2" BSPP<br>SAE-24 | 175 | 35 | 95 | 130 | 40 | 129 | 234 | 90 | 11 | 30 | 320 | 2,10 |
| FRS-30-B | | | | | | | | 263 | | | | 360 | 2,40 |

# FRS-40




| Code | A | B1 | B2 | B3 | D1 | D2 series 10 | D2 series 11 | D3 | H1 series 10 | H1 series 11 | H2 | H3 | H4 series 10 | H4 series 11 | R (element removal) | Mass (Kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FRS-40-A | 1 1/4" BSPP<br>1 1/2" BSPP<br>2" BSPP<br>SAE-32 | 220 | 42 | 115 | 175 | 50 | 65 | 174 | 181 | 165 | 105 | 11 | 50 | 37 | 270 | 3,20 |
| FRS-40-B | | | | | | 63 | | | 240 | 224 | | | | | 330 | 3,60 |
| FRS-40-C | | | | | | | | | 289 | 274 | | | | | 380 | 4,20 |
| FRS-40-D **(1) (2)** | | | | | | | | | - | 224 | | | | | 330 | 3,60 |
| FRS-40-E **(1)** | | | | | | | | | - | 424 | | | | | 530 | 4,00 |

**(1)** Available only for series 11, on request

**(2)** Filter type FRS-40-D is similar to FRS-40-B but it uses filter elements with smaller internal diameter

**12** **ACCESSORIES** - to be ordered separately

Following accessories can be assembled on return filters type FRS-20, FRS-30 and FRS-40 (not available for FRS-10) to avoid the foam or air/oil emulsion inside the tank caused by the return flow.

The discharge ending pipes **DSC-END-*** are used to extend the outlet port of the FRS filters below the oil level in the tank.
They are available with length 250 (200 mm for FRS-40) and 500 mm

The diffusers **DIFF-FRS** are used in case of high flow rates to evenly distribute the return flow inside the tank.
They can be mounted directly on the filter bowl or using the connecting pipes **CONN-END-***, available with lengths of 250 (200 for FRS-40) and 500 mm.

### MODEL CODE OF DISCHARGE ENDING PIPES ①

| DSC-END | - | 250 | FRS-20/30 |
|---|---|---|---|
| Discharge ending pipe | | **Pipe lenght** for **FRS-20** and **FRS-30**:<br>250 = 250 mm<br>500 = 500 mm<br>**Pipe lenght** for **FRS-40**:<br>200 = 200 mm<br>500 = 500 mm | **Filter type**:<br>FRS-20/30 = for FRS-20 and FRS-30<br>FRS-40 = for FRS-40 |

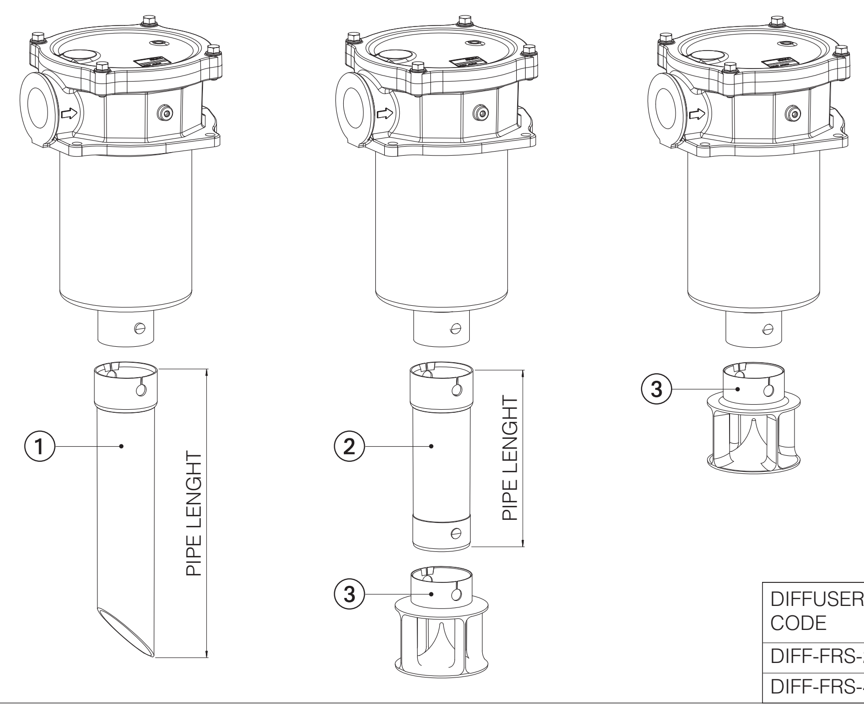
### MODEL CODE OF CONNECTING ENDING PIPES ②

| CONN-END | - | 250 | FRS-20/30 |
|---|---|---|---|
| Connecting ending pipe | | **Pipe lenght** for **FRS-20** and **FRS-30**:<br>250 = 250 mm<br>**Pipe lenght** for **FRS-40**:<br>200 = 200 mm (for FRS-40)<br>500 = 500 mm (for FRS-40) | **Filter type**:<br>FRS-20/30 = for FRS-20 and FRS-30<br>FRS-40 = for FRS-40 |

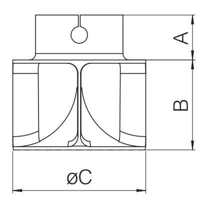
### MODEL CODE OF DIFFUSERS ③

| DIFF | - | FRS-20/30 |
|---|---|---|
| Diffuser | | **Filter type**:<br>FRS-20/30 = for FRS-20 and FRS-30<br>FRS-40 = for FRS-40 |

**DISCHARGE ENDING PIPE** **CONNECTING ENDING PIPE** **DIFFUSER**

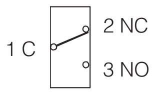
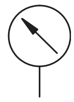



**DIFFUSER DIMENSIONS**



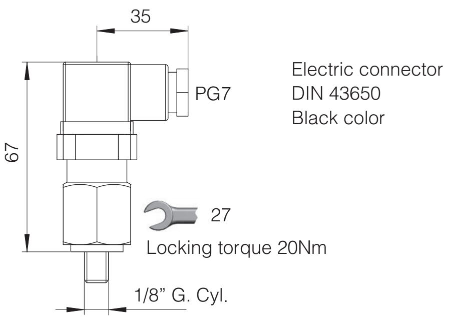

| DIFFUSER CODE | DIMENSIONS | | |
|---|---|---|---|
| | A | B | C |
| DIFF-FRS-20, DIFF-FRS-30 | 30 | 45 | 75 |
| DIFF-FRS-40 | 35 | 70 | 105 |

## 13 CHARACTERISTICS OF CLOGGING INDICATORS

| Model code | CIA-E electrical | | CIA-V visual |
|---|---|---|---|
| Switching pressure | 2 bar | | green sector = 0 ÷ 3 bar<br>red sector = 3 ÷ 10 bar |
| Switching tolerance at 20°C | ± 10% of switching pressure | | - |
| Electric connection | Electric plug connection as per DIN 43650 with cable gland type PG7 | | - |
| Power supply | 14 $V_{DC}$ ÷ 30 $V_{DC}$ | 125 $V_{AC}$ ÷ 250 $V_{AC}$ | |
| Max current - resistive (inductive) | 4 A (3 A) ÷ 3 A (2 A) | 5 A (3 A) ÷ 3 A (2 A) | |
| Fluid temperature | -25°C ÷ +100°C | | -25°C ÷ +100°C |
| Protection degree according to DIN 40050 | IP65 with mathing connector | | - |
| Hydraulic connection | G1/8" BSP | | G1/8" BSP |
| Duty factor | 100% | | 100% |
| Mass (Kg) | 0,16 | | 0,04 |
| Electric scheme / Hydraulic symbol |   | The electric scheme shows the switch position in case of clean filter element |  |

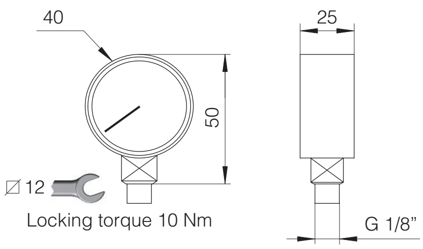
## 14 DIMENSIONS OF CLOGGING INDICATORS

**CIA-E**

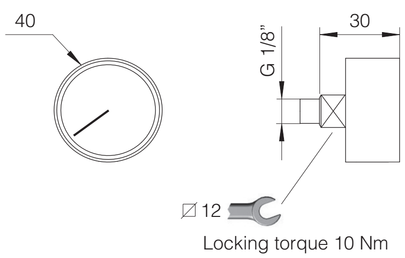



Note: add sealant on indicator threads

**CIA-V**

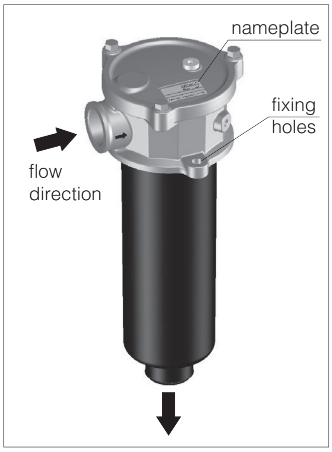



**CIA-V/P**
(available on request)



## 15 INSTALLATION AND COMMISSIONING

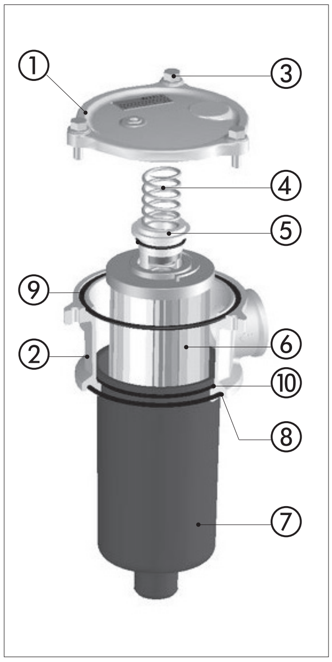
The tank flange with the filter mounting surface must be free of scratches.
During the filter installation, pay attention to respect the flow direction, shown by the arrow on the filter head.
Install the filter on the tank cover using the fixing holes on the filter head.
Connect the IN port of the filter to the system return pipe.
The OUT port of the filter can be connected to a pipe which length has to be properly sized so that its end remains under the oil level. See section 12 for additional discharge ending pipes.
Make sure that there is enough space for the replacement of the filter element.
Never run the system without the filter element.
For filters ordered with clogging indicator, code E or V:
• remove the steel plug from the indicator port on the filter head
• install the clogging indicator and lock it at the specified torque
During the cold start up (fluid temperature lower than 30°C), a false clogging indicator signal can be given due to the high fluid viscosity.




## 16 MAINTENANCE

The filter element must be replaced as soon as the clogging indicator switches to highlight the filter clogged condition
For filters without clogging indicator, the filter element must be replaced according to the system manufacturer's recommendations.
Select the new filter element according to the model code reported on the filter nameplate, see section 17.2

For the replacement of the filter element, proceed as follow:
• switch-off the system and make sure that there is no residual pressure in the filter line (i.e. pressurized tank); the filter has no pressure bleeading device
• pay attention to the fluid and filter surface temperature. Always use suitable gloves an protection glasses
• remove the cover ① from the filter head ② by releasing the bolts ③
• remove the spring ④ and the bowl ⑦
• remove the dirty filter element ⑥ pulling it upward carefully
• clean the bowl ⑦
• install the bowl ⑦ after having checked the good condition of the seal ⑧
• insert the new filter element over the spigot in the filter bowl; the filter element includes the by-pass valve ⑤
• install the spring ④
• mount the cover and lock the relevant bolts ③ after having checked the good condition of the seal ⑨




**WARNING**: The dirty filter elements cannot be cleaned and re-used. They are classified as "dangerous waste material", then they must be disposed of by authorized Companies, according to the local laws.

### 16.1 SEALS KIT

| Filter type | Seal kit code |
|---|---|
| FRS-10 | GUARN FRS-10 ⑧+⑨+⑩ |
| FRS-20 | GUARN FRS-20 ⑧+⑨+⑩ |
| FRS-30 | GUARN FRS-30 ⑧+⑨+⑩ |
| FRS-40 | GUARN FRS-40 ⑧+⑨+⑩ |

### 17.2 SPARE SPRING ④

| Filter type | Seal kit code |
|---|---|
| FRS-10 | MO-1246 |
| FRS-20 | MO-1247 |
| FRS-30 | MO-1248 |
| FRS-40 | MO-1249 |

### 16.2 FILTER IDENTIFICATION NAMEPLATE

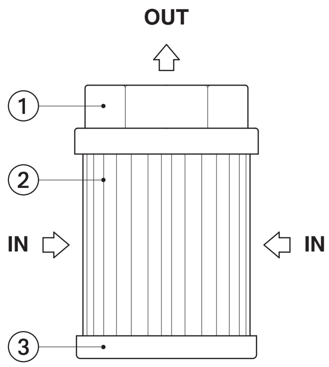

① Model code of complete filter
② Model code of filter element
③ Filter matrix code

## 17 RELATED DOCUMENTATION

**LF010** Fluid contamination
**LF020** Filtration guidelines

# Suction filters type FSS

Threaded ports




**FSS-20-***

① Filter head
② Wire mesh
③ End cap

**FSS**

Suction filters are designed to protect pumps from ingestion of solid particles and coarse contamination present in the oil tank, which may cause heavy damage and seizures.

They are designed to be screwed onto the pumps suction line.

FSS filters are available with following features:

- four sizes with BSPP threaded ports, from 1/2" to 3 "
- wire mesh 125 µm (c)
- version without or with by-pass valve

Max flow **450 l/min**

## 1 MODEL CODE

**FSS** - **10** - **A** - **W125** - **00** - **N** **

Suction filter

**Filter size**:
**10**
**20**
**30**
**40**

**Filter lenght**: Max flow [l/min] **(1)**

| | FSS-10 | FSS-20 | FSS-30 | FSS-40 |
|---|---|---|---|---|
| **A** = | 20 | 38 | 85 | 330 |
| **B** = | - | 60 | 125 | 450 |
| **C** = | - | - | 200 | - |

**Filtration rating**:
**W125** = wire mesh 125 µm

**Port size**:
BSPP threaded:

| | | |
|---|---|---|
| FSS-10-A<br>**00** = G 1/2" | | |
| FSS-20-A<br>**01** = G 3/4" | FSS-20-B<br>**02** = G 1" | |
| FSS-30-A<br>**03** = G 1 1/4" | FSS-30-B<br>**04** = G 1 1/2" | FSS-30-C<br>**05** = G 2" |
| FSS-40-A<br>**06** = G 2 1/2" | FSS-40-B<br>**07** = G 3" | |

**By-pass**:
**N** = without by-pass
**R** = by-pass valve, craking pressure 0,35 bar

Series number

**(1)** Max flow rates are performed in following conditions:
- clean filter element
- $\Delta p$ = 0,015 bar
- mineral oil with viscosity 32 $mm^2/s$

In case of different conditions see Q/$\Delta$p diagrams at section 6

## 2 HYDRAULIC SYMBOL (representation according to ISO 1219-1)


## 3 GENERAL CHARACTERISTICS

| | |
|---|---|
| Assembly position / location | Any position |
| Differential collapse pressure [bar] | 1 |
| Ambient temperature range | -20°C ÷ +70°C |
| Storage temperature range | -20°C ÷ +80°C |
| Materials — Filter head | Nylon |
| Materials — Filter end cap | Carbon steel, zinc plated |
| Materials — Filter Mesh | Stainless steel AISI 304 |

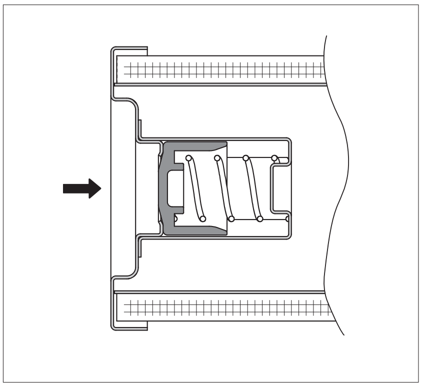
## 4 HYDRAULIC FLUIDS - for other fluids not included in below table, consult our technical office

| | | |
|---|---|---|
| Recommended fluid temperature | -25°C ÷ +100°C, with HFC hydraulic fluids = +10°C ÷ +50°C | |
| Recommended viscosity | 15 ÷ 100 $mm^2/s$ - max allowed range 2.8 ÷ 500 $mm^2/s$ | |
| **Hydraulic fluid** | **Classification** | **Ref. Standard** |
| Mineral oils | HL, HLP, HLPD, HVLP, HVLPD | DIN 51524 |
| Flame resistant without water | HFDU, HFDR | ISO 12922 |
| Flame resistant with water | HFC | ISO 12922 |

## 5 BY-PASS VALVE - version **-R**

The by-pass valve allows the oil flow to by-pass the suction filter when the pressure drop across the element exceeds 0,35 bar, so that to avoid the pump cavitation.

This may happens in particular conditions as:
- instantaneous high flow peaks
- filter mesh clogged by contamination



## 6 FILTER SIZING

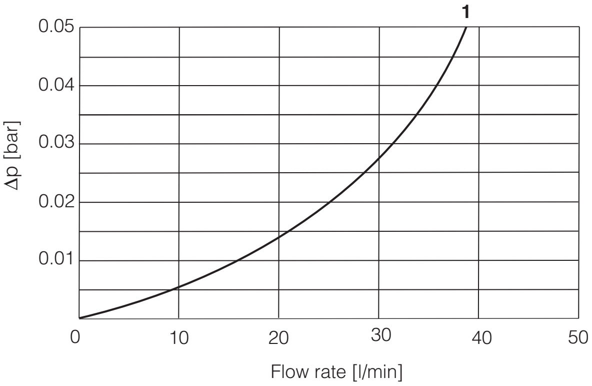
Suction filters must be largely sized to avoid the pumps cavitation. In the best conditions the $\Delta p$ should not exceed 0.015 bar

### 6.1 Q/Δp DIAGRAMS

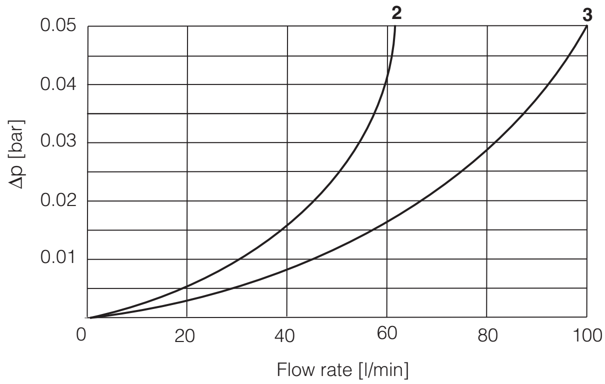
In following diagrams are reported the $\Delta p$ characteristics of filter based on mineral oil with density 0,86 kg/dm² and viscosity 32 mm²/s.
in case of different viscosity the effective $\Delta p_E$ is given by the formula:

$$\Delta p_E = \Delta p \times \frac{viscosity}{32}$$

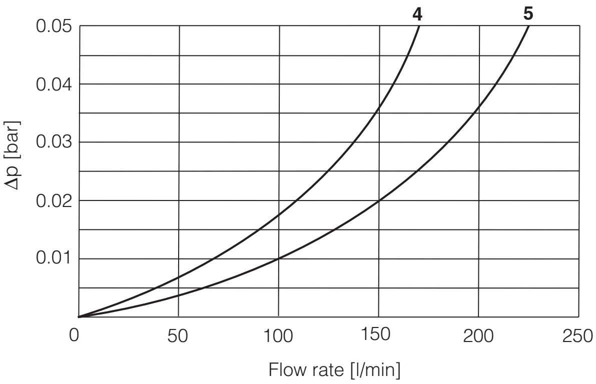
$\Delta p_E$ = pressure drop calculated at the effective viscosity
$\Delta p$ = pressure drop reported in the below diagrams
Viscosity = effective fluid viscosity in the working conditiond (mm²/s)



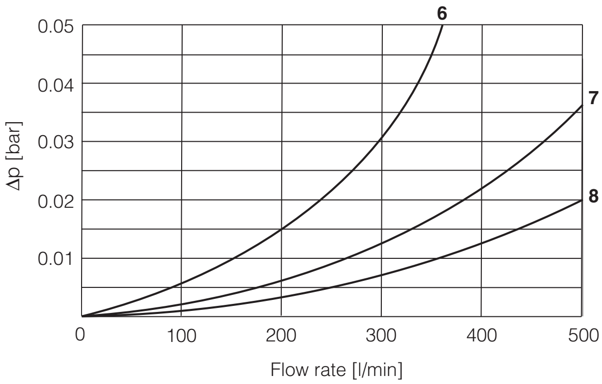

**1** = FSS-10-A




**2** = FSS-20-A
**3** = FSS-20-B

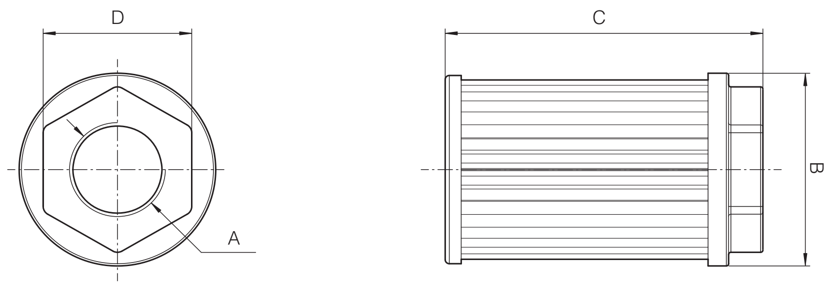



**4** = FSS-30-A
**5** = FSS-30-B




**6** = FSS-30-C
**7** = FSS-40-A
**8** = FSS-40-B

## 7 INSTALLATION DIMENSIONS OF FSS FILTERS [mm]



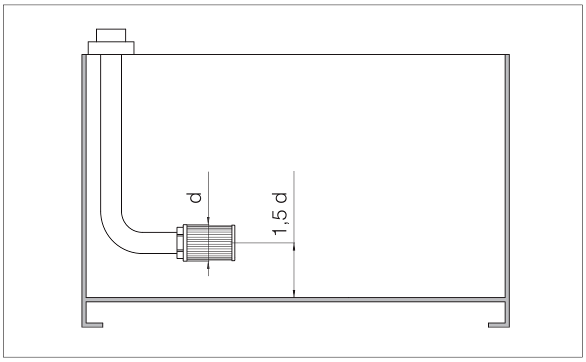

| Code | A | B | C | D | Mass (Kg) |
|---|---|---|---|---|---|
| FSS-10-A | 1/2” BSPP | 46 | 106 | 36 | 0,10 |
| FSS-20-A | 3/4” BSPP | 64 | 109 | 50 | 0,19 |
| FSS-20-B | 1” BSPP | | 139 | | 0,21 |
| FSS-30-A | 1 1/4” BSPP | 86 | | 65 | 0,33 |
| FSS-30-B | 1 1/2” BSPP | | 200 | | 0,24 |
| FSS-30-C | 2” BSPP | | 260 | 75 | 0,51 |
| FSS-40-A | 2 1/2” BSPP | 150 | 212 | 110 | 1,07 |
| FSS-40-B | 3” BSPP | | 272 | | 0,92 |

## 8 INSTALLATION AND COMMISSIONING

The suction filters FSS must be generously sized to avoid pump cavitation. The size of the OUT port of the FSS filter must be equal to or greater than the corresponding suction port of the pump.

The SSP filter must always remain below the oil level in the tank, in any operating condition.
During installation, a minimum distance must be observed between the filter and the bottom of the tank (see figure on the side) to avoid the possibility that the contaminant deposited on the bottom is sucked up.

The SSP filter should be installed as far as possible from the return pipe. It is advisable to use separators inside the tank to keep the suction area separate from the area affected by the return flow.

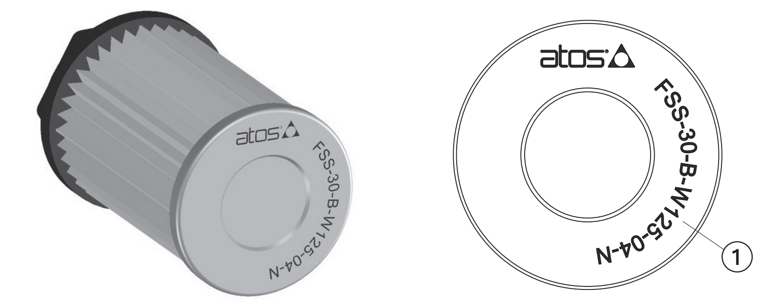



## 9 MAINTENANCE

The filter must be replaced according to the system manufacturer's reccomendations

**WARNING**: The dirty filters cannot be cleaned and re-used. They are classified as "dangerous waste material", then they must be disposed of by authorized Companies, according to the local laws.

### 9.1 FILTER IDENTIFICATION




① Model code of filter

## 10 RELATED DOCUMENTATION

| | |
|---|---|
| **LF010** | Fluid contamination |
| **LF020** | Filtration guidelines |

Алматы (7273)495-231
Ангарск (3955)60-70-56
Архангельск (8182)63-90-72
Астрахань (8512)99-46-04
Барнаул (3852)73-04-60
Белгород (4722)40-23-64
Благовещенск (4162)22-76-07
Брянск (4832)59-03-52
Владивосток (423)249-28-31
Владикавказ (8672)28-90-48
Владимир (4922)49-43-18
Волгоград (844)278-03-48
Вологда (8172)26-41-59
Воронеж (473)204-51-73
Екатеринбург (343)384-55-89

Иваново (4932)77-34-06
Ижевск (3412)26-03-58
Иркутск (395)279-98-46
Казань (843)206-01-48
Калининград (4012)72-03-81
Калуга (4842)92-23-67
Кемерово (3842)65-04-62
Киров (8332)68-02-04
Коломна (4966)23-41-49
Кострома (4942)77-07-48
Краснодар (861 )203-40-90
Красноярск (391)204-63-61
Курск (4712)77-13-04
Курган (3522)50-90-47
Липецк (4742)52-20-81

Магнитогорск (3519)55-03-13
Москва (495)268-04-70
Мурманск (8152)59-64-93
Набережные Челны (8552)20-53-41
Нижний Новгород (831)429-08-12
Новокузнецк (3843)20-46-81
Ноябрьск (3496)41-32-12
Новосибирск (383)227-86-73
Омск (3812)21-46-40
Орел (4862)44-53-42
Оренбург (3532)37-68-04
Пенза (8412)22-31-16
Петрозаводск (8142)55-98-37
Псков (8112)59-10-37
Пермь (342)205-81-47

Ростов-на-Дону (863)308-18-15
Рязань (4912)46-61-64
Самара (846)206-03-16
Саранск (8342)22-96-24
Санкт-Петербург (812)309-46-40
Саратов (845)249-38-78
Севастополь (8692)22-31-93
Симферополь (3652)67-13-56
Смоленск (4812)29-41-54
Сочи (862)225-72-31
Ставрополь (8652)20-65-13
Сыктывкар (8212)25-95-17
Тамбов (4752)50-40-97
Сургут (3462)77-98-35
Тверь (4822)63-31-35

Тольятти (8482)63-91-07
Томск (3822)98-41-53
Тула (4872)74-02-29
Тюмень (3452)66-21-18
Ульяновск (8422)24-23-59
Улан-Удэ (3012)59-97-51
Уфа (347)229-48-12
Хабаровск (4212)92-98-04
Чебоксары (8352)28-53-07
Челябинск (351 )202-03-61
Череповец (8202)49-02-64
Чита (3022)38-34-83
Якутск (4112)23-90-97
Ярославль (4852)69-52-93

Россия (495)268-04-70
Казахстан (772)734-952-31
Киргизия (996)312-96-26-47

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