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FILTERS

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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

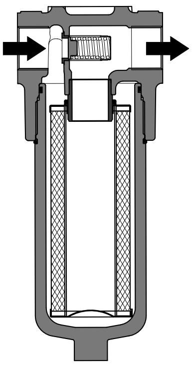
It is responsible for wearing and damages of hydraulic components causing approximately 80% of hydraulic systems failures.
Solid contaminants can enter into the hydraulic system from the external environment or they can be generated during the system operation. A detailed analysis about the potential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

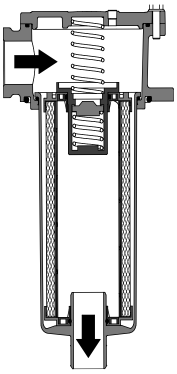
Removal methods: the solid contamination cannot be completely removed but it can be consistently reduced at acceptable levels by means **of hydraulic filters (in line and return line type)**.
Contamination coming from external environment can be also prevented using specific air filters and pressurized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

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

In line



Return line



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.

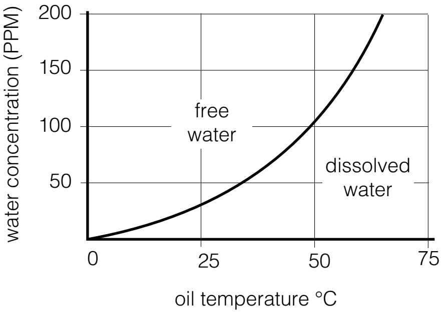
Effects: water contamination causes oxidation and corrosion of metal parts, plus alteration of chemical proprieties of the hydraulic fluid.

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

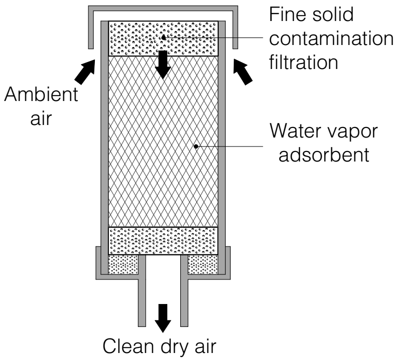
Air is always present into the hydraulic system before its commissioning, or it can be introduced during maintenance.

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 www.atos.com, tech. table P002 for system commissioning

Breather filter



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

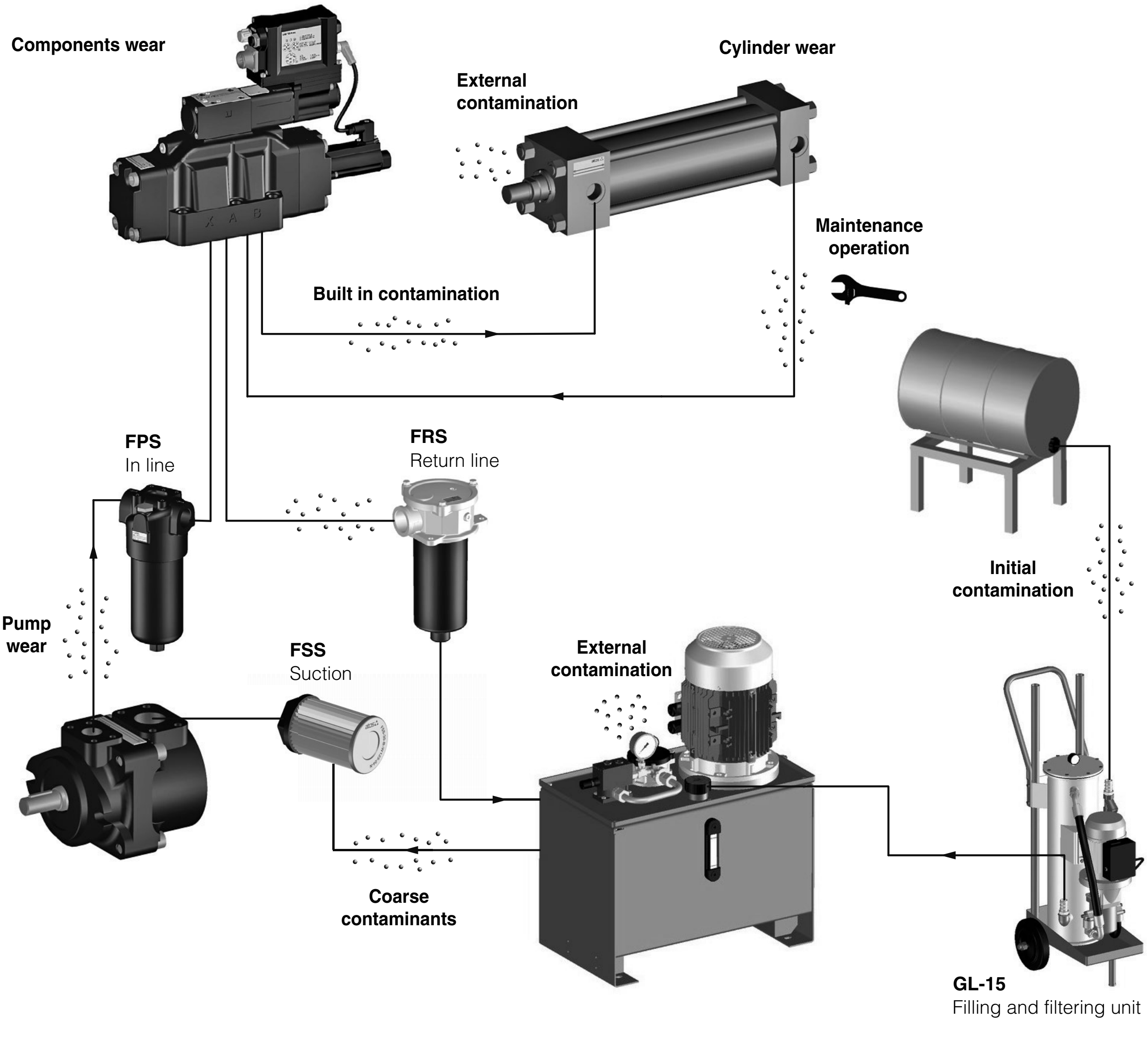
The major source of contamination directly comes from the normal hydraulic system operation. Most of contaminant are due to rubber released from the inner walls of flexible hoses, some from with moving parts of hydraulic components, like pumps and valves

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.

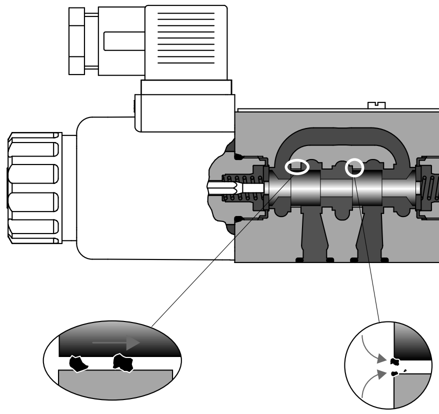
They mainly cause abrasion, erosion and fatigue effects on components surface with following main consequences:

- 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 degradation 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

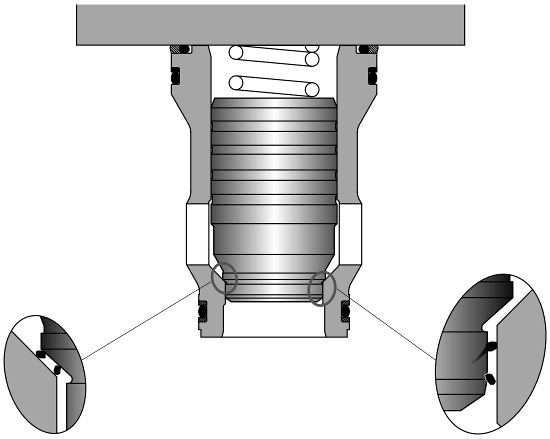
Typical failures in spool valve



Transitory failure:
sticking effects
(control inaccuracy)

Progressive degradation:
erosion of the spool, leakages

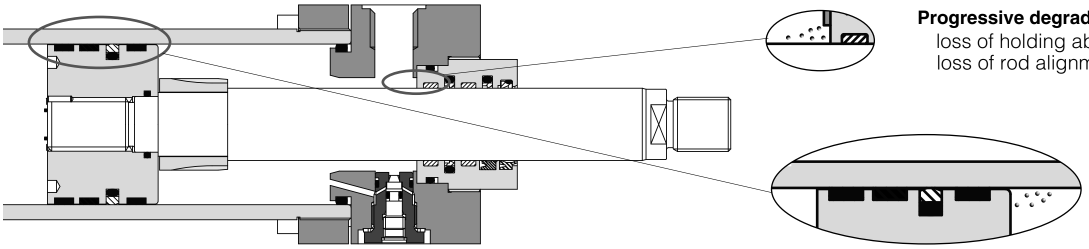
Typical failures in poppet cartridges



Transitory failure:
leakages

Progressive degradation:
erosion of the poppet

Typical failures in cylinders



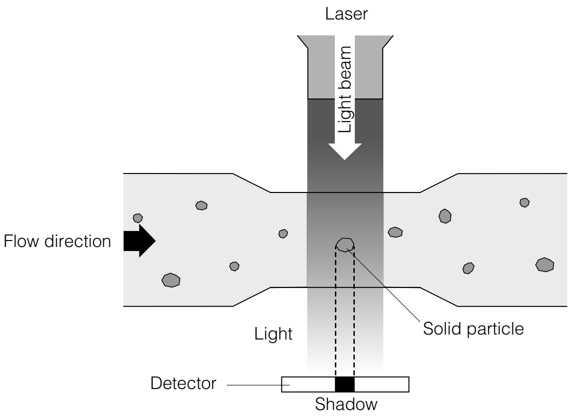
Progressive degradation:
loss of holding ability
loss of rod alignment

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



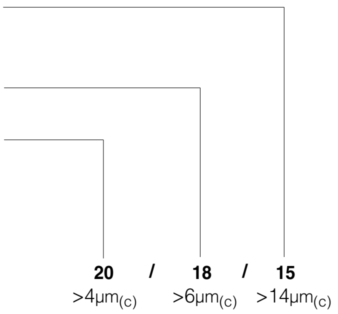
7 CLASSIFICATION OF CONTAMINATION LEVEL

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

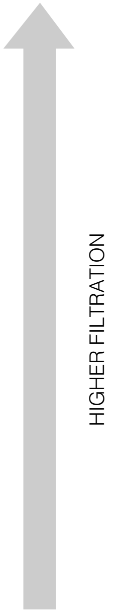
ISO CODE (to ISO 4406)	Particle quantity / 100 ml from	to
5	16	32
6	32	64
7	64	130
8	130	250
9	250	500
10	500	1.000
11	1.000	2.000
12	2.000	4.000
13	4.000	8.000
14	8.000	16.000
15	16.000	32.000
16	32.000	64.000
17	64.000	130.000
18	130.000	260.000
19	260.000	500.000
20	500.000	1.000.000
21	1.000.000	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

$>4\mu m_{(c)}$ $>6\mu m_{(c)}$ $>14\mu m_{(c)}$

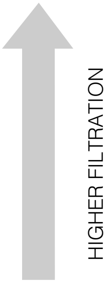
Example of contamination classification



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	



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

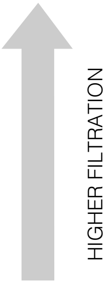


Table **LF020-0/E**

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
Component							
Proportional valves		longer life		normal operation			
Solenoid & conventional valves						normal operation	
Variable displacement pumps				longer life		normal operation	
Fixed displacement pumps					longer life		normal operation
Cylinders						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

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 are suitable for two maximum pressure levels: type **FPH** for max operating pressure up to 420bar, type **FPS** for max operating pressure up to 320bar.

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 $\boxed{6}$.


FPS


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.

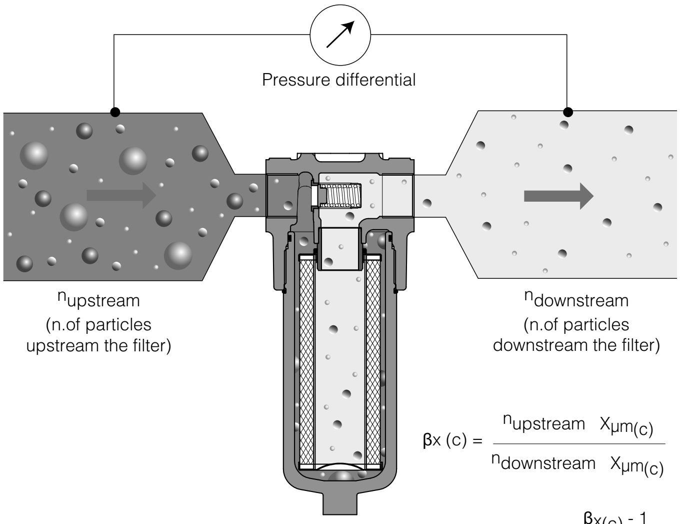
Due to cavitation reasons they are normally avoided for variable displacement piston pumps.


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 **$\mu m_{(c)}$**

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

ATOS FILTRATION TYPE	$\beta_{x(c)}$ > 1000 (ISO16889)	β_x > 200 (ISO4572)
F03	4.5 $\mu m_{(c)}$	3 µm
F06	7 $\mu m_{(c)}$	6 µm
F10	12 $\mu m_{(c)}$	10 µm
F25	27 $\mu m_{(c)}$	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.

The greater is the surface of the filter element, the higher is the DHC.

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.

COMPLEXITY

Filtration Circuit	**D**					▨	▨	▨
	C			▨	▨	▨	▨	
	B	▨	▨	▨	▨			
	A	▨	▨					
		21/19/16	**20/18/15**	**19/17/14**	**18/16/13**	**17/15/12**	**16/14/11**	**15/13/10**
	Contamination classes							

HIGHER FILTRATION

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

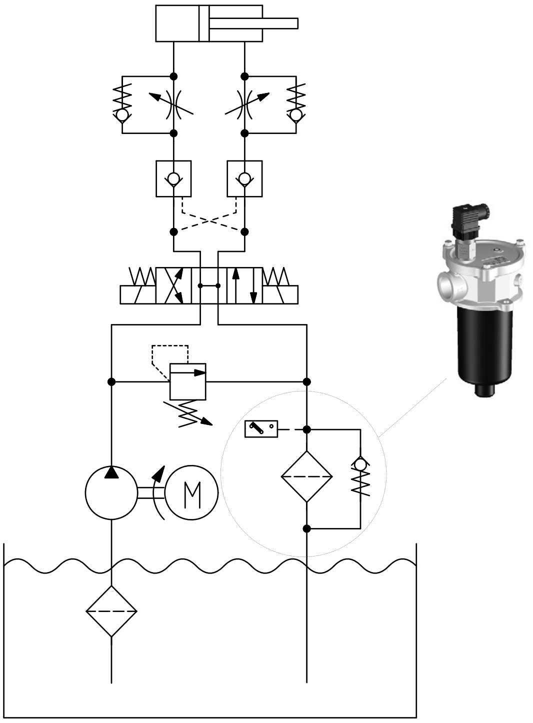
- the hydraulic tank has to be properly designed to limit the ingress of external contamination
- maintenance operations must be performed to avoid the ingress of contamination.

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.

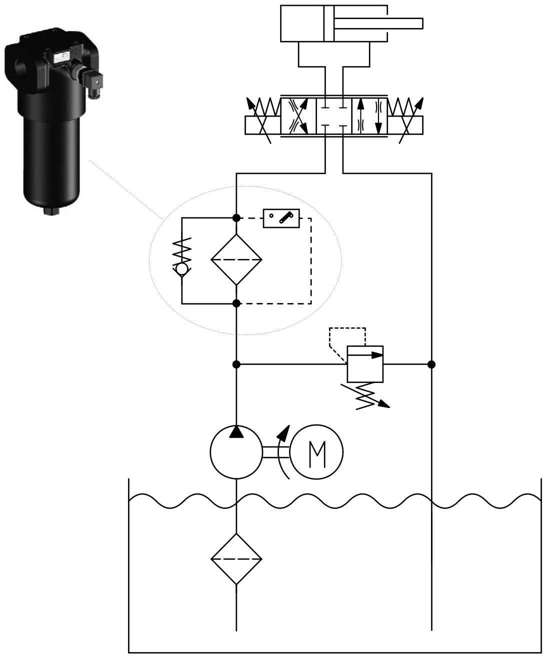
This configuration can't ensure protection of hydraulic components from wear generated by the pump.



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.

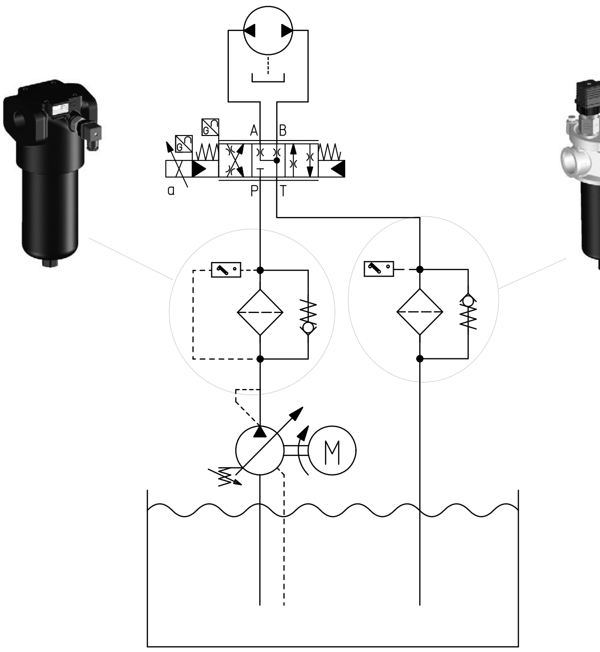


CIRCUIT C

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.

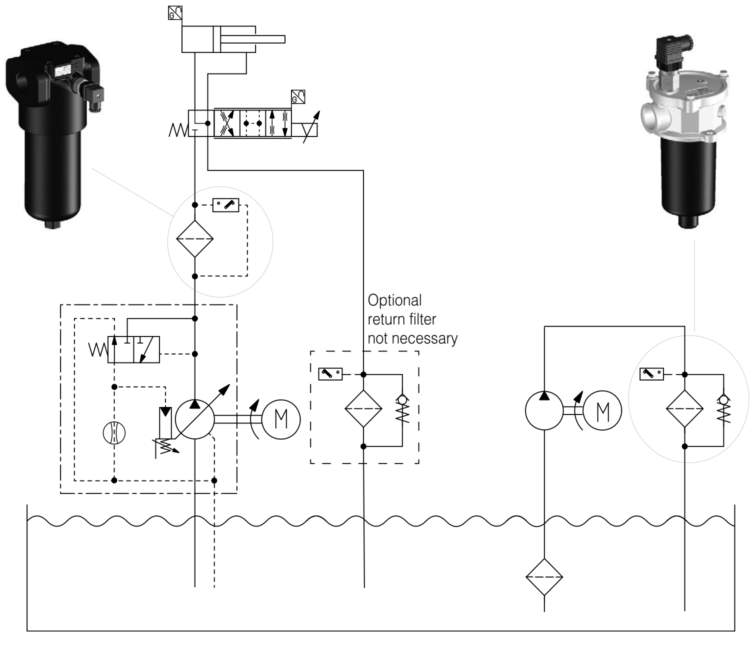


CIRCUIT D

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 1 bar) = filter element in good condition;
  Yellow (range 1 to 1,5 bar) = filter element partially clogged;
  Red (> 1,5) = filter element to be immediately replaced
  It requires a constant visual inspection by the operator to verify the filter condition

CIA-V

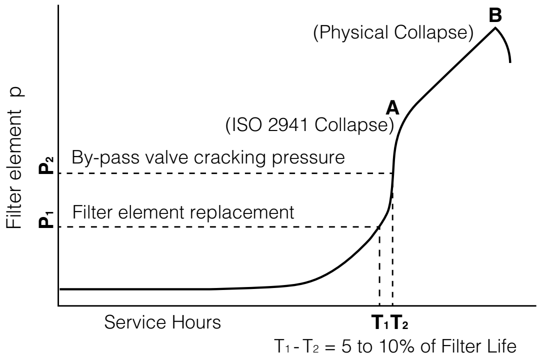
- **Electrical indicator**, Atos type **CIA-E**, normally used with **return line filters**
  It is a pressure switch which measures the pressure before the filer element and it indicates the clogged condition by means of switching contact (NO or NC)
  The switching pressure if factory set at 2 bar corresponding 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

- **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

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

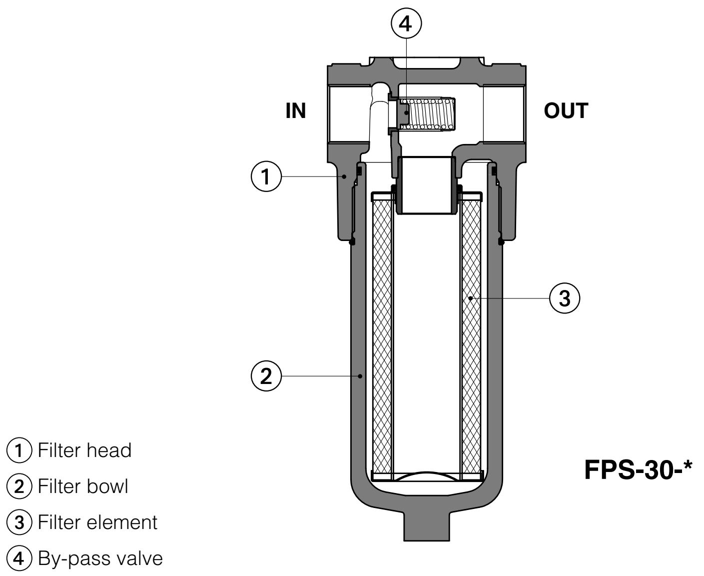
ISO 23181 Hydraulic fluid power – Filter element – determination of resistance to flow fatigue using high viscosity fluid

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 type FPS

Threaded ports - max flow 330 l/min, max pressure 320 bar



FPS in line filters are designed to protect the whole hydraulic circuit or a single valve from contamination present in the working fluid.
They are particularly recommended for systems with proportional valves.

FPS filters are available with following features:

- two head sizes with BSPP or SAE threaded ports, from 3/4” to 1 1/2”
- max working pressure 320 bar
- four filter lengths with max flow 330 l/min
- without or with by-pass valve with cracking pressure 6 bar
- microfibre filter element with filtration rating 4,5 - 7 - 12 μm(c) (βx (c) >1000, ISO 16889). Collapse pressure 21 bar for filters equipped with by-pass valve or 210 bar for filters without by-pass
- without or with electrical differential clogging indicator with optional led

1 MODEL CODE OF COMPLETE FILTERS

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

In line filter

Series number

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

Electrical differential clogging indicator see sect. 9:
W = without, indicator port unplugged
P = without, indicator port with steel plug
L = indicator with LED **(3)**
M = indicator without LED **(3)**

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

By-pass:
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)

Filter lenght:	Max flow [l/min] **(1)** FPS-10	FPS-30
A =	75	170
B =	105	250
C =	-	300
D =	-	330

Ports size:

BSPP threaded:

FPS-10	FPS-30
01 = G 3/4”	**03** = G 1 1/4”
02 = G 1”	**04** = G 1 1/2”

SAE J1926-1 threaded **(2)**:

FPS-10	FPS-30
42 = SAE-16 (1”)	**44** = SAE-24 (1 1/2”)

Microfibre filtration rating, βx(c) >1000 - ISO 16889:
F03 = 4,5 μm (c)
F06 = 7 μm (c)
F10 = 12 μm (c)

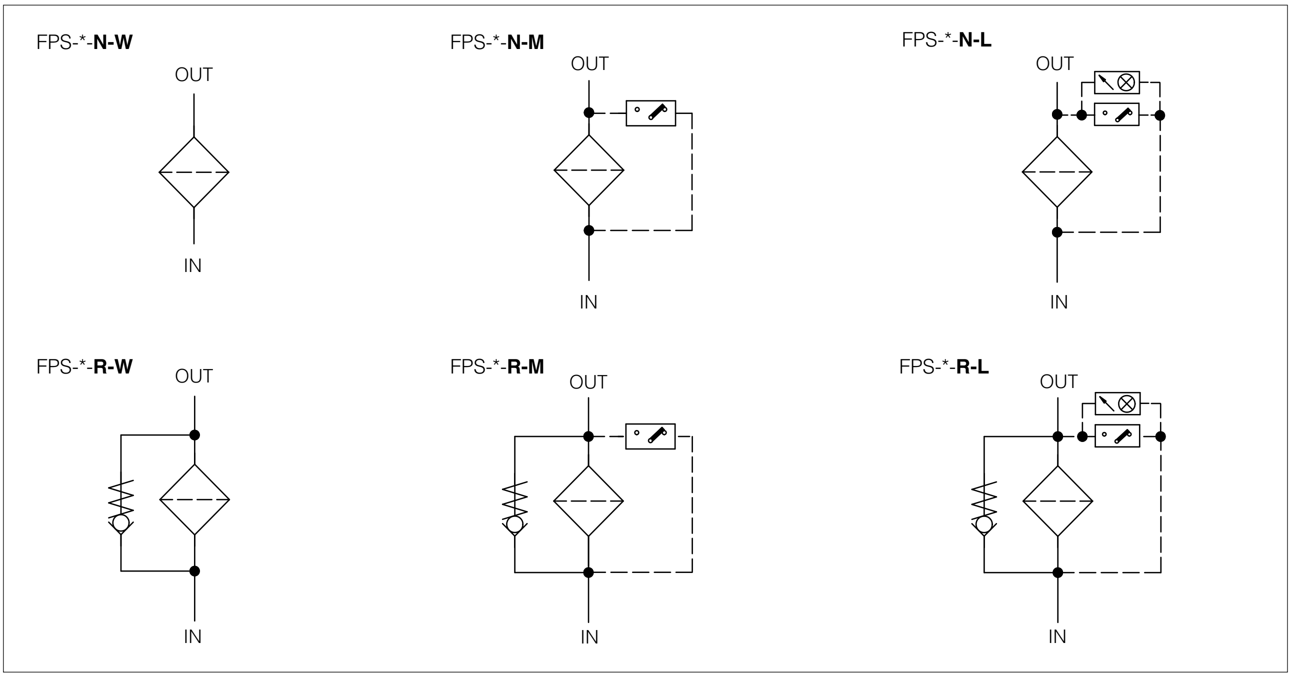
Note: filters for use in potentially explosive atmosphere are available on request, contact Atos Technical Office

(1) Max flow rates are performed in following conditions:
- clean filter element
- filtration rating F10 (12 μm (c))
- largest port size
- option /R, filter element with collapse pressure 21 bar
- Δp = 1 bar
- mineral oil with viscosity 32 mm²/s

In case of different conditions the max flow rates have to be recalculated - **see section 10**

(2) Filters with SAE threaded ports are available on request
(3) The clogging indicator is supplied disassembled from the filter. The indicator port on filter head is plugged with plastic plug
(4) Filters with FKM seals are available on request

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



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

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

Spare filter element
for in line filter
type FPS

Series number

Seals material:
- = NBR
PE = FKM **(2)**

Filter element size:
10 = for FPS-10
30 = for FPS-30

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

Filter element lenght:

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

Microfibre filtration rating, βx(c) >1000 - ISO 16889:
F03 = 4,5 μm (c)
F06 = 7 μm (c)
F10 = 12 μm (c)

(1) Select the filter element according to the model code reported on the filter nameplate, see section 14.1
(2) Filters element with FKM seals are available on request

4 MODEL CODE OF ELECTRICAL DIFFERENTIAL CLOGGING INDICATORS - only for spare

CID	-	**E05**	-	**M**	**	/	*

Spare electrical differential clogging indicator
for in line filter

Series number

Seals material:
- = NBR
PE = FKM

Differential switching pressure:
E05 = 5 bar for filters with by-pass valve
E08 = 8 bar for filters without by-pass valve

Optional LED for visual indication:
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	Steel
Surface protection		Phosphatized
Fatigue strength		min. 1 x 10^6 cycles at 320 bar

6 HYDRAULICS CHARACTERISTICS

Filter size		**10**			**30**		
Port size code		**01**	**02**	**42**	**03**	**04**	**44**
Port dimension	BSPP threaded	G3/4"	G1"		G1 1/4"	G1 1/2"	
	SAE J1926-1 threaded			SAE-16			SAE-24
Max operating pressure	(bar)	320					
Max flow **(1)** (l/min)	**R** = filter with by-pass	60 ÷ 80	75 ÷ 105	60 ÷ 80	165 ÷ 305	170 ÷ 330	170 ÷ 330
	N = filter without by-pass	55 ÷ 75	65 ÷ 90	55 ÷ 75	145 ÷ 245	150 ÷ 260	150 ÷ 260
Direction of filtration		See the arrow on the filter head					

(1) Max flow rates are performed in following conditions:
- clean filter element
- filtration rating F10 (12 μm (c))
- Δp 1 bar
- min ÷ max filter lenght
- mineral oil with viscosity 32 mm^2/s

In case of different conditions the max flow rates have to be recalculated - **see section** 10

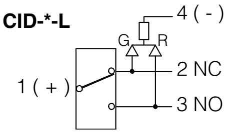
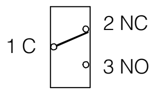
7 FILTER ELEMENTS

Material		Inorganic microfibre
Filtation rating as per ISO16889	**F03**	$\beta_{4,5\mu m\ (c)} \geq 1000$
	F06	$\beta_{7,5\mu m\ (c)} \geq 1000$
	F10	$\beta_{12\mu m\ (c)} \geq 1000$
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 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 ELECTRICAL DIFFERENTIAL CLOGGING INDICATORS

Differential switching pressure	CID-E05	5 bar ± 10% for filters with by-pass valve	
	CID-E08	8 bar ± 10% for filters without by-pass valve	
Max pressure		450 bar	
Max differential pressure		200 bar	
Electric connection		Electric plug connection as per DIN 43650 with cable gland type PG7	
Power supply	CID-*-L	24 V_{DC} ± 10%	
	CID-*-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)
Fluid temperature		-25°C ÷ +100°C	
Protection degree to DIN EN 60529		IP65 with mathing connector	
Hydraulic connection		M20x1,5	
Duty factor		100%	
Mechanical life		1 x 10^6 operations	
Mass (Kg)		0,16	
Electric scheme shown with switch position in case of clean filter element		**CID-*-L**  	**CID-*-M** 

10 FILTERS SIZING

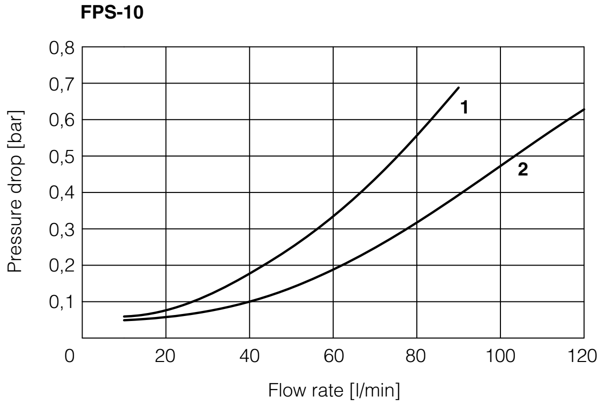
For the filter sizing it is necessary to consider the Total Δp at the maximum flow at which the filter must work.
The Total Δp is given by the sum of filter head Δp plus the filter element Δp:

Total Δp = filter head Δp + filter element Δp

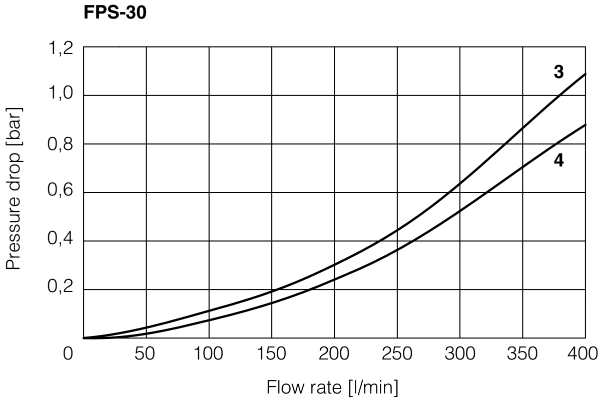
In the best conditions the total Δp should not exceed 1,0 bar
See below sections to calculate the Δp of filter head and Δp of the filter element

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



3 = FPS-30*** 03 (G $1^{1}/_{4}$”) **4** = FPS-30*** 04 (G $1^{1}/_{2}$”)
FPS-30*** 44 (SAE-24)

10.2 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:

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

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
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

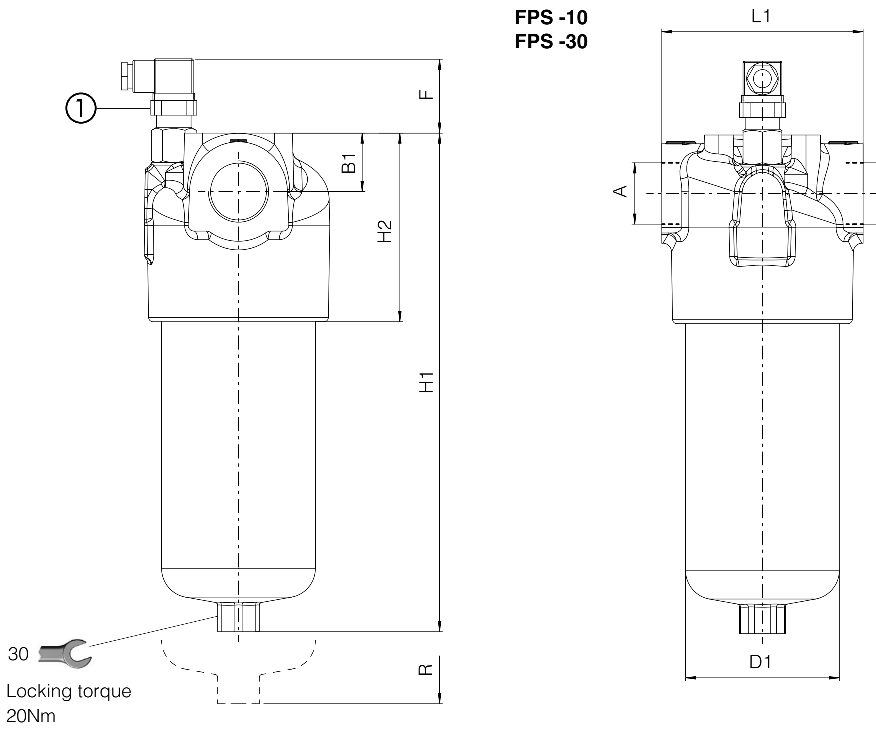
Example:
Calculation of Total Δp for filter type FPS-10-B-F10-02-R at Q = 80 l/min and viscosity 46 mm^2/s (filter element PSH-10-B-F10-R)
Δp of filter head = 0,31 bar
Gr = 4,91 mbar/(l/min)

$$\textbf{Filter element Δp} = \ 80 \ \text{X} \ \frac{4{,}91}{1000} \ \text{X} \ \frac{46}{30} \ = \ 0{,}60 \text{ bar}$$

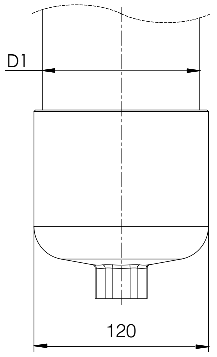
Total Δp = 0,31 + 0,60 = **0,91 bar**

11 INSTALLATION DIMENSIONS OF FPS FILTERS [mm]

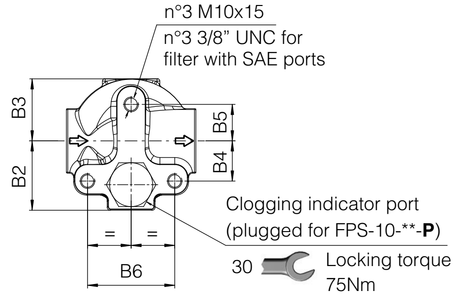
FPS -10
FPS -30



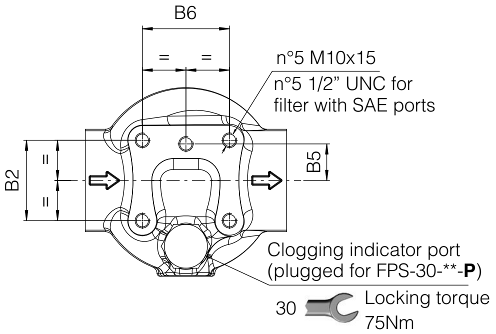
for
FPS-30-D
only



FPS -10



FPS -30



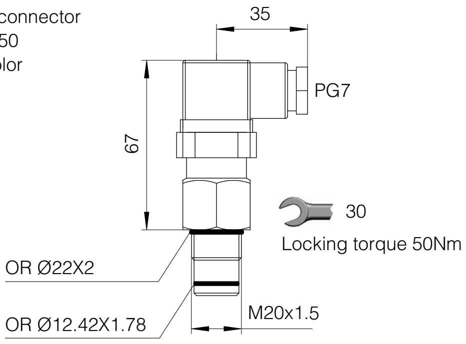
① Optional electrical differential clogging indicator

Code	A	B1	B2	B3	B4	B5	B6	D1	F	H1	H2	L1	**R** (element removal)	Mass (Kg)
FPS-10-A	3/4” BSPP 1” BSPP SAE-16	22,5	47,5	43,5	27,5	25	60,6	70	70	200	92	90	110	3,5
FPS-10-B										293				4,5
FPS-30-A	1 1/4” BSPP 1 1/2 BSPP SAE-24	40	55	-	-			107	50	248	129	140	130	9,0
FPS-30-B										341				9,5
FPS-30-C										461				14,4
FPS-30-D										554				18,8

12 DIMENSIONS OF ELECTRICAL DIFFERENTIAL CLOGGING INDICATORS

CID-E05-M
CID-E08-M

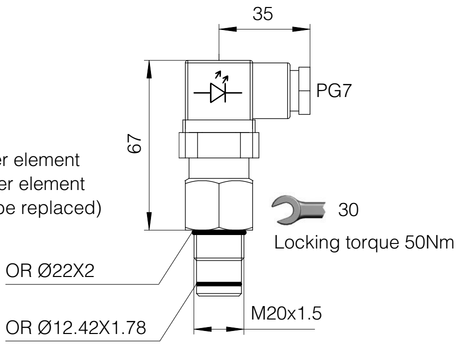
Electric connector
DIN 43650
Black color



CID-E05-L
CID-E08-L

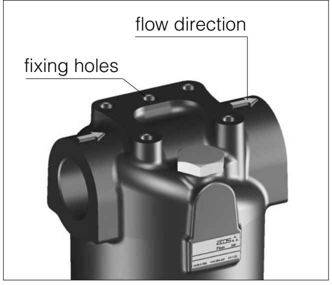
Electric connector
DIN 43650
Trasparent
with internal Led

Led 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°

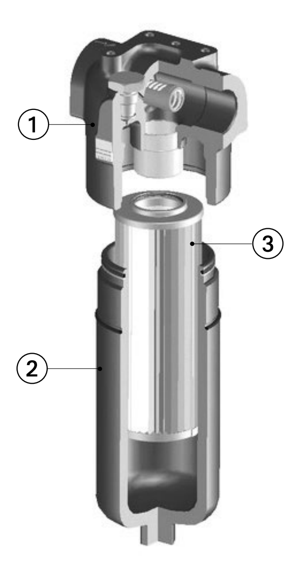
13 INSTALLATION AND COMMISSIONING



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 head 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, code L or M:
- 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.

14 MAINTENANCE

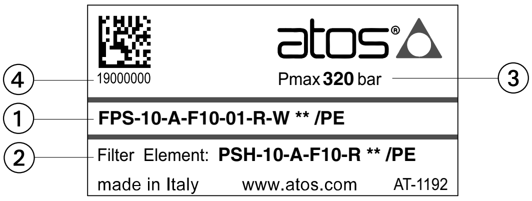


The filter element must be replaced as soon as the clogging indicator switches to highlight the filter clogged condition
For filters without clogging indicator, the filter element must be replaced according to the system manufacturer's recommendations.
Select the new filter element according to the model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

14.1 FILTER IDENTIFICATION NAMEPLATE

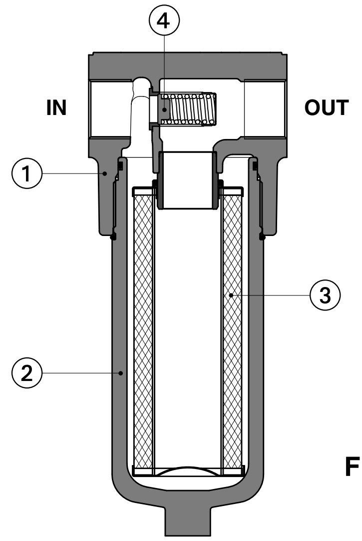


atos
19000000
Pmax **320** bar
FPS-10-A-F10-01-R-W ** /PE
Filter Element: **PSH-10-A-F10-R ** /PE**
made in Italy www.atos.com AT-1192

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

In line filters, high pressure type FPH

Threaded or SAE flanged ports - max flow 340 l/min, max pressure 420 bar



FPH-30-*

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

FPH in line filters are designed to protect the whole hydraulic circuit or a single valve from contamination present in the working fluid.
They are particularly recommended for circuits with proportional valves.

FPH filters are available with following features:

- two body sizes with BSPP or SAE threaded ports or SAE 6000 flanged ports, from 3/4" to 1 1/2"
- max working pressure up to 420 bar
- four filter lengths with max flow 340 l/min
- without or with by-pass valve with cracking pressure 6 bar
- microfibre filter element with filtration rating 4,5 - 7 - 12 μm(c) (βx (c) >1000, ISO 16889). Collapse pressure 21 bar for filters equipped with by-pass valve or 210 bar for filters without by-pass
- without or with electrical differential clogging indicator with optional led.

1 MODEL CODE OF COMPLETE FILTERS

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

In line filter, high pressure

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

Filter lenght:		Max flow [l/min] **(1)** FPH-10	FPH-30
A	=	75	175
B	=	105	260
C	=	-	310
D	=	-	340

Microfibre filtration rating, βx(c) > 1000 - ISO 16889:
F03 = 4,5 μm (c)
F06 = 7 μm (c)
F10 = 12 μm (c)

Ports size:

BSPP threaded:

FPH-10	FPH-30
01 = G 3/4"	**03** = G 1 1/4"
02 = G 1"	**04** = G 1 1/2"

SAE 6000 flange with metric bolts:

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

SAE J1926-1 threaded **(2)**:

FPH-10	FPH-30
42 = SAE-16 (1'')	**44** = SAE-24 (1 1/2'')

SAE 6000 flange with UNC bolts **(2)**:

FPH-10	FPH-30
32 = 1"	**34** = 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)

Electrical differential clogging indicator see sect. 9 :
W = without, indicator port unplugged
P = without, indicator port with steel plug
L = indicator with LED **(3)**
M = indicator without LED **(3)**

Series number

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

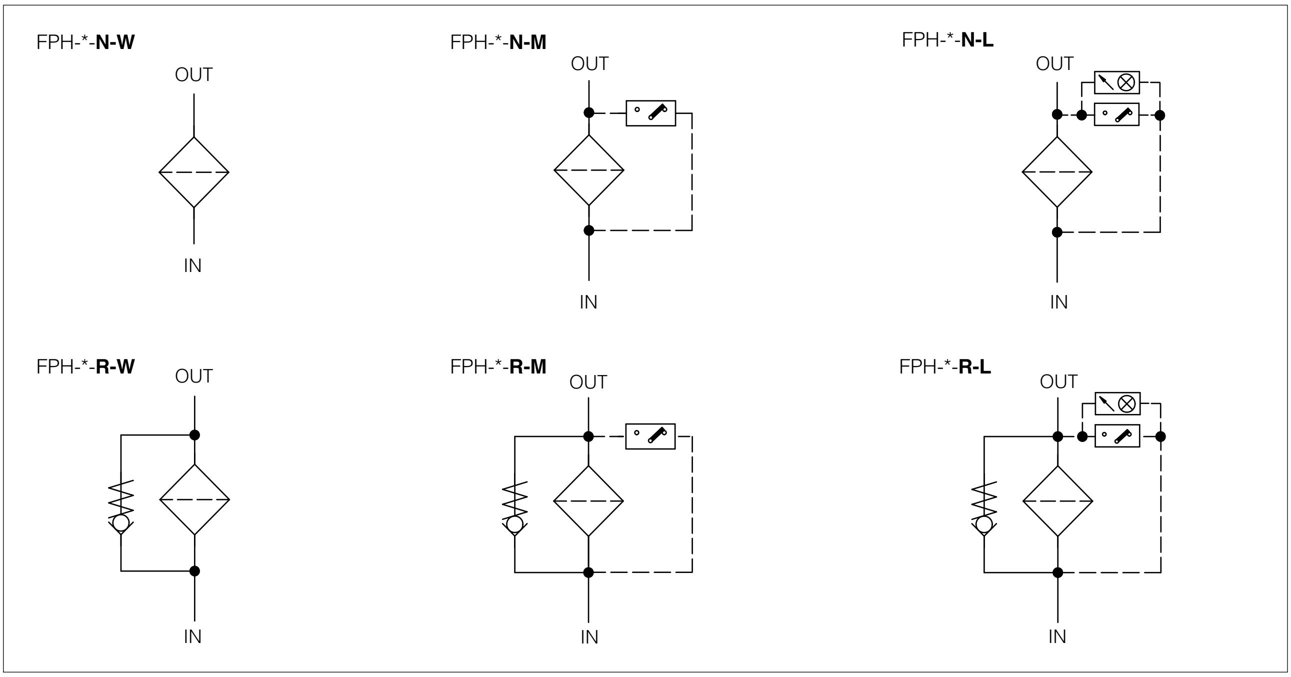
Note: filters for use in potentially explosive atmosphere are available on request, contact Atos Technical Office

(1) Max flow rates are performed in following conditions:
- clean filter element
- filtration rating F10 (12 μm (c))
- largest port size
- option /R, filter element with collapse pressure 21 bar
- Δp = 1 bar
- mineral oil with viscosity 32 mm²/s

In case of different conditions the max flow rates have to be recalculated - **see section 10**

(2) Filters with SAE threaded ports and SAE 6000 flange with UNC bolts are available on request
(3) The clogging indicator is supplied disassembled from the filter. The indicator port on filter head is plugged with plastic plug
(4) Filters with FKM seals are available on request

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



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

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

Spare filter element
for in line filter
type FPH

Series number

Seals material:
- = NBR
PE = FKM **(2)**

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 size:
10 = for FPH-10
30 = for FPH-30

Filter element lenght:

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

Microfibre filtration rating, $\beta x(c) > 1000$ - ISO 16889:
F03 = 4,5 μm (c)
F06 = 7 μm (c)
F10 = 12 μm (c)

(1) Select the filter element according to the model code reported on the filter nameplate, see section 14.1
(2) Filters element with FKM seals are available on request

4 MODEL CODE OF ELECTRICAL DIFFERENTIAL CLOGGING INDICATORS - only for spare

CID - **E05** - **M** ** / *

Spare electrical differential clogging indicator
for in line filter

Series number

Seals material:
- = NBR
PE = FKM

Differential switching pressure:
E05 = 5 bar for filters with by-pass valve
E08 = 8 bar for filters without by-pass valve

Optional LED for visual indication:
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	Steel
Surface protection		Phosphatized
Fatigue strength		min. 1 x 10^6 cycles at 420 bar

6 HYDRAULICS CHARACTERISTICS

Filter size		**10**						**30**					
Port size code		**01**	**21**	**02**	**22**	**32**	**42**	**03**	**23**	**04**	**24**	**34**	**44**
Ports dimensions:	BSPP threaded	G3/4”		G1”				G1 1/4”		G1 1/2”			
	SAE J1926-1 threaded						SAE-16						SAE-24
	SAE 6000 with metric bolts		3/4”		1”				1 1/4”		1 1/2”		
	SAE 6000 with UNC bolts					1”						1 1/2”	
Max operating pressure (bar)		420											
Max flow **(1)** (l/min)	**R** = filter with by-pass	65 ÷ 80		75 ÷ 105				165 ÷ 300		170 ÷ 330			
	N = filter without by-pass	55 ÷ 70		65 ÷ 90				145 ÷ 245		150 ÷ 260			
Direction of filtration		See the arrow on the filter head											

(1) Max flow rates are performed in following conditions:
- clean filter element
- filtration rating F10 (12 μm (c))
- Δp 1 bar
- min ÷ max filter lenght
- mineral oil with viscosity 32 mm²/s

In case of different conditions the max flow rates have to be recalculated - **see section 10**

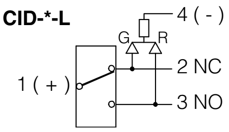
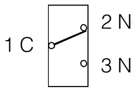
7 FILTER ELEMENTS

Material		Inorganic microfibre
Filtation rating as per ISO16889	**F03**	$\beta_{4,5\mu m\,(c)} \geq 1000$
	F06	$\beta_{7,5\mu m\,(c)} \geq 1000$
	F10	$\beta_{12\mu m\,(c)} \geq 1000$
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 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 ELECTRICAL DIFFERENTIAL CLOGGING INDICATORS

Differential switching	CID-E05	5 bar ± 10% for filters with by-pass valve	
	CID-E08	8 bar ± 10% for filters without by-pass valve	
Max pressure		450 bar	
Max differential pressure		200 bar	
Electric connection		Electric plug connection as per DIN 43650 with cable gland type PG7	
Power supply	CID-*-L	24 V_{DC} ± 10%	
	CID-*-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)
Fluid temperature		-25°C ÷ +100°C	
Protection degree to DIN EN 60529		IP65 with mathing connector	
Hydraulic connection		M20x1,5	
Duty factor		100%	
Mechanical life		1 x 10^6 operations	
Mass (Kg)		0,16	
Electric scheme shown with switch position in case of clean filter element		**CID-*-L** 	**CID-*-M** 

10 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:

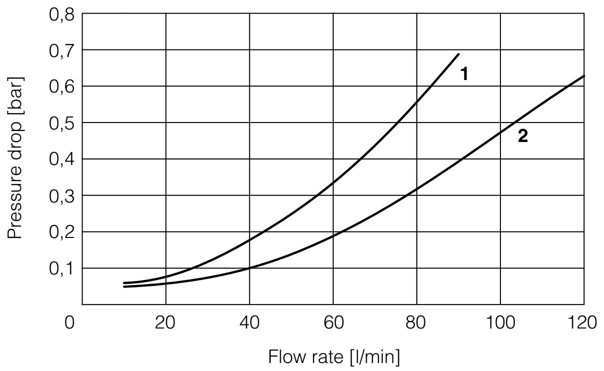
Total Δp = filter head Δp + filter element Δp

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

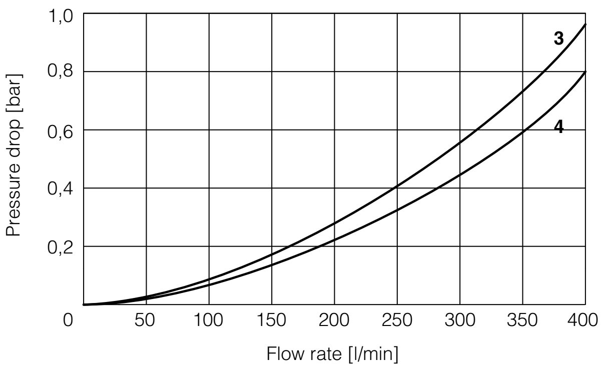
10.1 Q/Δp DIAGRAMS OF FILTER HEAD

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

FPH-10



FPH-30



1 = FPH-10*** 01 (G 3/4")
FPH-10*** 21 (3/4" SAE 6000)

2 = FPH-10*** 02 (G 1")
FPH-10*** 22 (1" SAE 6000)
FPH-10*** 32 (1" SAE 6000)
FPH-10*** 42 (1" SAE-16)

3 = FPH-30*** 03 (G 1$^{1}/_{4}$")
FPH-30*** 23 (1 $^{1}/_{4}$"SAE 6000)

4 = FPH-30*** 04 (G 1$^{1}/_{2}$")
FPH-30*** 24 (G 1 $^{1}/_{2}$"SAE 6000)
FPH-30*** 34 (G 1 $^{1}/_{2}$"SAE 6000)
FPH-30*** 44 (SAE-24)

10.2 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:

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

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 (mm^2/s)

Gradient coefficent Gc of PSH filter elements

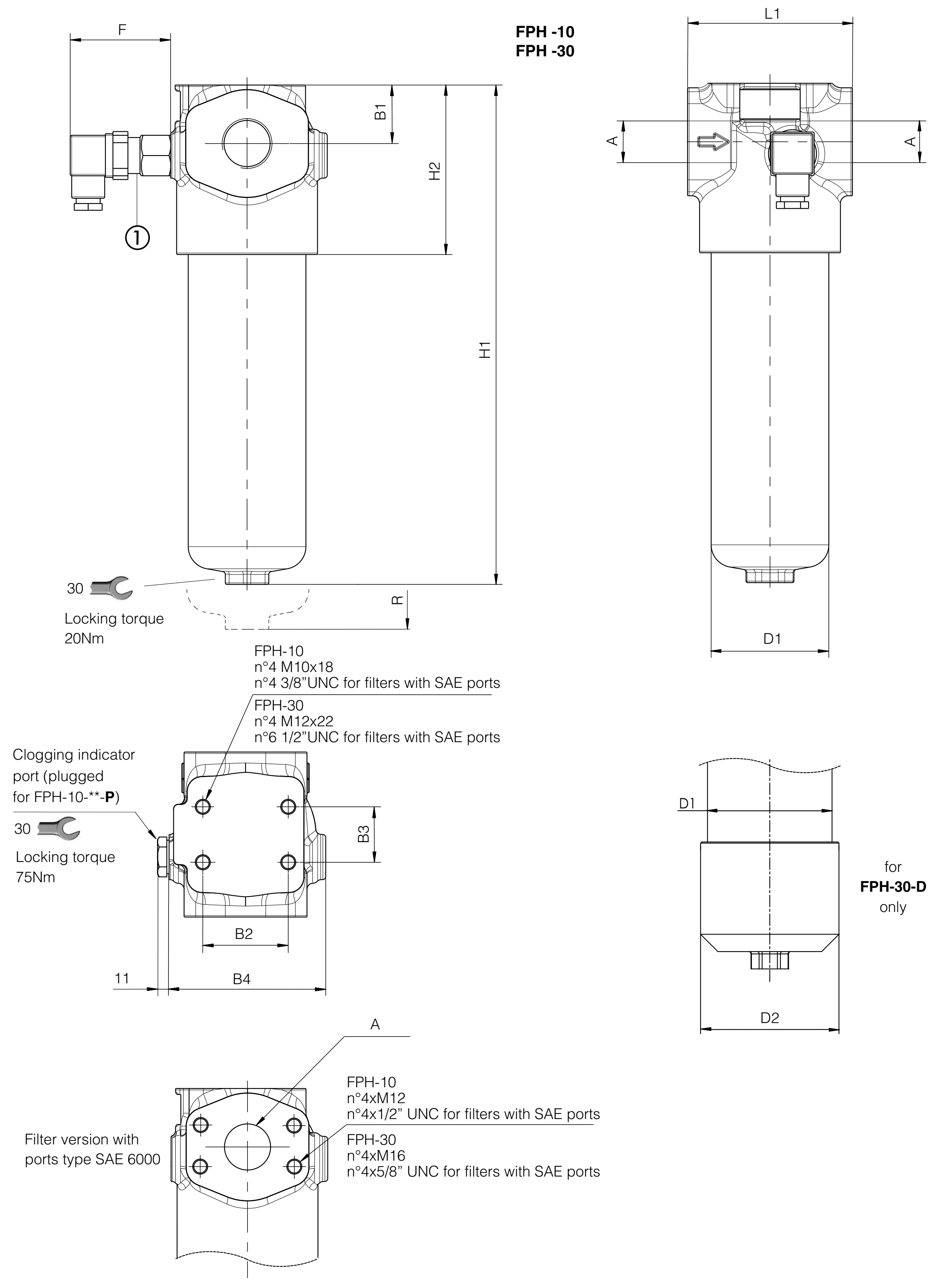
Filter element size		**10**		**30**			
Filter element lenght		**A**	**B**	**A**	**B**	**C**	**D**
Filter element type	Filtration rating	**Gc** Gradient coefficient					
R for filter with bypass valve	**F03**	27.75	15.25	14	7.13	4.7	3.62
	F06	15.12	7.58	8.03	3.37	2.2	1.89
	F10	9.37	4.91	4.43	2.33	1.5	1.12
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

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 = 0,22 bar
Gr = 2,2 mbar/(l/min)

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

Total Δp = 0,22 + 0,68 = **0,90 bar**

11 INSTALLATION DIMENSIONS OF FPH FILTERS [mm]



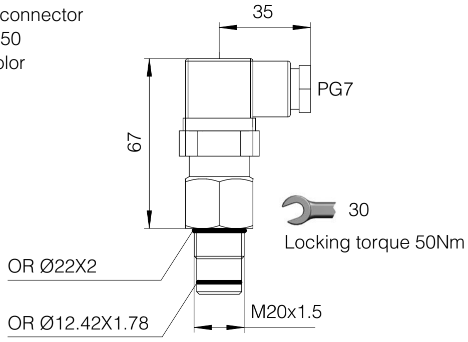
① Optional electrical differential clogging indicator

Code	A	B1	B2	B3	B4	D1	D2	F	H1	H2	L1	R	Mass (Kg)
FPH-10-A	see sect. 6 for available port size	39	57	37	105	78,5	-	68	222	113	110	130	6,7
FPH-10-B									333				8,4
FPH-30-A		47	76	64	140	107			262	145	140	140	13,2
FPH-30-B									355				15,5
FPH-30-C									475				18,4
FPH-30-D							120		568				22,8

12 DIMENSIONS OF ELECTRICAL DIFFERENTIAL CLOGGING INDICATORS

CID-E05-M
CID-E08-M

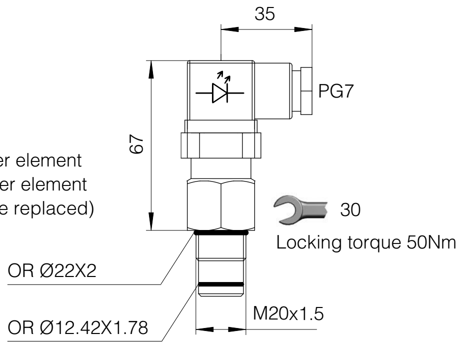
Electric connector
DIN 43650
Black color



CID-E05-L
CID-E08-L

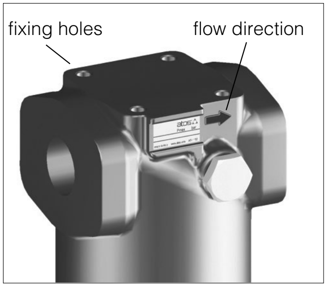
Electric connector
DIN 43650
Trasparent
with internal Led

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



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

13 INSTALLATION AND COMMISSIONING



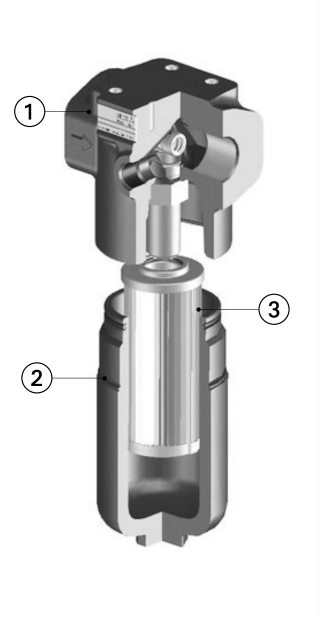
The max operating pressure of the system must not exceed the max working pressure of the filter.
During the filter installation, pay attention to respect the flow direction, shown by the arrow on the filter head.
The filter should be preferably mounted with the housing downward.
The filter head should 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, code L or M:
- 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.

14 MAINTENANCE

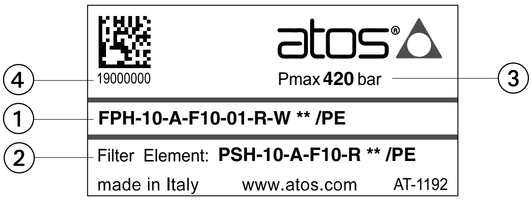
The filter element must be replaced as soon as the clogging indicator switches to highlight the filter clogged condition
For filters without clogging indicator, the filter element must be replaced according to the system manufacturer's recommendations.
Select the new filter element according to the model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

14.1 FILTER IDENTIFICATION NAMEPLATE

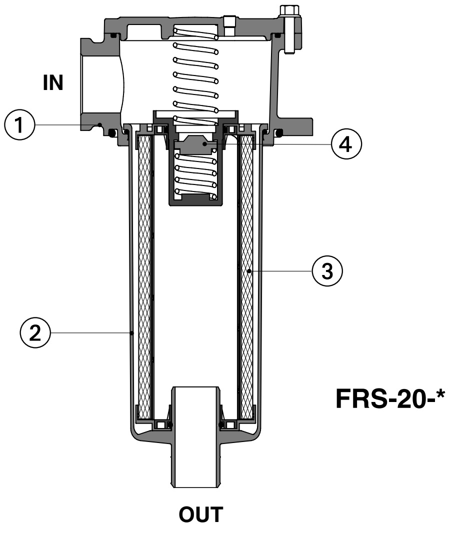


atos®
19000000
Pmax **420** bar
FPH-10-A-F10-01-R-W ** /PE
Filter Element: **PSH-10-A-F10-R ** /PE**
made in Italy www.atos.com AT-1192

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

Return line filters, tank-top type FRS

Threaded ports - max flow 550 l/min, max pressure 8 bar



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

FRS return line filters are designed to protect pumps and the whole hydraulic circuit from contamination present in the working fluid.

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

FRS filters are available with following features:

- four body sizes with BSPP, NPT or SAE threaded ports, from 1/2" to 2"
- four filter lengths with max flow up to 550 l/min
- by-pass valve with cracking pressure 3 bar
- microfibre filter element with filtration rating 12 or 27 µm(c) (βx (c) >1000, ISO 16889)
- without or with electrical or visual clogging indicators

1 MODEL CODE OF COMPLETE FILTERS

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

Return line filter

Series number

Seals material:
- = NBR
PE = FKM **(5)**

Clogging indicator see sect. 9:
W = without indicator (port plugged with steel plug)
E = electrical indicator **(4)**
V = visual indicator **(4)**

Filter size:
10 = ports size 1/2" ÷ 3/4"
20 = ports size 3/4" ÷ 1¹/₄"
30 = ports size 1¹/₄" ÷ 1¹/₂"
40 = ports size 1¹/₄" ÷ 2"

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

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

Ports size:

BSPP threaded:

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

NPT threaded **(3)**:

FRS-10	FRS-20	FRS-30	FRS-40
11 = 3/4"	**13** = 1 1/4"	**14** = 1 1/2"	**15** = 2"

SAE J1926-1 threaded **(3)**:

FRS-10	FRS-20	FRS-30	FRS-40
41 = SAE-12 (3/4'')	**43** = SAE-20 (1 1/4'')	**44** = SAE-24 (1 1/2'')	**45** = SAE-32 (2'')

Microfibre filtration rating, βx(c) >1000 - ISO 16889:
F10 = 12 µm (c)
F25 = 27 µm (c)

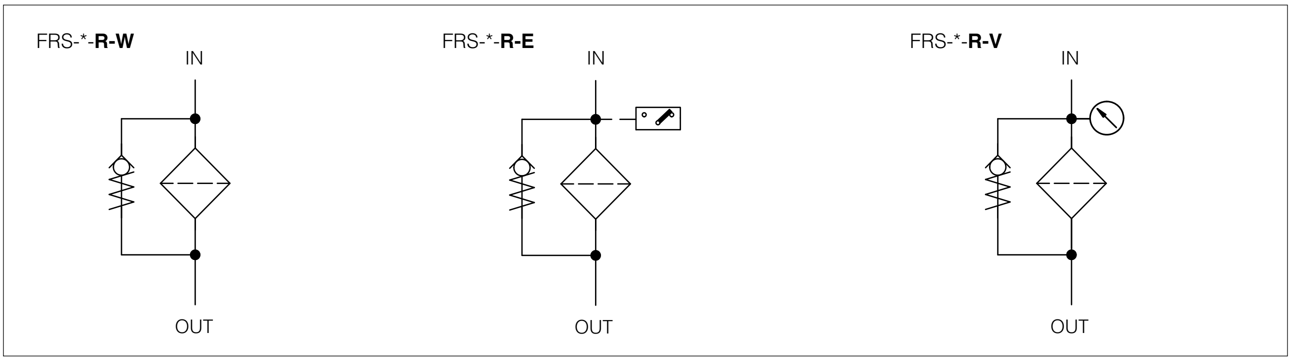
Note: filters for use in potentially explosive atmosphere are available on request, contact Atos Technical Office

(1) Max flow rates are performed in following conditions:
- clean filter element
- filtration rating F25 (27 µm (c))
- largest ports size
- Δp = 0,5 bar
- mineral oil with viscosity 30 mm²/s

In case of different conditions the max flow rates have to be recalculated - **see section 10**

(2) For FRS-40 with lenght B and C the max flow is limited by the max flow velocity allowed in the pipe connections
(3) Filters with NPT or SAE threaded ports are available on request
(4) The clogging indicator is supplied disassembled from the filter. The indicator port on filter head is plugged with steel plug
(5) Filters with FKM seals are available on request

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



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

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

Spare filter element for
return line filter
type FRS

Series number

Seals material:
- = NBR
PE = FKM **(2)**

Microfibre filtration rating, βx(c) > 1000 - ISO 16889:
F10 = 12 µm (c)
F25 = 27 µm (c)

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**
	C		**C**
	D		

(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

CIA	-	**V**	**

Clogging indicator for
return line filter type FRS

Series number

Type of indicator:
E = Electrical - pressure switch, switching pressure 2 bar
V = Visual - pressure gauge, range 0 ÷ 4 bar

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 for FRS-10, FRS-20, and FRS-30; steel for FRS-40
Surface protection		Zinc plated (only FRS-40)

6 HYDRAULICS CHARACTERISTICS

Filter size		10				20					30				40				
Port size code		**00**	**01**	**11**	**41**	**01**	**02**	**03**	**13**	**43**	**03**	**04**	**14**	**44**	**03**	**04**	**05**	**15**	**45**
Ports dimensions	BSPP	1/2”	3/4”			3/4”	1”	1 1/4”			1 1/4”	1 1/2”			1 1/4”	1 1/2”	2”		
	NPT			3/4”					1 1/4”				1 1/2”					2”	
	SAE J1926-1				12					20				24					32
Max operating pressure (bar)		8																	
Max flow **(1)** (l/min)		44 ÷ 53	45÷55			59 ÷ 125	60 ÷ 192	65÷200			263	275			325 ÷ 512	343 ÷ 530	355÷550		
Direction of filtration		See the arrow on the filter head																	

(1) Max flow rates are performed in following conditions:
- clean filter element
- filtration rating F25 (27 μm (c))
- Δp 0,5 bar
- min ÷ max filter lenght
- mineral oil with viscosity 30 mm²/s

In case of different conditions the max flow rates have to be recalculated - **see section** 10

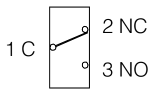
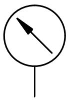
7 FILTER ELEMENTS

Material		Inorganic microfibre
Filtation rating as per ISO16889	**F10**	$\beta_{12\mu m\,(c)} \geq 1000$
	F25	$\beta_{27\mu m\,(c)} \geq 1000$

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 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 CLOGGING INDICATORS

Model code	**CIA-E electrical**		**CIA-V visual**
Switching pressure	2 bar		green sector = 0 ÷ 1 bar yellow sector = 1 ÷ 1,5 bar red sector = 1,5 ÷ 4 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		

10 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:

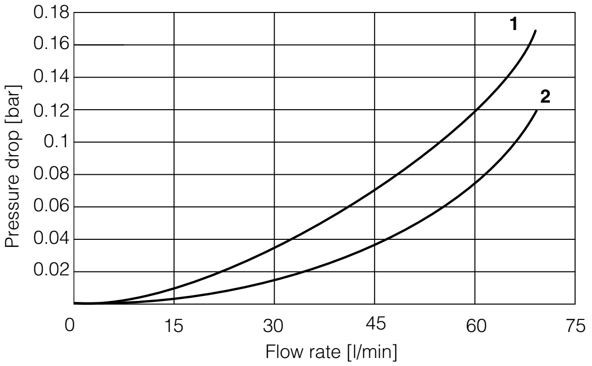
Total Δp = filter head Δp + filter bowl Δp + filter element Δp

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

10.1 Q/Δp DIAGRAMS OF FILTER HEAD + FILTER BOWL

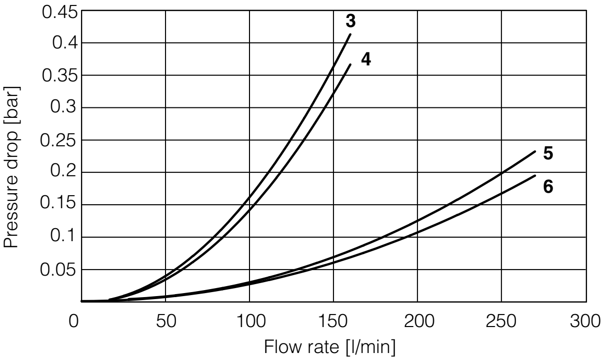
The pressure drop mainly depends on the ports size and fluid density
In the following diagrams are reported the Δp characteristics based on mineral oil with density 0,86 kg/dm^3 and viscosity 30 mm^2/s

FRS-10



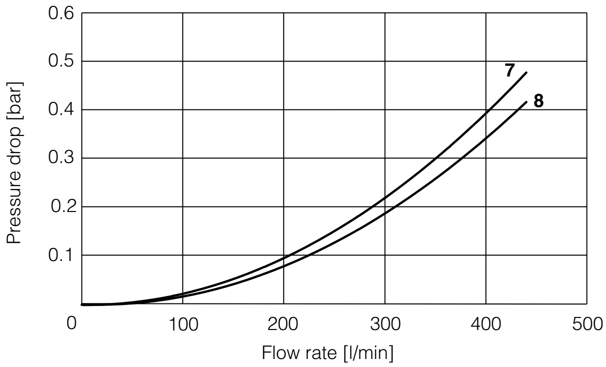
1 = FRS-10-*-00-*
2 = FRS-10-*-01-*
FRS-10-*-11-*
FRS-10-*-41-*

FRS-20



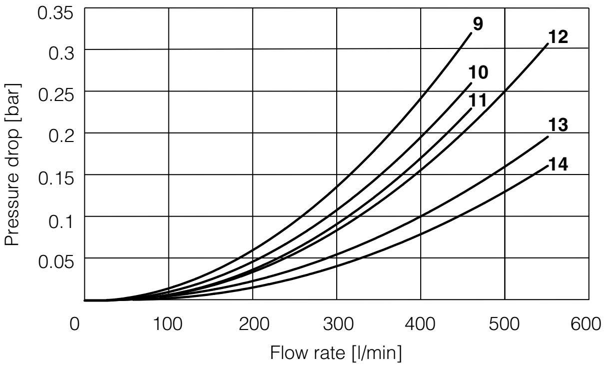
3 = FRS-20-*-01-*
4 = FRS-20-A-02-*
FRS-20-B-02-*
5 = FRS-20-C-02-*
FRS-20-D-02-*
6 = FRS-20-*-03-*
FRS-20-*-13-*
FRS-20-*-43-*

FRS-30



7 = FRS-30-*-03-*
8 = FRS-30-*-04-*
FRS-30-*-14-*
FRS-30-*-44-*

FRS-40



9 = FRS-40-A-03-*
10 = FRS-40-A-04-*
11 = FRS-40-A-05-*
FRS-40-A-15-*
FRS-40-A-45-*
12 = FRS-40-B-03-*
FRS-40-C-03-*

13 = FRS-40-B-04-*
FRS-40-C-04-*
14 = FRS-40-B-05-*
FRS-40-B-15-*
FRS-40-B-45-*
FRS-40-C-05-*
FRS-40-C-15-*
FRS-40-C-45-*

10.2 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:

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

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 FRS filter elements

Filter element size	**10**		**20**				**30**	**40**		
Filter element lenght	**A**	**B**	**A**	**B**	**C**	**D**	**A**	**A**	**B**	**C**
Filtration rating	**Gc** Gradient coefficient									
F10	19.8	10.4	10.77	5.86	3.54	2.29	1.62	1.34	0.84	0.61
F25	9.22	7.18	7.14	3.92	2.25	1.88	1.19	0.98	0.52	0.43

Examples:

1) calculation of Total Δp for filter type FRS-20-B-F10-02-R at Q = 50 l/min and viscosity 46 mm^2/s (filter element PRS-20-B-F10)
   Δp of filter head = 0,034 bar
   Gr = 5,86 mbar/(l/min)

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

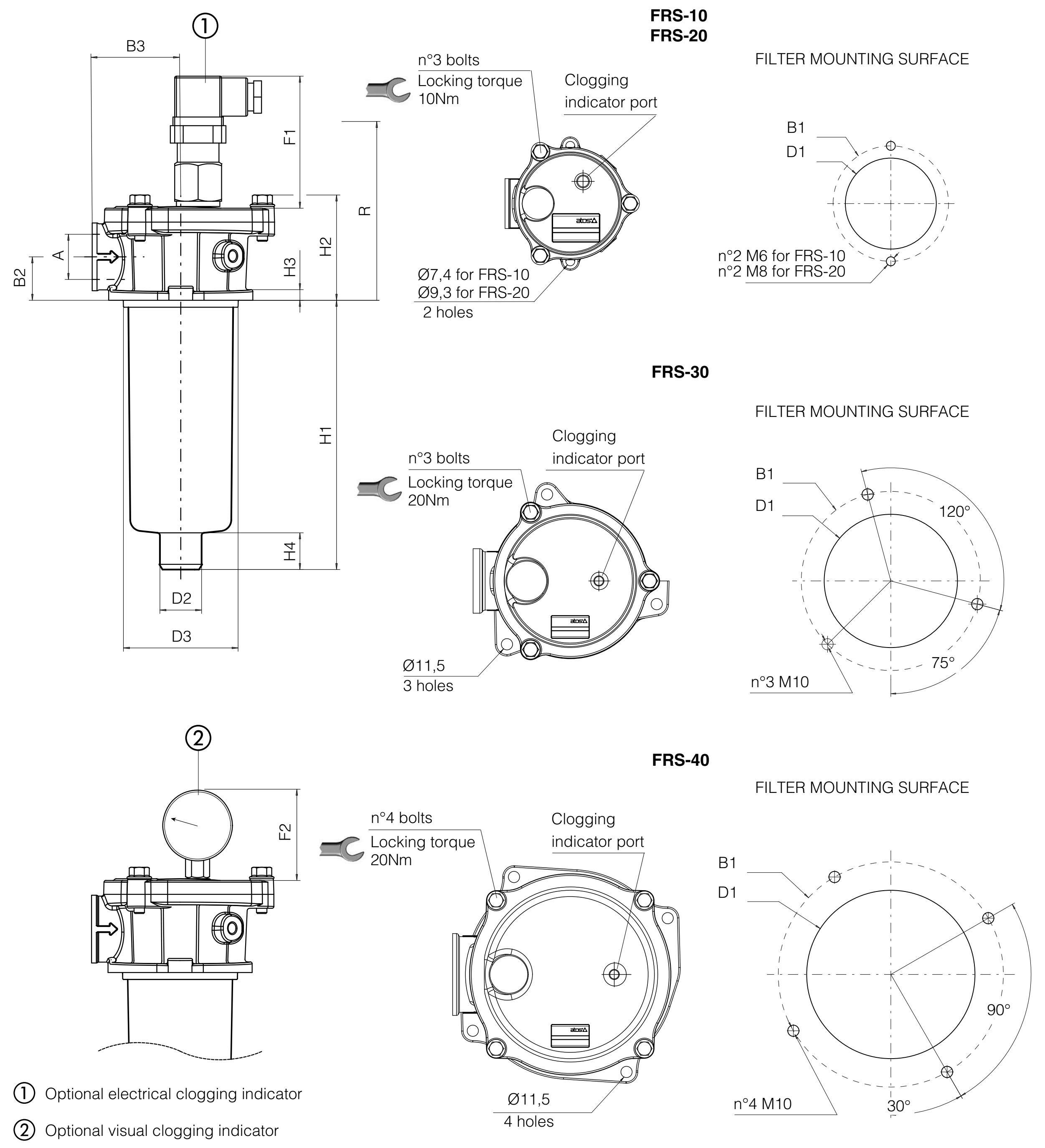
Total Δp = 0,034 + 0,449 = **0,48 bar**

2) calculation of Total Δp of filter type FRS-40-C-F25-05-R at Q = 500 l/min and viscosity 46 mm^2/s (filter element PRS-40-C-F25)
   Δp of filter head = 0,13 bar
   Gr = 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**

11 INSTALLATION DIMENSIONS OF FRS FILTERS [mm]



① Optional electrical clogging indicator

② Optional visual clogging indicator

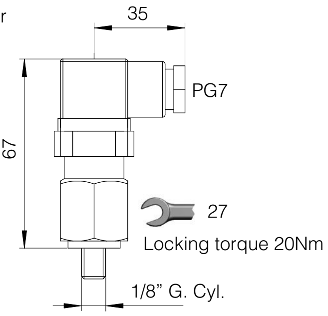
Code	A	B1	B2	B3	D1	D2	D3	H1	H2	H3	H4	F1	F2	R	Mass (Kg)
FRS-10-A	1/2" BSPP 3/4" BSPP 3/4" NPT SAE-12	89	25	51	67,5	24	67	82	60	8	22	67	50	150	0,45
FRS-10-B								155						220	0,60
FRS-20-A	3/4" BSPP 1" BSPP 1 1/4" BSPP 1 1/4" NPT SAE-20	115	28,5 (1)	67	88,5	28	87	106	73	11	24			190	0,80
FRS-20-B								151						230	0,90
FRS-20-C			32 (2)			40		232						310	1,10
FRS-20-D								336						420	1,30
FRS-30-A	1 1/4" BSPP 1 1/2" BSPP 1 1/2" NPT SAE-24	175	35	95	130		129	241	90		30			320	2,10
FRS-40-A	1 1/4" BSPP 1 1/2" BSPP 2" BSPP 2" NPT SAE-32	220	42	115	175	50	174	181	105		50			270	3,20
FRS-40-B						63		240						340	3,60
FRS-40-C								289						380	4,20

(1) For port size 3/4" and 1"
(2) For port size 1 1/4" and SAE-20

12 DIMENSIONS OF CLOGGING INDICATORS

CIA-E

Electric connector
DIN 43650
Black color

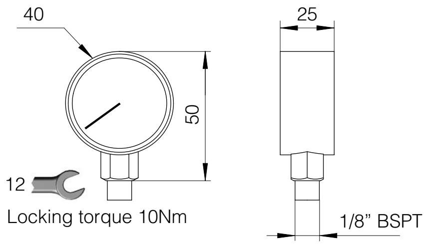


Note: add sealant on indicator threads

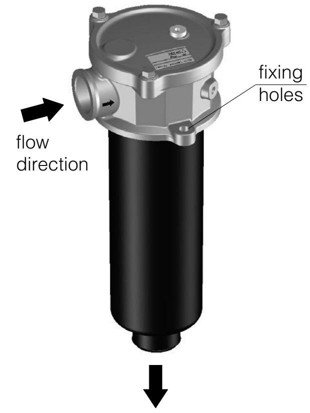
CIA-V

Housing in black ABS

green sector = 0 ÷ 1 bar
yellow sector = 1 ÷ 1,5 bar
red sector = 1,5 ÷ 4 bar



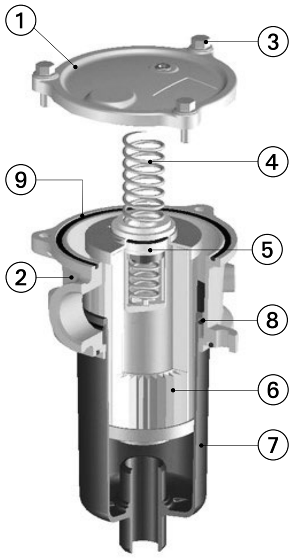
13 INSTALLATION AND COMMISSIONING



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.
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
The filter head 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, 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.

14 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:
- 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.

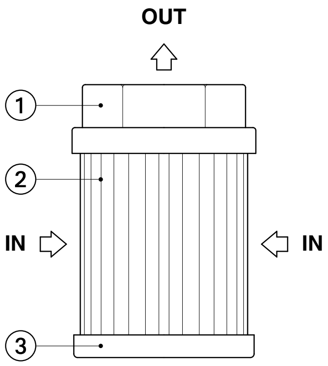
14.1 FILTER IDENTIFICATION NAMEPLATE

③ 19000000
① FRS-10-A-F10-01-R-W ** /PE
② Filter Element: PRS-10-A-F10 ** /PE
made in Italy www.atos.com AT-1193

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

Suction filters type FSS

Threaded ports - max flow 450 l/min



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 "
- three different lengths with max flow up to 450 l/min
- wire mesh 125 µm (c)

FSS filters are without by-pass valve.

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

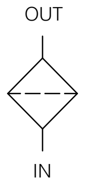
By-pass:
N = without by-pass

Series number

(1) Max flow rates are performed in following conditions:
- clean filter element
- Δp = 0,015 bar
- mineral oil with viscosity 30 mm²/s

In case of different conditions see Q/Δp diagrams at section 5

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
	Filter end cap	Carbon steel, zinc plated
	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 mm²/s - max allowed range 2.8 ÷ 500 mm²/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	

5 FILTER SIZING

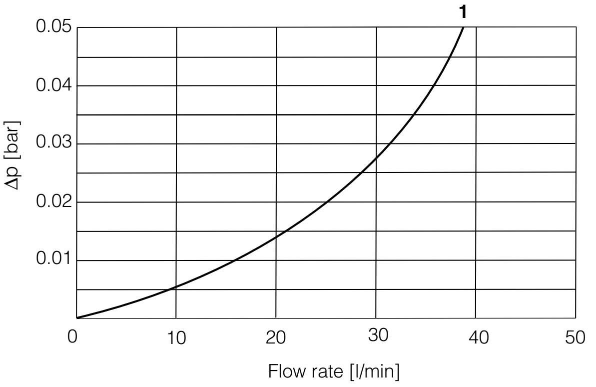
Suction filters must be largely sized to avoid the pumps cavitation. In the best conditions the Δp should not exceed 0.015 bar

5.1 Q/Δp DIAGRAMS

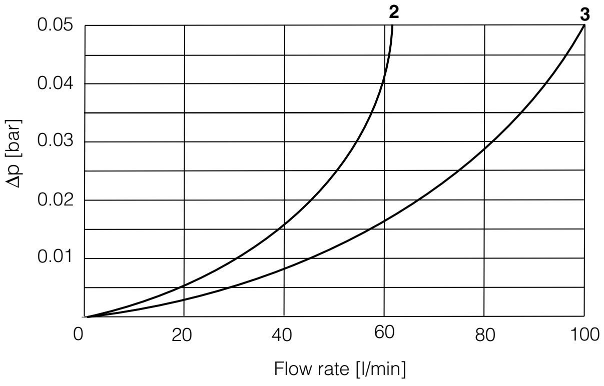
In following diagrams are reported the Δp characteristics of filter based on mineral oil with density 0,86 kg/dm² and viscosity 30 mm²/s. in case of different viscosity the effective Δp_E is given by the formula:

$$\Delta p_E = \Delta p \times \frac{\text{viscosity}}{30}$$

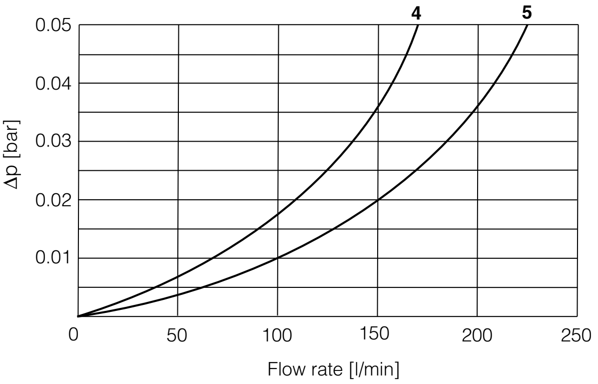
Δp_E = pressure drop calculated at the effective viscosity
Δp = pressure drop reported in the below diagrams
Viscosity = effective fluid viscosity in the working conditiond (mm²/s)



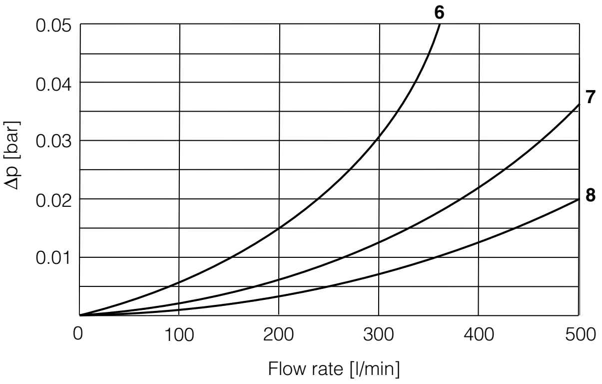
1 = FSS-10-A



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

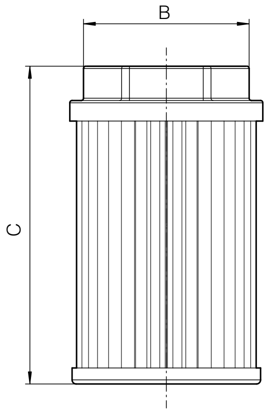


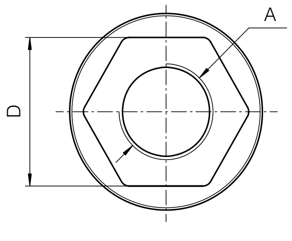
4 = FSS-30-A
5 = FSS-30-B



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

6 INSTALLATION DIMENSIONS OF FSS FILTERS [mm]

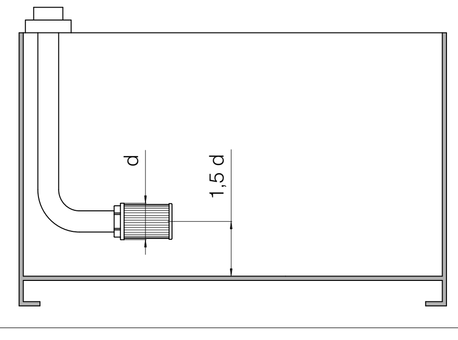




Code	A	B	C	D	Mass (Kg)
FSS-10-A	1/2” BSPP	46	106	36	0,1
FSS-20-A	3/4” BSPP	64	109	50	0,21
FSS-20-B	1” BSPP		139		0,23
FSS-30-A	1 1/4” BSPP	86		65	0,37
FSS-30-B	1 1/2” BSPP		200		0,45
FSS-30-C	2” BSPP		260	75	0,57
FSS-40-A	2 1/2” BSPP	150	212	110	1,02
FSS-40-B	3” BSPP		272		1,06

7 INSTALLATION AND COMMISSIONING

During the filter installation, pay attention that the filter remains below the minimum oil level in the tank.
A minimum distance between the filter and the tank bottom must be considered as rapresented in the aside drawing.

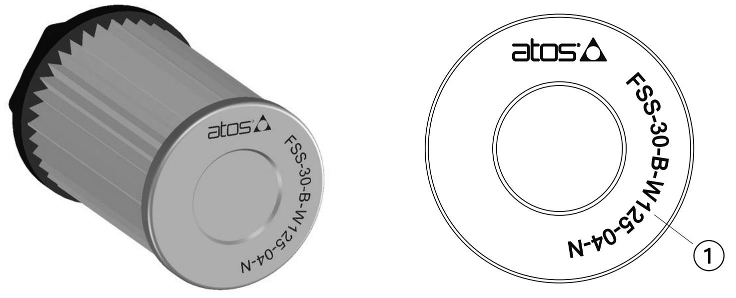


8 MAINTENANCE

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.

8.1 FILTER IDENTIFICATION



① Model code of filter

atos®

the Italian electrohydraulics

KTF19/E

Headquarters
Italy - 21018 Sesto Calende
Phone +39 0331 922078
info@atos.com

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