

Purpose of hydraulic fluids engineering essay

[Engineering](#)



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Abstract:

The objective of this lab experiment is to highlight the importance of hydraulic fluids, its properties, types, and limitations. The reader is expected to understand these properties and its effect on health and the environment as well as the selection of proper type of fluid relevant to the application.

Introduction:-

Today hydraulic fluids are used everywhere around us whether we know it or not. It is used in our automobiles steering system, automatic transmission, and our recreational trailers. Also it used in planes, excavators, wheel loaders, delivery trucks, loading rams, forklifts, cranes, and the list is endless. Dealing with hydraulics as a designer, engineer, technician, or operator requires the basic understanding of hydraulic fluids properties, varieties, limitations, and most importantly its effect on people health and the environment around us. In order to understand hydraulic fluids it is important to know purpose of hydraulics fluids, types, physical characteristics, quality requirements, the types of hydraulics fluids, as well as the application and its limitations. The choice of suitable hydraulic fluids or lubricants is critical for the lifetime, operational safety and efficiency of hydrostatic components and gears

Purpose of Hydraulic Fluids:-

Power transmission. The main purpose of any hydraulic fluid is to transmit power mechanically throughout a hydraulic power system. The hydraulic power system consists mainly of fluid reservoir, pump, high pressure hoses or pipes, actuators, and control valves. Fluids generally are incompressible or

with very little compressibility, therefore; the fluid pressure is increased via hydraulic pump and transmitted to actuators that perform the required work. Lubrication. In addition to the power transmission the hydraulic fluids work as lubricators to the hydraulic system to protect all hydraulic system components against friction and wear, rust, oxidation, and corrosion. It also lubricate the O-ring seals in hydraulic cylinders to extent its life in service. Sealing. Hydraulic system components such as control valves operate with tight clearances where seals are not provided. In these applications hydraulic fluids act as sealant between the low pressure and high-pressure side of valve ports. The amount of leakage depends on the tolerances between adjacent surfaces and the fluid viscosity. Cooling. The hydraulic system particularly the pump whether run by PTO or electric motor produces excessive heat due to friction or from the operating median. The hydraulic fluid acts as a cooling medium to the moving components reducing heat and increase the system efficiency.

Physical Characteristics (Properties):-

Viscosity A hydraulic fluid has a low viscosity when it is thin and a high viscosity when it is thick. The viscosity changes with the temperature. • If the temperature increases, viscosity is reduced. • If the temperature decreases, viscosity is increased. Hydraulic units work under extreme temperature changes, especially in heavy duty vehicles. The viscosity range of the hydraulic fluid is extremely important. The hydraulic fluid must be thin enough to flow through the filter, inlet and return pipes without too much resistance. On the other hand, the hydraulic fluid must not be too thin, in order to avoid wear due to lack of lubrication and to keep internal leakage

within limits. Viscosity index (VI) The viscosity index is a calculated number, according to which describes the viscosity change of a mineral oil based or a synthetic fluid versus temperature. A high viscosity index means a small viscosity change when the temperature changes. A low index means a large viscosity change when the temperature changes Viscosity. Most hydraulic fluids have a VI value of 90 - 110. Hydraulic fluids with a VI larger than 110, e. g. between 130 -200, are not as sensitive to temperature change. These hydraulic fluids distinguish themselves by starting up well and having minimal loss in performance at low temperatures. At high temperatures a sufficient sealing effect and protection against wear is achieved by using hydraulic fluids with high viscosity index. The high durability of a hydraulic fluid with a high viscosity index avoids damage and machine breakdown, lowers the operating cost and increases the life of hydrostatic transmissions and units. Shear stability Fluids using polymer viscosity index improver may noticeably shear down (> 20 %) in service. This will lower the viscosity at higher temperatures below the originally specified value. The lowest expected viscosity must be used when selecting fluids. Pour point. The pour point according to defines the temperature when the fluids stops to flow. Startup temperature is recommended to be approximately 15 °C [59 °F] above hydraulic fluid pour point. Density The density has to be specified by the manufacturer of the hydraulic fluid. Using hydraulic fluid with a high density requires the sufficient diameter of the suction line and/or elevated tank to provide positive inlet pressure. Sealing compatibility. In general NBR (Nitrile) or FPM (Fluorocarbon, Viton) is used as seal material for static and dynamic seals. For most hydraulic fluids both seal materials are suitable, but for some hydraulic fluids only one kind is preferred. Air in the hydraulic fluid.

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Free air is considered as contamination as well. Air typically enters the circuit through the suction line if the seals and fittings are not tight. This free air then may be dissolved in the hydraulic fluid. Mineral based hydraulic fluid may contain up to 9 % volume percent dissolved air at atmospheric pressure. This is not a problem unless the pressure drops down quickly to a lower level. Then the air becomes free again and bubbles show up. These bubbles collapse when subjected to pressure, which results in cavitation which causes erosion of the adjacent material. Because of this, the greater the air content within the oil, and the greater the vacuum in the inlet line, the more severe will be the resultant erosion. The bubbles may also result in a spongy system, slow response time, and poor controllability. Therefore care must be taken to avoid air to enter the system. If air has entered a system the air release time and foam characteristic becomes important. Air release Air release is a measure for the time needed to release air bubbles (free air) contained in the fluid to the surfaces. Air typically enters the circuit through the suction line if the seals are not tight as explained above. Foaming characteristic Foaming characteristic defines the amount of foam collected on the surface in the reservoir and the air bubble decomposition time. Foaming may become a problem when air has entered the circuit as explained above, through an insufficient tight suction line. Bulk modulus/Compressibility. While fluids are usually considered incompressible, the pressures that can occur in hydrostatic systems are of a magnitude that fluid compressibility can be significant. In applications that experience system pressure fluctuations resulting in random high pressure rise rates, consideration must be given to fluid compressibility when sizing a charge pump to ensure adequate charge pressure. The amount that a specific fluid

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compresses for a given pressure increase is related to a fluid property known as the bulk modulus. The bulk modulus is a measure of a fluid's resistance to being compressed. It depends on pressure and temperature. The air content is important as well especially below 50-100 bar [725-1450 psi]. The higher the air content the spongier the system (lower bulk modulus). For a given pressure increase and fluid volume, a fluid with a large bulk modulus will experience a smaller reduction in volume than a fluid with a low bulk modulus. Flash point and fire point. The flash point is the lowest temperature, to which a fluid must be heated before it vaporizes, when mixed with air, will ignite but not continue to burn. The fire point is the temperature at which lubricant combustion will be sustained. The flash and fire points are useful in determining a lubricant's volatility and fire resistance. The flash point can be used to determine the transportation and storage temperature requirements for Hydraulic Fluids.

Types of Hydraulic Fluids

Petroleum. Petroleum-based oils are the most commonly used stock for hydraulic applications where there is no danger of fire, no possibility of leakage that may cause contamination of other products, no wide temperature fluctuations, and no environmental impact. Fire resistant. In applications where fire hazards or environmental pollution are a concern, water based or aqueous fluids offer distinct advantages. The fluids consist of water-glycols and water-in-oil fluids with certain chemical additions is used. Furthermore, vane pumps should not be used with water-based fluid unless they are specifically designed to use such fluids. Water-glycol. Water-glycol fluids contain from 35 to 60 percent water to provide the fire resistance, plus

glycol antifreeze such as ethylene, or propylene which is nontoxic and biodegradable, and a thickener such as polyglycol to provide the required viscosity. These fluids also provide all the important additives such as anti-wear, foam, rust, and corrosion inhibitors. Operating temperatures for water-glycol fluids should be maintained below 49 C (120 F) to prevent evaporation and deterioration of the fluid. Viscosity, pH, and water hardness monitoring are very important in water-glycol systems. If water is lost to evaporation, the fluid viscosity, friction, and operating temperature of the fluid will increase. The end result is sluggish operation of the hydraulic system and increased power consumption. If fluid viscosity is permitted to drop due to excessive water, internal leakage at actuators will increase and cause sluggish operation. Water-oil emulsions. Oil-in-water. These fluids consist of very small oil droplets dispersed in a continuous water phase. These fluids have low viscosities, excellent fire-resistance, and good cooling capability due to the large proportion of water. Additives must be used to improve their inherently poor lubricity and to protect against rust. Water-in-oil. The water content of water-in-oil fluids may be approximately 40 percent. These fluids consist of very small water droplets dispersed in a continuous oil phase. The oil phase provides good to excellent lubricity while the water content provides the desired level of fire-resistance and enhances the fluid cooling capability.

Hydraulic Oils Produced by Sauer Danfoss

Hydraulic Oil ISO 11 158 - HM (Seal compatibility and vane pump wear resistance per DIN 51 524-2 must be met)•Hydraulic Oil ISO 11 158 - HV(Seal compatibility and vane pump wear resistance per DIN 51 524-3 must be

met)•Hydraulic Oil DIN 51 524-2 - HLP• Hydraulic Oil DIN 51 524-3 - HVLP•Automatic Transmission Fluid ATF A Suffix A (GM)•Automatic Transmission Fluid Dexron II (GM), which meets Allison C-3 and Caterpillar TO-2 test•Automatic Transmission Fluid M2C33F and G (Ford)•Engine oils API Classification SL, SJ (for gasoline engines) and CI-4, CH-4, CG-4, CF-4 and CF (for diesel engines)•Super Tractor Oil Universal (STOU) special agricultural tractor fluid Contact Sauer-Danfoss and/or follow further mentioned information before using. Premium Turbine Oils•Automatic Transmission Fluid Dexron III (GM)•Universal Tractor Fluids•Biodegradable hydraulic fluids HETG, HEPG, HEES, and HEPR per VDMA 24 568 and ISO 15 380 meeting Annex B of ISO 15 380 – DIN 51 350-6 TaperRoller Bearing Shear Stability test for fluids containing polymers (ISO 20 844Diesel Injector Nozzle Shear Stability test only for medium duty applications) – VDMA 24 570 Yellow Metal Compatibility test•Fire resistant fluids HFA, HFB, HFC, and HFD are suitable at modified operating parameters, but not with Gear Pumps and Motors.

Fire resistant fluids HFA, HFB, HFC, and HFD are suitable at modified operating parameters, but not with Gear Pumps and Motors.

Hydrostatic products, except gear pumps and gear motors, may be used with fire resistant fluids under modified operating parameters as listed below.

Operating parameters for fire resistant hydraulic fluidsTyp of fluid

HFA**HFB****HFC****HFD**

Standard ISO 12 922, DIN 24 320 ISO 12 922, VDMA 24 317
 Features Oil in water emulsion
 Water in Oil emulsion Watery polymer solution
 Water free synthetic fluids
 Operating temperature * 5 – 55 °C [40 – 130 °F] 5 – 60 °C [40 – 140 °F] 20 – 60 °C [4 – 140 °F] 10 – 70 °C [50 – 160 °F]
 Water content * > 80% > 40% > 35%

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Typical roller bearing life (mineral based fluid is 100 %) < 5% 30 – 35% 10 – 20% 50 – 100% * The temperature range and the water content are based on the specific fluid properties.

HFA fluids – oil-in-water emulsions according to DIN 24 320 and ISO 12 922.

There can be bacterial control problems and corrosion problems. Fluid pH stability can be a problem and can cause wear and chemical reaction with aluminum. Also, there may be a solvent action on some paints. A positive head reservoir is required to maintain a positive inlet pressure when operating, and to keep air out of internal passageways when shut down. HFB fluids – water-in-oil emulsions according to VDMA 24 317 and ISO 12 922. These fluids can break down with repeated freezing and thawing. Also, heating above 60 °C [140 °F] can cause emulsion breakdown. High specific gravity requires an elevated reservoir and increased inlet line size.

Monitoring of fluid water content is necessary. Frequent additions may be necessary in order to overcome evaporation losses. These fluids also show poor vapor phase corrosion inhibition.

HFC fluids – watery polymer solutions or water glycols according to VDMA 24 317 and ISO 12 922.

They attack zinc and cadmium, and produces solvent action on some paints. For more information contact the fluid manufacturer. Wear of aluminum in transmission parts sometimes occurs in the presence of these fluids. Viton seals are not recommended. High specific gravity requires an elevated reservoir and increased inlet line size. Water content and pH-number may be a problem.

HFD fluids – water free, synthetic fluids according to VDMA 24 317 and ISO 12 922.

Viton seals are required. Consult the fluid manufacturer to obtain a recommendation of the particular fluid used. These fluids attack some plastics, zinc and cadmium. High specific gravity requires an elevated reservoir and increased inlet line size. Some of these fluids have caused high wear of aluminum parts in transmissions.

Automatic Transmission Fluid ATF A Suffix A (GM)•

See Appendix A

Conclusion:-

The hydraulic fluid topic is broad and complex, therefore it is recommended that the technician and operator always refer to manufacturer recommended

hydraulic oil to extend his equipment life in service and avoid unexpected breakdowns and hefty repair bills.