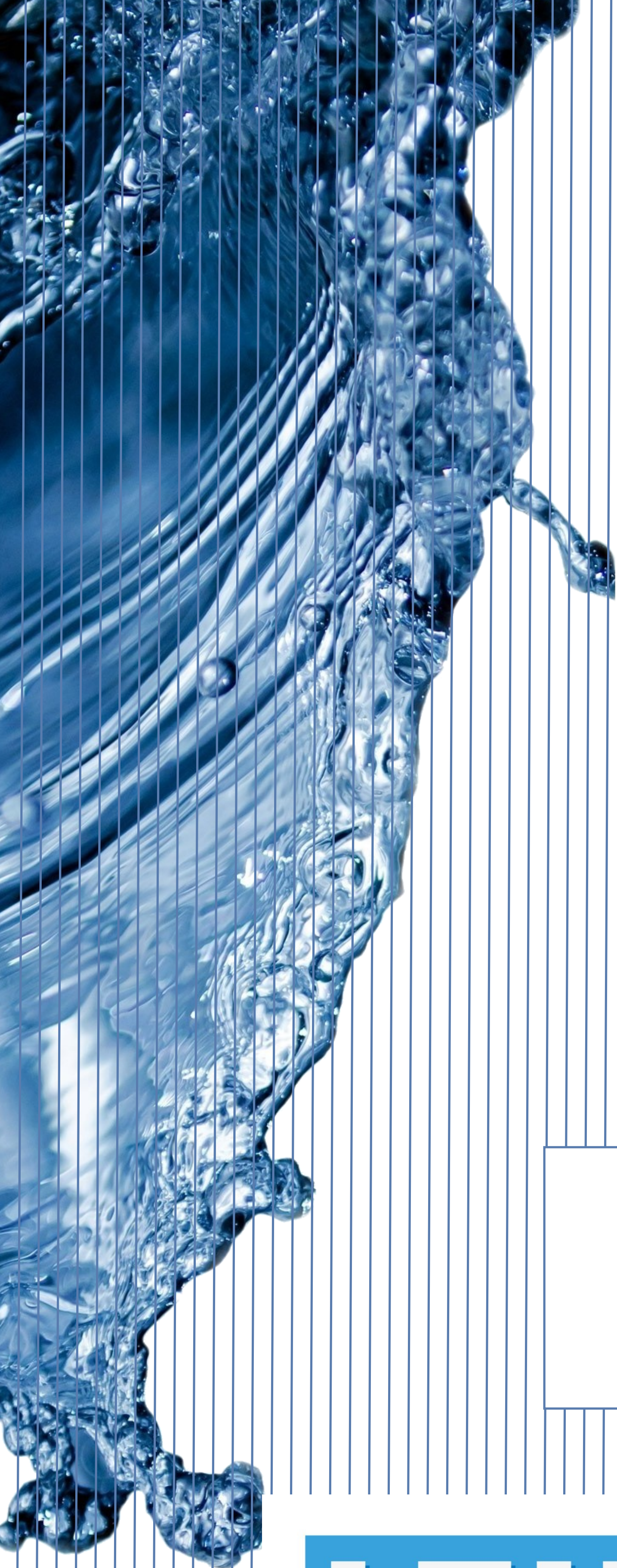


Filtrazione in pillole

UFI Filters

HYDRAULIC
COMPONENTS
& FLUID CONTAMINATION
CONTROL

FILTRATION IN BRIEF

FILTRATION IN BRIEF

Contamination Control in the hydraulic system is a very wide and complex matter; the following is just a short summary.
Our Customer Service is at your disposal for any further information.
The function of the fluid in the hydraulic systems is transmitting forces and motion.
In view of a reliable and efficient operation of the system, it is very important to select the fluid considering the requirements of the system and the specific working conditions (working pressure, environment temperature, location of the system, etc.).
Depending on the required features (viscosity, lubricant capacity, anti-wear protection, density, resistance to ageing and to thermal variances, materials compatibility, etc.), the proper oil can be selected among a number of mineral oils (the most popular), synthetic fluids, water based fluids, environmental friendly fluids, etc.
All the hydraulic fluids are classified according to international standards.
Solid contamination is recognized as the main reason for malfunction, failures and early decay in hydraulic systems; it is impossible to eliminate completely it, but it can be well kept under control with proper devices (filters).
No matter which fluid is used, it must be kept at the contamination level required by the most sensitive component used on the system.

HOW THE CONTAMINATION IS MEASURED

The contamination level is measured by counting the number of particles of a certain dimension per unit of volume of the fluid; this number is then classified in Contamination Classes, according to international standards.
Measuring is made with Automatic Particle Counters that can make the analysis on line (through sampling connectors put on the system for this purpose) or from sampling bottles.
The calculations and sampling of the fluid must be done according to the specific ISO norms, to attest their validity.
The most popular standard for Contamination Classes in the hydraulic systems is ISO 4406; the standard NAS 1638
(under revision) is also quite used.

CONTAMINATION CLASSES ACCORDING TO ISO 4406

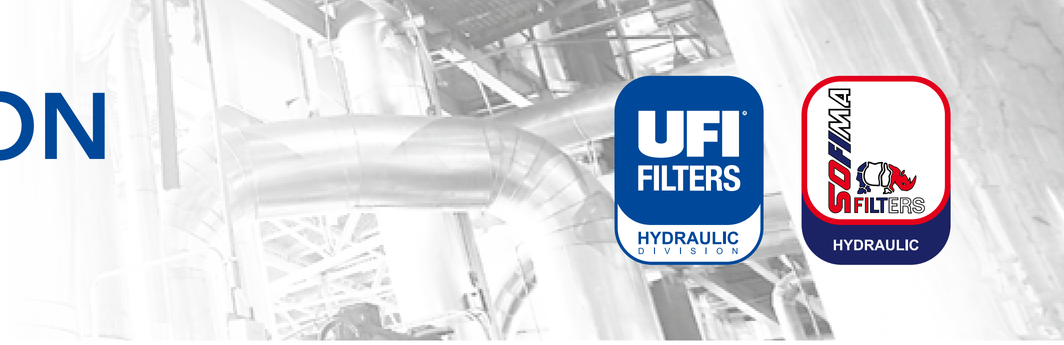
The Contamination Class according to this standard is described by 3 numbers indicating the number of particles per 100 ml of fluid having bigger size than 4, 6 and 14 μm(c) respectively.

ISO Code	Number of particles per 100 ml more than	up to
22	2.000.000	4.000.000
21	1.000.000	2.000.000
20	500.000	1.000.000
19	250.000	500.000
18	130.000	250.000
17	64.000	130.000
16	32.000	64.000
15	16.000	32.000
14	8.000	16.000
13	4.000	8.000
12	2.000	4.000
11	1.000	2.000
10	500	1.000
9	250	500
8	130	250

ISO Code 21/18/15	21®	≥ 4 μm(c)
ISO Code 21/18/15	18®	≥ 6 μm(c)
ISO Code 21/18/15	15®	≥ 14 μm(c)

The above Contamination Class describes a fluid containing:
- between 1.000.000 and 2.000.000 particles ≥ 4 μm(c) per 100 ml
- between 130.000 and 250.000 particles ≥ 6 μm(c) per 100 ml
- between 16.000 and 32.000 particles ≥ 14 μm(c) per 100 ml

FILTRATION IN BRIEF



FILTERS AND FILTER MEDIA

All the hydraulic systems have an initial solid contamination, tending to increase during operation due to component wear, ingression from seals, etc. For this reason it is necessary to use filters that retain the contaminant and allow the fluid to reach and maintain the required contamination class.
Depending on their location into the system, the most common filter types are:

- RETURN FILTERS, downstream from all the components, filtering the oil before it returns into the tank. Their function is keeping the required contamination level inside the tank (indirect protection of the components) and must be sized to have a high dirt holding capacity (i.e. a long life). They usually have filter elements by glassfiber (absolute filtration, $\beta x \geq 75$) or by cellulose (nominal filtration, $\beta x \geq 2$)
- IN LINE FILTERS, on the pressure line, protecting directly one or more components, ensuring they are fed with oil having the proper contamination class. They usually have filter elements by glassfiber (absolute filtration, $\beta x \geq 75$) sometime by cellulose (nominal filtration, $\beta x \geq 2$)
- SUCTION FILTERS, on the suction line, protecting the pump from possible coarse contamination. They usually have filter elements by metal wire mesh (geometric filtration) and must be sized properly, to avoid any possible pump cavitation.

Good AIR FILTERS (breathers), filtering the air drawn into the tank when the oil goes to the actuators, must be used to avoid contaminant ingression from the environment. When a very low contamination class is required (i.e. very good cleanliness) it can be necessary to use a OFF-LINE FILTER, that operates at steady flow rate and pressure, thus getting the highest filtration efficiency.
Even the new oil has always a certain solid contamination, so it is a good rule to make any filling or refilling of the system by using a FILTRATION UNIT.

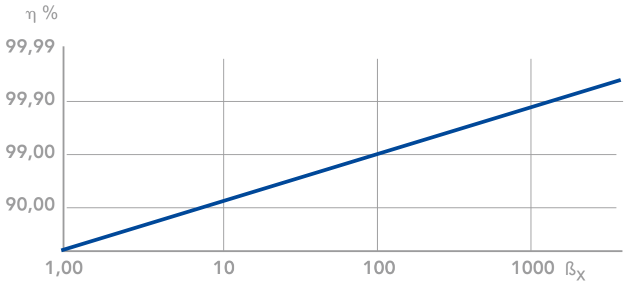
HOW TO MEASURE THE FILTRATION EFFICIENCY

BETA RATIO

$\beta_x = (n_{in} = X\ \mu m) : (n_{out} = X\ \mu m)$

where "n" is the number of particles = x µm upstream and downstream from the filter.

E.g. if you have 100.000 particles = 10µm upstream and 1.000 particles downstream:
β_{10} = 100.000 : 1.000 = 100



FILTRATION EFFICIENCY η(%):

$\eta = 100 - (100 : \beta)$

i.e.
β_x = 2 means = 50,00 %
β_x = 20 means = 95,00 %
β_x = 75 means = 98,67 %
β_x = 100 means = 99,00 %
β_x = 200 means = 99,50 %
β_x = 1.000 means = 99,90 %

FILTRATION IN BRIEF

UFI FILTERS HYDRAULIC DIVISION

SOFIMA FILTERS HYDRAULIC

REFERENCES FOR THE “BETA” RATIO

The standard ISO 16889 has replaced since 1999 the former ISO 4572 concerning the Multi-Pass test, stating the Beta value of a filter element.
The current standard considers the test dust ISO MTD instead of the ACFTD formerly used, both in the Multi-Pass test rigs and for the calibration of the automatic particle counters.

In the ISO 16889 the particles sizes are measured in a different way than in the ISO 4572.
To avoid any confusion, when micron are measured according to the current spec they are indicated as **$\mu m_{(c)}$**.

Depending on the measuring method, the reference Beta values of the UFI filter media are as follows:

UFI MEDIA	SOFIMA MEDIA	$\beta_{x(c)} > 1000$ (ISO 16889)	$\beta_x > 200$ (ISO 4572)
FA	FT	5 $\mu m_{(c)}$	3 µm
FB	FC	7 $\mu m_{(c)}$	6 µm
FC	FD	12 $\mu m_{(c)}$	12 µm
FD	FV	21 $\mu m_{(c)}$	25 µm

N.B.
The contamination classes achieved
(i.e. the performances on the field) as well as the pressure drop values **are unchanged.**

FILTER MEDIA AND CONTAMINATION CLASSES

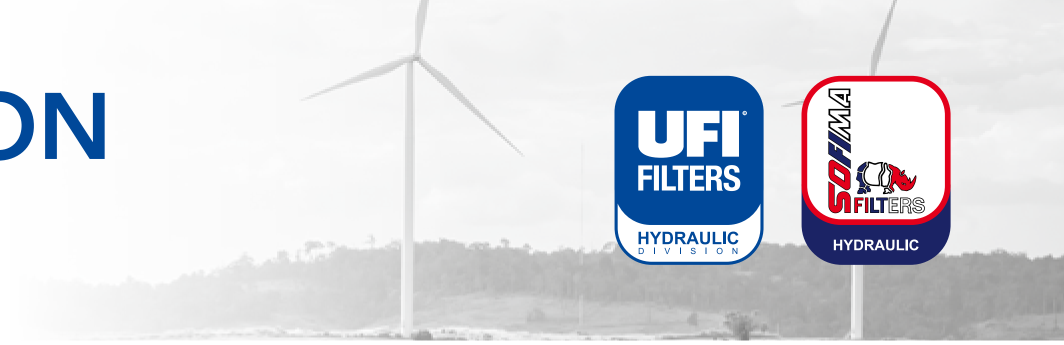
Each hydraulic components manufacturer specifies the contamination class required for the best performance and life of their components.

To achieve the required contamination class, the proper UFI filter media must be chosen according to this table:

Typical application	Aeronautic, test rigs.	Aeronautic, ind. Robotics	Ind. robotics, precision machine tools	High reliability ind. machines, Hydrostatic transmissions	Industrial machines, earth moving machines	Mobile machines	Machines for heavy industry	Machines for agriculture systems not continuos service
Pumps and/or motors	-	Piston, variable > 21 Mpa	Piston, variable < 21 MPa Vane, variable > 14 Mpa	Pist./vane, variable < 14 MPa Pist./vane, flxed > 14 Mpa	Pistons, fixed < 14 Mpa Vane, fixed > 14 Mpa	Vane, fixed gear > 14 Mpa	Vane, fixed gear < 14 Mpa	Vane, fixed gear < 14 Mpa
Valves	Servovalves > 21 Mpa	Servovalves < 21 MPa Proportional > 21 Mpa	Proportional < 21 MPa Cartridge > 14 Mpa	Cartridge < 14 Mpa	Solenoid > 21 Mpa	Solenoid < 21 Mpa	Solenoid > 14 Mpa	Solenoid > 14 Mpa
Contamination class ISO 4406	15/13/10	16/14/11	17/15/12	18/16/13	19/17/14	20/18/15	21/19/16	22/20/17
Recommended UFI filter media	**FA** $\beta_{5(c)} > 1.000$	**FA - FB** $\beta_{5(c)} > 1.000$ $\beta_{7(c)} > 1.000$	**FB** $\beta_{7(c)} > 1.000$	**FB - FC** $\beta_{7(c)} > 1.000$ $\beta_{12(c)} > 1.000$	**FC - FD** $\beta_{12(c)} > 1.000$ $\beta_{21(c)} > 1.000$	**FD** $\beta_{21(c)} > 1.000$	**FD - CC** $\beta_{21(c)} > 1.000$ $\beta_{10} > 2$	**CC** $\beta_{10} > 2$

N.B. NAS 1638 is officially inactive for new designs after May 30, 2001.

FILTRATION IN BRIEF



REAL FLOW RATE THROUGH THE FILTER

In order to size properly the filter, it is essential to calculate the REAL flow rate of the oil passing through it:

- IN SUCTION AND PRESSURE FILTERS the flow rate is usually the same as the pump delivery (with the exception of the FPD01 and 12 series, where the flow rate is just the one required by the pilot valve)
- in RETURN FILTERS it is necessary to calculate the maximum possible flow rate, taking in account any possible additional return line, cylinder and accumulator. If such data are unknown, as a good rule a flow rate at least 2 ÷ 2,5 times the pump delivery should be considered.

Filter element life is significantly effected by the pollution level at the machine location and by the maintenance level of the machine. Considering these parameters the actual flow rate should be multiplied by the following "Environmental Factor":

ENVIRONMENTAL FACTOR

System maintenance level	Environment contamination level LOW	MEDIUM	HIGH
• tank with good protection, efficient air breathers • few actuators, with very good protection from contaminant ingression • frequent monitoring of filter conditions	1	1	1,3
• tank with protection, good air breathers • many actuators, with good protection from contaminant ingression • scheduled monitoring of filter conditions	1	1,5	1,7
• tank with poor protection • many actuators, with low protection from contaminant ingressions • random monitoring of filter conditions	1,3	2	2,3
	F. i. system located in climatized room	F. i. system located in industrial building	F. i. system located in hostile environment (foudry, wood workingmachines, mobile machines)

PRESSURE DROP (Δp)

After having stated the filter media and the REAL flow rate, the filter must be chosen from the "flow rate tables" in the catalogue.
The values shown there take in account the pressure drop Δp met by the fluid passing through the filter, that must be within a certain value.
In practice, the "assembly Δp" (Δp filter housing + Δp filter element) with clean filter element should be:

· **3 kPa** (0,03 bar) max for suction filters
· **35 ÷ 50 kPa** (0,35 ÷ 0,5 bar) max for return filters
· **35 ÷ 50 kPa** (0,35 ÷ 0,5 bar) max for pressure filters < 11 MPa (110 bar)
· **80 ÷120 kPa** (0,80 ÷1,2 bar) max for pressure filters > 11 MPa (110 bar)

Lower initial pressure drop provides better filter efficiency and longer filter element service life.

N.B. The flow rate values given in the tables are referred to mineral oil with kinematic viscosity "V" of 30 cSt and density "ps" = 0,86 Kg/dm³.
When using oils with different features, the following correction factors must be applied at the Δp_0 values obtained on the curves:
FILTER HOUSING
the pressure drop is directly proportional to the oil density "ps", so in case you have $ps_1 \neq 0{,}86$ ► $\Delta p_1 = (\Delta p_0 \times ps_1) : 0{,}86$
FILTER ELEMENT
the pressure drop through the filter element varies in function of the kinematic oil viscosity, so in case you have a kinematic viscosity V_1 (cSt) different from cSt:
· for kinematic oil viscosity ≤ 150 cSt ► $\Delta p_1 = \Delta p_0 \times (V_1 : 30)$
· for kinematic oil viscosity > 150 cSt ► $\Delta p_1 = \Delta p_0 \times [V_1 : 30 + \sqrt{(V_1 : 30)}] : 2$
(for more details about kinematic oil viscosity see the diagram on the next page)
Some fluids have **filterability problems** (difficulty in passing through a "multilayer" (glassfiber) filter media).
In such cases a **correction factor** must be considered when sizing the filter: this factor must be verified with the filter manufacturing, specifying all the features of the fluid.
It is a good rule, when sizing the filter, to consider also the max recommended fluid speed:
in suction lines 0,1< v < 1 m/s | in return lines 1,5< v < 4 m/s | in pressure lines 5< v < 10 m/s

FILTRATION IN BRIEF

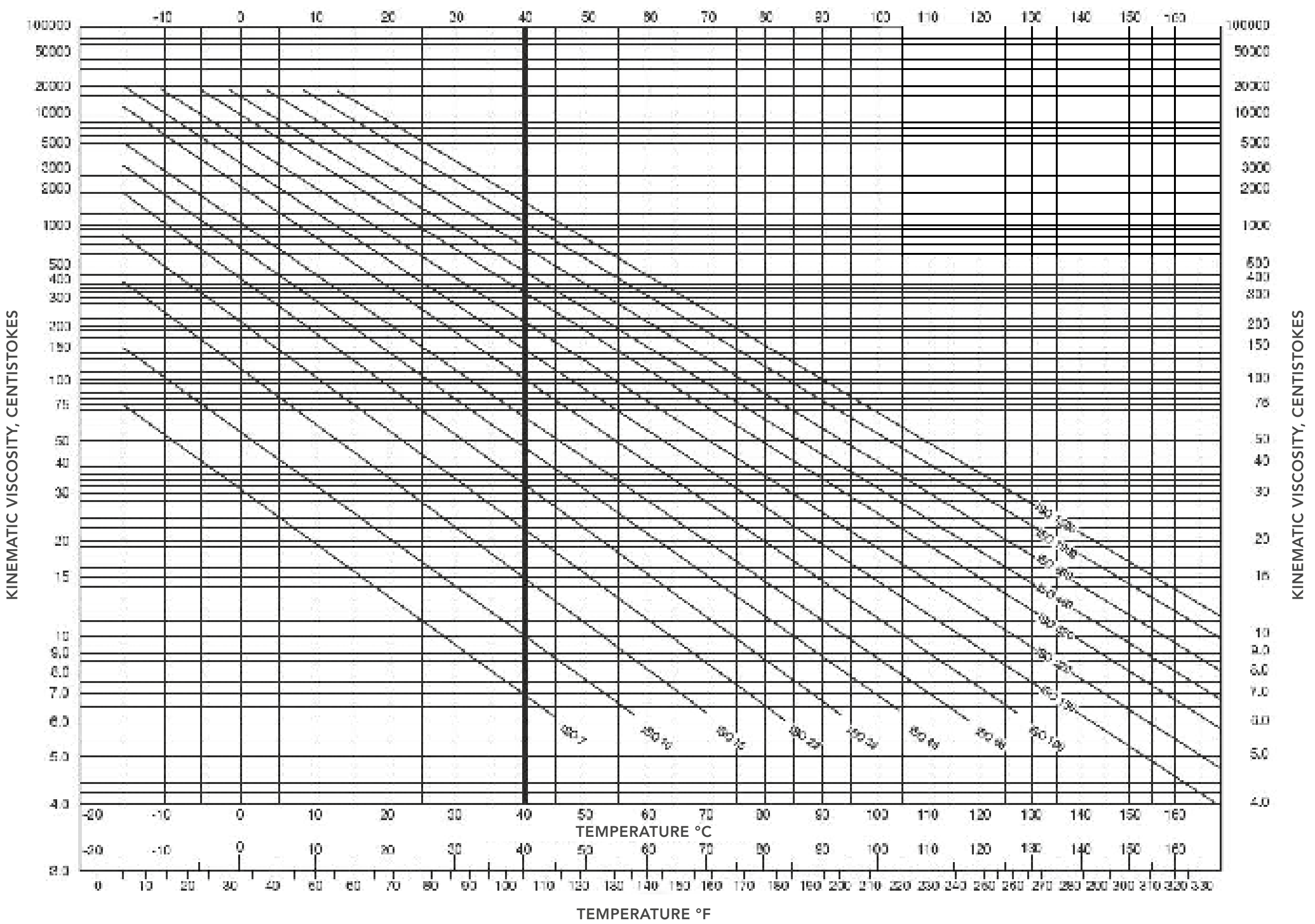
UFI FILTERS HYDRAULIC DIVISION

SOFIMA FILTERS HYDRAULIC

CLOGGING INDICATOR

During the system operation, the pressure drop through the filter increases as the element clogs, due to the contaminant retained.
The filter element must be replaced when clogged and anyway before the pressure drop reaches the bypass valve set value.
For this reason it is recommended a clogging indicator on the filter. It gives a visual or electrical indication and must have a set value lower than the bypass valve set value, to get an exact indication of the right time for filter element replacement.
On return and low pressure filters the clogging indicator can be a pressure gauge or a pressure switch, measuring the pressure upstream the filter. On some return filters and on high pressure filters, the clogging indicator can be of differential type: measuring the pressure upstream and downstream the filter and activating a signal when the differential pressure reaches the set value.
On suction filters the clogging indicator is a vacuum gauge or a vacuum switch, measuring the depressure downstream the filter.
All the UFI filters have the port for the indicator as a standard feature; if the filter is ordered without indicator the port is plugged with a removeable plug allowing the indicator to be added easily at any time.

VISCOSITY VS TEMPERATURE



Lines shown refer to oils of ISO preferred grades and V.I. = 100.
Lower V.I. oils will show steeper slopes.
Higher V.I. oils will show flatter slopes.

FILTRATION IN BRIEF

UFI FILTERS HYDRAULIC DIVISION

SOFIMA FILTERS HYDRAULIC

ISO FLUIDS CLASSIFICATION AND COMPATIBILITY WITH MATERIALS

The table here gives some general indication of fluid classification (ref. ISO 6743) and their compatibility; we recommend to verify the exact features of the fluid with the supplier.

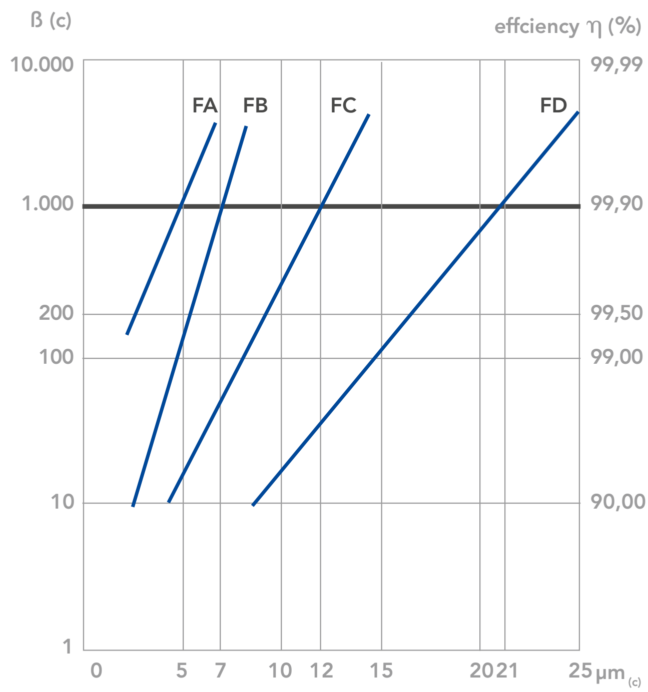
ISO ref.	Type of fluid	Features	Compatibility (10th digit in ordering code)
HH	Mineral base fluid	No additives	N
HL	Mineral base fluid	Anticorrosion, antioxidation add.	N
HM	Mineral base fluid	Antiwear additives	N
HV	Mineral base fluid	Viscosity improver additives	N
HFA	Fire extinguishing fluid	Oil in water emulsion (water >90%)	G (aluminium and zinc not compatible)
HFB	Fire extinguishing fluid	Water in oil emulsion (water >40%)	G (aluminium and zinc not compatible)
HFC	Fire extinguishing fluid	Water glycol	G (aluminium and zinc not compatible)
HFD	Fire extinguishing fluid	Synthetic fluid (phosforic ester)	F (NBR not compatible)
HTG	Environmentally accepted fluid	Vegetal base fluid	N
HPG	Environmentally accepted fluid	Glycol base synthetic fluid	G (aluminium and zinc not compatible)
HE	Environmentally accepted fluid	Esther base synthetic fluid	F (NBR not compatible)

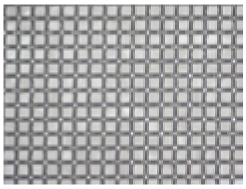
The filter element can be considered as the processor within the filtration computer, that's why extensive knowledge and a many years of manufacturing expertise make significant difference in the design and development of filter element performances and reliability.
Hydraulic filter elements normally use one of three different types of media :

- Metal wire mesh: it is a surface filter and it gives a geometrical filtration. It's rating is determined as "Largest diameter of hard spherical particle that will pass through the media";
- Cellulose (paper impregnated with resin): it is a depth filter media with a irregular structure. It's classified on average pore dimension.
- Microfiber (inorganic fiber impregnated with resin): it is a depth filter media with regular structure. It's classified on average pore dimension and it consists of multiple layers
- Thanks to the multilayer structure with differential porosity the microfiber media retains even smaller particle sizes than the reference filtration ratio of each filter media.

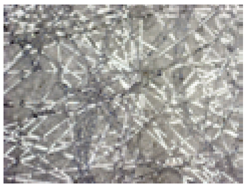
FILTRATION IN BRIEF

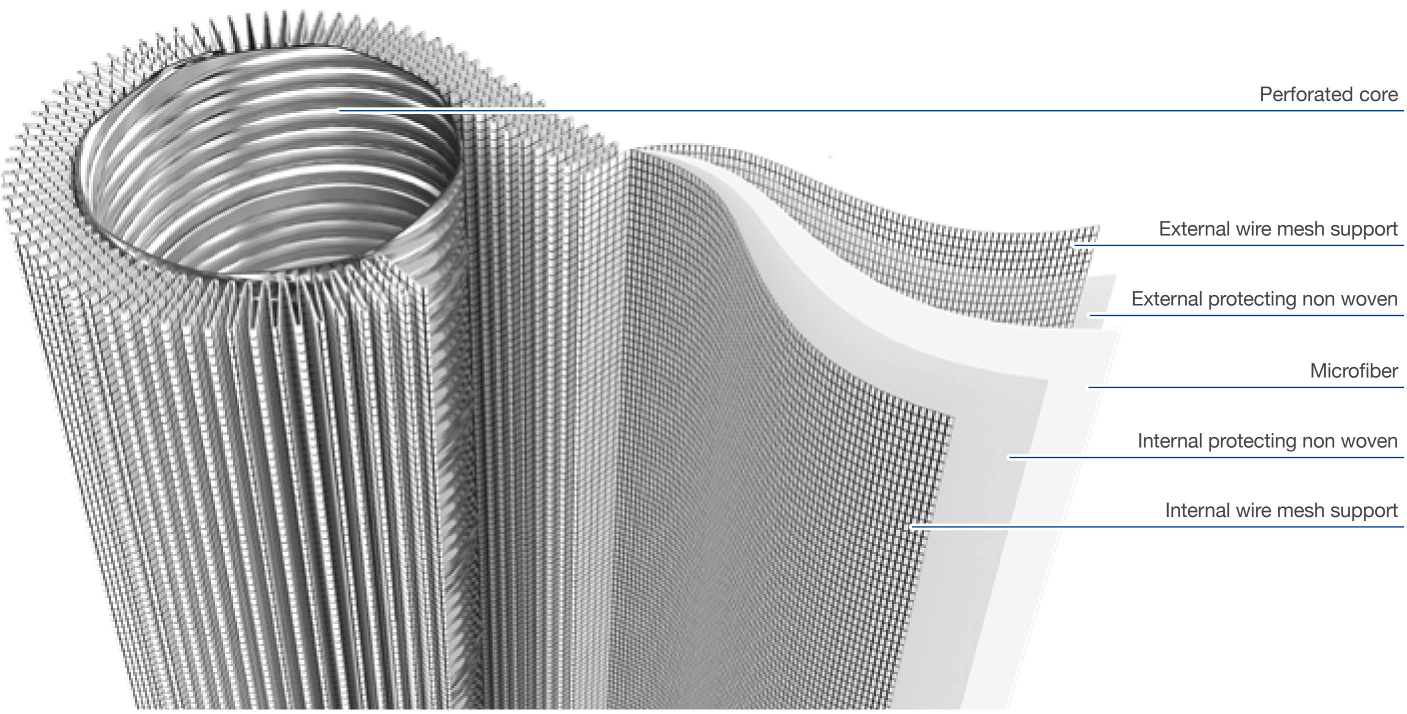
The actual retention capacity behaviour is described in the graph here below:



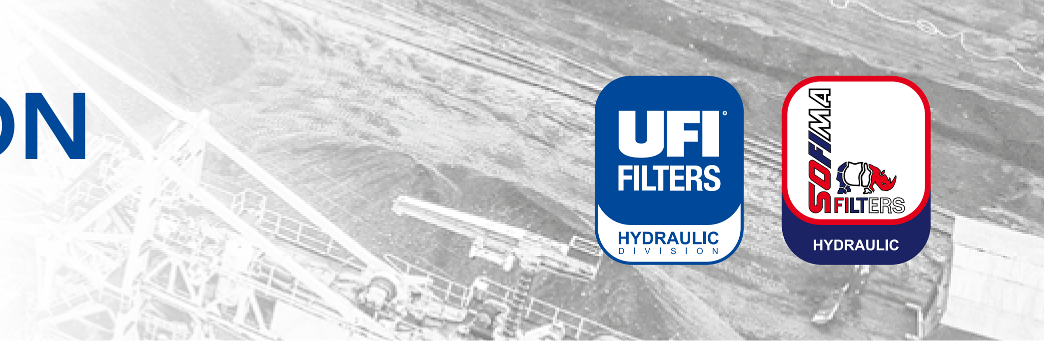

METAL WIRE MESH


CELLULOSE


MICROFIBER



FILTRATION IN BRIEF



UNIT CONVERSION TABLE

TO CONVERT ►	INTO	MULTIPLY BY
INTO ◄	TO CONVERT	DIVIDE BY
l	gal_{US}	0,2642
l	gal_{UK}	0,22
l/min	m^3/h	0,06
kg	lb	2,205
bar	psi	14,5
kPa	psi	0,145
bar	kPa	100
°C	°F	°C x 1,8 +32

LubeTeam Hydraulic S.r.l.
Administration and Headquarter:
Via Tufara Scautieri, 6
83018 - San Martino Valle Caudina (AV)
Office and Warehouse:
S.S. 7 Appia, Km. 237,00
82011 - Airola BN
ITALY

Tel. +39 0823 950 994
Fax +39 0823 412 546

www.lubeteam.it info@lubeteam.it

Italian VAT / C.F. e P.IVA: 01251720627

Follow us