Oil Hydraulics and Pneumatics
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Part 1: Introduction, Classifications, Construction, Operation and Application of Needle Valve, Choke Valves
Lecture - 40
Flow Control Valves

My name is Somashekar, course faculty for this course.

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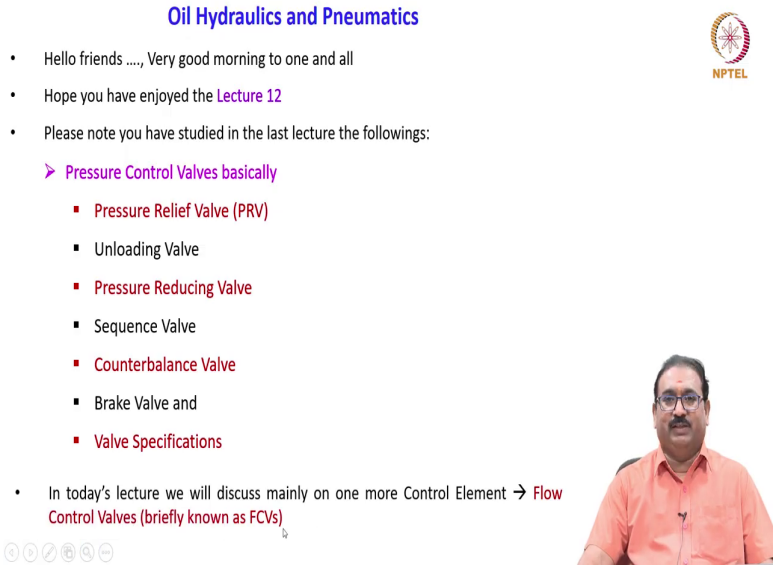

Hello friends, very good morning to one and all. Hope you have enjoyed the lecture 12. Please note you have studied in the last lecture the followings pressure control valves basically, pressure relief valve, unloading valve, pressure reducing valve, sequence valve, counterbalance valve, brake valve and finally, we have seen the valve specifications. In

today's lecture we will discuss mainly on the one more control element Flow Control Valves briefly known as FCVs.

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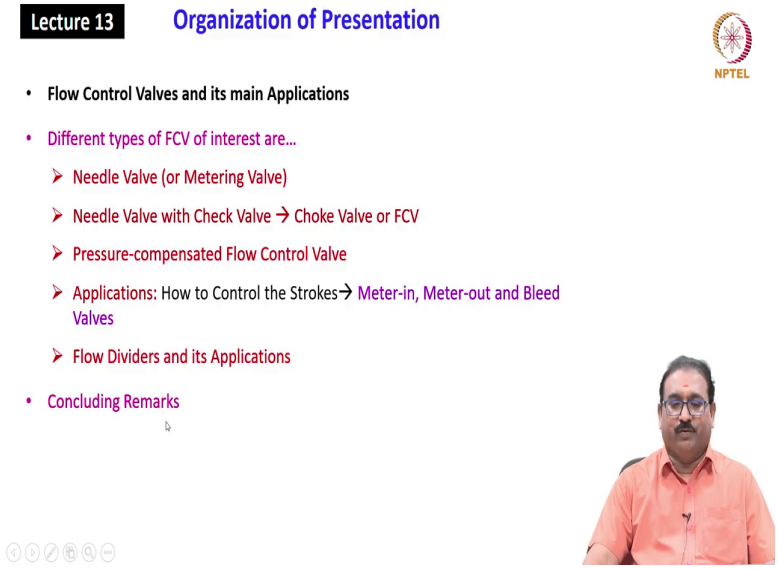

Now, we will move on to organization of presentation, which includes the flow control valves and its main applications. Here we will discuss different types of FCVs of current interests are needle valve or a metering valve. Needle valve with check valve also known as a choke valve or a flow control valve, pressure compensated flow control valve.

Application of these valves: to control the strokes of than actuator. Here we will discuss the meter in circuit, meter out circuit and a bleed valve circuits. Later we will move on to the flow divider and its applications in controlling the multi cylinders. Finally, we will conclude the today's lecture.

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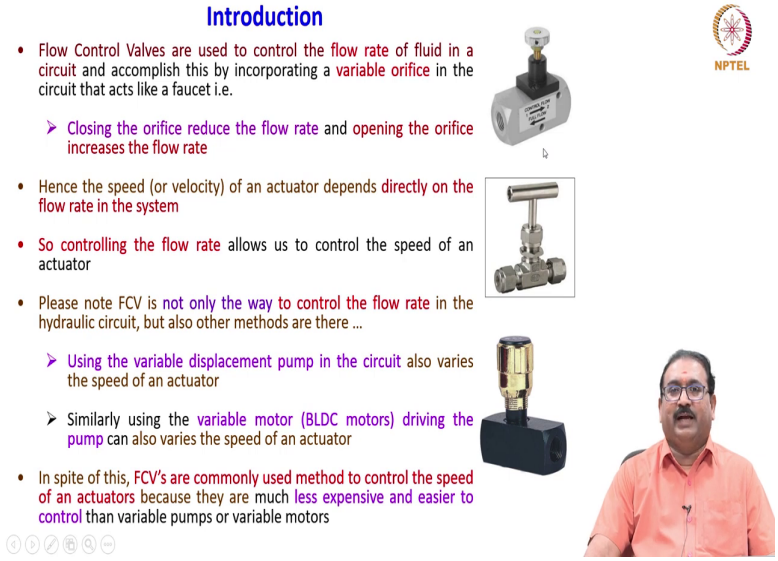

Quickly I will give you some brief introduction about the flow control valve. Flow control valves are used to control the flow rate of a fluid in a circuit and accomplish this by incorporating a variable orifice in the circuit that acts like a faucet. That is closing the orifice reduces the flow rate, and opening the orifice increases the flow rate like a tap in your bathrooms.

Hence, the speed or velocity of an actuator depends directly on the flow rate in the system. So, controlling the flow rate allows us to control the speed of an actuator. Please note FCV is not only the way to control the flow rate in the hydraulic circuit or a pneumatic circuit, but also other methods are there. Some of them are using the variable displacement pump in the circuit which also varies the speed of an actuator by varying the flow rate.

Similarly, using the variable motor like a BLDC motor driving the pump can also varies the speed of an actuator. In spite of this, FCVs are commonly used a method to control the speed of an actuator because they are much less expensive and easier to control than a variable pumps or a variable motors. From pictorial views I have shown here commercially high level flow control valve. Very simple friend here the flow is in here it is out here.

In the passage there is a stem along with the needle which can be moved up and down using this open and close valve, knob it is correct. If you will open up, flow will maximum flow will takes from inlet to outlet. If we will close this knob the flow is restricted this is like a tap as I have told you.

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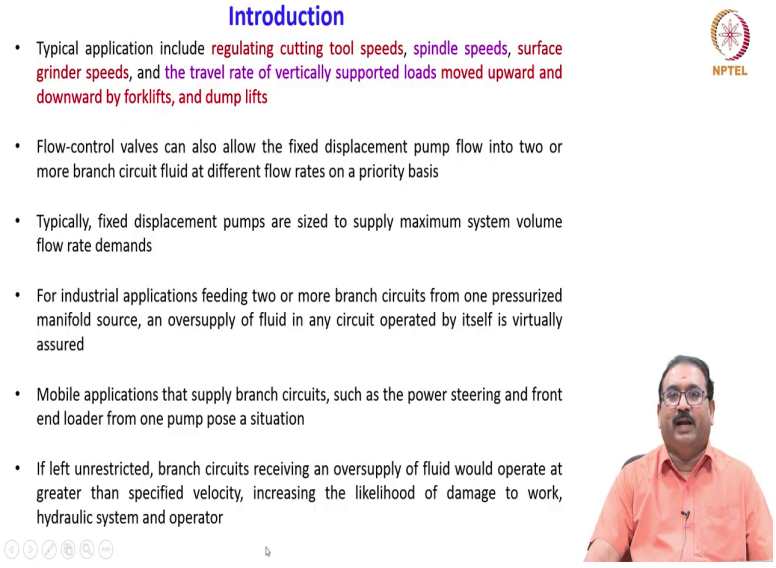

Typical application include regulating the cutting tool speeds, spindle speeds, surface grinder speeds and the travel rate of vertically supported loads moved up and down by a forklifts and

a dump lifts. Flow control valves can also allow the fixed displacement pump flow into two or more branch fluid at a different flow rates on a priority basis.

Typically, fixed displacement pumps are sized to supply maximum system volume flow rate demands. For industrial applications feeding two or more branch circuits from one pressurized manifold source and over supply of fluid in any circuit operated by itself is virtually assumed assured it is.

Mobile applications that supply branch circuits, such as a power steering and front end loaders from one pump pose a situation. If left unrestricted, branch circuits receiving an oversupply of fluid would operate at greater than specified velocity, increasing the likelihood of damage to work or hydraulic system and operator.

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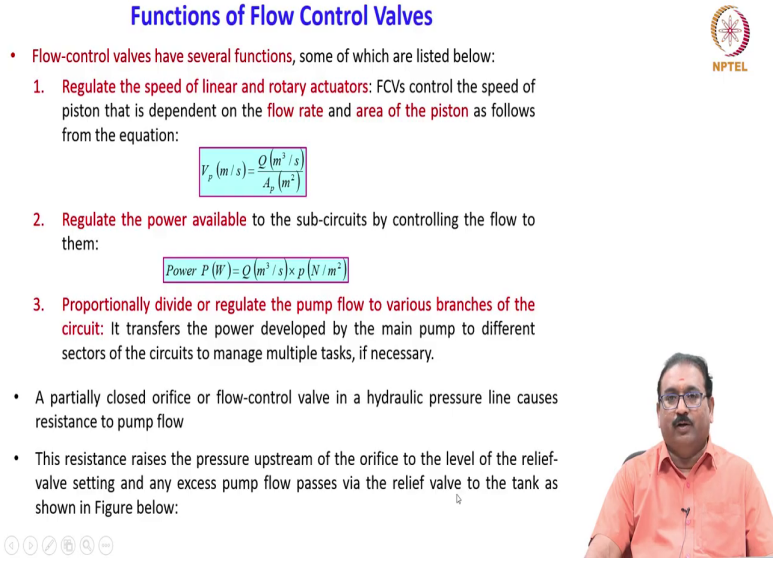

That is why flow control valves are very very essential to ensure the safety of the operator as well as an actuator. Now, we will see the functions of flow control valves. Flow control valves have a several functions, some of which are listed below.

First one is regulate the speed of linear and rotary actuators. FCVs control the speed of piston that is dependent on the flow rate and the area of the piston as follows from the equation. As we know the continuity equation Q equal to A into V velocity of the piston equal to Q by A P.

If you will control the Q, automatically I am controlling velocity. Second important function is regulate the power available to the sub circuits by controlling the flow to them. Power P equal to already we know that Q into pressure P. Third function of flow control valve is proportionately divide or regulate the pump flow to various branches of the circuit.

It transfers the power developed by the main pump to different sectors of the circuit to manage a multiple task, if necessary. A partially closed orifice or a flow control valve in a hydraulics pressure line causes a resistance to pump flow. This resistance raises the pressure upstream of the orifice to the level of the relief valve setting and any excess pump flow passes via the relief valve to the tank as shown in the figure below here.

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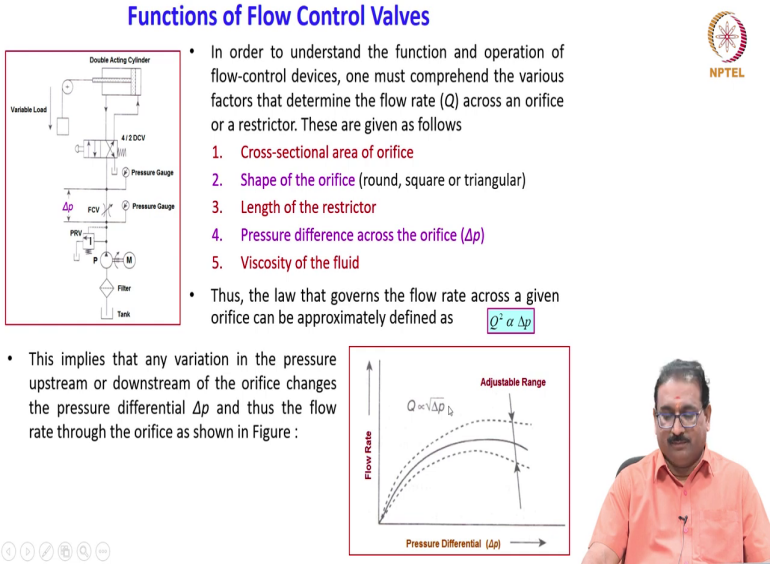

Here I am showing you a double acting cylinder which is used to control the variable load here through the 4 by 2 DCV, spring centered one it is. Here one flow control valve I am using here in between the pump flow and the BCV.

This is a throttle type and a pressure relief valve is here to control the main system pressure. This is always a closed one as we have seen, correct. The pressure gauges are there to monitor the pressure across the flow control valve. Always there is a delta p across the FCV and this is a filter and this is a tank.

In order to understand the function and operation of flow control valves, one must comprehend the various factors that determines the flow rate Q across an orifice or a

restrictor. These are given as follows. Cross sectional area of orifice will determines how much flow is taking place across the valve.

Shape of the orifice is very important whether a round, square, triangular; shape of the orifice plays a major role then length of the restrictor, pressure differential delta p, viscosity of the fluid. Thus, the law that governs the flow rate across a given orifice can be approximately defined as Q square proportional to delta p.

This implies that any variation in the pressure upstream or a downstream of the orifice changes the pressure differential delta p and thus the flow rate through the orifice as given in the figure here. You will see here flow rate versus the pressure differential, how it is varying with the adjustable range. Always Q is proportionate to square root of delta p.

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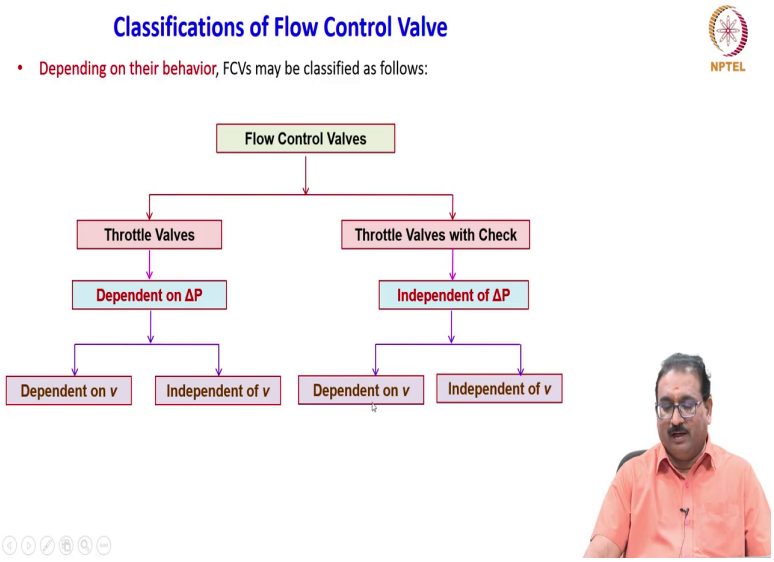

After knowing some of brief introduction about the flow control valve, we will move on to the classifications of flow control valves. Depending on their behavior FCVs can be classified as throttle valves and throttle valves with check. In throttle valves dependent on differential pressure. Here they are independent of delta p. In this category, dependent on v; viscosity parametric viscosity, independent of the v. Here also dependent on v and independent of v.

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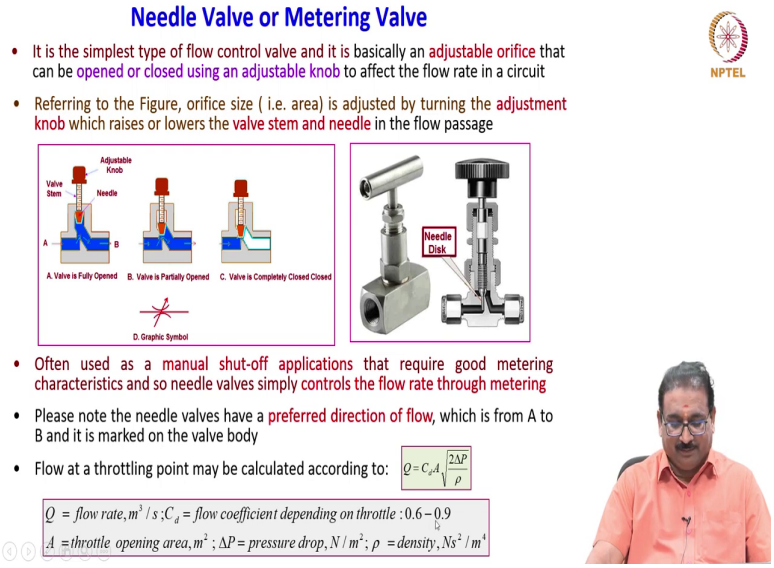

Let us we will see some of the popular valves used to control the flow rate in the hydraulic and pneumatic circuits. First and foremost thing is a needle valve, it is also known as a metering valve. It is a simplest type of flow control valve and it is basically an adjustable orifice that can be opened or a closed using an adjustable knob to affect the flow rate in the circuit.

Referring to this figure, orifice size that is a area here is adjusted by turning the adjustable knob which raises or lowers the valve stem and a needle in the passage fluid passage. Here you will see the valve is fully opened then the unrestricted flow from A to B, but here it is you will see the adjustable knob I have closed here partially then flow is takes place only through the open orifice from A to B.

Here you will see in third figure valve is completely closed no flow to the B side. This is the needle valve commercially available, inlet, outlet, in between this thing valve stem and a needle is there. Often used as a manual shut off application that require a good metering characteristics and so, needle valves simply control the flow rate through a metering.

Please note the needle valves have a preferred direction of flow which is from A to B and it is marked on the valve body always. The flow at a throttling point may be calculated according to simple orifice equation Q equal to C d A root 2 delta P by rho, where A is a cross sectional area of the opening, C d is a coefficient of discharge, delta P is a pressure drop across the valve; rho is the density of the fluid. These are the terms used in this equation. The coefficient of discharge is generally used as 0.6 to 0.9.

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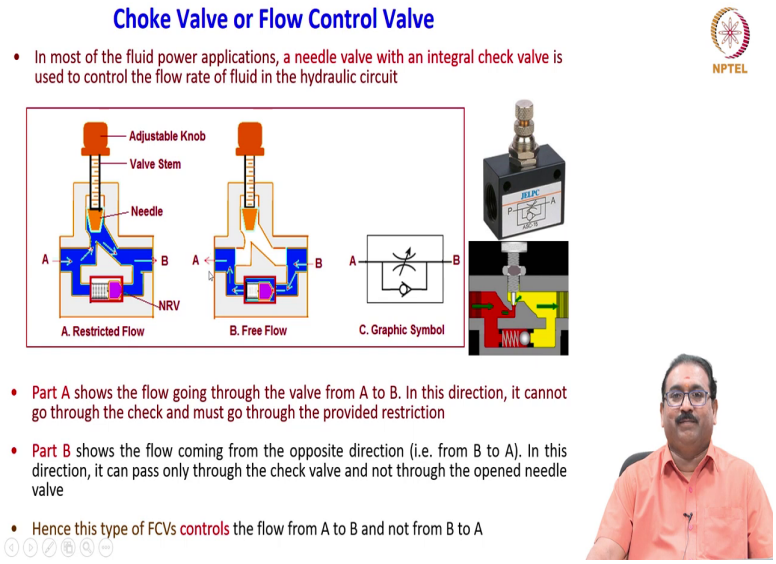

In most of the fluid power applications a needle valve with an integral check valve is used to control the flow rate of fluid in the hydraulic circuit. That is known as a choke valve or a flow control valve. Previous one is only metering valve. As you will open the valve more flow is going to an actuator. If you will close the valve flow will be cut off.

But, in most of the applications what we required is a needle valve with a integral check valve in the hydraulic circuit. This looks like here in the schematic diagram what I have shown here, similar to previous one friends here. You will see the adjustable knob is there, valve stem and the needle which can be raised up and down in the passage. Flow is taking place from the inlet to outlet. Inlet is A, outlet is B.

Here you will see here the NRV; non return or a check valve is integrated here. Here valve is completely opened; the flow is taking place from A to B through the opened orifice. If you

will reverse the flow from B to A, it will not follow this open passage because the path of least resistance is a check valve.

Check valve will lift, it will move. Graphically this is represented using the symbol here: A to B through the opened orifice, variable orifice because adjustable knob is there and B to A is through the check valve. Please see the direction. The same thing is engraved on the valve body here. So, the part A, this is a part A shows the flow going through the valve from A to B.

In this direction, it cannot pass through the check valve and must go through the provided restriction from A to B. Here in part B shows the flow coming from the opposite direction that is from B to A, it is coming. In this direction, it can pass through the check valve and not through the opened middle valve. Hence, this type of FCV controls the flow from A to B and unrestricted flow from B to A.

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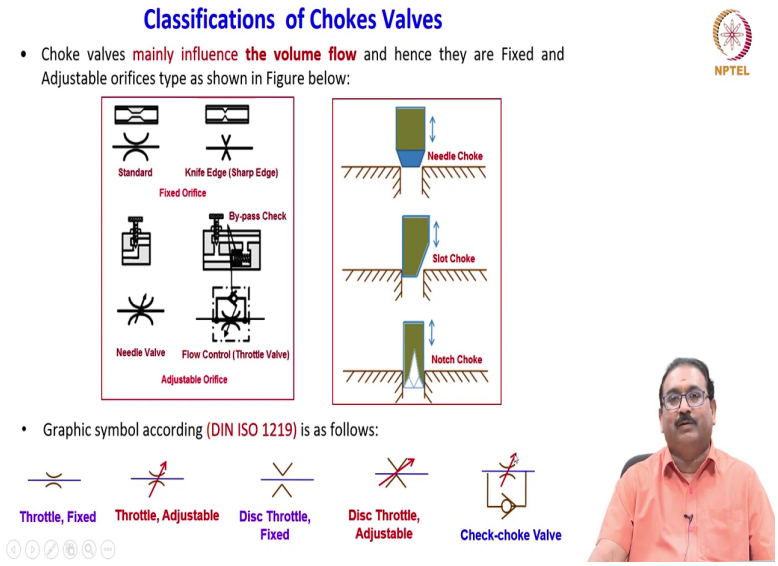

Quickly we will see the classifications of choke valve that is a flow control valves. Choke valves mainly influence the volume of flow. Hence, they are fixed and adjustable orifice as shown in the figure below. Here you will see the fixed orifice things are there.

The standard one is a circular orifice and here you will knife edge or a sharp edge orifice are there, fixed orifice it is. Here you will see friends adjustable orifice. The one arrow is there across the symbol, which will show the throttling can be done here in both the cases that is why it is an arrow mark over the symbol.

Here also you will see the openings. The needle choke if we will move up and down you will see the port opening how it is. Here you will see the slot choke. Here you will see notch

choke based on the flow requirement the commercially the different types of choke valves are available.

Graphic symbols according to the DIN ISO 1219 as follows: throttle, fixed; how they are representing please see here friends. Here throttle, adjustable arrow mark over that. Disc throttle or it is also known as knife edge or a sharp edge throttle, which is a fixed one; arrow over a disc throttle, adjustable type. Here you will see check choke valve meaning here from here to here through the valve opened valve, from B to A is through the check valve.