Oil Hydraulics and Pneumatics
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Part 2: Significant sources of heat generation and its effects, Role of heat exchangers, Symbolic representations, Construction and operation of air cooler and water cooler
Lecture - 59
Subsystems: Hydraulic Reservoir, Coolers and Filters

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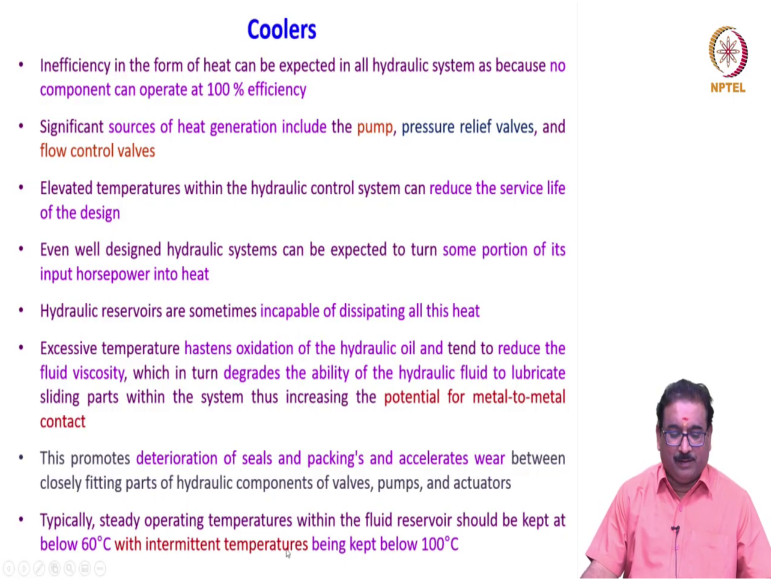

My name is Somashekhar, course faculty for this course. Now, we will see the Coolers. Inefficiency in the form of heat can be expected in all hydraulic system as because no component can operate 100 percent efficiency. Significant sources of heat generation include the pump, pressure relief valves, and the flow control valves. Elevated temperatures within the hydraulic system can reduce the service life of the design.

Even well designed hydraulic systems can be expected to turn some portion of its input horsepower into heat. Hydraulic reservoirs are sometimes incapable of dissipating all this heat. Excessive temperature hastens oxidation of the hydraulic oil and tend to reduce the fluid viscosity, which intern degrades the ability of the hydraulic fluid to lubricate the siding parts within the system.

Thus increasing the potential for metal-to-metal contact. This promotes the deterioration of seals and packing's and accelerates wear between the closely fitted parts of hydraulic components of valves, pumps, and actuators. Typically, steady operating temperatures within the fluid reservoir should be kept at below 60 degree centigrade with intermittent temperatures being kept below 100 degree centigrade.

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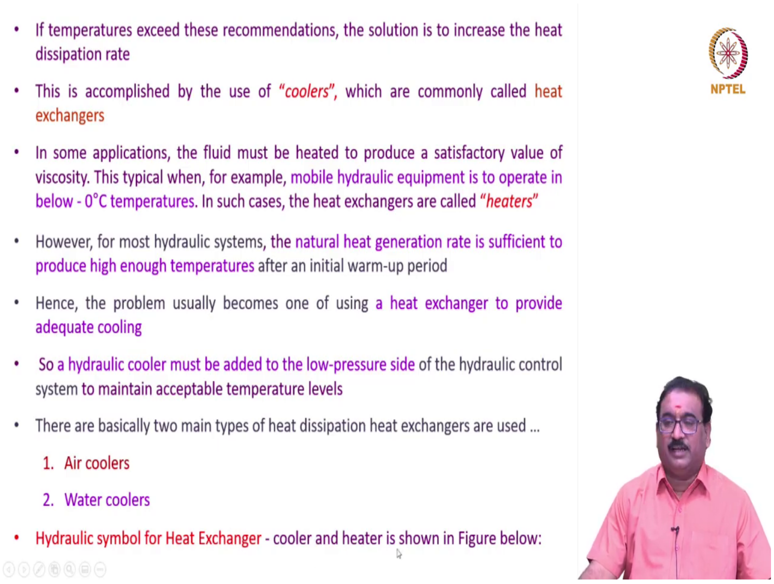

If temperature exceeds these recommendations, the solution is to increase the heat dissipation rate. This is accomplished by the use of coolers, which are commonly called heat exchangers. In some applications, the fluid must be heated to produce a satisfactory value of viscosity.

This typically when, for example, a mobile hydraulic equipment is to operate in below minus 0 degree centigrade temperatures. In such cases, the heat exchangers are called a heaters. However, for most hydraulic systems, the natural heat generation rate is sufficient to produce high enough temperature after an initial warm up period. Hence, the problem usually becomes one of using a heat exchanger to provide adequate cooling.

So, a hydraulic cooler must be added to the low-pressure side of the hydraulic control system to maintain acceptable temperature levels. There are basically two types of heat dissipation heat exchangers are used. One is air coolers; another one is a water coolers. Hydraulic symbol for heat exchangers which includes the cooler and heater is shown in the figure below.

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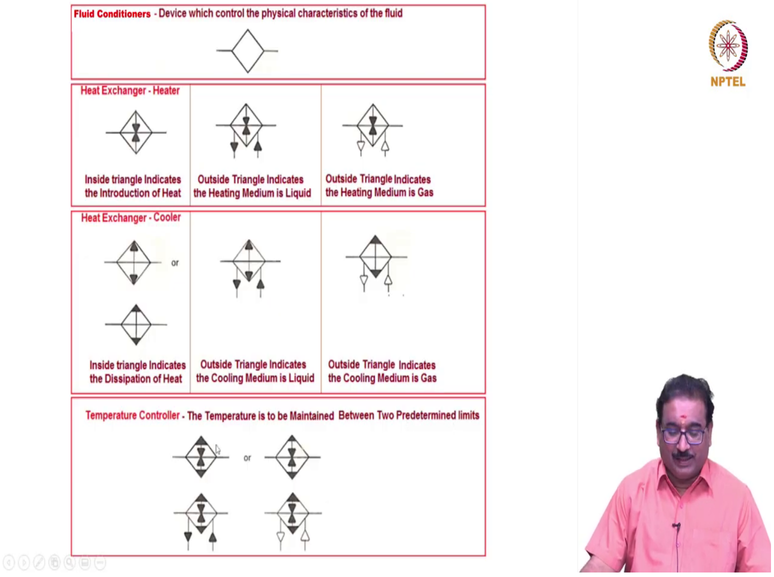

Fluid conditioner, device which controls the physical characteristics of the fluid. We will see here like this heat exchangers heater I am showing you now. Here you will see the inside triangle indicates the introduction of heat. You will see here the outside triangle indicates the heating medium is a liquid because filled triangle it is.

You will see here the outside triangle indicates the heating media is gas. Please see the heat exchanger symbol here. Please understand the triangle is inside. Then you will see the heat exchanger used as a cooler you will see the triangle direction is outside. You will see both are allowed. You will use like this or use like this. The inside triangle indicates the dissipation of heat.

Here you will see the outside triangle indicates the cooling medium is liquid because it is a filled. Here the outside triangle indicates the cooling medium is gas because it is not a filled air it is. Then temperature controller both we will see. The temperature is to be maintained between the two predetermined limits you will see how it is. This is a heater as well as the cooler how they are using.

Here the cooling medium is a cooling, and heating medium is a water. Here cooling and heating medium is a air. Please understand the hydraulic symbols.

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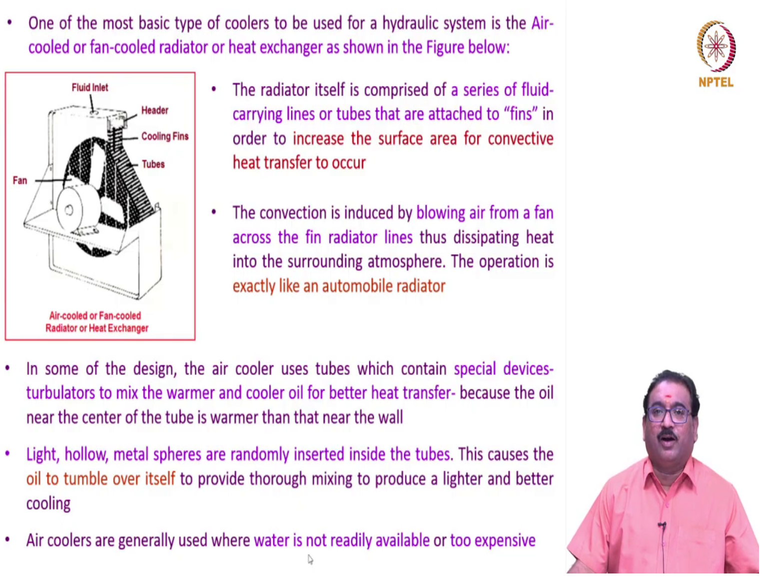

One of the most basic types of cooler to be used for a hydraulic system is the air cooler or a fan-cooled radiator or a heat exchanger is shown in the figure below. What are the things are there here friends? We will see the fluid inlet is there, then it is header it is full, the cooling fins are there, and a tubes are there, then here a fan. This is a air cooled or a fan cooled radiator or a heat exchanger.

The radiator itself is composed of a series of fluid carrying lines or a tubes that are attached to the fins in order to increase the surface area for the convective heat transfer to occur. The convection is induced by blowing air from if fan across the fin radiator lines thus dissipating a heat into the surrounding atmosphere. The operation is exactly an automobile radiator.

In some of the design, the air cooler tubes this air cooler uses the tubes which contains a special devices turbulators to mix the warmer and a cooler oil for better heat transfer - because the oil near the centre of the tube is warmer than near the wall. Light, hollow, metal spheres are randomly inserted inside the tube.

This causes the oil to tumble over itself to provide a thorough mixing, to produce a lighter and better cooling. Air coolers are generally used where water is not readily available or too expensive.

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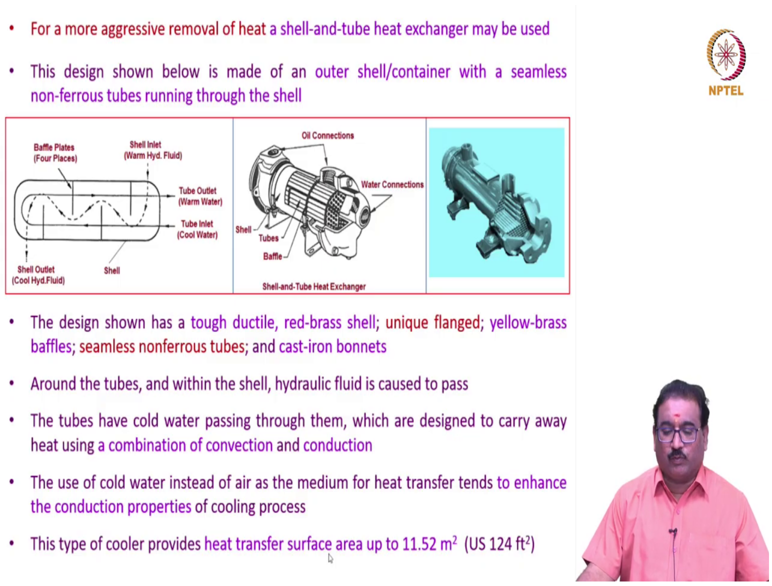

For a more aggressive removal of heat a shell-and-tube heat exchangers may be used. This design shown below is made of an outer shell or a container with a seamless non-ferrous tubes running through the shell. You will see here friends, this is whole outer body is a shell. Here the tubes you will see here in the three-dimensional view, tubes are there here.

Here oil connections, and here water connections. Here you will see here the tube inlet once will carries the cool water and comes out as a hot water. Here also you will see friends here the shell inlet is a warm hydraulic fluid will go, and it will move like this, and come out as a cool hydraulic fluid, it is a shell outlet. Then also you will see the baffle plate, four baffle plates how they are placed. This is a shell and tube heat exchanger.

The design shown has a tough ductile, red-brass shell; unique flanged; yellow brass baffles; seamless nonferrous tubes; and a cast iron bonnets. Around the tubes, and within the shell, hydraulic fluid is caused to pass. The tubes have cold water passing through them, which are designed to carry away the heat using a combination of convection and a conduction.

The use of cold water instead of air as the medium for heat transfer tends to enhance the conduction properties of cooling process. This type of cooler provides a heat transfer surface area up to 11.52 meter square.

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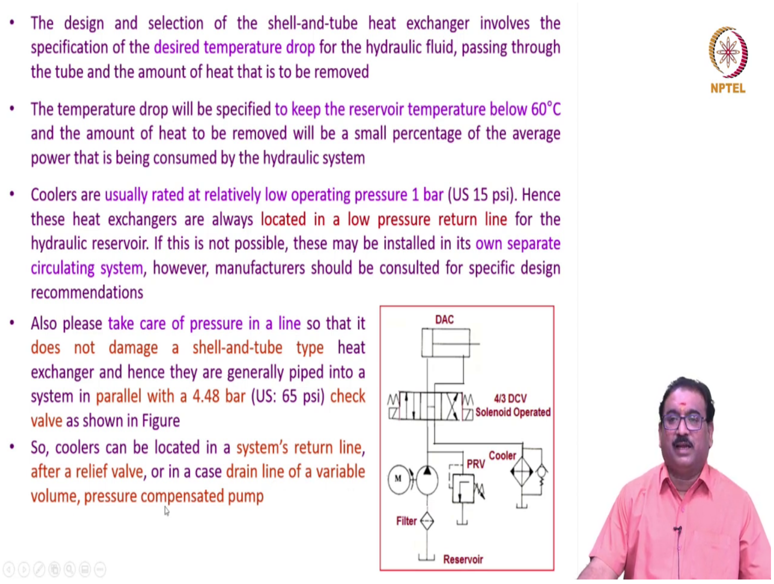

The design and selection of the shell-and-tube heat exchanger involves the specification of the desired temperature drop for the hydraulic fluid, passing through the tube and the amount of heat that is to be removed. The temperature drop will be specified to keep the reservoir temperature below 60 degree centigrade and the amount of heat to be removed will be a small percentage of the average power that is being consumed by the hydraulic system.

Coolers are usually rated at relatively low operating pressure 1 bar. Hence these heat exchangers are always located in the low pressure return line for the hydraulic reservoir. If this is not possible, these may be installed in its own separate circulating system, however, manufacturer should be consulted for a specific design recommendations.

Also please take care of pressure in line so that it does not damage a shell-and-tube type heat exchanger. And hence they are generally piped into a system in a parallel with a 4.48 bar check valves as shown the figure here. Here see double acting cylinder 4 by 3 solenoid valve. It is a pump here.

You will see here friends, it is a motor, filter ok, here PRV. And see here always coolers are placed in the return line, here along with the check valve with a 4.48 check valve it is a cooler. A coolers can be located in a system's return line, after a relief valve, or in a case drain line of a variable volume, pressure compensated pump.