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Filtration - Why?

Good hydraulic filtration is gaining more and more importance in the use of hydraulic systems.

Reducing contamination in the hydraulic system will reduce the wear of the components and thus extend the service life of the machine. This will prevent production downtime and lower the overall production costs.

Right from the beginning, there is contamination in a new hydraulic system, which reduces the service life of the system and its components such as valves and cylinders without any or with inadequate filtration.

This built-in dirt is created during the manufacturing of the components and mainly consists of coarse particles.

In addition to the contamination that arises during operation of the system, e.g. abrasive wear, dirt particles can also get into the system when it is filled with hydraulic oil. This is called ingress contamination.

Choosing the right filter contributes significantly to prevent the dangers mentioned above thereby ensuring efficient operation even after many years.

Reduction of Contamination

- Extension of service life
- Extension of maintenance intervals
- Reduction of machine downtime
- Reduction of environmental pollution

► Cost savings for the user

Contamination

Particle Sizes (Selection)

- 100 µm table salt, fine sand
- 75 µm diameter of a human hair
- 60 µm flower pollen
- 50 µm fog
- **30 µm (from approx.) resolution of the human eye**
- 15 µm fine particles
- 7 µm red blood cells
- 2 µm bacteria
- 1 µm layer of lubricating film (for comparison)

Type of Contamination

The most frequent ones are:

- Solid particles
- Free and dissolved water
- Non-dissolved air

A majority of the contamination can be removed with filtration.

Origin of Contamination

The main cause of failures and downtimes is dirt in the hydraulic system.

Failure analysis indicate that 80% of the failures are caused by faults in the hydraulic system. 90% of them are caused by impurities in the hydraulic oil.

Sources of External Contamination

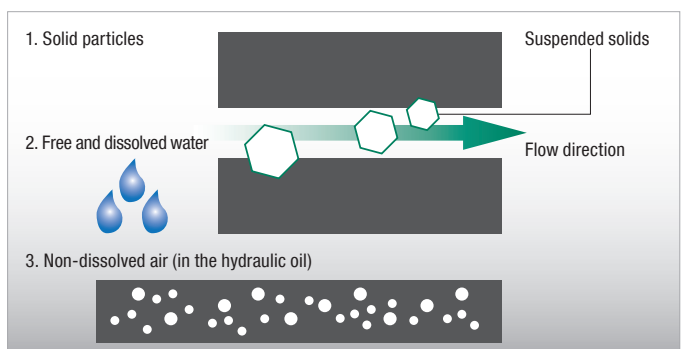
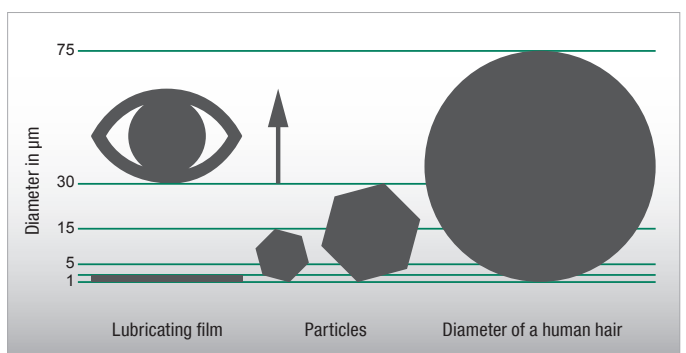
- Filling and refilling the hydraulic tank
- Inadequately dimensioned breathers
- Damaged tank seals
- Replacement of hydraulic lines and components (pumps, cylinders)
- Impurities in the air

Types of Internal Contamination

- Contamination on / in the components caused by the manufacturing process (e.g. chips)
- Contamination on the components caused by the installation of the components

Sources of Internal Contamination

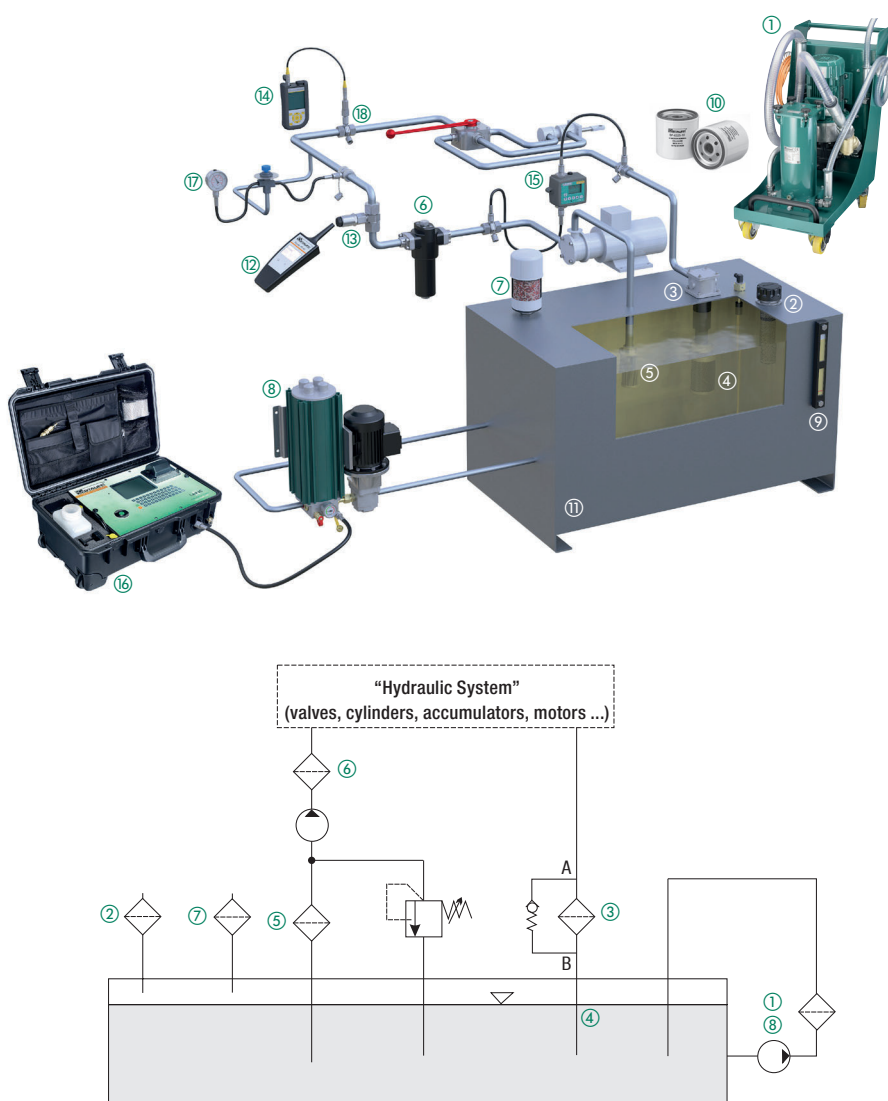
- Disintegration of particles from high pressure changes and tension on the surface of hydraulic components (e.g. cavitation)
- Material erosion that occurs at places in the hydraulic units due to the impact of pressurised liquid at high speeds (erosion wear)



A



①	STAUFF Mobile Filter System	SMFS-U
②	STAUFF Plastic Filler Breather	SPB
③	STAUFF Return-Line Filter	RF
④	STAUFF Diffusor	SRV
⑤	STAUFF Suction Strainer	SUS
⑥	STAUFF Pressure Filter	SF
⑦	STAUFF Desiccant Air Breather	SDB
⑧	STAUFF Offline Filter	OLS
⑨	STAUFF Level Gauge	SNA
⑩	STAUFF Spin-On Filter	SSF
⑪	Oil tank	
⑫	STAUFF Reader	PT-RF
⑬	STAUFF Pressure Transmitter	PT-RF
⑭	STAUFF Hydraulic Tester	PPC
⑮	STAUFF Particle Monitor	LPM-II
⑯	STAUFF Laser Particle Counter	LasPac-II
⑰	STAUFF Pressure Gauge	SPG
⑱	STAUFF Test Coupling	SMK / SKK



STAUFF Filter Components

A



Pressure Filters Series SF / SF-TM / SFZ / SFA / SMPF (see page 34 - 35)

Pressure Filters ⑥ are placed behind the pump and clean the hydraulic oil before it flows through down-stream components like valves, cylinders and so on. The main reason for pressure filtration is the protection of downstream, sensitive components.

Eroded particles from the pump are immediately filtered out of the hydraulic oil. Besides working as a protection filter, Pressure Filters also help to maintain the required purity class.

Because it is placed right behind the pump, a Pressure Filter has to withstand the maximum system pressure. The filter element in the Pressure Filter also has to withstand the loads and is more intricately constructed, for example as a Return-Line Filters element.



Return-Line Filters Series RF / RFA / RFB / RFS / RTF (see page 66 - 125)

Return-Line Filters ③ are installed in the Return-Line, on top of or within the oil tank. They filter the hydraulic oil before it flows back into the reservoir. This ensures that contamination arising in the components does not get into the tank. Return-Line Filters maintain the targeted purity class like Pressure Filters. However, because of their arrangement, they do not fulfil the additional function of a protection filter. In contrast to a Pressure Filter, it only has to withstand low pressure levels.

Diffusers ④ are used in combination with Return-Line Filters and ensure that the returning oil flow is settled before it reaches the oil tank thereby preventing foaming and re-suspension of deposited dirt.

The job of **Suction Strainers ⑤** is mainly to provide functional protection of the downstream pumps in the circulation. Suction Strainers always have to be provided if the risk of pump damage from coarse impurities is particularly high. This risk exists if impurities are collected in the tank and if they can't be filtered out afterwards. Suction Strainers are coarse filter elements with a micron rating that is usually bigger than 100 µm.



Diffusers / Suction Strainers / Filler Breathers / Desiccant Air Breathers
(see Catalogue No. 10 - Hydraulic Accessories)

Filler Breathers ② are mounted on the oil tank and prevent the entry of dirt from the surroundings during tank breathing. They should be chosen with a filter unit that is similar to the working filter (Pressure Filter, Return-Line Filter).

The replacement cycles of filter inserts is highly dependent on the surrounding conditions of the hydraulic system.

Another variant of the breather is the **Desiccant Air Breather ⑦**. The additional function of this filter is dehumidification of the inflowing air with a special silicate gel.



Offline and Bypass Filters / Mobile Filter Units
(see page 178 - 209)

Offline / Bypass Filters ⑧ / ① are not part of the main hydraulic system. They are supplementary to achieve the best possible filtration results. Because of the high efficiency of the Offline / Bypass Filters, purity levels are reached that cannot be achieved with conventional main filter systems.

Offline Filters work with an integrated motor / pump unit that draws in the fluid from the system, filters it and then feeds it back into the tank. Because the offline filter is independent from the hydraulic main circuit, i.e. it can still be operated if the hydraulic system is switched off, it is used in practice for continuous cleaning of the tank.

Bypass Filters on the other hand use the existing system pressure to draw a small volumetric flow out of the hydraulic system for filtration. They are only active while the unit is in operation.

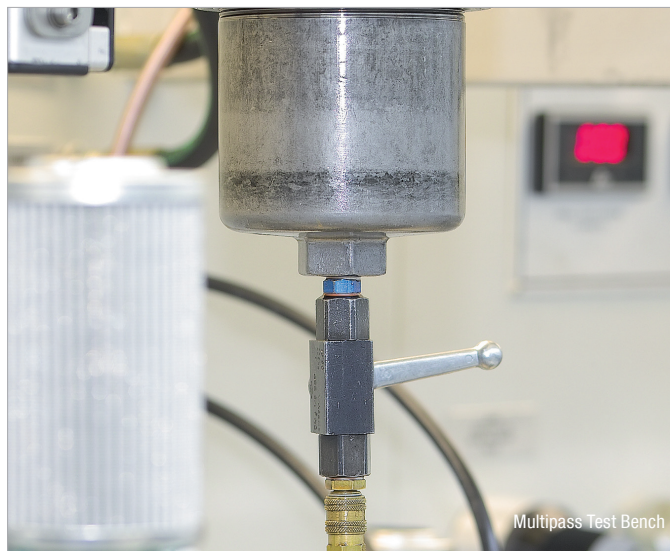
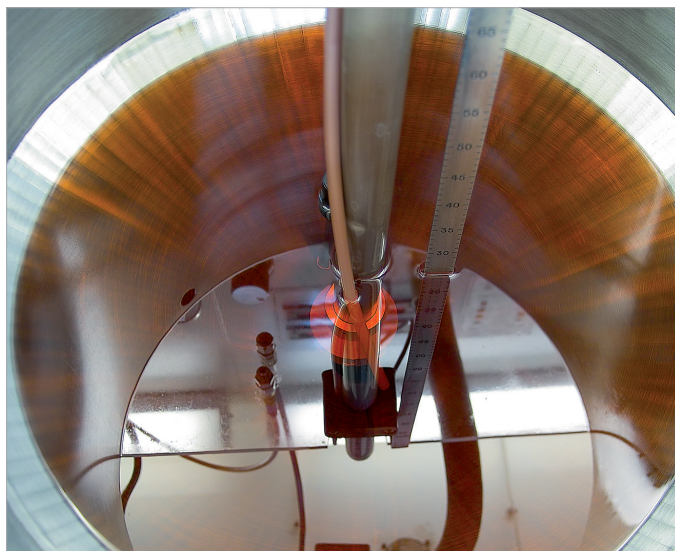
Another mobile variant of the bypass filter is the **Mobile Filter System ①**.



Spin-On Filters (see page 148 - 177)

STAUFF provides a complete range of **Spin-On Filters ⑩** which can be used either as Suction Filters or as Return-Line filters for low pressure applications.





Multipass Test Bench

Test Standards and Oil Purity

Definition of the Required Micron Rating

Essentially, the components found in the hydraulic system determine the micron rating of the filtration system.

To guarantee a reliable mode of operation over the years, it is mandatory to maintain the optimum oil purity class for specific components.

The most sensitive component determines the choice of filter material and micron rating.

To determine the oil purity according to ISO 4406 (1999), a laser particle counter is used to count particles that are $>4 \mu\text{m}_{(c)}$, $>6 \mu\text{m}_{(c)}$ and $>14 \mu\text{m}_{(c)}$ in 100 ml of hydraulic oil. The number of particles is then assigned with a classification number (e.g. 14/11/8) that then corresponds to the ISO purity class. Please note here that the number of particles doubles for the next higher class. The cleanliness level that has to be achieved is an important criterion for choosing the right filtration system.

STAUFF Filter Elements are subject to the following Test Methods

- ISO 2941 Collapse and burst resistance
- ISO 2942 Verification of fabrication integrity (bubble point test)
- ISO 2943 Compatibility with hydraulic media
- ISO 3723 End load test
- ISO 3724 Flow fatigue characteristics
- ISO 3968 Flow characteristics
- ISO 16889 Filtration performance test (multi-pass method)

Number of particles in 100 ml fluid		Classification numbers ISO 4406 (1999)		
More than	Less than	$> 4 \mu\text{m}_{(c)}$	$> 6 \mu\text{m}_{(c)}$	$> 14 \mu\text{m}_{(c)}$
16000000	32000000	25	25	25
8000000	16000000	24	24	24
4000000	8000000	23	23	23
2000000	4000000	22	22	22
1000000	2000000	21	21	21
500000	1000000	20	20	20
250000	500000	19	19	19
130000	250000	18	18	18
64000	130000	17	17	17
32000	64000	16	16	16
16000	32000	15	15	15
8000	16000	14	14	14
4000	8000	13	13	13
2000	4000	12	12	12
1000	2000	11	11	11
500	1000	10	10	10
250	500	9	9	9
130	250	8	8	8
64	130	7	7	7
32	64	6	6	6
16	32	5	5	5





STAUFF Laser Particle Counter
LasPaC-II, LPM-II
and Bottle Sampler

Short & Curt: Filter Rating

(For exact recommendation see SCCP - STAUFF Contamination Control Program see on page 15)

Type	Component	ISO 4406 Code	Recommended Filter Rating
Pump	Piston Pump (Slow Speed, Inline)	22/20/16	20 µm
	Gear Pump	19/17/15	20 µm
	Vane Pump	18/16/14	5 µm
	Piston Pump (High Speed, Variable)	17/15/13	5 µm
Motor	Gear Motor	20/18/15	20 µm
	Vane Motor	19/17/14	10 µm
	Radial Piston Motor	19/17/13	10 µm
	Axial Piston Motor	18/16/13	5 µm
Valve	Directional Valves (Solenoid)	20/18/15	20 µm
	Check Valves	20/18/15	20 µm
	Logic Valves	20/18/15	20 µm
	Cartridge Valves	20/18/15	20 µm
	Pressure Control Valves (Modulating)	19/17/14	10 µm
	Flow Control Valves	19/17/14	10 µm
	Standard Hydraulic <100 bar / <1450 PSI	19/17/14	10 µm
	Proportional Valves	18/16/13	5 µm
	Servo Valves <210 bar / <3045 PSI	16/14/11	3 µm
	Servo Valves >210 bar / >3045 PSI	15/13/10	3 µm
Actuator	Cylinder	20/18/15	20 µm

β-Value and Separations Efficiency

To select filtration that meet the requirements, performance characteristics like the filter fineness, the filtration efficiency, the dirt-hold capacity and the pressure loss has to be observed.

The β-value as per ISO 16889 is the relevant characteristic value for the filtration efficiency. The β-value is the ratio of particles before ($N_{up\ x}$) and after ($N_{down\ x}$) the filter related to a specific particle size x.

$$\beta_x = \frac{N_{up\ x}}{N_{down\ x}}$$

$\beta_{10} > 200$ means that of 1000 particles that are 10 µm in size, only five particles can pass through the filter. 995 particles will be trapped by the filter element.

Popular filters with inorganic glass fibre medium have to achieve a β-value of at least 200 in order to meet the demands placed on hydraulic filtration today.

The filtration efficiency, also called the retention rate, is directly related to the β-value and is calculated as follows:

$$E = \frac{(\beta_x - 1)}{\beta_x}$$

$\beta_{10} > 200$ corresponds to filtration efficiency of 99,5%.

Comparison of the β-Value and Efficiency E (each related to a defined Particle Size)

β-value	Filtration Efficiency E
1	0,00 %
2	50,00 %
10	90,00 %
25	96,00 %
50	98,00 %
75	98,67 %
100	99,00 %
200	99,50 %
1000	99,90 %
9999	99,99 %

The **dirt-hold capacity** (DHC) shows how much solid dirt a filter element can hold before it has to be replaced. The dirt-hold capacity is therefore the most important parameter in the filter service life.

The **differential pressure** (Δp) is another important criterion for the configuration of the filter. Ensure that the size of the filter element is chosen according to the calculation guideline by STAUFF.

To guarantee optimum filtration, the β-value, the dirt-hold capacity (DHC) and the differential pressure (Δp) must be carefully matched.



Filtration Terminology

B-value

The B-value as per ISO 16889 is the relevant characteristic value for filtration efficiency. The B-value is the ratio of particles before ($N_{up\ x}$) and after ($N_{down\ x}$) the filter related to a specific particle size x.

$$B_x = \frac{N_{up\ x}}{N_{down\ x}} \quad (\text{see page 19})$$

Cavitation Damage

Cavitation is defined to be the cavity formation in liquids. Cavitation occurs if the local static pressure of a liquid drops below a critical value. This critical value usually corresponds to the vapour pressure of the liquid. Critical effects of cavitation are:

- Cavitation wear
- Undissolved gas in the hydraulic system
- Loud high-frequency noises
- Local high temperatures in the liquid
- Changes to the resistance characteristics of the hydraulic resistance

Cleanliness Level

The cleanliness level of a hydraulic fluid is defined by the number of solid particles per ml of fluid. The number of particles is usually measured with an automatic particle counter. The cleanliness level is determined by a class code created by counting the number of particles of different sizes.

Particle counting as well as the coding of the cleanliness class for hydraulic oils are described in the ISO 4406 (1999) standard. Beside the ISO 4406 (1999), NAS 1638 (1964) and SAE AS4059 Rev. D (2001) are also still common.

Clogging Indicator

The clogging indicator signals a specific pressure level where the soiled filter element should be replaced. They work with differential pressure (Δp) or back pressure. Clogging indicators are available in visual, electrical and visual / electrical versions. While it is the responsibility of the installation or maintenance personnel to check the degree of clogging of the filter element with visual clogging indicators, a signal contact (switch) can be connected to the machine controller with an electrical or visual / electrical clogging indicator.

Collapse Pressure

The permissible collapse pressure according to ISO 2941 is understood to be the pressure difference that a filter element can withstand with the stipulated direction of flow. Exceeding the collapse pressure results in the destruction of the filter element.

Depth Filter

Impurities penetrate into the filter fabric and are retained by the structure of the filter fabric. Mainly cellulose and inorganic glass fibre media are used in hydraulic filters. For special applications, Plastic Media (high-strength) and Stainless Fibre media are also used. The design of the depth filter combines the highest micron rating with a high dirt retention capacity. Due to the fleece-like structure of depth filters, particles are not only separated on the surface of the filter material, but they can penetrate into the filter material, which leads to a considerable increase of the effective filter area. In contrast to sieves, there are no holes in fleece, rather they practically consist of labyrinths in which the particles are trapped. Hence, there is no sharply defined screening, rather a wide range of particles are trapped.

Differential Pressure

The differential pressure (Δp) is defined as the pressure difference between the filter inlet and the filter outlet, or alternatively in front of and behind the filter element.

Exceeding the maximum permissible pressure differential leads to the destruction of the filter element.

An integrated bypass valve in the filter prevents destruction of the filter element by opening if the differential pressure (Δp) is too high. Then the oil is passed unfiltered into the hydraulic circuit. For applications in which no unfiltered oil is allowed to pass into the hydraulic circuit, there is the possibility of using filters without bypass valves with filter elements that can withstand a high differential pressure (Δp). The filter elements must be designed such that they can withstand the maximum expected differential pressure (Δp).

Dirt-Hold Capacity (DHC)

The dirt-hold capacity (DHC) shows how much solid dirt a filter element can hold. It is measured in the multipass test according to ISO 16889.

Filter

A filter (hydraulic filter) has the job of keeping solids out of a liquid (oil). A filter is usually made of an filter housing and a filter element.

Filter Area

The filter area is the size of the theoretically spread-out filter element. The larger the filter area, the lower the flow resistance of the filter element. Simultaneously, the dirt-hold capacity (DHC) increases. The following applies in general: the larger the filter area, the longer the service life of the element. Basically the filter area can be enlarged by the number of pleats.

Filter Cake

A filter cake is made up of the particles trapped on the surface of a filter medium.

Filter Design

Essentially depends on the following factors: specific flow rate, cleanliness level, amount of contamination, the maximum pressure setting and the required filter service life.

Filter Element

The filter element is located in the filter housing and performs the actual filtering task.

Filtration Efficiency

Filtration efficiency E is a measure of the effectiveness of a filter element for separating solid particles. It is given in percent.

Filter Housing

Depending on the application, the filter housing is built into the pressure or Return-Line and must be designed for the specific operating or system pressure and the flow rate. The filter element is located in the filter housing. Depending on the application, the filter housing may be equipped with a bypass valve, a reversing valve, a clogging indicator and other options.

Filter Material

The choice of the right filter material is dependent on different criteria. Amongst others, this includes the type of application, the filter function, degree of contamination or alternatively the required dirt-hold capacity (DHC) as well as requirements of chemical or physical resistance. The following list gives you an overview of how these filter materials differ with regard to specific properties:

Inorganic Glass Fibre

Inorganic Glass Fibre media are among the most important materials in modern filtration. During production, selected fibres (1 mm ... 5 mm long and with a diameter of 3 μm ... 10 μm) are processed into a specific mix. The manufacturing process is very similar to paper production. The fibres are bound with a resin and impregnated. The benefit compared to cellulose paper is a fibre structure that is considerably more homogenous and consequently has larger open pored surfaces. As a result, lower flow resistance is achieved.

- Based on Glass Fibres with acrylic or epoxy resin binding
- High retention and dirt-hold capacity (DHC)
- Excellent separation efficiency of the finest particles due to the three-dimensional labyrinth structure with depth filtration
- Outstanding price / performance ratio



Filter Material (Continuation)

Polyester

- 100% Polyester Fibres with thermal bonding
- High pressure differential resistance
- Good chemical resistance
- High separation efficiency of the finest particles
- Tear-proof structure

Cellulose

- Filter material made of Cellulose Fibres with special impregnation
- Variants with the lowest price with good dirt retention capacity
- Not suitable for water based media

Stainless Fibre

- Sintered Stainless Fibres with three-dimensional labyrinth structure for depth filtration
- Low flow resistance with high dirt-hold capacity
- Excellent chemical and thermal resistance

Stainless Mesh

Filter elements with a Metal Wire Mesh are often used as a conditionally reusable solution in protection filters, Suction-Line Filters or Return-Line Filters. Depending on the requirements (micron rating, pressure, dynamics) different types of mesh are used like twill, linen, or also Dutch weave.

- Wire mesh fabric made of material 1.4301 or 1.4305 for surface filtration (other material on request)
- Low flow resistance due to large-pored screening surface
- Excellent chemical and thermal resistance
- Cleanable under special conditions

Flow Rate

This is the amount of fluid that flows past a specific cross-section per unit time. It is given in litres per minute (l/min) or gallons per minute (US GPM).

Hydraulic Fluid

A pressure liquid is defined to be a fluid used in hydraulic and lubrication systems. According to ISO 6743, the fluids are divided into mineral oil based, flame resistant and biodegradable liquids.

Micron Rating

Regarding micron rating, we must differentiate between the filter materials that are used. To define the micron rating for Inorganic Glass Fibre filter elements, the β -value as per ISO 16889 is commonly used.

Absolute and Nominal micron rating

Micron rating is the size of particles which are filtered out by filters at a certain efficiency. When this efficiency is at least 99.5%, we speak about absolute micron rating/filtration.

Nominal micron rating is just a commercial trick for all efficiencies lower than 99.5%, meaning that for the same micron rating (for ex. 5 μm) in the case of nominal rating, not all particles will be captured in the filter as in the case of absolute micron rating.

Multipass Test

The Multipass Test evaluates the performance of a filter element. Standardised in ISO 16889-2008, this test allows comparable and repeatable results of the elements performance. If a normal filter element life is between a few weeks up to several months, this test reduces this life down to 90 minutes. The element is subjected to a fluid that a large amount of a special test dust ISO MTD contains. Results are given for the β -ratio, dirt-hold capacity (DHC) and differential pressure. It is used for designing hydraulic circuits, developing new filter materials and comparison of different filter elements.

See also page 18 and page 19 to get more information about the outcome data. In former time this test was also known as the Multipass Test ISO 4572.

Nominal Flow Rate

The nominal flow rate describes the flow rate or the volumetric flow rate for which the respective filter has been designed. It is usually given in litres per minute (l/min) or US Gallons per minute (US GPM) and is an important parameter in the filter design.

Nominal Pressure

Pressure for which the filter is designed and which it can be identified with.

Operating Pressure / System Pressure

Maximum pressure with which the filter may be used.

Surface Filter

Impurities are separated on the surface of the filter element. Surface filters are designed to have uniform pores (gaps), therefore they can almost completely retain specific particle sizes. Surface filters are made of Metal Wire Mesh or Cellulose materials.

Other surface filters are metal-edge filters.

Valve

Bypass Valve

A bypass valve is a valve that is integrated in a filter or filter element and allows the oil to bypass the contaminated filter element if a defined pressure differential is exceeded. Bypass valves are used to protect the filter element.

Non-Return Valve

It prevents the continuation line from draining while the filter element is changed.

Reverse Flow Valve

It is used to bypass the filter element for reversible oil flow so that the fluid does not pass through the filter element in the reverse direction.

Multi-Function Valve

A combination of bypass, reverse flow and non-return valve.

Viscosity

The viscosity of a fluid describes the flow behavior of a liquid. There are the kinematic viscosity ν with the unit " m^2/s " and the dynamic viscosity η with the unit " Ns/m^2 ". In the field of filtration, in the design of filters the kinematic viscosity is required for calculating. The kinematic viscosity ν can also be calculated with the dynamic viscosity η and density ρ :

$$\nu = \frac{\eta}{\rho}$$

The kinematic viscosity unit is " mm^2/s ", before it was called centistokes or Stokes (1 cSt = 1 mm^2/s = 10⁻⁶ m^2/s). The unit of dynamic viscosity is " Ns/m^2 ", it was previously reported in Poise (10 P = 1 Ns/m^2 = 1 Pa s).



Choice of Filters

Choice of a Suitable Micron Rating

Generally, the type of components incorporated in the hydraulic system will determine the micron rating required. It has been clearly demonstrated that system components will operate reliably for years if a specific minimum oil cleanliness grade is maintained. Frequently the choice will be determined by the most sensitive component in the system.

a) Operating Filter

To get a rough, first rating of what filter is needed to assure a certain oil cleanliness grade please have a look at page 19.

Apart from the specific flow rate (l/min per cm² of filter area), other factors such as operating environment and condition of seals and breathers can have an effect on the cleanliness grade which can actually be achieved.

b) Protective Filter

Occasionally, protective filters are fitted downstream of major components, e.g. the pump, to collect the debris in case of a catastrophic failure. This avoids total stripping and flushing of the system. For economic reasons, protective filters are normally one grade coarser than the operating filters since they do not significantly contribute to the cleaning of the system and this extends filter service intervals.

Choice of the Optimum Filter

In selecting the filter, the following information must be considered:

- Maximum flow volume (Q_{\max}) through the filter including surge flows
- Kinematic viscosity (ν) of the fluid in mm²/s (cSt) at cold start temperature and operating temperature
- Density ρ of the fluid
- Micron rating (μm): see table on page 19
- Filter material

The aim is to choose a filter whose total differential pressure (Δp) is not higher than $\Delta p_{\max} = 1,0$ bar (for Pressure Filters) or $\Delta p_{\max} = 0,5$ bar (for Return-Line filters), in a clean state at the normal operating temperature. These values have been proven in practice to give the optimum service life for the element.

The nominal flow volume of the filter is the obvious reference value for pre-selection and this should be larger than the flow to be filtered.

$$Q_{\text{nom}} > Q_{\max}$$

Calculations based on the filter data will verify whether the pre-selected filter meets the requirements, at operating temperatures:

$$\begin{aligned} \Delta p_{\max} &\leq 1,0 \text{ bar (for Pressure Filter)} \\ \Delta p_{\max} &\leq 0,5 \text{ bar (for Return-Line Filter)} \end{aligned}$$

The total differential pressure of the assembly Δp_{Assy} is calculated by adding the differential pressure of the housing Δp_{Hous} and that of the element Δp_{Elem} . Both the kinematic viscosity and density of the operating medium should be considered for the selection, as the flow curves on the pages following have been determined with a kinematic viscosity of $\nu = 30$ cSt and a density of $\rho = 0,86$ kg/dm³. The values of the pressure drops for the Δp_{Hous} and the Δp_{Elem} can be read from the flow curves on the pages following. The values for the kinematic viscosity in cSt and the density in kg/dm³ should be inserted into the following formula:

$$\Delta p_{\text{Assy}} = \frac{\rho}{0,86} \cdot \Delta p_{\text{Hous}} + \frac{\rho}{0,86} \cdot \frac{\nu}{30} \cdot \Delta p_{\text{Elem}}$$

The filter size is suitable if the $\Delta p_{\text{Assy}} < \Delta p_{\max}$. If the calculated Δp_{Assy} is higher than Δp_{\max} select the next larger filter size and re-calculate until a satisfactory solution is found.

The following two examples explain and help to understand the procedure of calculating a filter.

Examples of Calculation

Example 1: Selection Pressure Filter

System Information: A Pressure Filter with an Inorganic Glass Fibre element is required immediately after the pump. The system has standard components and is operating at pressures up to 200 bar. The filter shall be fitted with a bypass valve and a visual clogging indicator.

For better understanding only the calculation at the upper temperature is carried out.

Data given:	Q_{\max} :	100 l/min
	Oil type:	ISO 68
	Temperature max.:	+50°C
	Viscosity $\nu_{\text{operating}}$:	44 mm ² /s
	Density ρ :	0,882 kg/dm ³
	Micron rating:	10 μm (see table on page 19)

First Step

Pre-selection of the size: SF-045, $Q_{\text{nominal}} = 160$ l/min $> Q_{\max}$

Pressure drop values (at viscosity of 30 mm²/s) from the flow characteristics:

$$\begin{aligned} \Delta p_{\text{Hous}} &= 0,15 \text{ bar} && (\text{SF-045 ... , see page 40}) \\ \Delta p_{\text{Elem}} &= 0,77 \text{ bar} && (\text{SE-045-G-10-B/4, see page 40}) \end{aligned}$$

Determination of the correction factor:

$$\Delta p_{\text{Assy}} = \frac{0,882}{0,86} \cdot 0,15 \text{ bar} + \frac{0,882}{0,86} \cdot \frac{44}{30} \cdot 0,77 \text{ bar}$$

$$\Delta p_{\text{Assy}} = 1,31 \text{ bar} \geq \Delta p_{\max} = 1,0 \text{ bar}$$

Since the actual pressure drop is larger than the allowed pressure drop, a larger filter has to be chosen.

Second Step

Selection of the next larger filter size: SF-070, $Q_{\text{nominal}} = 240$ l/min $> Q_{\max}$

$$\begin{aligned} \Delta p_{\text{Hous}} &= 0,15 \text{ bar} && (\text{SF-070 ... , see page 40}) \\ \Delta p_{\text{Elem}} &= 0,45 \text{ bar} && (\text{SE-070-G-10-B/4, see page 40}) \end{aligned}$$

$$\Delta p_{\text{Assy}} = \frac{0,882}{0,86} \cdot 0,15 \text{ bar} + \frac{0,882}{0,86} \cdot \frac{44}{30} \cdot 0,45 \text{ bar}$$

$$\Delta p_{\text{Assy}} = 0,83 \text{ bar} \leq \Delta p_{\max} = 1,0 \text{ bar}$$

In a clean state, this filter fulfills the requirements and is suitable for the application. The correct filter designation would be **SF-070-G-10-B-T-G20-B-V**.



Example 2: Selection Return-Line Filter

System Information: A Return-Line filter with a Cellulose element with a micron rating of 10 µm is required to clean the oil. No clogging indicator is required.

Please note: If the system incorporates either accumulators or cylinders, the return flow can dramatically exceed pump flow and the maximum surge flow should be the flow used to calculate the pressure drop through the filter.

Data given:	Q_{\max} :	100 l/min
	Oil type:	ISO 68
	Temperature max.:	+60°C
	Viscosity $\nu_{\text{operating}}$:	29 mm²/s
	Density ρ :	0,882 kg/dm³
	Micron rating:	10 µm (see table on page 19)

First Step

Pre-selection of the size: RF-030, $Q_{\text{nominal}} = 110 \text{ l/min} > Q_{\max}$

Pressure drop values (at viscosity of 30 mm²/s) from the flow characteristics:

$$\Delta p_{\text{Hous}} = 0,30 \text{ bar} \quad (\text{RF-030 ... , see page 72})$$

$$\Delta p_{\text{Elem}} = 0,067 \text{ bar} \quad (\text{RE-030-N-10-B, see page 72})$$

Determination of the correction factor (see page 22):

$$\Delta p_{\text{Assy}} = \frac{0,882}{0,86} \cdot 0,30 \text{ bar} + \frac{0,882}{0,86} \cdot \frac{29}{30} \cdot 0,067 \text{ bar}$$

$$\Delta p_{\text{Assy}} = 0,37 \text{ bar} \leq \Delta p_{\max} = 0,5 \text{ bar}$$

In a clean state, this filter fulfills the requirements and is suitable for the application. No further calculation is necessary. The correct filter designation would be **RF-030-N-10-B-G16**.





Filter Elements

24 - 33



Filter Material – Quality And Properties

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For Return-Line Filters

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Filter Elements

For Single, Double and Automatic Filters

32 - 33

B

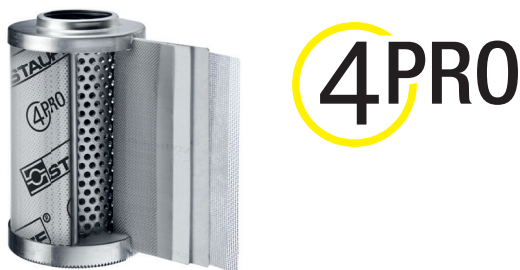


Replacement Filter Elements for Applications involving Hydraulic and Lubrication Oils

The STAUFF 4PRO Glass Fibre Elements

The PLUS for customers:

- Longer operating times through higher dirt holding capacity
- Improved energy efficiency through lower differential pressure
- Excellent β values and outstanding β stability



The 4Pro stands for 4 pros that characterise STAUFF glass fibre materials:

- **proACTIVE**
- **proGRESSIVE**
- **proFESSIONAL**
- **proTECTION**

Or simply: **Fo(u)r Protection**

In terms of the β value, STAUFF elements have always exhibited excellent performance. For those who take filtration seriously, there's no other valid approach – the measured values must hold up under any inspection. The elements cannot afford any vulnerabilities. The new generation of elements also have excellent dirt holding capacities. Values that users have been looking for. Values that make it possible for the user to extend operating times thereby providing significant reductions to purchasing costs for elements as well maintenance costs.

Protecting Filter Elements Against Direct Flow Impact

The sensitive filter bellows on filter elements are frequently prone to damage during transportation, storage and filter replacement work. In addition, large particles in the flow of fluid may harm the filter material.

STAUFF offers a solution: SE and RE series filter elements with protective sheath (only available for glass fibre elements). This is a thin, perforated plastic sheet that completely encases the pleats of the filter from the outside as well as making the element more stable. A further positive effect is that the volume of flow is distributed more evenly by the protective sheath, thus ensuring an efficient flow rate.

In its standard version, the foil is printed with the STAUFF 4PRO logo, eliminating any mix-up with other brands. Larger quantities can also be produced with a customised imprint on the sheath.

β value

Key evaluation criteria for filter elements using glass fibre technology are the retention rate (micron rating) the β value, the β stability, the dirt holding capacity and the initial pressure differential. These values are determined using the multipass test established by ISO 16889.

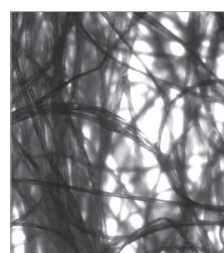
The designation for STAUFF elements typically includes a rating based on filter fineness.

Filter designation β value > 200 according to ISO 4406	$\beta_{(c)} > 200$ ISO 11171	$\beta_{(c)} > 1000$ ISO 11171
03	4,0 $\mu\text{m}_{(c)}$	4,5 $\mu\text{m}_{(c)}$
05	5,0 $\mu\text{m}_{(c)}$	6,0 $\mu\text{m}_{(c)}$
10	8,8 $\mu\text{m}_{(c)}$	11,0 $\mu\text{m}_{(c)}$
20	21,0 $\mu\text{m}_{(c)}$	23,0 $\mu\text{m}_{(c)}$

Filter Material – Quality And Properties

The choice of the right filter material is dependent on different criteria. Among others, this includes the type of application, the filter function, degree of contamination or alternatively the required dirt-hold capacity as well as requirements of chemical or physical resistance. Inorganic Glass Fibre, Polyester, Cellulose, Stainless Fibre Material and Stainless Steel Wire Mesh are used for hydraulic applications.

The following list gives you an overview of how these five filter materials differ with regard to specific properties:

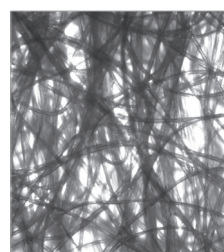


Inorganic Glass Fibre

- Inorganic Glass Fibre based on synthetic fibres with acrylic resin binding
- Large dirt-hold capacity
- Excellent separation efficiency of the finest particles due to the three-dimensional labyrinth structure with deep-bed filtration
- Outstanding price/performance ratio

Micron rating

- 3 ... 25 μm (alternative micron ratings on request)

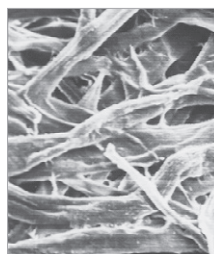


Polyester Fibre

- 100% Polyester Fibres with thermal bonding
- High pressure differential resistance
- Good chemical resistance
- High separation efficiency of the finest particle
- Tear-proof structure

Micron rating

- 3 ... 25 μm (alternative micron ratings on request)

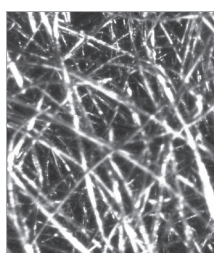


Cellulose Fibre

- Filter material made of Cellulose Fibres with special impregnation
- Variants with lowest price with good dirt-hold capacity
- Not suitable for water based fluids

Micron rating

- 10 ... 50 μm (alternative micron ratings on request)

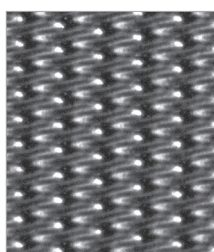


Stainless Fibre

- Sintered Stainless Fibres with three-dimensional labyrinth structure for depth filtration
- Low flow resistance with high dirt-hold capacity
- Excellent chemical and thermal resistance

Micron rating

- 3 ... 25 μm (alternative micron ratings on request)



Stainless Mesh

- Wire Mesh fabric made of material 1.4301 or 1.4305 for surface (other material on request)
- Type of weave: square weave or Dutch weave
- Low flow resistance due to large-pored screening surface
- Excellent chemical and thermal resistance

Micron rating

- 10 ... 1000 μm (alternative micron ratings on request)



Replacement Filter Elements for Applications Involving Hydraulic and Lubrication Oils

Replacement Filter Element for Return-Line Filters

Filter media

- Inorganic Glass Fibre
- Polyester Fibre
- Cellulose Fibre
- Stainless Fibre
- Stainless Mesh

Micron rating

- see on page 26 Filter Materials

max. Δp^* collapse

- 10 ... 25 bar / 145 ... 362 PSI

Sealing Material

- NBR (Buna-N®)
- FKM/FPM (Viton®)
- EPDM

Bypass

- 1 ... 7 bar / 0 ... 101 PSI

End cap

- Plastic / Steel / Stainless Steel (alternative End caps on request)

Note: * Collapse / burst resistance as per ISO 2941.



B

Replacement Filter Element for Pressure Filters

Filter media

- Inorganic Glass Fibre
- Polyester Fibre
- Cellulose Fibre
- Stainless Fibre
- Stainless Mesh

Micron rating

- see on page 26 Filter Materials

max. Δp^* collapse

- 10 ... 210 bar / 145 ... 3045 PSI

Sealing Material

- NBR (Buna-N®)
- FKM/FPM (Viton®)
- EPDM

End cap

- Steel / Stainless Steel / Aluminium (alternative End caps on request)

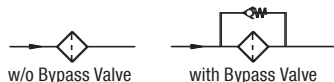
Note: * Collapse / burst resistance as per ISO 2941.



Replacement Filter Elements for Applications involving Hydraulic and Lubrication Oils

Replacement Filter Element for Spin-On-Filters (see on Page 168 - 173)

B

**max. Δp^* collapse**

- 5 ... 10 bar / 72 ... 145 PSI

Sealing Material

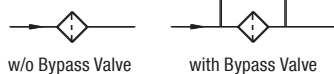
- NBR (Buna-N®)

Connection Thread

- BSP / UNF / NPT

Note: * Collapse / burst resistance as per ISO 2941.

Replacement Filter Element for Suction Strainers

**Filter media**

- Stainless Mesh

Micron rating

- 60, 125, 250 μm

Flow Rate

- 12 - 400 l/min / 3.1 - 104 US GPM

Bypass

- 0,2 bar / 2.9 PSI

End cap

- Aluminium / Plastic

Connection Thread

- BSP / NPT

Note: * Collapse / burst resistance as per ISO 2941.

For details, please see Catalogue No. 10 - Hydraulic Accessories.



Interchanging STAUFF Filter Elements

As well as original Filter Elements for our own filter housings, STAUFF also provides access to a comprehensive range of Replacement Filter Elements. They match the quality and can be installed in the products of for example:

- Argo-Hytos
- Donaldson
- Eppensteiner Bosch Rexroth
- Fairey Arlon
- Hydac
- Mahle
- Internormen
- Pall
- Parker
- Other types are available on request

STAUFF offers many options for filter conversion, design and calculation and supports interested parties and customers with the design of efficient solutions:

- Online filter search with more than 65000 data sets under www.filterinterchange.com
- Offline filter database with deposited measurements, filter surfaces and drawings
- Filter selection software for easy filter design and calculation

Thanks to their excellent dirt-hold capacity, all of the filter products supplied by STAUFF have an impressive long service life and high β value stability:

- Inorganic glass fibre, filter paper, stainless fibre (micron ratings between 3 μ m and 25 μ m respectively) as well as stainless mesh (micron ratings between 10 μ m and 1000 μ m)
- Maximum differential pressure depending on filter media and application for the options 16 bar / 232 PSI, 30 bar / 435 PSI or 210 bar / 3000 PSI.

Your local STAUFF Distributor will assist you interchanging to STAUFF elements.

B

Find the suitable STAUFF replacement filter element at

www.filterinterchange.com



It's this easy:



search



enquire



save

Your advantages:

- Over 65000 datasets from various manufacturers
- Conversion for all common filter brands and types
- Watch list function for storing search results
- Request price and delivery time with enquiry history

Order Codes

RE - 045 - G - 20 - B / X - 123456

① ② ③ ④ ⑤ ⑥ ⑦

① Type

Series	Filter Element
Argo-Hytos High Pressure Filter Element	SD
Argo-Hytos Medium Pressure Filter Element	MD
Argo-Hytos Return-Line Filter Element	RD
Argo-Hytos Suction-Line Filter Element	AD
Eppensteiner Bosch Rexroth High Pressure Filter Element	SS
Eppensteiner Bosch Rexroth Return-Line Filter Element	RS
Eppensteiner Bosch Rexroth Low Pressure Filter Element	LS
Fairey Arlon High Pressure Filter Element	SA
Fairey Arlon Return-Line Filter Element	RA
Hydac High Pressure Filter Element	SE
Hydac Return-Line Filter Element	RE
Mahle High Pressure Filter Element	SL
Mahle Low Pressure Filter Element	ML
Mahle Return-Line Filter Element	RL
Internormen High Pressure Filter Element	SN
Internormen Return-Line Filter Element	RN
Pall High Pressure Filter Element	SP
Pall Return-Line Filter Element	RP
Medium Pressure Filter Element according to standard	NL
Return-Line Filter Element according to standard	NR
Spin-On Filter Element	SFC
Special Element STAUFF	SXX

Note: Other series on request

② Nominal Size

Depending on the nominal flow or element length

③ Filter Material and Pressure Setting

Stainless Fibre, high collapse pressure	A, M
Stainless Wire mesh, low collapse pressure	B, S
Polyester Fibre, high collapse pressure	C, Q
Filter Paper, low collapse pressure	D, K, L, N
Inorganic Glass Fibre, low collapse pressure	E, G
Inorganic Glass Fibre, high collapse pressure	F, H
Stainless Wire Mesh, high collapse pressure	R, T, W

④ Micron Rating

Stainless Wire Mesh	
10 μ m	10
20 μ m	20
25 μ m	25
40 μ m	40
50 μ m	50
60 μ m	60
80 μ m	80
100 μ m	100
125 μ m	125
150 μ m	150
200 μ m	200
500 μ m	500
1000 μ m	1000
Stainless Stainless Fibre	
3 μ m	03
5 μ m	05
10 μ m	10
20 μ m	20
25 μ m	25
Filter paper	
10 μ m	10
20 μ m	20
50 μ m	50

④ Micron Rating

Inorganic Glass Fibre	
3 μ m	03
5 μ m	05
10 μ m	10
15 μ m	15
20 μ m	20
25 μ m	25
Polyester Fibre	
3 μ m	03
5 μ m	05
10 μ m	10
20 μ m	20
25 μ m	25

Note: Other micron ratings on request

⑤ Sealing Material

NBR (Buna-N®)	B
FKM/FPM (Viton®)	V
EPDM	E

Note: Other sealing materials on request.

⑥ Design Code

Only for information	X
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⑦ STAUFF Special Number

If element varies from the standard type	X
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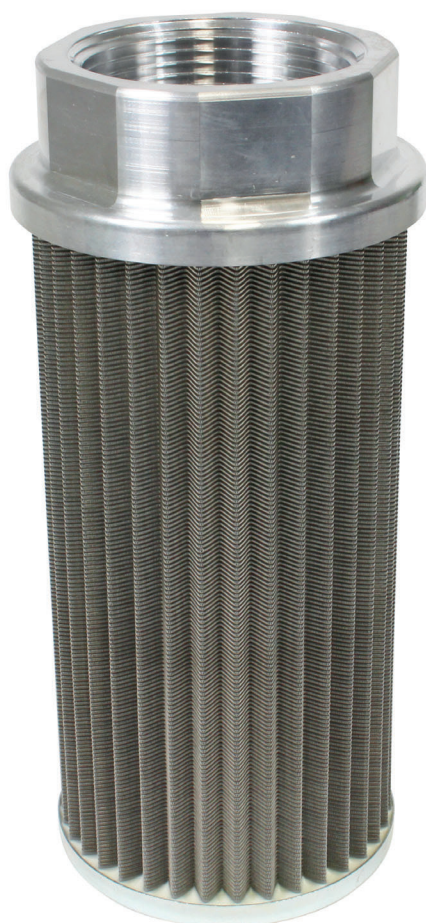
Special Filter Element Solutions



Special Ammonia Filter Element



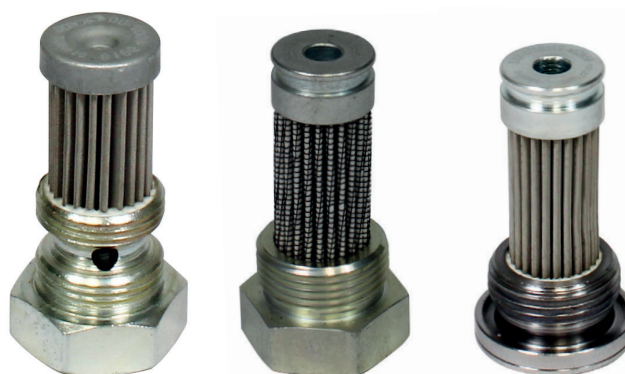
High Pressure Block with Threaded Filter Element



Special Suction Strainer



Filter Element with Bypass and Special Sealing



High Pressure Threaded Elements

Custom-designed Filter element solutions in addition to the Original-STAUFF-Filtartion Technology range according to customers specifications or based on STAUFF developments.

If you have similar requirements please contact STAUFF.



Checklist for the selection of filter housings

Please use the following Checklist as a guideline when preparing an enquiry for the selection of filter housings. Scan or copy the page from the catalogue, print and com-

plete it with as much information as possible, before sending it by email or fax to the closest STAUFF branch office. If possible, please also let us know the quantities required,

and if the enquiry is for a one-time or recurring demand. We look forward to hearing from you, and are always available for consultation, when required.

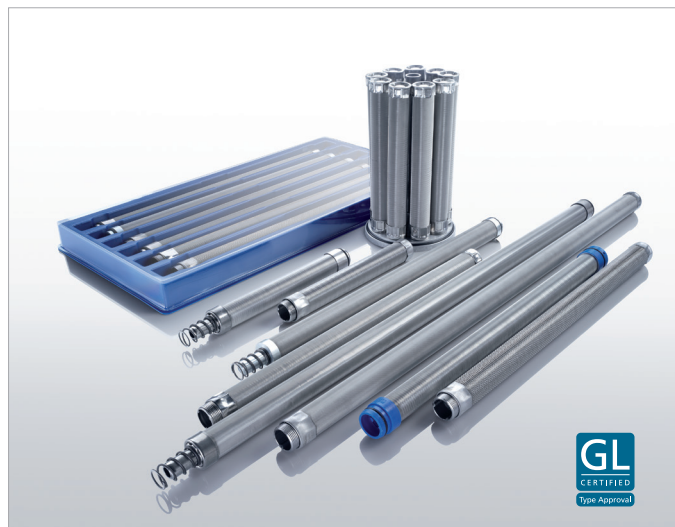
Information on the fluid in use					
Type of fluid	<input type="text"/>	Brand	<input type="text"/>	ISO designation	
Fluid viscosity	<input type="text"/>	<input type="text"/>	mm ² /sec	<input type="text"/>	cSt
Fluid temperature	<input type="text"/>	°C	<input type="text"/>	°F	
	<input type="text"/>		In cold condition	<input type="text"/>	In warm condition
Information on the filter housing					
Position in the hydraulic system	<input type="checkbox"/>	Suction line	<input type="checkbox"/>	Pressure line	<input type="checkbox"/>
					Return line
Operating pressure	<input type="text"/>	<input type="text"/>	bar	<input type="text"/>	PSI
Nominal flow	<input type="text"/>	<input type="text"/>	l/min	<input type="text"/>	US GPM
Valve	<input type="checkbox"/>	No, not required			
	<input type="checkbox"/>	Yes, the following type:	<input type="checkbox"/>	Bypass valve	<input type="checkbox"/>
				Non-return valve	<input type="checkbox"/>
				Reverse flow valve	<input type="checkbox"/>
				Multi-function valve	
Clogging indicator	<input type="checkbox"/>	No, not required			
	<input type="checkbox"/>	Yes, the following type:	<input type="checkbox"/>	Visual	<input type="checkbox"/>
				Electrical	<input type="checkbox"/>
				Visual-electrical	
Connection type and size	<input type="text"/>				
Sealing material	<input type="checkbox"/>	NBR (Buna®)	<input type="checkbox"/>	FKM/FPM (Viton®)	<input type="text"/>
					Other
Information on the filter element					
Filter media	<input type="checkbox"/>	Inorganic Glass Fibre	<input type="checkbox"/>	Polyester Fibre	<input type="checkbox"/>
				Cellulose Fibre	<input type="checkbox"/>
				Stainless Fibre	<input type="checkbox"/>
				Stainless Mesh	
Micron rating	<input type="text"/>	<input type="text"/>	µm		
Cleanliness level	<input type="text"/>	<input type="text"/>	(to ISO 4406)		
Information on the application	<input type="text"/>				
Information on the ambient conditions	<input type="text"/>				
Additional information and requirements	<input type="text"/>				



Replacement Filter Elements for Single, Double and Automatic Filters

Screw-In and Plug-In Elements ■ Type SFK

B



We produce high-quality Screw-In and Plug-In Elements in Stainless Steel design or in Plastic design. They fit into the most common single, double and automatic filters.

Length

- 220 mm ... 750 mm / 8.66 in ... 29.53 in

Diameter

- 30 mm / 1.18 in

Filter media

- Stainless Mesh

Micron rating

- 10 ... 200 µm (alternative micron ratings on request)

End cap

- Stainless Steel / Plastic

Application

- For lubricating oils, heavy fuels, water, chemicals and cooling lubricants

Star-Pleated Elements, Basket and Ring Sieves ■ Types SBS and SBK



We deliver high-quality Star- Pleated Elements, Basket and Ring Sieves in Stainless Steel design with particularly pleated filter media which offer a very good filtrate quality and aw long durability.

Length

- 95 mm ... 390 mm / 3.74 in ... 15.35 in

Diameter

- 65 mm ... 85 mm / 2.56 in ... 3.35 in

Filter media

- Stainless Mesh

Micron rating

- 10 ... 200 µm (alternative micron ratings on request)

End cap

- Stainless Steel

Application

- For lubricating oils, heavy fuels, water, chemicals and cooling lubricants

Heavy Fuel Elements ■ Type SFK-439



STAUFF Heavy Fuel Elements separate particles from the fluid flow as the last filtration step before direct injection to the engine room / combustor.

Length

- 439 mm / 17.28 in

Diameter

- 48 mm / 1.89 in

Filter media

- Stainless Mesh

Micron rating

- 6 µm or 10 µm

End cap

- Stainless Steel

Application

- Separation of particles from the fluid flow as the last filtration step before direct injection to the engine room / combustor.



Replacement Filter Elements for Single, Double and Automatic Filters

Paper, Fibreglass and Polyester Elements ■ Type SBS-124

Due to the pleated design of STAUFF Paper Elements, they can offer a large filter area in a small place and with a long durability. The cover made of Polyester allows a safe treatment during the installation and the demounting without damaging the filter media.

Length

- 254 mm, 500 mm or 750 mm / 10.00 in , 19.69 in oder 29.53 in (alternative lengths on request)

Diameter

- 124 mm / 4.88 in

Filter media

- Paper, Fibreglass and Polyester (Stainless Mesh on request)

Micron rating

- 10 µm or 50 µm (alternative micron ratings on request)

End cap

- Steel, zinc plated or Stainless Steel

Application

- Bypass and flushing filter for automatic filters and double filters in the field of lubricating oil



Plastic Elements ■ Types SFK-320 and SFK-445

STAUFF Plastic Elements have a special cloth and a special format which ensure the safety and the optimal protection of the motors. The molded end caps allow a quick installation and demounting as they can be easily connected.

Length

- 320 mm or 445 mm / 12.59 in oder 17.52 in

Diameter

- 19 mm ... 33 mm / 0.75 in ... 1.29 in

Filter media

- Plastic (Stainless Mesh on request)

Micron rating

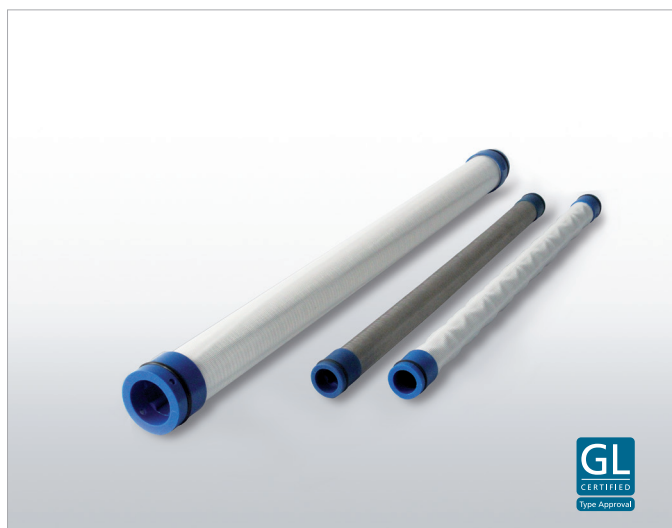
- 25 µm or 31 µm

End cap

- Plastic

Application

- Pre-filter of motors



Multimantle Elements ■ Type SBM

Multimantle Elements in different types and sizes complete the STAUFF exchange program.

Length

- 128 mm ... 723 mm / 5.03 in ... 28.46 in

Diameter

- 86 mm ... 230 mm / 3.39 in ... 9.05 in

Filter media

- Stainless Mesh

Micron rating

- 10 µm ... 2000 µm

End cap

- Aluminium

Application

- Multimantle filter elements are generally used in marine applications for filtering fuels and lubricants as well as water. The elements are also used in the processing industry for purifying water, oils, coolants and chemicals.

