The Drive & Control Company

New filter materials for hydraulic systems:

Longer service life and reduced operating costs

Bosch Rexroth is introducing a new generation of filter media, using state-of-the-art materials and advanced designs to protect hydraulic systems, reduce overall costs and improve hydraulic total cost of ownership (TCO).

New filter element technology from Bosch Rexroth utilizes an advanced, six-layer design to significantly improve filtration.

No other industrial and manufacturing drive technology provides the power density, life cycle performance and resistance to adverse environmental conditions offered by hydraulics. This only applies, however, as long as the hydraulic fluid is not contaminated.

Similar to pathogens in humans, particles in the hydraulic fluid, invisible to the naked eye, can lead to malfunctions and permanent damage even in large systems—and as hydraulic technologies are engineered to tighter tolerances and utilize higher pressures, sensitivity to particle contamination has increased.

It is useful to take into consideration several key aspects of filtration, in order for hydraulic systems users to make intelligent and effective use of this newest generation of filter media. These considerations include:

- Cleanliness requirements of hydraulic systems
- Technical criteria for filter selection:
  - Filter rating
  - Retention rate
  - Dirt holding capacity
  - Pressure differential
- Controlling/reducing life cycle costs

Requirements for hydraulic systems cleanliness

For centuries, people attributed contagious diseases to a wide variety of causes because they were not able to detect pathogens such as viruses or bacteria without microscopes and scientific insights. In hydraulic systems, many malfunctions are caused by very small particles in the hydraulic oil as well. According to research, contamination is the number one cause for failures of hydraulic systems accounting for 80 percent of these failures.

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Solid particles are primarily responsible for abrasion in components. Their effect depends on the particle's shape, hardness and material composition. Rigid and sharp-edged parts are the most common cause of damage. Furthermore, the level of damage and abrasion depends on factors including working fluid pressure, size and geometry of the particle, and particle velocity, among others.

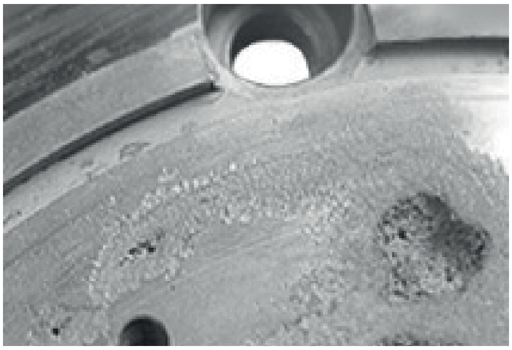
Generally speaking, the higher the system's working pressure, the more forcefully particles will be pressed into component gaps, thus increasing the risk and potential severity of the system damage.

One source of contamination is the production and assembly of new hydraulic systems. Even with extremely thorough cleaning prior to system commissioning, contamination cannot be completely removed and then gets into the hydraulic fluid during operation over time.

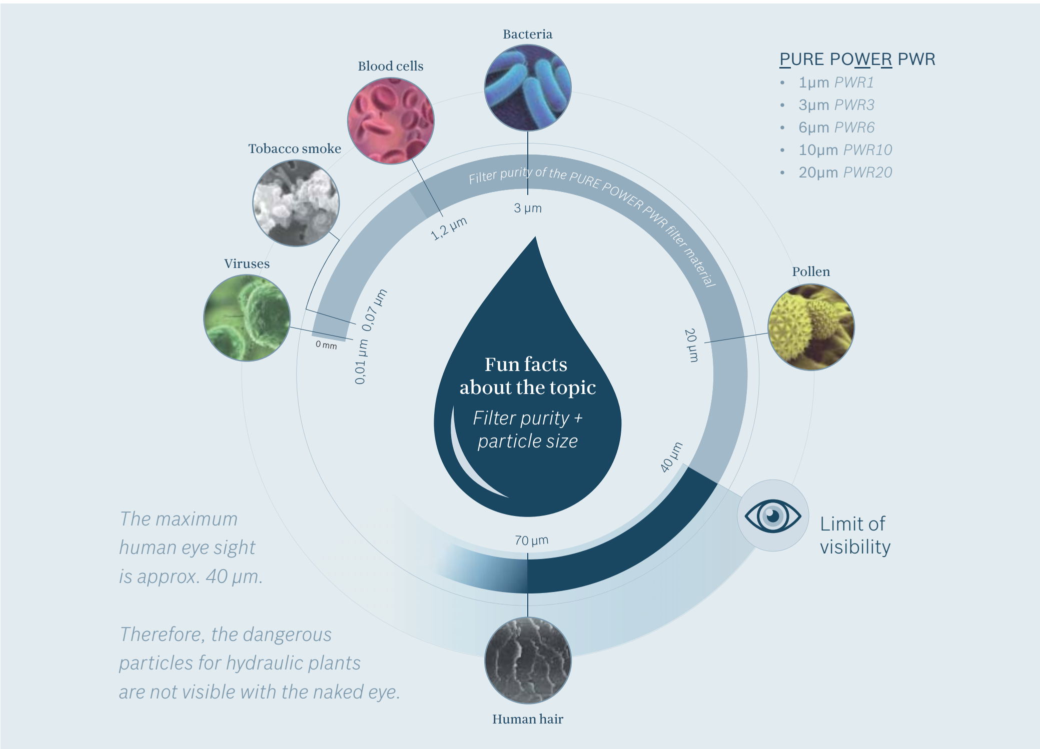
During operation, dirt may enter into the system from the plant air or via the piston rods. Internally, particles are mainly produced by the abrasion and erosion of metal components and seals. Chemically generated substances, such as oil aging products, oxidation residues and substances insoluble in oil due to the mixing of oils, are additional contamination sources.

Not visible to the naked eye: Contamination particles in hydraulic fluids are classified based on their size in thousandth of a millimeter (µm). With optimum lighting conditions, the human eye can see objects only down to a size of 40 µm. The particles which are particularly dangerous for hydraulic systems are 15 µm and smaller and can therefore not be detected in a visual inspection.

Users can only determine the actual contamination level using particle counters. There are two possibilities: Users take an oil sample either regularly or after special occurrences and analyze it for contamination. The second option is the integration of a particle counter in the hydraulic circuit. In this way, users can continuously monitor the contamination with particles.



Contaminated hydraulic fluid can lead to damage such as scratches on bearing components and erosion of surfaces due to particles streaming against parts.



Visual inspection of hydraulic fluid is insufficient to protect systems, since most fluid contaminants are too small to be seen with the naked eye.

Contamination risks with new fluids: New hydraulic fluids can have a high level of contamination, which is why users should not assume that new operating liquids are particularly clean and therefore safe. Particularly after filling systems with new hydraulic fluids, filtration is extremely important. Best practices can include performing professional fluid analysis to gain information on the actual contamination of the hydraulic fluid; if possible, new fluid should be filtered once before being added to hydraulic systems.

Technical criteria for filter selection

Filters clean operating liquids by retaining particles of a defined size in the filter material. They thus guarantee proper function and a long life cycle of the hydraulic system. There are four important criteria that industrial operators should consider when selecting the right filter for their equipment:

- Filter rating
- Retention rate
- Dirt holding capacity
- Pressure differential

Only the overall consideration of all properties leads to the optimum technical and economical solution. Recently developed filter materials have set new standards regarding economic efficiency.

Filter rating: The tolerated particle size in a hydraulic fluid results from the fitting tolerance or as well from the lowest gap of the component applied in the system. In combination with the system pressure as well as the general sensitivity of a component, the so called fluid cleanliness is derived and stated in the data sheet of the respective component.

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Particles, which often show a laminar type due to the chipping type of their appearance can move without in general causing damage even through the smaller tolerances of e.g. a gear pump (<0,5µm).

• Systems with components which are very sensitive to contamination, and which require high uptime • Filling of servo systems	1 µm
• Systems with components which are very sensitive to contamination, and which require high uptime • Servo valve technology	3 µm
• Systems with proportional valves and pressures > 160 bar	6 µm
• Vane pumps, piston pumps, piston motors	10 µm
• Industrial hydraulics, directional valves, pressure valves	10 µm
• Industrial hydraulics with high tolerances/low sensitivity to contamination	20 µm

High-class filter elements are as well able to segregate even smaller particles than indicated on the grade of filtration.
The indicated grades of filtration are therefore to be understood as recommendation which are collected due to a long-time experience of different systems. Besides the pollution with particles the users have to take into consideration also more influences by environmental conditions and production processes. To this are counted among e.g. the influence on the filtration bearing by water or air in the oil.

Retention rate: The retention rate indicates how many particles of a certain size are retained in the filter mesh and how many reach the clean side. This ratio is measured in ßx according to ISO 16889. The number of particles in the specified filter rating is measured upstream and downstream of the filter. If one of 100 retained particles reaches the clean side, then the ß-value is 100 for the specified filter rating x. If the considered size "x", e.g. 10 µm has reached a ß-value of minimum 200, then the filter is by definition according to the DIN24550 a filter with the fineness 10 µm. Depending on the filter rating, new filter materials have ß-values between 200 and 1,000. As a result, users achieve excellent filtration performance and increase their system availability thanks to optimally cleaned hydraulic fluids.

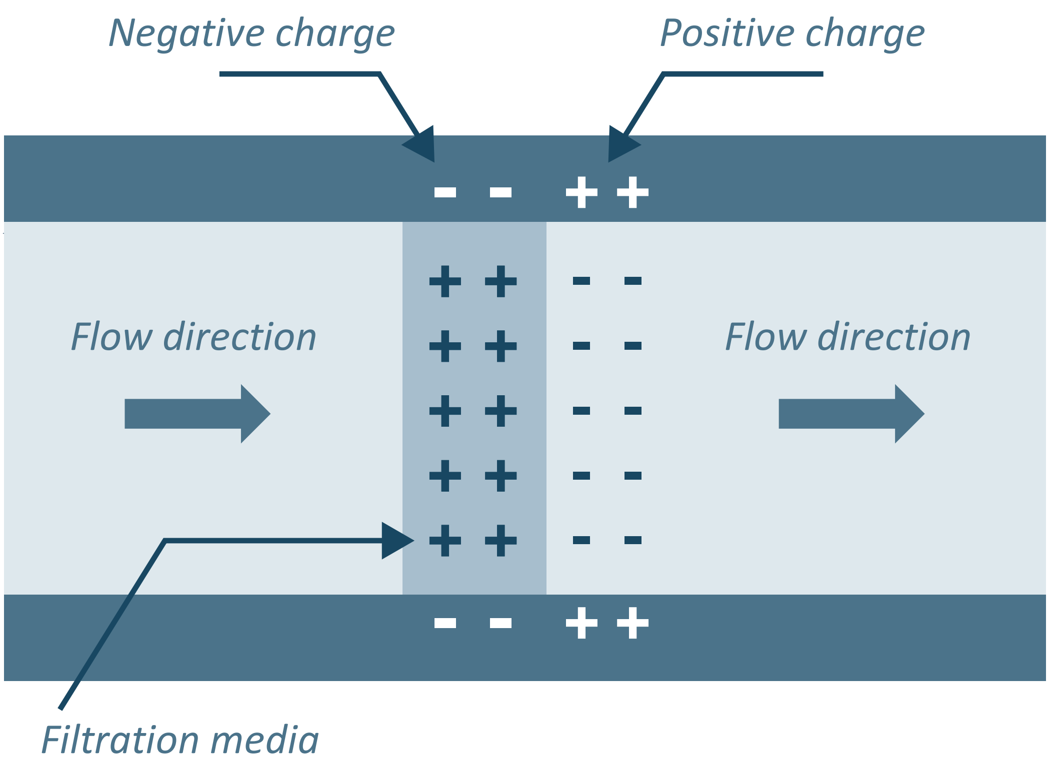
Dirt holding capacity: The dirt holding capacity is also measured according to ISO16889 and indicates the capacity of a filter and is the decisive factor for the duration of the replacement intervals. The more dirt is absorbed by a filter, the longer the replacement interval and the lower the filtration costs. Compared to the previous generation, newly developed filter elements absorb up to 50 percent more particles thanks to ideally engineered multi-layer filter materials made of glass fibers. They therefore have a longer service life and reduce the life cycle costs of the hydraulic system.

Pressure differential: Every filter element causes a differential presssure between the clean side and the dirt side. This differential pressure is rated for the filter element itself and for the filter by the test method ISO 3968. While the filter is working the quantity of contamination and the filter efficiency have influence on the level of the differential pressure.
The higher the flow resistance the liquid has to overcome the more pressure gets lost and has to be re-created with a lot of energy. In spite of a higher retention rate and dirt hold capacity the new filter materials have still a very low starting differential pressure.

Conductive woven filter materials

End users of hydraulic systems increasingly use zinc- and ash-free oils. These hydraulic media usually have reduced conductivity. If it is less than 300 picosiemens per meter, the danger of electrostatic discharge increases. Discharge processes are often visible in the form of spark discharges or can be identified by a crackling noise. Each discharge can burn tiny amounts of oil and reduce the service life of the medium. Discharges can also cause pin hole damage filter layers. This reduces the retention rate and increases the danger of particles passing through the filter and causing damage in the system.

Newly developed filter elements are equipped with an additional electrical conductive layer as a standard. It provides for a charge exchange between oil and filter material and thereby reduces the risk of electrostatic charge and discharge in the filter.



Use of an electrically conductive filter reduces the risk of electrostatic buildup and subsequent discharge, which can damage the filter and allow particles to pass through.

Increasing filter dirt holding capacity improves filtration efficiency, reduces filter replacement intervals and helps lower maintenance costs and overall TCO.

Reducing life cycle costs

Effective filtration increases the availability and life cycle of hydraulic systems. However, there are operational costs associated with the proper use of fluid filtration: labor and downtime costs required for exchanging filter elements on a regular basis.
In this regard, newly developed filter elements can reduce the life cycle costs in several ways:

- The dirt holding capacity which is increased up to 50 percent prolongs the replacement intervals. This means a reduction in labor, material and disposal costs.
- The optimum retention rate of the new filter elements and their electrical conductive properties reliably protect hydraulic systems and prevent damage or system downtime due to contamination—which is the cause of 80 percent of hydraulic system failures.

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Conclusion:

Hydraulic fluid is often referred to as the “life-blood” of hydraulic systems—and with good reason: keeping this fluid clean and contaminant-free is essential to preventing damage and increasing the life cycle of these systems. Newly developed filter materials for more powerful filter elements reduce the operating costs by ensuring a longer service life.

For future filter exchanges, users should therefore first compare the technical specifications of filter elements by different suppliers. Independent of the manufacturer of the filter housing, the operating costs can be significantly reduced by using the new generation of filter media.

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