Lesson 2: Hydraulic Fluids

Basic Hydraulic Systems

- Hydraulic Tank
- **Hydraulic Fluids**
- HydraulicPumps and Motors
- Pressure Control Valves
- Directional Control Valves
- Flow Control Valves
- Cylinders

Introduction

The selection and care of the hydraulic fluid has an important effect on the life of the system. Just like the hardware components of a hydraulic system, the hydraulic fluid must be selected on the basics of its characteristics and properties to accomplish the designed task.

Objectives

Upon completion of this lesson the student will:

1. State the functions of hydraulic fluids.
2. Measure the viscosity of fluids.
3. State the meaning of viscosity index.
4. List the types of fire resistant hydraulic fluids.

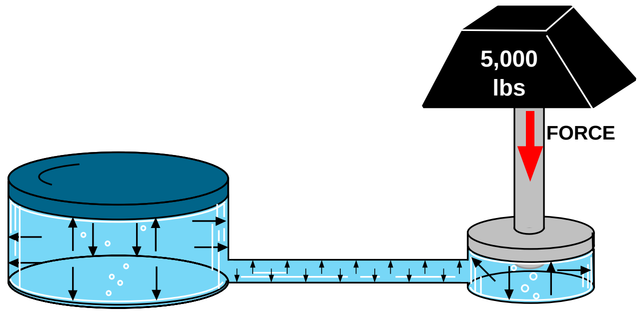

Fig. 3.2.1 Hydraulic Fluids

Functions of Hydraulic Fluids

Fluids are virtually incompressible. Therefore, fluids can transmit power instantaneously in a hydraulic system. For example, petroleum oil compresses approximately 1% for every 2000 psi. Therefore, petroleum oil can maintain a constant volume under high pressure. Petroleum oil is the primary fluid used in developing most hydraulic oils.

The primary functions of hydraulic fluids are:

- Power transmission
- Lubrication
- Sealing
- Cooling

Power Transmission

Because hydraulic fluids are virtually incompressible, once the hydraulic system is filled with fluid it can instantly transmit power from one area to another. However, this does not mean that all hydraulic fluids are equal and will transmit power with the same efficiency. Choosing the correct hydraulic fluid depends on the application and the operating conditions.

Lubrication

Hydraulic fluid must lubricate the moving parts of the hydraulic system. The rotating or sliding components must be able to function without touching other surfaces. The hydraulic fluid must maintain a thin film between the two surfaces to prevent friction, heat and wear.

Sealing

Many hydraulic components are designed to use hydraulic fluid instead of mechanical seals within the component. The viscosity of the fluid helps to determine its ability to function as a seal.

Cooling

The hydraulic system develops heat as it transfers mechanical energy to hydraulic energy and hydraulic energy back to mechanical energy. As the fluid moves throughout the system, heat flows from the warmer components to the cooler fluid. The fluid gives up the heat to the reservoir or to coolers that are designed to maintain fluid temperatures within design limits.

Other properties expected of the hydraulic fluid are the prevention of rust and corrosion on metal parts, the resistance to foaming and oxidation, the ability to separate air, water and other contaminates from the fluid, and the ability to maintain stability over a wide range of temperatures.

Viscosity

Viscosity is the measurement of a fluid's resistance to flow at a specific temperature. A fluid which flows easily has a low viscosity. A fluid which does not flow easily has a high viscosity.

A fluid's viscosity is affected by temperature. When a fluid becomes warmer, the fluid's viscosity becomes lower. Likewise, when a fluid cools, the viscosity increases. Vegetable oil is a very good example of how viscosity changes with a change in temperature. When vegetable oil is very cold, vegetable oil thickens and is very slow to pour. As vegetable oil is heated, vegetable oil becomes thinner and pours more readily.

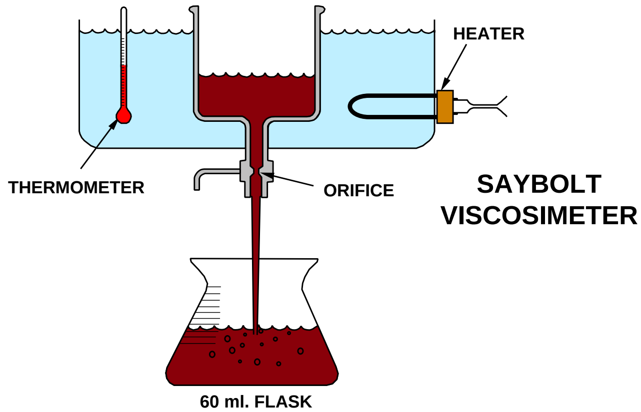

Fig. 3.2.2 Saybolt Viscosimeter

Saybolt Viscosimeter

The most common tool of measuring viscosity is the Saybolt Viscosimeter (Figure 3.2.2). The Saybolt Viscosimeter was invented by and named after George Saybolt.

The Saybolt Viscosimeter unit of measurement is the Saybolt Universal Second (SUS). In the original viscosimeter a container of fluid was heated to a specific temperature. When the temperature was reached, a stopcock (orifice) was opened and the fluid flowed out of the container and into a 60 ml. flask. A stopwatch was used to measure the time it took to fill the flask. The viscosity was recorded as the number of seconds the flask took to fill at a given temperature. If a fluid, when heated to a temperature of 75°F, took 115 seconds to fill the flask, it's viscosity was 115 SUS @ 75°F. If the same fluid was heated to 100°F and took 90 seconds to fill the flask, it's viscosity would be 90 SUS @ 100°F.

Viscosity Index

Viscosity index (VI) is a measure of a fluid's change in thickness with respect to changes in temperature. If a fluid's consistency remains relatively the same over varying temperatures, the fluid has a high VI. If a fluid becomes thick at low temperatures and very thin at high temperatures,the fluid has a low VI. In most hydraulic systems, fluids with a high VI is desirable over fluids with a low VI.

Petroleum Oil

All petroleum oil becomes thin as the temperature goes up and thickens as the temperature goes down. If the viscosity is too low, there may be excessive leakage past seals and from joints. If the viscosity is too high, sluggish operation may be the results and extra power is needed to push the oil through the system. Viscosity of petroleum oil is expressed by the Society of Automotive Engineers (SAE) numbers: 5W, 10W, 20W, 30W, 40W, etc. The lower the number, the better the oil will flow at low temperatures. The higher the number, the more viscous the oil and the more suited to high temperatures.

Synthetic Oils

Synthetic oils are formed by processes which chemically react materials of a specific composition to produce a compound with planned and predictable properties. Synthetic oils are specifically blended for extreme service at both high and low temperatures.

Fire Resistant Fluids

There are three basic types of fire resistant fluids: water-glycols, water-oil emulsions and synthetics.

Water-glycol fluids contains 35% to 50% water (water inhibits burning), glycol (synthetic chemical similar to some anti-freeze) and a water thickener. Additives are added to improve lubrication and to prevent rust, corrosion and foaming. Water-glycol fluids are heavier than oil and may cause pump cavitation at high speeds. These fluids may react with certain metals and seals and cannot be used with some types of paints.

Water-oil emulsion are the least expensive of the fire resistant fluids. A similar amount (40%) of water is used as in water-glycol fluids to inhibit burning. Water-oil can be used in typical hydraulic oil systems. Additive may be added to prevent rust and foaming.

Certain conditions may require that synthetic fluids be used to meet specific requirements. The fire resistive synthetic fluids are less flammable than oil and more suitable for used in areas of high pressure and high temperature.

Many times fire resistant fluids react to polyurethane seals and may require that special seals be used.

Oil Life

The hydraulic oil never wears out. The use of filters to remove solid particles and some chemicals add to the useful life of the oil. However, eventually the oil will become so contaminated that it will have to be replaced. In construction machines, the oil is replaced at regular time intervals.

The contaminates in the oil may also be used as indicators of high wear and prospective problem areas. One such program that uses oil contaminates as its source of information is the Caterpillar Schedule Oil Sampling Program (S•O•S).

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LAB 3.2.1: VISCOSITY AND TEMPERATURE OF FLUIDS

Name ________________________

Purpose

To measure the viscosity and the temperature of selected fluids.

Materials needed

1. Tap water (16 oz.)
2. 2 Empty 1 qt. containers
3. Viscosimeter
4. Hydraulic oil (16 oz.)
5. Stop watch

Procedure

1. Place a finger firmly over the outside of the orifice (hole) in the bottom of the viscosimeter.
2. Fill the viscosimeter (to the top) with hydraulic oil.
3. Use the stop watch to time the draining of the viscosimeter.
4. Hold the oil filled viscosimeter over an empty container. Start the stop watch at the same time the finger is removed from the viscosimeter drain. Stop the watch when draining is complete. (When the stream of oil stop flowing.)
5. Record the number of seconds on the oil and water chart below.
6. Use a clean shop towel and wipe out the viscosimeter.
7. Place a finger firmly over the outside of the orifice (hole) in the bottom of the viscosimeter.
8. Fill the viscosimeter (to the top) with water.
9. Use the stop watch to time the draining of the viscosimeter.
10. Hold the water filled viscosimeter over an empty container. Start the stop watch at the same time the finger is removed from the viscosimeter drain. Stop the watch when draining is complete. (When the stream of water stop flowing.)
11. Record the number of seconds on the oil and water chart.

    A. Compare the two times. Explain the shortest.

SUBSTANCE	TIME (SECS.)
OIL	
WATER	

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Name ________________________

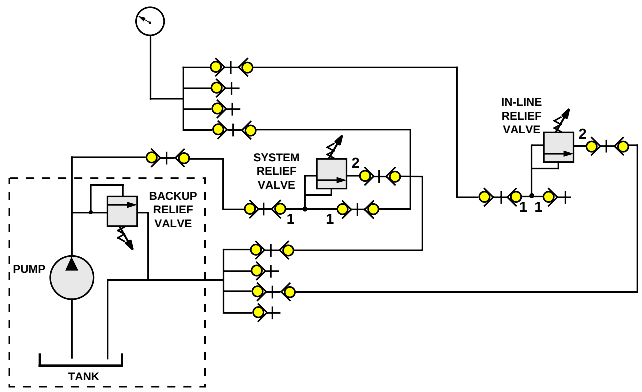

Fig. 3.2.2 Circuit

LAB 3.2.2: TEMPERATURE OF FLUID UNDER PRESSURE

Purpose

To measure the temperature of a fluid under pressure.

Materials needed

1. Thermometer
2. Basic Hydraulic Training Unit

Procedure

1. Build the circuit shown in Fig. 3.2.2.

2. Turn the in-line relief valve adjustment fully clockwise.

3. Using the thermometer, touch the ball on the bottom of the thermometer to the fluid reservoir for 1 minute.

4. Read the thermometer and record the temperature on the chart below. (Answers will vary according to prior system use.)

5. Touch the ball on the bottom of the thermometer to the front of the in-line relief valve for 1 minute.

6. Read the thermometer and record the temperature on the chart below. (Answers will vary according to prior system use.)

7. Turn ON the training unit and adjust the system relief valve pressure to 850 psi.

8. Turn the in-line relief valve adjustment counter-clock wise until it stops.

Name ________________________

LAB 3.2.2: TEMPERATURE OF FLUID UNDER PRESSURE (CONTINUED)

9. Turning the in-line relief valve adjustment clockwise until the pressure gauge reads 600 PSI.
10. Let the system run for 5 minutes at this setting.
11. Again, touch the ball on the bottom of the thermometer to the fluid reservoir for 1 minute.
12. Read the thermometer and record the temperature on the chart below.
13. Touch the ball on the bottom of the thermometer to the front of the in-line relief valve for 1 minute.
14. Read the thermometer and record the temperature on the chart below.

	BEFORE START-UP	AFTER 5 MINUTES
RESERVOIR		
IN-LINE RELIEF VALVE		

A. Is the temperature at the reservoir the same?

Yes _______ No _______

B. Why?

____

____

C. What is the cause of the higher temperature at the in-line relief valve?

____

D. If the in-line relief valve pressure is increased to more than 600 psi, what most likely would happen to the system oil temperature?

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14. Take any additional temperature readings you may wish. Then turn OFF the training unit and remove all lines.

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