Oil Hydraulics and Pneumatics
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Part 2: Main Classification of Hydraulic Fluids- Mineral oils, Fire resistant oils, Synthetic oils, biodegradable oils, Factors influencing the selection of a hydraulic fuilds
Lecture - 62
Subsystems: Hydraulic Fluids, Conduits and Simple Numericals

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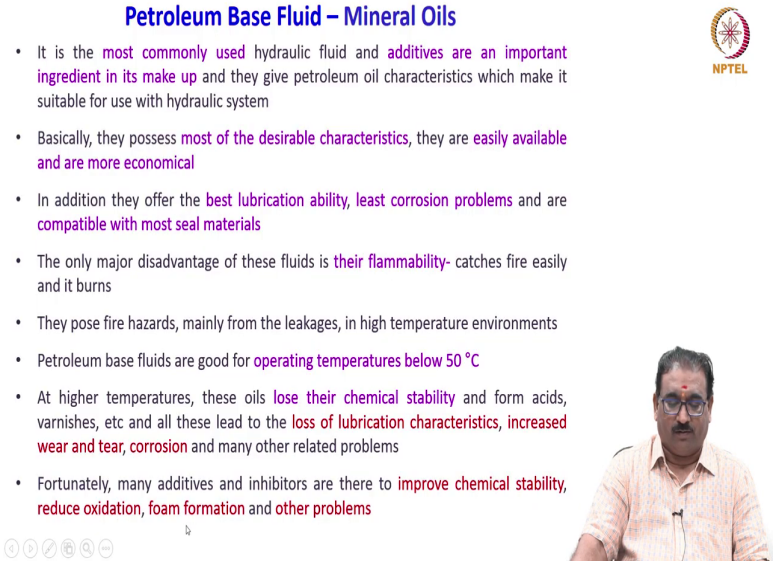

My name is Somashekhar, course faculty for this course. Now, we will move on to the petroleum base fluid mineral oils. It is the most commonly used hydraulic fluid and additives are an important ingredients in it in its makeup. And, they give petroleum oil characteristics which make it suitable for use with the hydraulic system. Basically, they possess most of the desirable characteristics; they are easily available and are more economical.

In addition they offer the best lubrication ability least corrosion problems and are compatible with most seal materials. The only major disadvantages of these fluids is their flammability, meaning it catches the fire easily and it burns out. They pose the fire hazards, mainly from the leakages, in high temperature environments. Petroleum base fluids are good for operating temperature below 50 degrees centigrade.

At higher temperatures, this oil lose their chemical stability and form acids, varnishes, etcetera and all these lead to the loss of lubrication characteristics, increased wear and tear corrosion and many other related problems. Fortunately, the many additives and inhibitors are there to improve the chemical stability, reduction, chemical stability reduce oxidation, foam formation and other problems.

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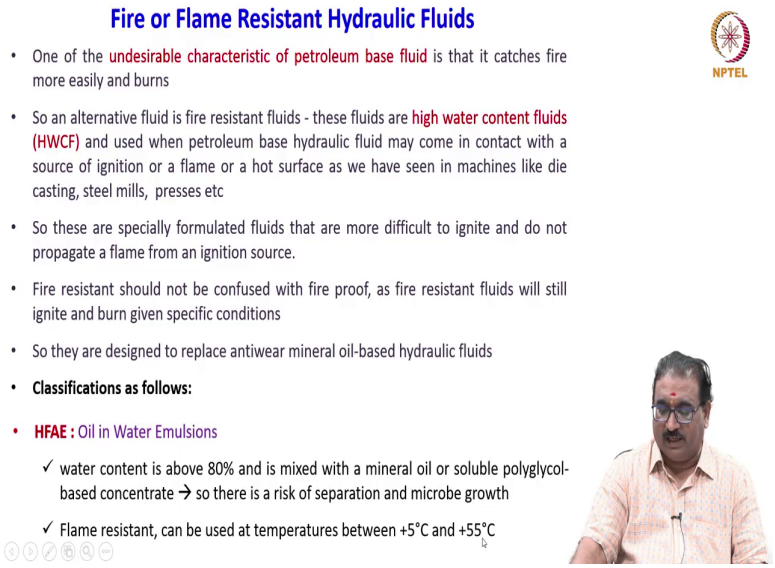

Now, quickly we will see the fire or a flame resistant hydraulic fluids. One of the undesirable characteristics of the petroleum base fluid is that it catches fire more easily and burns. So, an alternative fluid is a fire resistant fluids, these fluids are High Water Content Fluids HWCF.

And used when petroleum base hydraulic fluid may come in contact with a source of ignition, or a flame, or hot surface as we have seen in machines like die casting, steel mills and a presses.

So, these are specially formulated fluids that are more difficult to ignite and do not propagate a flame from an ignition source. Fire resistant should not be confused with fire proof, as fire resistant fluids will still ignite and burn given specific conditions. So, they are designed to replace anti wear mineral oil based hydraulic fluids.

Classification is as follows: HFAE meaning oil in water emulsions, water content is above 80 percent and is mixed with mineral oil or a soluble polyglycol based concentrate. So, there is a risk of separation and a microbe growth. Flame resistant can be used at temperatures between plus 5 degree centigrade to plus 55 degree centigrade.

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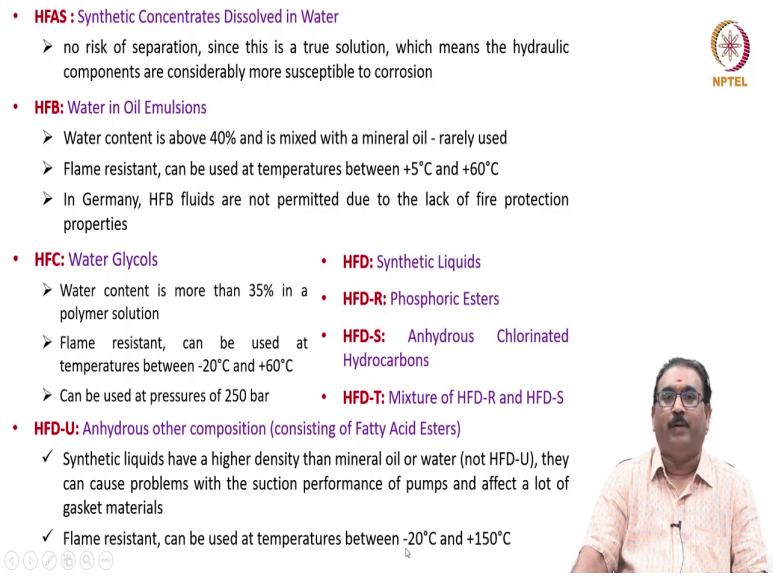

HFAS synthetic concentrates dissolved in water, no risk of separation. Since this is a true solution, which means the hydraulic components are considerably more susceptible to corrosion. HFB the water in oil emulsions; water content is above 40 percent is mixed with a mineral oil rarely used this is. Flame resistant can be used at a temperature between plus 5 degrees centigrade to plus 60 degree centigrade. In Germany HFB fluids are not permitted due to the lack of fire protection properties.

HFC water glycols water content is more than 35 percent in a polymer solution. Flame resistant can be used at a temperature between minus 20 degree centigrade to plus 60 degree centigrade can be used at a pressure of 250 bar. HFD synthetic liquids. HFD-R meaning, phosphoric esters, HFD-S anhydrous chlorinated hydrocarbons, HFD-T mixture of HFD-R and HFD-S, HFD-U the anhydrous other composition consisting of fatty acid esters.

Synthetic liquids have a higher density than a mineral oil or water not HFD-U they can cause a problems with the suction performance of pumps and affects a lot of gasket materials. Flame resistant can be used at a temperatures between minus 20 to plus 150 degree centigrades.

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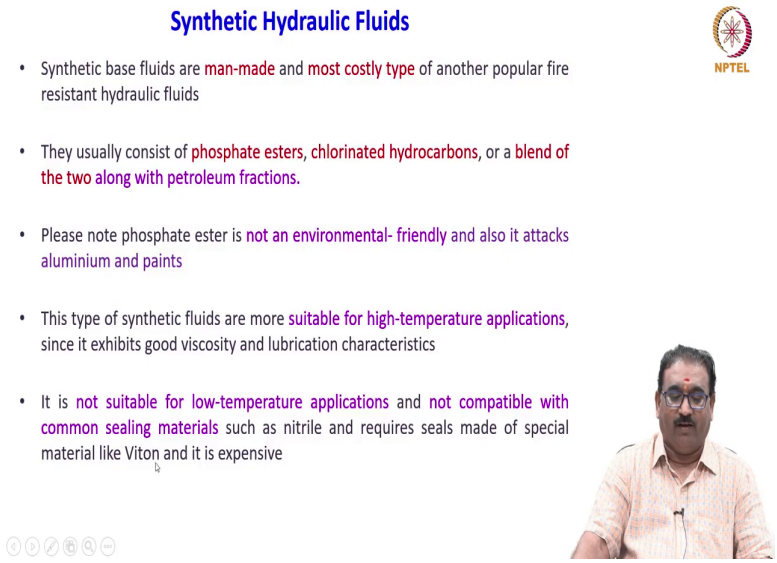

Quickly we will see some of the synthetic fluids. Synthetic base fluids are manmade and most costly type of another popular fire resistant hydraulic fluids. They usually consists of phosphate esters, chlorinated hydrocarbons, or a blend of the two along with the petroleum fractions.

Please note phosphate ester is not an environmental friendly and also it attacks aluminum and paints. This type of synthetic fluids are more suitable for high temperature applications, since it exhibits good viscosity and lubrication characteristics. It is not suitable for low temperature

applications and not compatible with common sealing materials such as a nitrile and requires a seal made of spatial materials like a Viton which is an expansive material.

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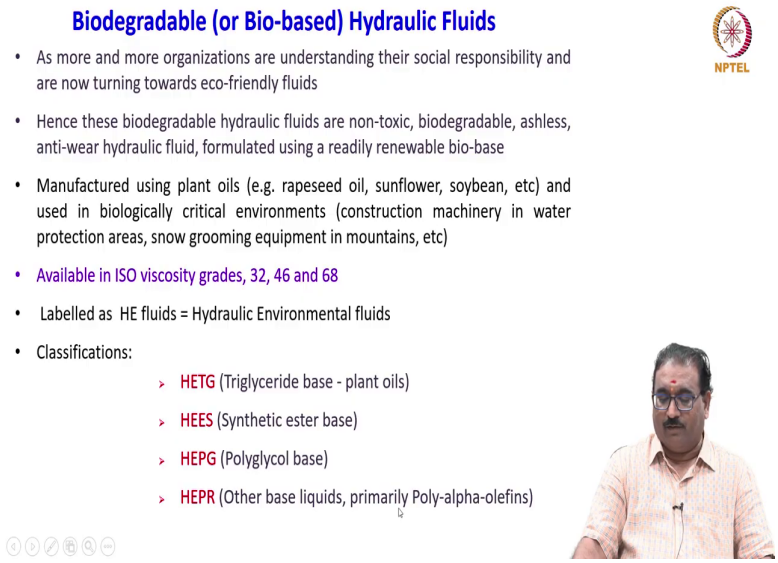

Now, we will see the biodegradable or a bio based hydraulic fluids. As more and more organizations are understanding their social responsibility and are now turning towards eco friendly fluids, in their hydraulic machines. Hence these biodegradable hydraulic fluids are non toxic, biodegradable ashless, antiwear hydraulic fluid formulated using a readily renewable bio base.

Manufactured using a plant oils rapeseed oil, sunflower, soybean and many more and used in biologically critical environments like a constructional machinery, in water protection area, snow grooming equipment in mountains etcetera.

Available in ISO viscosity grades 32, 46 and 68 labeled as HE fluids meaning, Hydraulic Environmental fluids. Classification here, HETG meaning triglyceride base plant oils, HEES synthetic ester base, HEPG polyglycol base, HEPR other base liquids primarily poly alpha olefins.

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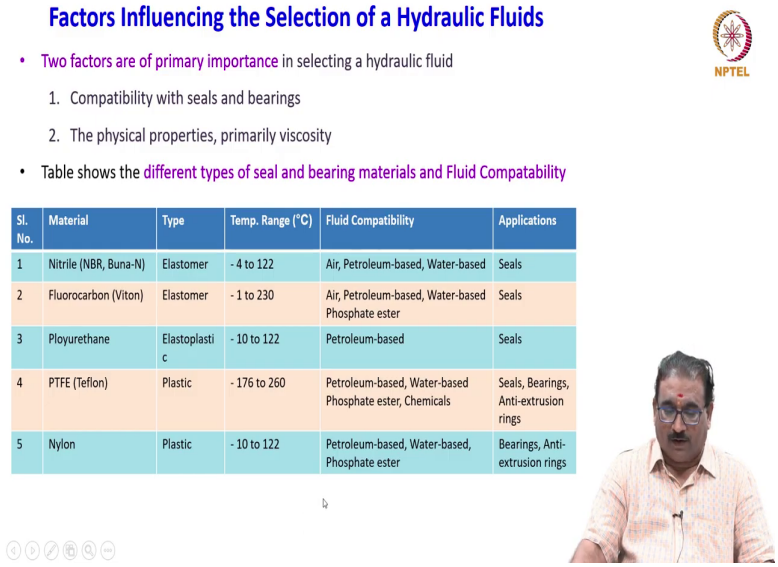

Now, we will see some factors influencing the selection of hydraulic fluids. Two factors are of primary importance in selecting a hydraulic fluids; first one is compatibility with seal and bearings very important it is. The physical properties primarily the viscosity. These are the two primary important property, while selecting the hydraulic fluids. There are many are there I list you all in the next slide but, you will see the seal and seal materials are playing a major role.

Table shows that different types of seal and bearing materials and a fluid compatibility. You will see here, I am showing the table here there are different material and a type, temperature range, fluid compatibility, because different types of fluids are there as we have seen air petroleum based, water based phosphor, phosphate ester many are there correct and application also I have told you seals and bearing material.

You will see here first material nitrile here, elastomer it is temperature range is minus 4 to 122 degrees centigrade here, air or petroleum based or a water based there for the seals. Similarly, we will see your there are the fluorocarbon Viton elastomer it is minus 1 to 230 air petroleum based water based.

Then, phosphate ester seals like this we will see many are there for example, nylon material type is plastic minus 10 to 122 petroleum based water based and phosphate ester. Here for the application for the bearings anti extrusion rings. This table will show you the different types of seal and bearing materials, affects the selection of the fluid compatibility and temperature range.

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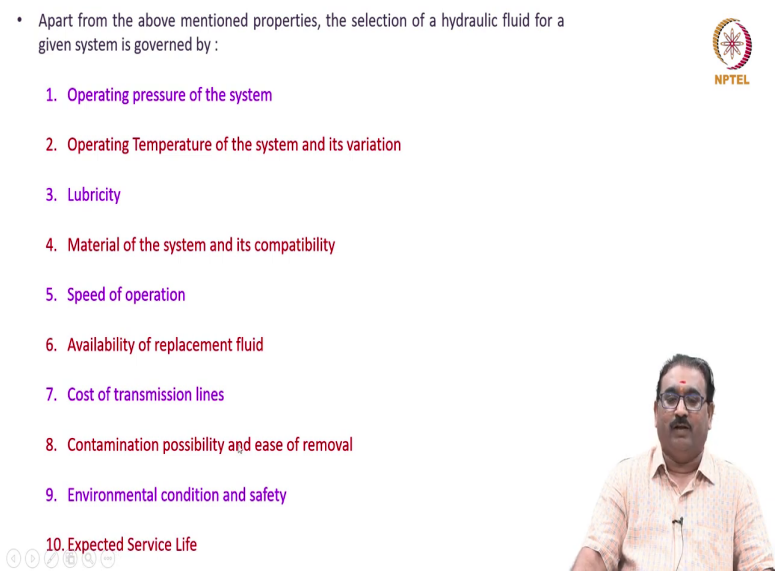

Apart from the above mentioned two properties, the selection of hydraulic fluids for a given system is governed by operating pressure of the system, operating temperature of the system, and its variation, lubricity, material of the system and its compatibility.

Speed of operation, availability of replacement fluids, cost of transmission lines, contamination possibility and ease of removal during the maintenance work. Environmental condition and safety issues, expected service life, these are also very important while selecting the hydraulic fluids for various applications.

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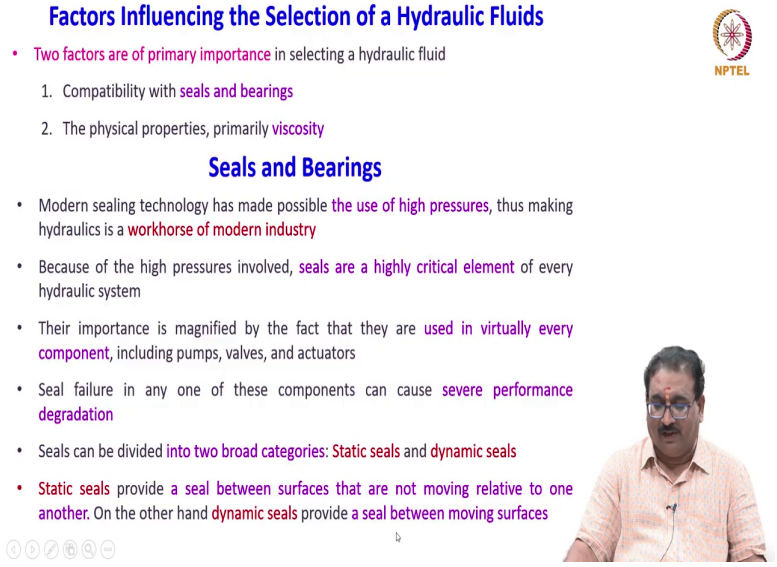

Now, let us we will see factors influencing the selection of a hydraulic fluids. Two factors are of primary importance in selecting a hydraulic fluids along with many parameters are there we will see now. First parameter is compatibility with seals and bearings. Second one is the physical properties primarily viscosity. Let us we will see now seals and bearings.

Modern sealing technology has made possible the use of high pressures thus making hydraulics is a workhorse of modern industry. Because of the high pressures involved seals are a highly critical element of every hydraulic system. Their importance is magnified by the fact that they are used in virtually every component including pumps, valves and actuators.

Seal failure in any one of these components can case a severe performance degradation. Seals can be divided into two broad categories; one is static seals and another one is a dynamic

seals. Static seals provide a seal between surfaces that are not moving relative to one another. On the other hand dynamic seals provide a seal between the moving surfaces.

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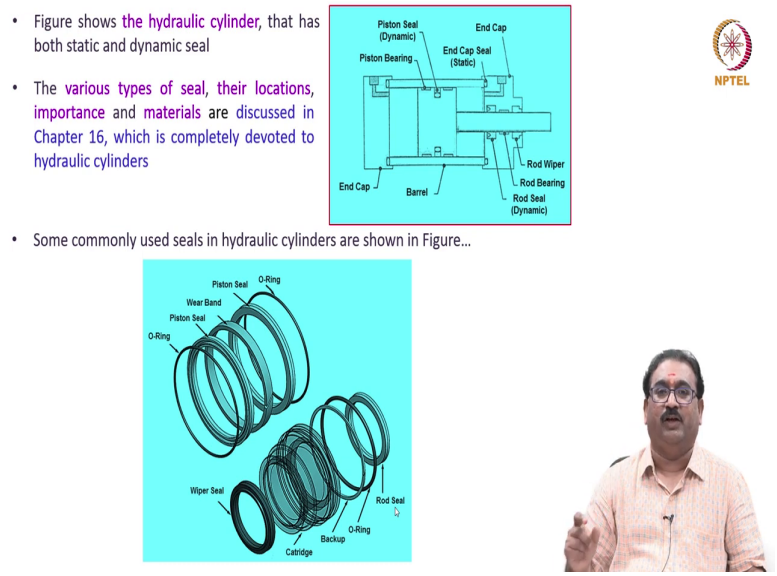

Here figure shows the hydraulic cylinder that has both, static and dynamic seals just you will see here a double acting cylinder, it is a barrel the end caps are there then you will see here the piston. The piston seals are there dynamic which are moving and piston bearings are here very important which will affect the through the oil properties, the barrel, then a end cap seals are there here.

Again they are the static and here you will see the rod seals are their dynamic seals, then rod wiper are there; there are many seals there. The various types of seal and their locations, importance and materials are discussed in chapter 16, which is completely devoted to hydraulic cylinders.

Please recap the chapter 16 for more information on the seals. Some commonly used seals in a hydraulic cylinders, as I have told you O-ring seals piston seal, then wear band piston seal O-ring wiper seal cartridge, backup, rod seals and many more friends. These are used to reduce a leakage, wherever the moving parts are there, wherever the clearance are there, the seals are very much essential to reduce a pressure drop along with the leakage.

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- Seals and bearings are made of different materials that fall into three distinct categories: elastomers, plastics, and elasto-plastics
  - Elastomers are also called synthetic rubber because they have the characteristic-elasticity (springiness) that one would expect from a rubber-like material
    - Natural rubber is never used in hydraulics because it is not compatible with the fluid used
  - Plastics are materials that are hard at room temperature, but can be moulded easily or formed when heated sufficiently
  - Elasto-plastics are softer than plastics, but harder and stronger than elastomers
- Table shows the different types of seal and bearing materials and fluid compatibility

Material	Type	Temp. Range (°C)	Fluid Compatibility	Applications
Nitrile (NBR, Buna-N)	Elastomer	- 4.00 to 122	Air, Petroleum-based, Water-based	Seals
Fluoro-carbon (Viton)	Elastomer	- 1.00 to 230	Air, Petroleum-based, Water-based, Phosphate ester	Seals
Polyu-rethane	Elasto-plastic	- 10.0 to 122	Petroleum-based	Seals
PTFE (Teflon)	Plastic	- 176 to 260	Petroleum-based, Water-based Phosphate ester, Chemicals	Seals, Bearings, Anti-extrusion rings
Nylon	Plastic	- 10.0 to 122	Petroleum-based, Water-based, Phosphate ester	Bearings, Anti-extrusion rings

Seals and bearings are made of different materials that fall into three distinct categories; elastomers, plastics and elasto plastics. Elastomers are also called a synthetic rubber, because they have the characteristics elasticity or springiness that one would expect from a rubber like material. Natural rubber is never used in hydraulics, because it is not compatible with the fluid used.

Plastics are materials that are harder at room temperature, but can be mounted easily or formed when heated sufficiently. Elasto plastics are softer than plastics, but harder and stronger than elastomers. Now, table shows the different types of seal and bearing materials and fluid compatibility that is why am telling, when we are selecting the fluid seals bearing material plays a major role in enhancing the performance of the hydraulic system.

Now, we will see the table shows here the material type, temperature range, fluid compatibility and applications for the seal and bearing material. You will see here, there are various materials are there nitrile, NBR and Buna-N the type is elastomer. The temperature range is minus 4 to 122 degree centigrade, here the fluid compatibility you may use air or petroleum based fluids or water based fluids this is for the seals.

Then, fluoro carbon; the fluoro carbon it is an elastomer the temperature range is minus 1 to 230 degrees centigrade here, you may use air petroleum based fluids, water based fluid, or a phosphate ester is also used again application is seal this material. Then polyu rethane, it is the elastomer minus 10 to 120 degree centigrade petroleum based fluids seals.

Then, PTFE a Teflon it is a plastic type it is minus 176 to 260 degree. Here petroleum, water based then phosphate ester and also chemicals; here it is used for seals bearings anti extrusion rings. Similarly, nylon again it is a plastic the temperature range is minus 10 to 122 degree centigrade petroleum based, water based phosphate ester, again it is used for bearings and anti extrusion rings.

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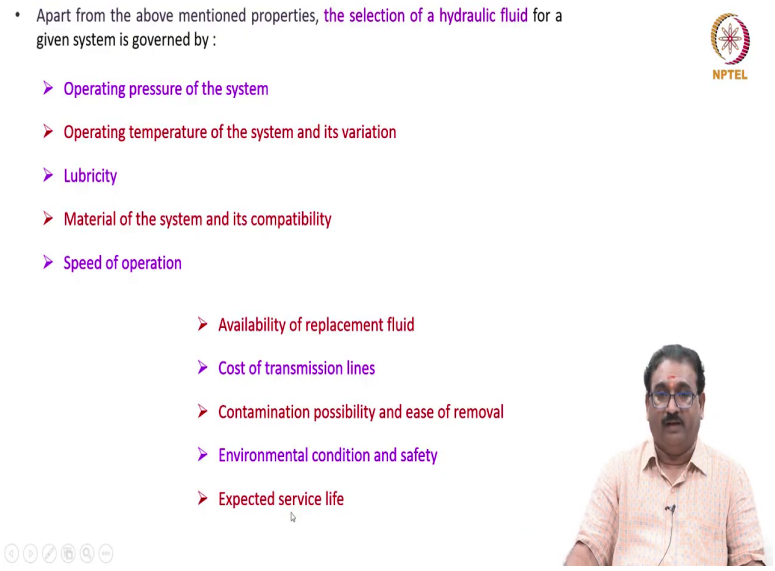

Apart from the above mentioned properties, the selection of the hydraulic fluids for a given system is governed by other parameter like a operating pressure of the system. Whether it is a low, medium or a high pressure applications, operating temperature of the system and its variation.

Lubricity material of the system and its compatibility, speed of operation availability of replacement of fluids, cost of transmission lines what we will call the distribution lines. Contamination possibility and ease of removal from the hydraulic fluids, environmental condition and safety, whether it is indoor or outdoor or a high temperature or a cold all you have to consider while selecting the hydraulic fluids; then expected service life.