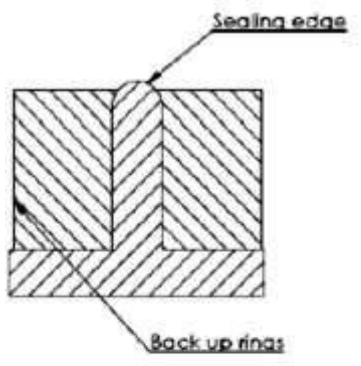
3. T-ring seal: T-ring seal is a dynamic seal that is extensively used to seal cylinder-pistons, piston rods and other reciprocating parts. It is made of synthetic rubber moulded in the shape of the cross-section T and reinforced by backup rings on either side. The sealing edge is rounded and seals very much like an O-ring.



4. Piston cup packings: Piston cup packings are designed specifically for pistons in reciprocating pumps and pneumatic and hydraulic cylinders. They offer the best service life for this type of application, require a minimum recess space and minimum recess machining, and can be installed easily and quickly.

5. Piston rings: Piston rings are seals that are universally used for cylinder pistons. Piston rings offer substantially less opposition to motion than synthetic rubber (elastomer) seals.

SEALING MATERIALS:

Various metallic and non-metallic materials are used for fabrication of seals that are used in hydraulic systems. Leather, metals and elastomers are very common seal materials.

1) Leather: This material is rugged and inexpensive. However, it tends to squeal (scream/screech) when dry and cannot operate above 90°C, which is inadequate for many hydraulic systems. Leather does operate well at cold temperatures to about -50°C.

2) Buna-N: This material is rugged and inexpensive and wears wells. It has a rather wide operating temperature range (-45°C to 110°C) during which it maintains its good sealing characteristics.

3) Silicone: This elastomer has an extremely wide operating temperature range (-65°C to 232°C). Hence it is widely used for rotating shaft seals and static seals. Silicone has low tear resistance and hence not used for reciprocating seal applications.

***4) Neoprene*:** This material has a temperature range of 50°C to 120°C. it is unsuitable above 120°C because of its tendency to vulcanize.

5) Viton: This material contains 65% fluorine. It has become almost a standard material for elastomer-type seals for use at elevated temperatures up to 240°C. Its minimum operating temperature is 28°C.

6) Tetrafluoroethylene: This material is the most widely used plastic for seals of hydraulic systems. It is a tough, chemically inert, waxy solid, which can be processed only by compacting and sintering. It has excellent resistance to chemical breakdown up to temperatures of 370°C.

PIPES AND HOSES:

In a hydraulic system, the fluid flows through a distribution system consisting of pipes (conductors) and fittings, which carry the fluid from the reservoir through operating components and back to the reservoir.

Hydraulic systems use primarily four types of conductors:

1. Steel pipes

2. Steel tubing

3. Plastic tubing

4. Flexible Hoses

The choice of which type of conductor to use depends primarily on the system's operating pressures and flow-rates.

QUICK ACTING COUPLINGS:

Couplings are precision components, engineered for specific uses with exact dimensions and close tolerances. There are a variety of applications in modern industrial plants for quick connect (QC) couplings both for pneumatically operated tools as well as other fluid power equipments which can be connected rapidly to their power source to permit wide versatility for production needs. For instance, in connecting or disconnecting a tractor and its hydraulically actuated agricultural component.

QCs make changes simple, do not require additional hand tools, take little time and do not require the help of additional trade or skill. They are devices which permit the rapid connection or disconnection of fluid conductors.

FLUID CONDITIONING THROUGH FILTERS AND STRAINERS:

Hydraulic components are very sensitive to contamination. The cause of majority of hydraulic system failures can be traced back to contamination. Hence for proper operation and long service life of a hydraulic system, oil cleanliness is of prime importance. Strainers and filters are designed to remove foreign particles from the hydraulic fluid.

Filters are devices whose primary function is the retention of insoluble contaminants from fluid, by some fine porous medium. Filters are used to pick up smaller contaminant particles because they are able to accumulate them better than a strainer. Particle sizes removed by filters are measured in microns. The smallest sized particle that can be removed is as small as 1 μm.

A strainer is a coarse filter, whose function is to remove large particles from a fluid using a wire screen. Fluid flows more or less straight through it. It does not provide as fine a screening action as filters do, but offers less resistance to flow. The smallest sized particle that can be removed by a strainer is as small as 0.15 mm or 150 μm.

CLASSIFICATION OF FILTERS:

Based on filtering methods:

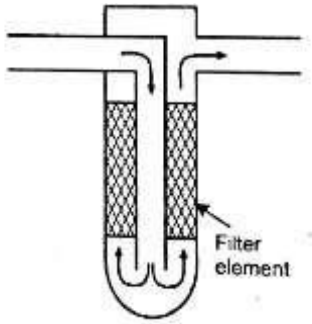
1. Mechanical: This type normally contains a metal or cloth screen or a series of metal disks separated by thin spacers. Mechanical filters are capable of removing only relatively coarse particles from the fluid.

2. Absorbent: These filters are porous and permeable materials such as paper, wood pulp, cloth, cellulose and asbestos. Paper filters are impregnated with a resin to provide added strength. In this type of filters, the particles are actually absorbed as the fluid infiltrates the material. Hence, these filters are used for extremely small particle filtration.

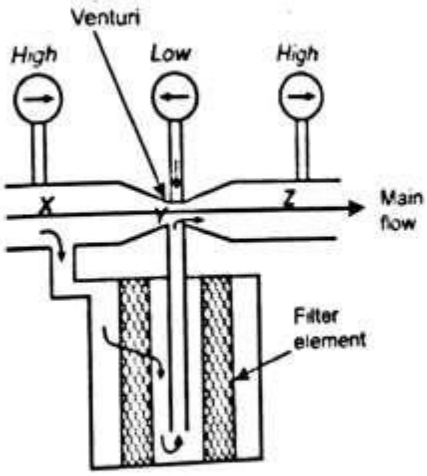
3. Adsorbent: Adsorption is a surface phenomenon and refers to the tendency of particles to cling to the surface of the filters. Thus, the capacity of such a filter depends on the amount of surface area available. Adsorbent materials used include activated clay and chemically treated paper.

Depending on the amount of oil filtered by a filter:

1. Full flow filters: In this type, complete oil is filtered. Full flow of oil must enter the filter element at its inlet and must be expelled through the outlet after crossing the filter element fully. This is an efficient filter. However, it incurs large pressure drops. This pressure drop increases as the filter gets blocked by contamination.



2. Proportional filters (bypass filters): In some hydraulic system applications, only a portion of oil is passed through the filter instead of entire volume and the main flow is directly passed without filtration through a restricted passage.



BETA RATIO OF FILTERS

Filters are rated according to the smallest size of particles they can trap. By mathematical definition, the beta ratio equals the number of upstream (before the filter) particles of size greater than Nμm divided by the number of downstream (after the filter) particles having size greater than Nμm. Where, N is the selected particle size for the given filter.

$$\text{Beta Ratio} = \frac{\text{No. of upstream particles of size} > N\mu m}{\text{No. of downstream particles of size} > N\mu m}$$

A beta ratio of 1 would mean that no particles above specified N are trapped by the filter. A beta ratio of 50 means that 50 particles are trapped for every one that gets through. Most filters have a beta ratio greater than 75.

$$\text{Beta Efficiency} = \frac{\text{No. of upstream particles - No. of downstream particles}}{\text{No. of upstream particles}}$$

$$\text{Beta Efficiency} = 1 - \frac{1}{\text{Beta Ratio}}$$

CAUSES OF CONTAMINATION:

1. Contaminants left in the system during assembly or subsequent maintenance work.

2. Contaminants generated when running the system such as wear particles, sludge and varnish due to fluid oxidation and rust and water due to condensation.

3. Contaminants introduced into the system from outside. These include using the wrong fluid when topping up and dirt particles introduced by contaminated tools or repaired components.

PROBLEMS CAUSED BY CONTAMINATION:

1. Accelerate component wear, decreasing system performance and service life.

2. Result in sluggish operation and cause moving parts to seize.

3. Damages seals resulting in leakage.

4. Act as a catalyst to accelerate hydraulic fluid oxidation and breakdown thereby shortening fluid life and reducing the useful operating temperature range of the fluid.

CONTAMINATION CONTROL:

There are many ways to reduce the effects of contaminants in a system.

1. Plumb the system with pipes, tubing and fittings that are reasonably free from rust, scale, dirt and other foreign matter.