***3) Water Glycols:*** These are solutions contains 35 to 55% water, glycol and water soluble thickener to improve viscosity. Additives are also added to improve anticorrosion, anti-wear and lubricity properties.

***4) Water Oil Emulsions*:** These are water-oil mixtures. They are of two types' oil-in-water emulsions or water-in-oil emulsions. The oil-in-water emulsion has water as the continuous base and the oil is present in lesser amounts as the dispersed media. In the water-in-oil emulsion, the oil is in continuous phase and water is the dispersed media.

***5) Phosphate Ester:*** It results from the incorporation of phosphorus into organic molecules. They have high thermal stability. They serve an excellent detergent and prevent building up of sludge.

**PROPERTIES OF HYDRAULIC FLUIDS:**

***1) Viscosity:*** It is a measure of the fluid's internal resistance offered to flow.

***2) Viscosity Index:*** This value shows how temperature affects the viscosity of oil. The viscosity of the oil decreases with increase in temperature and vice versa. The rate of change of viscosity with temperature is indicated on an arbitrary scale called viscosity index.

***3) Oxidation Stability:*** The most important property of hydraulic oil is its oxidation stability. Oxidation is caused by a chemical reaction between the oxygen of the dissolved air and the oil. The oxidation of the oil creates impurities like sludge, insoluble gum and soluble acidic products. The soluble acidic products cause corrosion and insoluble products make the operation sluggish.

***4) Demulsibility:*** The ability of a hydraulic fluid to separate rapidly from moisture and successfully resist emulsification is known as Demulsibility.

***5) Lubricity:*** The ability of the hydraulic fluid to lubricate the moving parts efficiently is called Lubricity.

***6) Rust Prevention:*** The moisture entering into the hydraulic system with air causes the parts made of ferrous materials to rust. This rust if passed through the precision made pumps and valves may scratch the nicely polished surfaces. So inhibitors are added to the oil to keep the moisture away from the surface.

***7) Pour Point:*** The temperature at which oil will clot is referred to as the pour point i.e. the lowest temperature at which the oil is able to flow easily.

***8) Flash Point and Fire Point:*** Flash point is the temperature at which a liquid gives off vapour in sufficient quantity to ignite momentarily or flash when a flame is applied. The minimum temperature at which the hydraulic fluid will catch fire and continue burning is called fire point.

***9) Neutralization Number:*** The neutralization number is a measure of the acidity or alkalinity of a hydraulic fluid. This is referred to the PH value of the fluid. High acidity causes the oxidation rate in an oil to increase rapidly.

***10) Density:*** It is that quantity of matter contained in unit volume of the substance.

***11) Compressibility:*** All fluids are compressible to some extent. Compressibility of a liquid causes the liquid to act much like a stiff spring. The coefficient of compressibility is the fractional change in a unit volume of liquid per unit change of pressure.

**SELECTION OF HYDRAULIC FLUIDS:**

A hydraulic fluid has the following four primary functions:

1) Transmit Power

2) Lubricate moving parts

3) Seal clearances between mating parts

4) Dissipate heat

In addition a hydraulic fluid must be inexpensive and readily available. From the selection point of view, a hydraulic fluid should have the following properties:

1) Good lubricity

2) Ideal viscosity

3) Chemical stability

4) Compatibility with system materials

5) High degree of incompressibility

6) Fire resistance

7) Good heat-transfer capability

8) Low density

9) Foam resistance

10) Non-toxicity

11) Low volatility

This is a challenging list, and no single hydraulic fluid possesses all of these desirable characteristics. The fluid power designer must select the fluid that is the closest to being ideal overall for a particular application.

**ADDITIVES:**

Various additives are added to the fluid to sustain the important characteristics. Few such additives are:

***1) Anti-foaming:*** They are added to reduce foaming of fluid.

***2) Anti-wear:*** Wear resistant chemicals are added to the fluid to protect critical hydraulic components from wear.

***3) Corrosion inhibitor:*** Chemicals are added to protect surfaces from chemical attack by water.

***4) Biocide:*** Emulsifying chemicals are added to the fluid to inhibit growth of water-borne bacteria.

***5) Emulsifier:*** These are added to facilitate formation and stabilisation of an emulsion.

***6) Lubrication Oiliness agents:*** Extreme Pressure (EP) agents are added to the fluid to enhance lubrication characteristics for effective full film boundary lubrication between the mating parts.

***7) Flocculants:*** Chemicals added to dispersion of solids in a liquid to combine fine particles to form floe or small solid masses in the fluid.

***8) Deionisation:*** Elements which provide hardness like calcium, manganese, iron, and aluminium salts are removed through deionisation of the water.

***9) Oxidation inhibitor:*** Anti-oxidation additives are added to provide anti-oxidation characteristics. Oxidation changes the chemical characteristics of the fluid.

***10) Vapour phase inhibitor:*** Prevention of oxidation or corrosion of metals in contact with the vapour phase of the fluid is ensured by addition of appropriate chemicals.

**EFFECT OF TEMPERATURE AND PRESSURE ON HYDRAULIC FLUID:**

Viscosity is the most important property of a hydraulic fluid. Temperature has an adverse effect on the viscosity of hydraulic oil. Hence it has to be seen that the operating temperature of a hydraulic system is kept at a reasonably constant level. Otherwise there will be tremendous losses in the system which will reduce the overall efficiency.

A hydraulic fluid that is too viscous generates more friction and heat and usually causes high-pressure drop, sluggish operation, low-mechanical efficiency, and high-power consumption. On the other hand low-viscosity fluids permit efficient low-drag operation, but tend to increase wear, reduce volumetric efficiency, and promote leakage.

**SEAL:**

The seal is an agent which prevents leakage of oil from the hydraulic elements and protects the system from dust/dirt. The major function of the seal is to maintain pressure, prevent loss of fluid from the system and to keep out contamination in the system to enhance its working life and functional reliability over a longer period.

**CLASSIFICATION OF SEALS:**

**According to the method of sealing:**

***1. Positive sealing:*** A positive seal prevents even a minute amount of oil from getting past. A positive seal does not allow any leakage whatsoever (external or internal).

***2. Non-positive sealing:*** A non-positive seal allows a small amount of internal leakage, such as the clearance of the piston to provide a lubrication film.

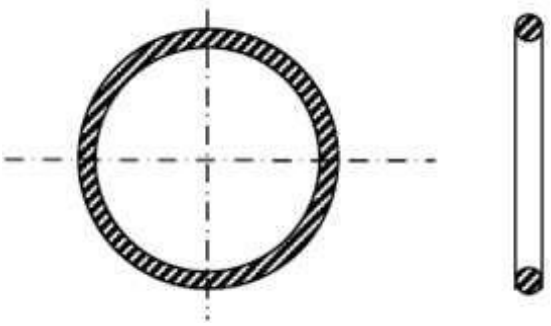
**According to the relative motion existing between the seals and other parts:**

***1. Static seals:*** These are used between mating parts that do not move relative to one another. These are relatively simple. They are essentially non-wearing and usually trouble-free if assembled properly.

***2. Dynamic seals:*** These are assembled between mating parts that move relative to each other. Hence, dynamic seals are subject to wear because one of the mating parts rubs against the seal.

**According to geometrical cross-section:**

***1. O-rings:*** O-ring is the most widely used seal for hydraulic systems. It is a moulded synthetic rubber seal that has a round cross-section in its free state. O-ring can be used for the most static and dynamic conditions. It gives effective sealing through a wide range of pressures, temperatures and movements.



***2. V-ring seal and U-ring seal:*** V- and U-ring seals are compression-type seals used in virtually all types of reciprocating motion applications. These include piston rods and piston seals in pneumatic and hydraulic cylinder, press rank, jacks and seals on plungers and piston in reciprocating pumps.