Hydraulic Systems and Fluid Selection

HISTORY

- It wasn't until the beginning of the industrial revolution when a British mechanic named Joseph Bramah applied the principle of Pascal's law in the development of the first hydraulic press.

- In 1795, he patented his hydraulic press, known as the Bramah press. Bramah figured that if a small force on a small area would create a proportionally larger force on a larger area, the only limit to the force that a machine can exert is the area to which the pressure is applied.

What is a Hydraulic System?

- Hydraulic systems can be found today in a wide variety of applications, from small assembly processes to integrated steel and paper mill applications.

- Hydraulics enable the operator to accomplish significant work (lifting heavy loads, turning a shaft, drilling precision holes, etc.) with a minimum investment in mechanical linkage through the application of Pascal's law, which states:

- “Pressure applied to a confined fluid at any point is transmitted undiminished throughout the fluid in all directions and acts upon every part of the confining vessel at right angles to its interior surfaces and equally upon equal areas (Figure 1).”

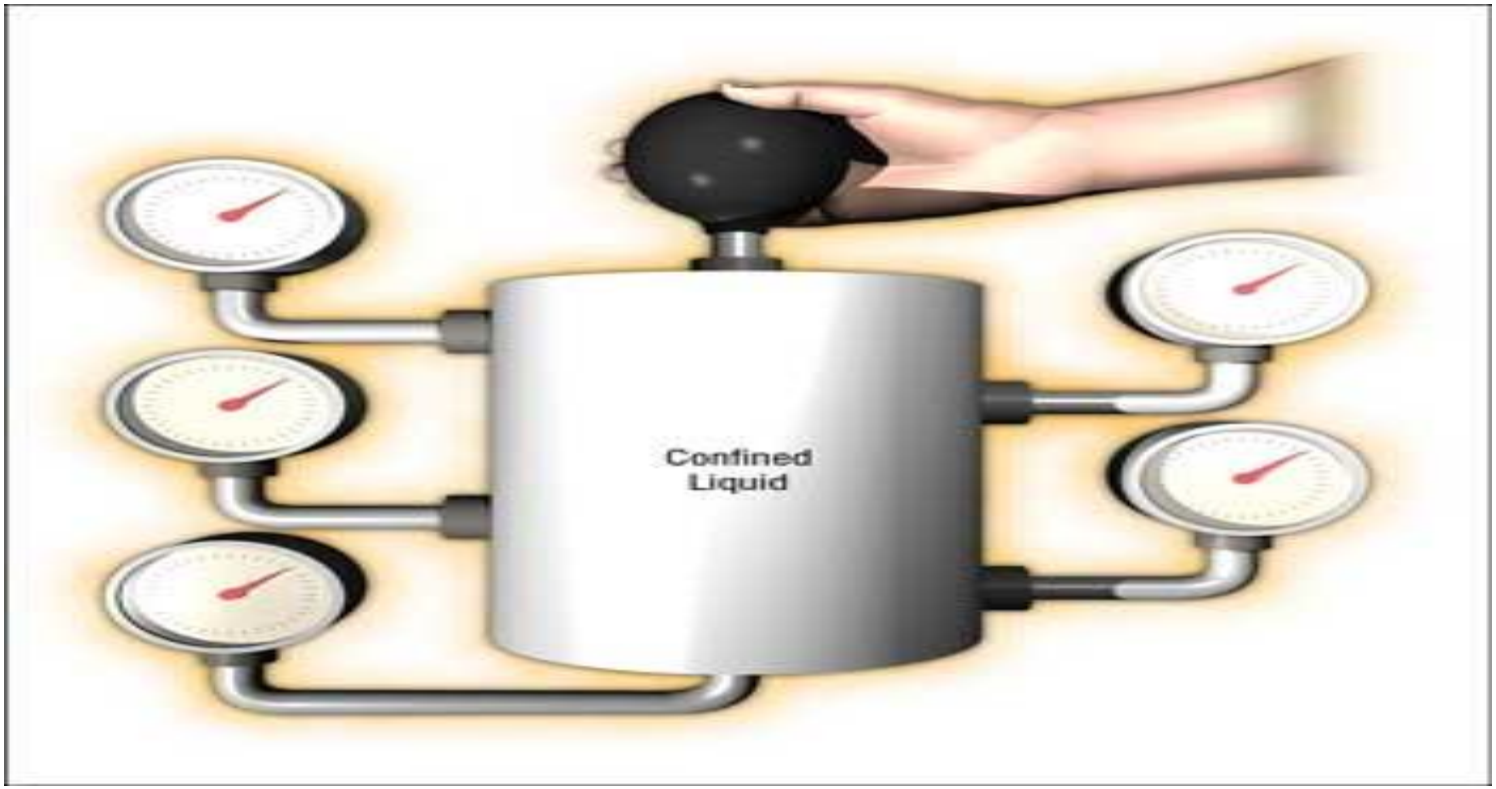

Figure 1 - Pascal's Law

- The principle of Pascal's law is realized in a hydraulic system by the hydraulic fluid that is used to transmit the energy from one point to another.

- Because hydraulic fluid is nearly incompressible, it is able to transmit power instantaneously.

Hydraulic Fluids

- Today's hydraulic fluids serve multiple purposes. The major function of a hydraulic fluid is to provide energy transmission through the system which enables work and motion to be accomplished.
- Hydraulic fluids are also responsible for lubrication, heat transfer and contamination control. When selecting a lubricant, consider the viscosity, seal compatibility, basestock and the additive package.
- Three common varieties of hydraulic fluids found on the market today are petroleum-based, water-based and synthetics.

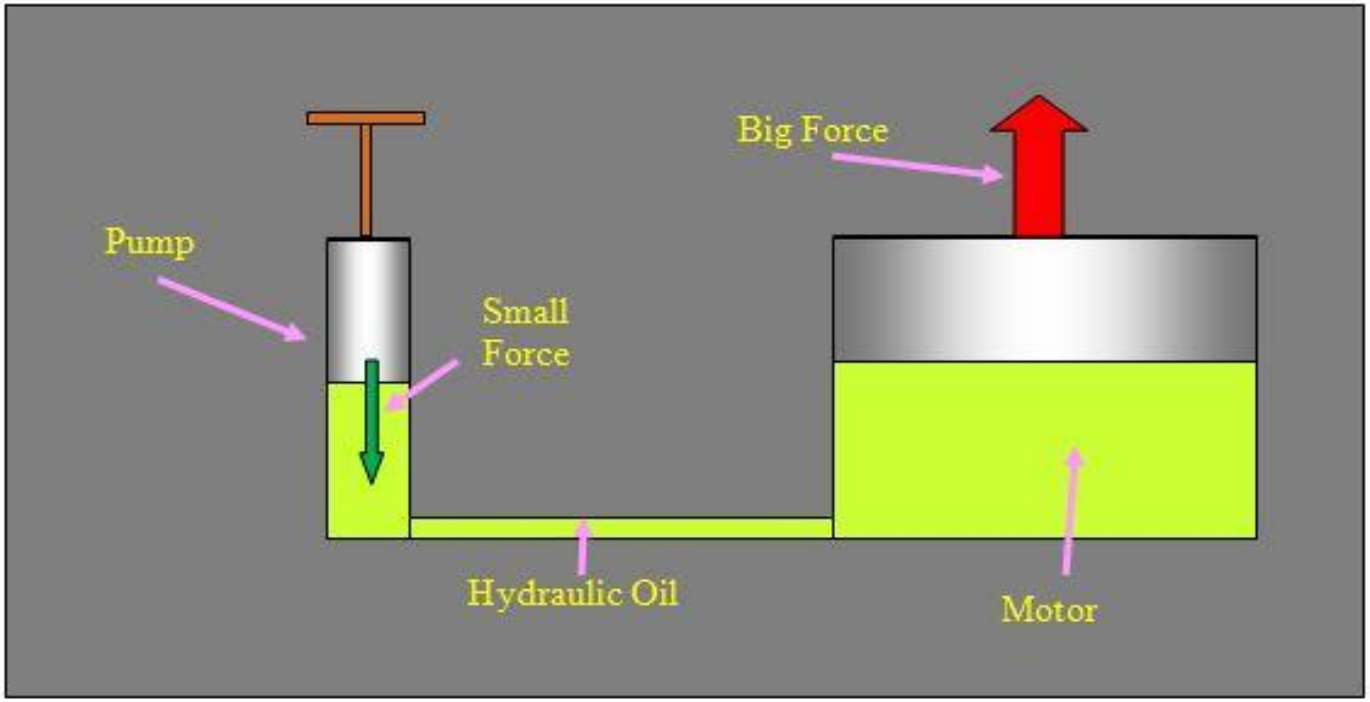

Figure 2: Hydraulic fluid working principle

- 1. Petroleum-based or mineral-based fluids are the most widely used fluids today. The properties of a mineral-based fluid depend on the additives used, the quality of the original crude oil and the refining process. Additives in a mineral-based fluid offer a range of specific performance characteristics.

- Common hydraulic fluid additives include rust and oxidation inhibitors (, anticorrosion agents, demulsifiers, antiwear and extreme pressure agents, VI improvers and defoamants. Mineral-based fluids offer a low-cost, high quality, readily available selection.

- 2. Water-based fluids are used for fire-resistance due to their high-water content. They are available as oil-in-water emulsions, water-in-oil (invert) emulsions and water glycol blends.

- Water-based fluids can provide suitable lubrication characteristics but need to be monitored closely to avoid problems. Because water-based fluids are used in applications when fire resistance is needed, these systems and the atmosphere around the systems can be hot.

- 3. Synthetic fluids are man-made lubricants and many offer excellent lubrication characteristics in high-pressure and high- temperature systems. Some of the advantages of synthetic fluids may include fire-resistance lower friction, natural detergency and thermal stability.

- The disadvantage to these types of fluids is that they are usually more expensive than conventional fluids, they may be slightly toxic and require special disposal, and they are often not compatible with standard seal materials.

Fluid Properties

- When choosing a hydraulic fluid, consider the following characteristics: viscosity, viscosity index, oxidation stability and wear resistance. These characteristics will determine how your fluid operates within your system.
- Fluid property testing is done in accordance with either American Society of Testing and Materials or other recognized standards organizations.

- 1. Viscosity is the measure of a fluid's resistance to flow and shear. A fluid of higher viscosity will flow with higher resistance compared to a fluid with a low viscosity.

- Excessively high viscosity can contribute to high fluid temperature and greater energy consumption. Viscosity that is too high or too low can damage a system, and consequently, is the key factor when considering a hydraulic fluid.

- 2. Viscosity Index is how the viscosity of a fluid changes with a change in temperature. A high VI fluid will maintain its viscosity over a broader temperature range than a low VI fluid of the same weight.

- High fluids are used where temperature extremes are expected. This is particularly important for hydraulic systems that operate outdoors.

- 3. Oxidation Stability is the fluid's resistance to heat-induced degradation caused by a chemical reaction with oxygen.

- Oxidation greatly reduces the life of a fluid, leaving by-products such as sludge and varnish. Varnish interferes with valve functioning and can restrict flow passageways

- 4. Wear Resistance is the lubricant's ability to reduce the wear rate in frictional boundary contacts.

- This is achieved when the fluid forms a protective film on metal surfaces to prevent abrasion, scuffing and contact fatigue on component surfaces.

- Hydraulic oil is engineered with other important properties, although these tend to be common regardless of brand, viscosity or application.

- Hydraulic oil has a package of chemical additives to improve the performance of both the oil and the components of the hydraulic system. These additives can improve the foaming resistance of the oil, its corrosion/rust resistance and the water-retention properties.

- The additive package of hydraulic fluid is what separates low and high quality fluids, and additives also improve the viscous properties of oil as well. When in doubt, always choose a premium fluid for your application at a viscosity appropriate for your operating conditions.