Oil Hydraulics and Pneumatics
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Task Based Selection and Analysis of Oil Hydraulic Circuits
Lecture - 70
Part 1: Circuit diagram, System of classification of circuits, The energy transfer process, Fundamental law of hydraulic circuit, Technical details of individual components, General requirements for a hydraulic circuit design

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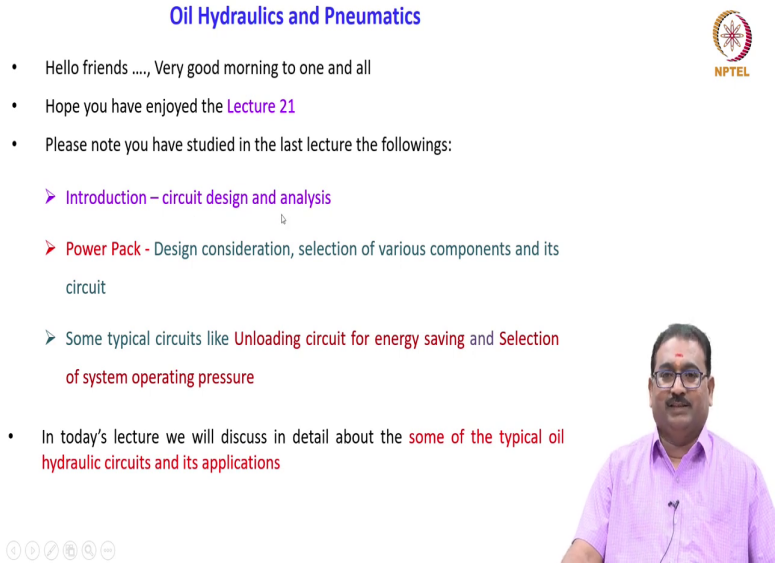

My name is Somashekar, course faculty for this course. Hello friends, very good morning to one and all, hope you have enjoyed lecture number 21. Please note, you have studied in the last lecture the following contents; introduction to circuit design and analysis, the power pack, design considerations, selection of various components and its circuit.

Also we have seen some typical circuits like unloading circuit for energy saving and selection of system operating pressure. In todays lecture, we will discuss in detail about some of the

typical oil hydraulic circuits and its application, continuing some of the design details required for circuit design and analysis, ok.

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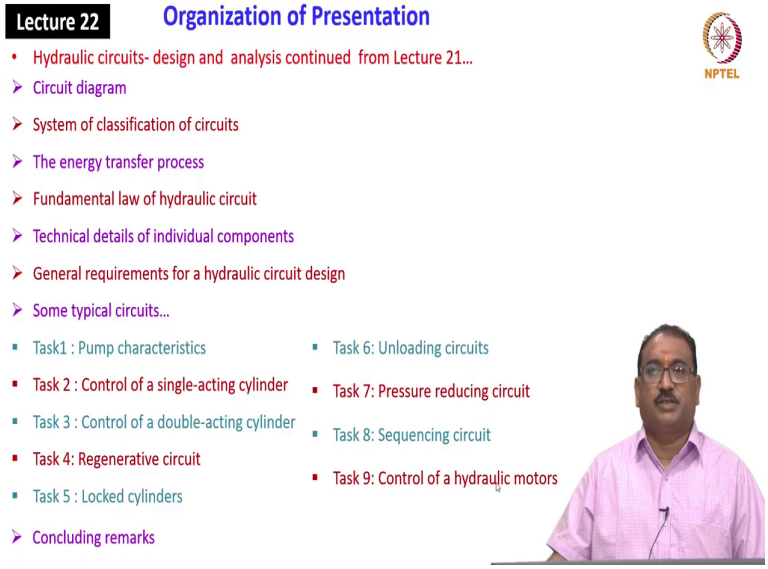

Let us we will see the organization of presentation of lecture 2; hydraulic circuit design and analysis continued from the lecture 21. We will discuss Circuit diagram, System of classification of circuits, The energy transfer process, Fundamental law of hydraulic circuit, Technical details of individual components, General requirements for a hydraulic circuit design.

Some typical circuits we will analyze today that includes the task 1 is a pump characteristics, task 2 is a control of single acting cylinder; I will explain to you different ways to control the direction as well as a speed, similarly control of a double acting cylinders.

The regenerative circuits, we will see the locked cylinders circuits, unloading circuits, pressure reducing circuits, sequencing circuits. Then we will see some of the circuits on hydraulic motors; then finally, we will conclude that today's presentation by passing the concluding remarks.

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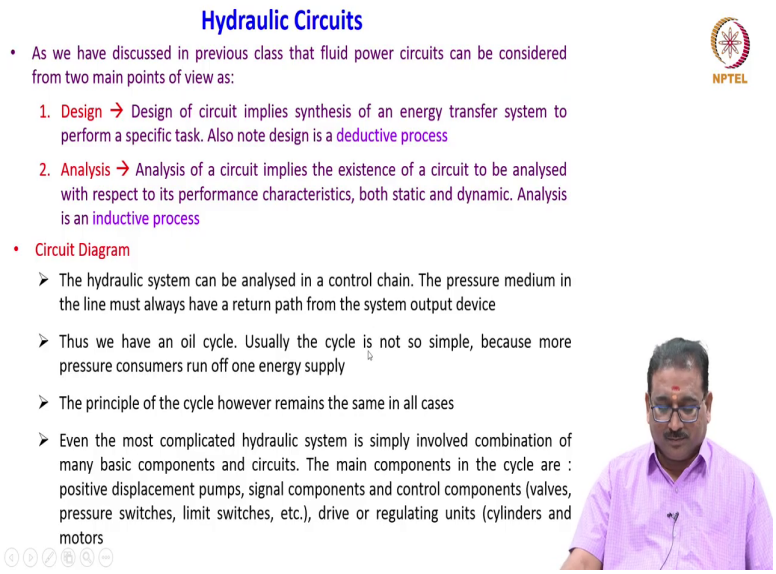

Let us we will begin with hydraulic circuits. As we have discussed in the previous class that, fluid power circuits can be considered from two main points of view; design, design of a circuit implies synthesis of an energy transfer system to perform a specific task. Also note, design is a deductive process.

Analysis - analysis of a circuit implies the existence of a circuit to be analysed with respect to its performance characteristics, both static and dynamic. Analysis is an inductive process.

Circuit diagram, the hydraulic system can be analysed in a control chain. The pressure medium in a line must always have a return path from the system output device.

Thus we have an oil cycle; oil cycle depicts how the oil will flow from the tank, to the pump, to the walls, actuator, then how it will back to the tank. Usually the cycle is not so simple; because more pressure consumers run off one energy supply. The principle of the cycle however remains the same in all cases. Even the most complicated hydraulic system is simply involved a combination of many basic components and circuits.

The main components in a cycle are positive displacement pumps, maybe fixed type or a variable type; based on the requirement cost factor, efficiency factors and many things. Signal components and control components, like a various types of valves, direction control valve, pressure control valve and flow control valves.

And pressure switches, limit switches to operate the direction control valves and to monitor the extension and retraction of the piston and cylinders; drive or a regulating units, cylinders and a motor. Already we have seen in the last class, based on the task; whether the work has been done through the cylinders or a motor, our selection of the component takes place.

In the last class you are seen the power pack, how you will select based on the output requirement, as we have seen in the last class the cylinders. After selecting the cylinder, how to determine the pump flow and velocity, electric motor, tank size, various filters, coolers and then other elements. The very important thing is friends, based on the output requirement; we will start selecting the various components.

Irrespective of that, the hydraulic circuit composed of the basic elements; as we have discussed in the previous class, like pump drive through the prime mover and which will sucks the fluid from the tank through the strainer and suction line filter, then it will goes from the pump to the valves through the so many filters, if required like a pressure line filter.

Then from the valves, it will go to the actuator. After performing the work, oil back to the tank through the return line filter. The filter locations we have seen in the previous class; very

important things are the strainers, suction line filters, pressure line filter, return line filters to safeguard our fluid in the system.

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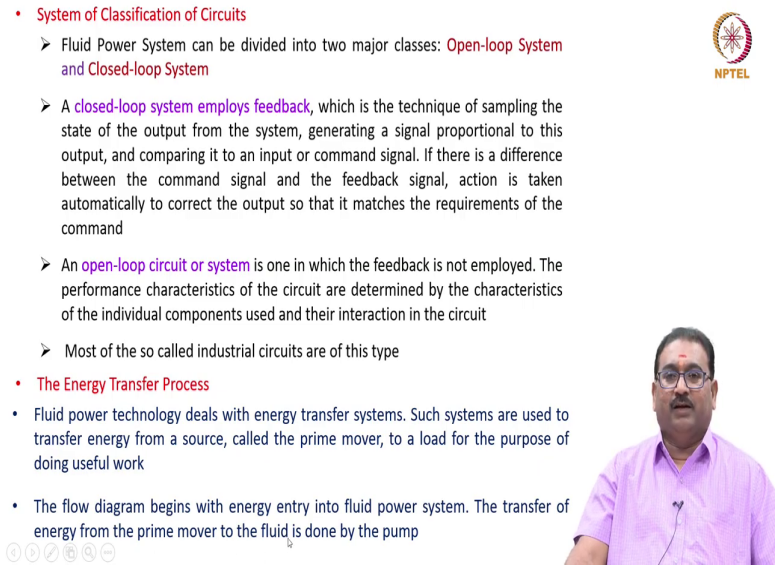

System of classification of circuits, fluid power system can be divided into two major classes; open loop system and a closed loop system. A closed loop system employs a feedback, which is the technique of sampling the state of the output from the system, generating a signal proportional to this output and comparing it to an input or a command signal.

If there is a difference between the command signal and the feedback signal, action is taken automatically to correct the output, so that it matches the requirement of the command. That is why if you see the survey valve, always there is a comparison between the input and output. That is why they are the closed loop systems.

An open loop circuit or a system is one in which the feedback is not employed. The performance characteristics of the circuit are determined by the characteristics of the individual components used and their interaction in the circuit. Please note friends, most of the so called industrial circuits are of this type.

Now, let us we will see the energy transfer process. Fluid power technology deals with energy transfer systems. Such systems are used to transfer energy from a source; source here is a pump; then called a prime mover to load for the purpose of doing the useful work.

Now, we are discussing how energy is transmitting, that is what we are doing in the fluid power, converting one form of energy into output form. Here the electric motor will convert the mechanical energy, from the electric motor we are converting into fluid energy; the fluid energy again converted into mechanical energy at the actuator site.

Then now we are discussing the various losses involved from the input to the output. The flow diagram begins with energy entry into the fluid power system. The transfer of energy from the prime mover to the fluid is done by the pump.

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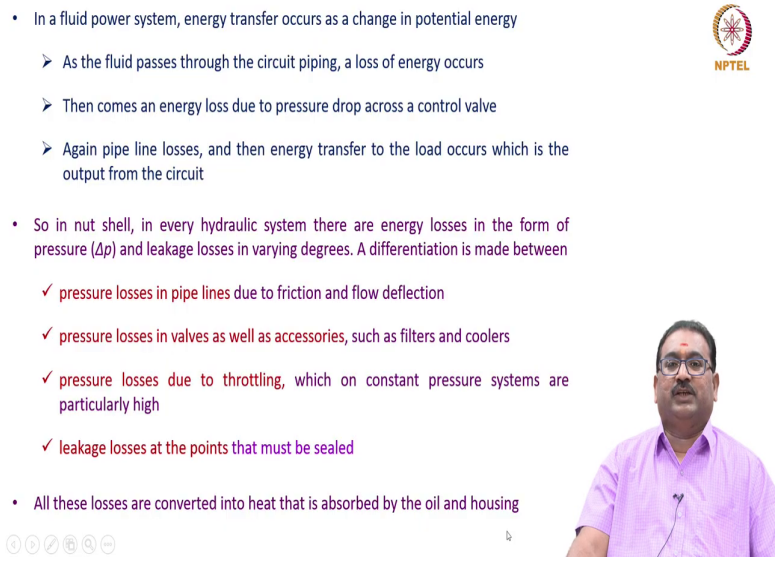

In fluid power system, energy transfer occurs as a change in potential energy. As the fluid passes through the circuit piping, a loss of energy occurs, due to the friction of the pipe ok, roughness of the pipe many things will affects. Then comes an energy loss due to pressure drop across the control valves.

Again a pipe line losses, and then energy transfer to the load occurs, which is the output from the circuit. So, in a nut shell, in a every hydraulic system there are energy losses in the form of pressure delta p and leakage losses in varying degrees.

A differentiation is made between pressure losses in pipe lines due to friction and a flow deflection; pressure losses in valves as well as accessories, such as filters and coolers; pressure losses due to throttling, which on constant pressure systems are particularly high;

leakage losses at the points that must be sealed, using the proper selection of the seals. All these losses are converted into heat that is absorbed by the oil and the housing.

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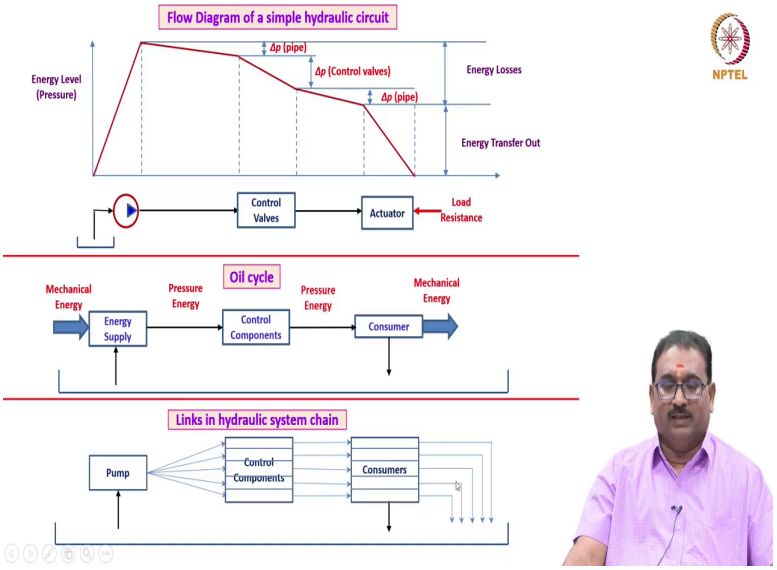

Now, quickly will show you these losses and oil cycle and distributive elements. Here you will see the flow diagram of a simple hydraulic circuit, starting with we will see tank is there, pump is there; from the pump, I will force the control valve through the piping, from the valves again through the piping it will go to the actuator, then it will do the required work here.

Then you will see top I have shown the various energy losses here; you will see the energy level pressure, then losses in the piping correct, when it will flow energy losses in the piping. Then the losses across the control valves delta p losses; from the control valves to actuator

again at delta p loss, these are the energy losses, finally the we are using the energy transfer output at the actuator.

You please see the flow diagram. Now, you will see the oil cycle from the tank, pump will sucks the fluid, sends to the valves and then to the actuator. Here you will see the mechanical energy from the prime mover is an input for the pump energy supply; then I am getting the pressure energy, which will goes to the controlled components.

Then pressure energy here, then again it will go to the consumer; meaning various types of actuators, where the mechanical energy, then oil will goes to the tank, this is known as a oil cycle. Now, we will see the links in the hydraulic system chain; pumps, control components many are there, similarly the consumers many actuators working in the system. Then often all it will goes to the tank, this is a links in the hydraulic system chain.

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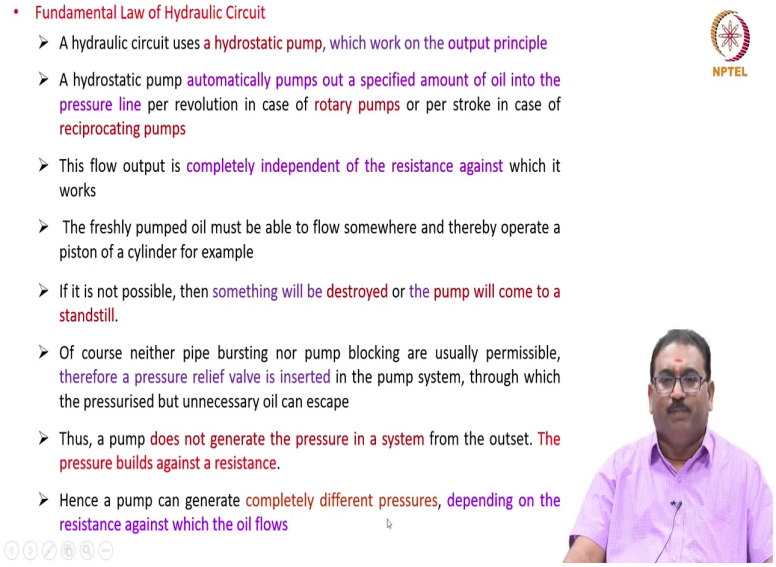

Now, we will want to the fundamental loss of hydraulic circuit. A hydraulic circuit uses a hydro static pump, which works on the output principle. A hydro static pump automatically pumps out a specified amount of oil into the pressure line per revolution in case of the rotary pumps or per stroke in case of reciprocating pumps. This flow output is completely independent of the resistance against which it works.

The freshly pumped oil must be able to flow somewhere and thereby operate a piston of a cylinder for example it is, if it is not possible, then something will be destroyed or the pump will come to a standstill. Of course neither a pipe bursting nor pump blocking are usually permissible, therefore a pressure relief valve is inserted into the pump system, through which the pressurized but unnecessary oil can escape to the tank.

Thus, a pump does not generate the pressure in the system from the outside. The pressure builds against the resistance coming from the actuator to move the load, to rotate the object anything. The pump will sucks the fluid and adjust the fluid; the pressure starts building from the resistance to this flow which arise from the actuator load. Hence a pump can generate completely different pressures, depending on the resistance against which oil flows.

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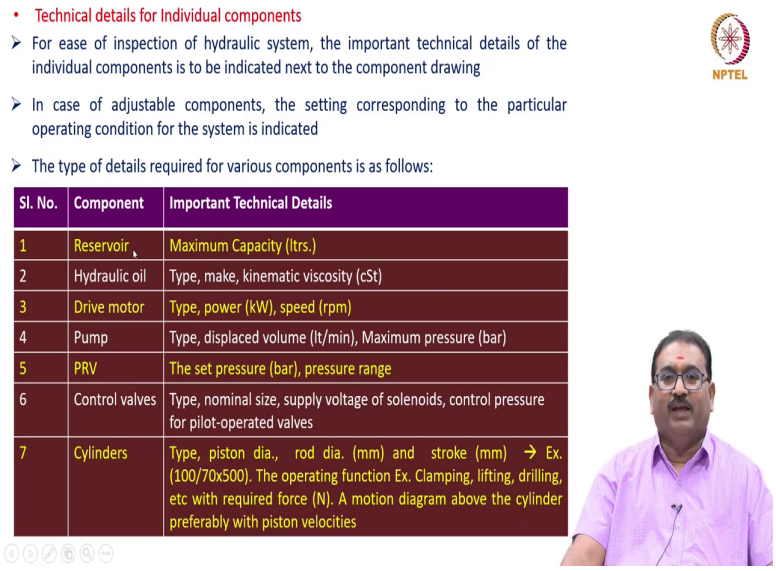

After knowing this in the circuit, we have come across the various elements correct pump, electric motor, tank, filters, control valves, actuator, pressure gauges, piping's many things. So, the mandatory fields are some of the technical details for the individual components are essential.

For ease of inspection of a hydraulic system, the important technical details of the individual components is to be indicated next to the component drawing. In case of adjustable component, the setting corresponding to a particular operating conditions for the system is indicated.

The type of details required for various components is as follows; I am showing you here the various components, some of the main important technical details you have to mention. Reservoir, here the maximum capacity you have to mention, which is based on the flow

requirement at the actuator and pumps how much it will ejects the fluid. Here reservoir maximum capacity in liters you have to mention.

Then hydraulic oil, you have to mention the type, make, kinematic viscosity and many other parameters. Drive motor, what type of motor, power speed. Similarly pump, what type of pump; as we have seen the various types of pumps are there hydro static pumps, gear pump, vane pump, piston pump each is having various category. These are very essential type, displacement volume and maximum pressure.

The pressure relief valve which is based on the system pressure, total system pressure on which it will works; for example, 250 bar if you insert it, the system will operate below 250 bar, beyond that the pump will sends the flow to the tank through this pressure relief valve. Pressure relief valve is very important; the set pressure and a pressure range you have to mention.

Control valves, as I have told you different types of control valves are there; direction control valves itself there are various categories you have to mention, then flow control valve various category, pressure control valves various categories correct friends, all these things have mentioned.

Type, nominal size, supply voltage of solenoids, the operation of the direction control valves; because when I am shifting left configuration, right configuration, middle configuration how it is achieved, there are various types of manual control to electrical operated valves are there, you have to mention all the details.

Sometimes these valves are also operated through the pilot operated; either it is a pneumatic operated or oil operated, you have to mention the pressure range, pneumatic line pressure or a oil pressure line to operate these valves you have to mention.

Cylinders similar to that, you have to mention the type of the cylinder; because various types are there you have seen in the previous class, single acting cylinder, double acting cylinder,

differential area, non-different vary many various types are there correct, you know you have to mention that.

Very important thing is piston diameter is very important and a rod diameter is very important and a stroke length. Example they will mention like this 100 by 70 into 500 the piston diameter, rod diameter and a stroke lengths. The operating function what for it is using? Clamping, lifting, drilling etcetera with a required force. A motion diagram above the cylinder preferably with piston velocities.

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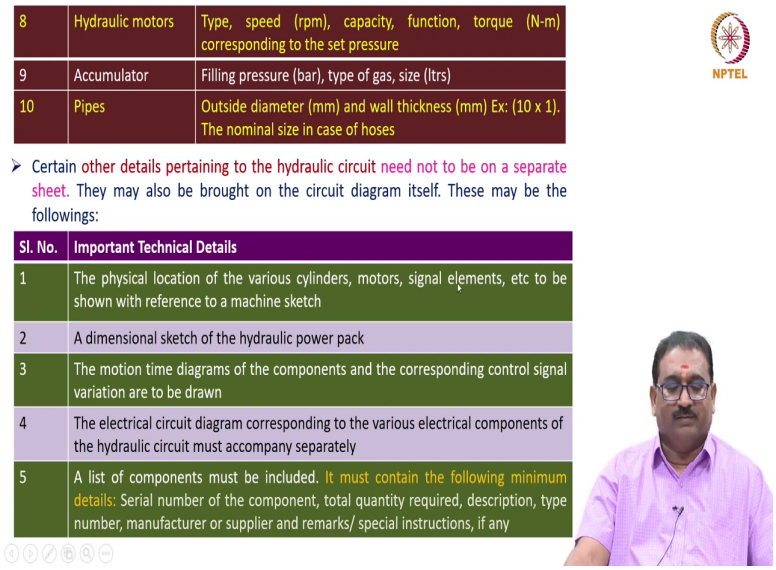

Apart from this, for the other component like a hydraulic motors; you have to mention type, speed, capacity, function, torque corresponding to the set pressure. For accumulators which are served as a pressure source again, you know source of energy it is like a oil tank; we have discussed different types of accumulator in the previous class.

Again we are discussing in detail, when we are discussing the accessories. Accumulator you have to mention the filling pressure, type of gas, size every details. Then piping's very very important thing is outside diameter of the pipe and the wall thickness. This will varies for the different pressure rating and different flow rates. You will get the manufacturing catalogues for 1 inch, 2 inch, 3 inch all pump, all pipes how much flow is allowed, how much pressure of is allowed.

The nominal size in case of the hoses you have to mention. Certain other details pertaining to the hydraulic circuit need not to be on a separate sheet. They may also be brought on the circuit diagram itself. These may be the followings; again I am showing you some of the details, you have to write it on the diagrams.

The physical location of the various cylinders, motors, signal elements, etcetera to be shown with reference to the machine sketch. Second one a dimensional sketch of the hydraulic power pack. A motion time diagrams of the components and the corresponding control signal variations are to be drawn.

Then very important thing is, the electrical circuit diagrams corresponding to the various electrical components of the hydraulics circuit must accompany separately. As I have told you, direction control valves for left position or a right position is operated using the solenoids.

You have to mention when the left actuated button, right actuated button will operate; when we will use these by using the electrical circuit diagram, they are the mandatory electrical circuit diagrams, you have to mention using the ladder diagrams, which is having the 0 line and 24 old line, then you will show how the circuits are connected.

A list of component must be included after completing. It must contain the following minimum details; serial number of the components, total quantity required, description, type number, manufacturer or a suppliers, and a remarks and a special instructions if any. You will

see now after building the circuit, it contains the various information, which are useful for the designer or maintenance people or anyone.

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The general requirements for a hydraulic circuit design. A considerable number of literatures provides information and a techniques for the design of hydraulic circuits. The designer rarely need to design a major component.

His task is to conceive a strategy appropriate to the particular application, to represent this strategy on a circuit diagram, and to select the components for this system from a wide range of commercial stock most of which will be available on the shelf.

Most of the time based on the task, you have to select the various components to suit the applications from the available components of the rack of shelf's. The designer must be

reasonably familiar with the hydraulic control systems and to some degree with their design. The various points to be considered are; appreciation of the task to be performed. Here load - meaning the type, size, mass, shape of the load to be driven; motion required type, size, speed, frequency of changes, and reversals.

Location of the task - where you are performing; meaning factory, field, airborne, dockside, mobile etcetera; working environment - dust or dirt levels, humidity, temperatures, noise levels, space limitation. Next in case of the mode of operation and control of the system, you must mention manual or automatic; continuous or intermittent operation; how much full power operation.

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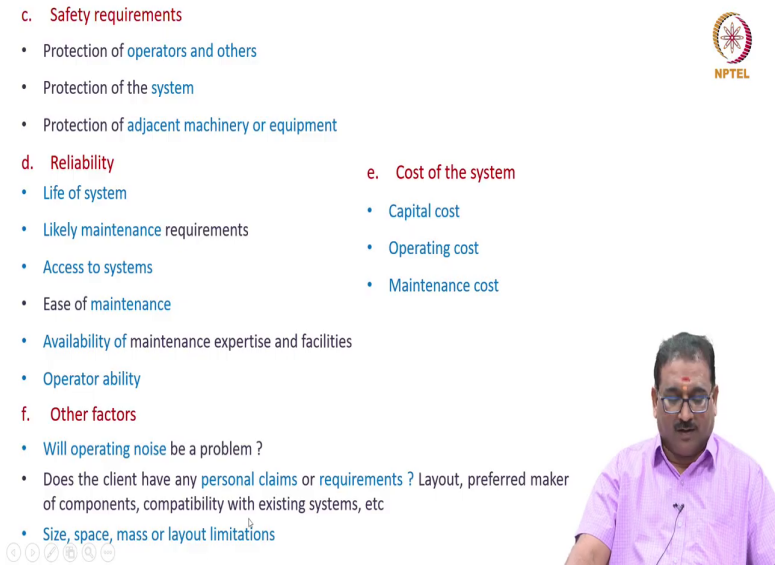

Concerned with the safety requirements, protection of operators and others; protection of the system; protection of adjacent machinery or equipment; reliability is concerned; the life of the

system; likely maintenance requirements; access to systems; ease of maintenance; availability of maintenance expertise and facilities; operator ability to perform all the works, concerned with the cost of the system.

Important thing is capital cost, operating cost and maintenance costs. Then other factors are also important, like will operating a noise be a problem? Does the client have any personal claims or a requirements? Layout, preferred makers of components, compatibility with the existing system etcetera. Size, space, mass or layout limitations are also considered.