Oil Hydraulics and Pneumatics
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Proportional Valve Technology
Lecture - 87
Part 2: Quick glance on flapper valve and jet pipe valve, Status on proportional valve technology and introduction, Signal sequence in proportional control valves, Possible fuctions

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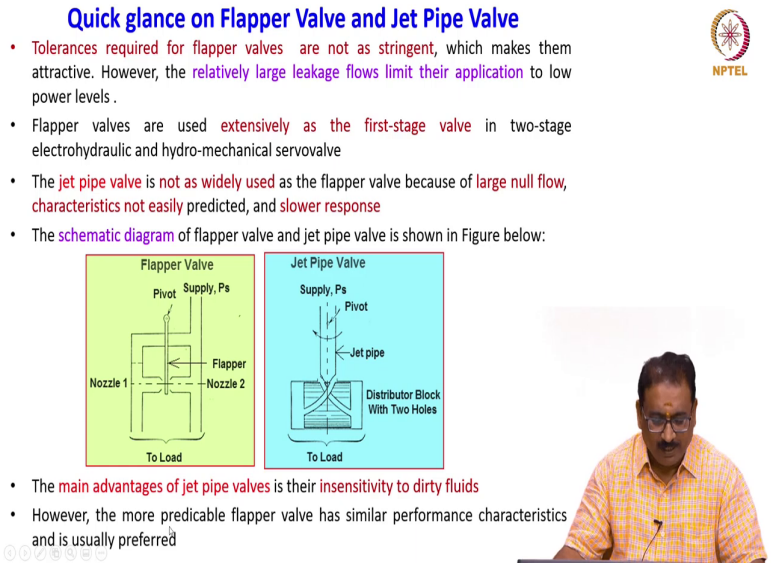

My name is Somashekhar course faculty for this course. After knowing this the another category of valve configuration is based on the flow diversion either through the flapper or through the jet pipe. Now, let us I will give you 1 or 2 slide on the Flapper and Jet Pipe Valve this we are discussing again in the next class.

Tolerances required for flapper valves are not as stringent, which makes them attractive. However, the relatively large leakage flows limit their application to low power levels. Flapper valves are used extensively as the first-stage valve in two-stage electro hydraulic and hydro-mechanical servo valves.

This we will discuss in the next class, what is the first stage and what is the second stage? First stage here as I have told you the flapper nozzle valves to drive the second stage spool valve. We will see all details in the next class no need to worry. The jet pipe valve is not as widely used as the flapper valve because of large null flow, characteristics not easily predicted, and slower response.

The schematic diagram of flapper valve and a jet pipe valve is shown in figure below. You will see here flapper valve it is what are the things you will see here the flapper it is nothing, but a one rod, which is pivoted at the point here. Here there are the 2 nozzles, nozzle 1 and nozzle 2 from which the continuous supply of oil will be exiting.

The this flapper will be rotated either to the left or to the right based on the requirement. When for example, if it will rotated like this, it will blocks the fluid coming out from the nozzle 1. What happens here the pressure starts melting. Where it is across the spool, then spool starts moving. When the flapper is rotating to the right side, this nozzle will be closed then pressure starts building the spool will be move in the other directions.

Meaning, the flapper is used to create the differential pressure across the spool valve. That is why it is the first stage spool valve is the next, whole objective is to move the spool proportionate to the current to the torque motor. This how I am rotating this about the pivot point using the torque motor valve servo valves generally, we will discuss later in this.

Now, we will see jet pipe valve what is the condition here? It is a jet pipe will carries a fluid now. Jet pipe will carries a continuous supply of oil. Over the distributor block with a 2 holes are closed as near as possible. And, these two holes are connected to the spool valve. Meaning again this jet pipe is a first stage and second stage is a spool valve.

Whole objective is to move the spool either to the left or to the right, which metered the flow to the actuator ends. Now, we will see when the jet pipe is center, the equal amount of oil with some losses will go across the spool valve. Then it will not move, then what I have to do again jet pipe if pivoted, it will rotate either clockwise or anticlockwise. Based on the current input to the torque motor, these things we will discuss in the next class in detail how it is.

But you will remember here now jet pipe over the distributor block. This distributor block contains the two closely spaced holes connected to the spool valve, across the spool valve. The main advantages of jet pipe valve is their insensitivity to dirty fluids. However, the more predictable flapper valve has a similar performance characteristics and usually preferred.

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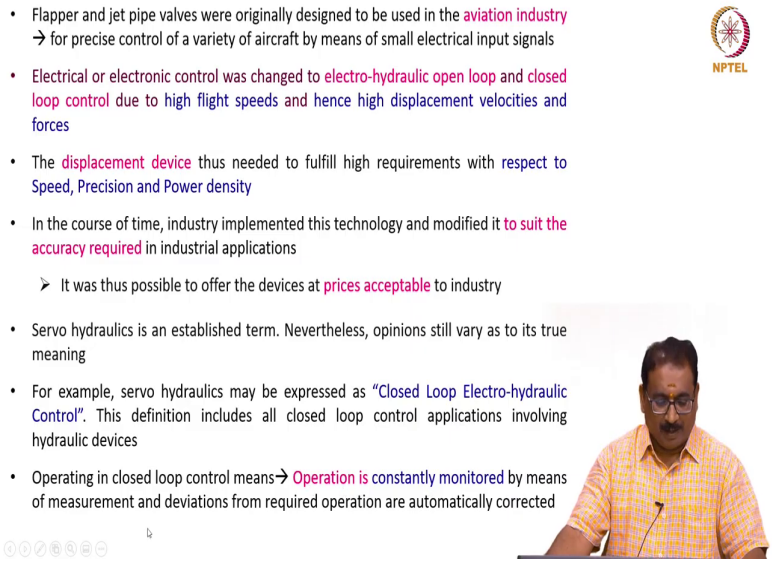

Flapper and jet pipe valves were originally designed to be used in the aviation industry. For a precise control of a variety of aircraft by means of small electrical input signals. Electrical or electronic control was changed to electro hydraulic open loop and a closed loop control.

Due to high flight speed and hence high displacement velocities and forces. The displacement devices thus needed to fulfill the high requirements with respect to the speed, precision and a power density. In the course of time, the industry implemented this technology and modified it to suit the accuracy required in industrial application. Accuracy and precision required in aviation industry or a defense industry is very high.

Servo valve will suits, but they are very expensive to meet the industrial requirement some modification is taken place in the controlled valves, what are those you will see. It was thus possible to offer the devices at price acceptable to industry. Servo hydraulics is an established term nevertheless, option still vary as to its true meaning.

For example, servo hydraulics may be expressed as “Closed Loop Electro-hydraulic Control”. This definition includes all closed loop control application involving hydraulic devices. Operating in closed loop control means, operation is continuously monitored by means of measurement and deviations from required operations or automatically corrected.

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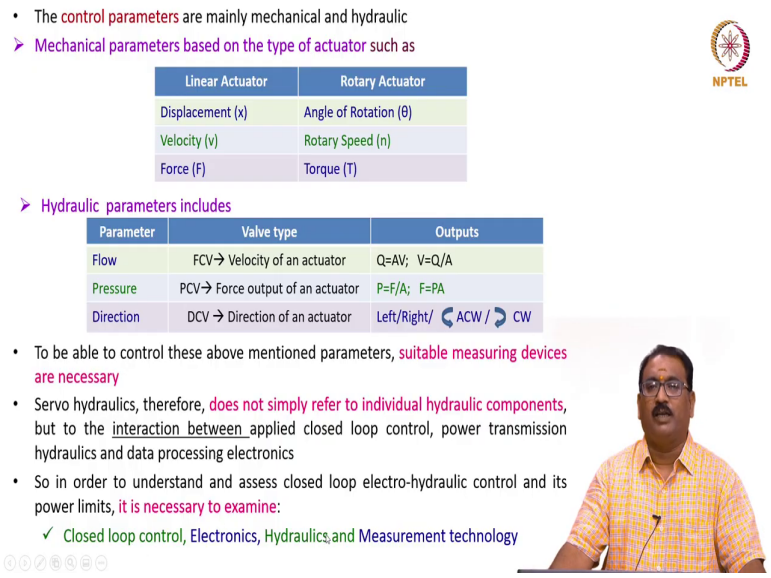

The control parameters are mainly mechanical and hydraulic. Mechanical parameters based on the type of actuators. Such as if you are using the linear actuator displacement, velocity, and force, are the parameters. Rotary actuator if you will see the angular rotation, rotary speed, and a torque. Hydraulic parameters includes, the flow if you will see flow control valves the velocity of an actuator Q equal to A into V correct or a rotation of the rotary actuator.

If pressure the pressure control valves here force output of an actuator I am controlling or a torque in case of the motor P equal to F by A, F equal to P into A. If you want to control the direction, the direction control valve of the actuator. Left or Right or a clockwise or a anti clockwise in case of the hydraulic motor, you know all these things. To be able to control these above mentioned parameters, suitable measuring devices are necessary.

Servo hydraulics, therefore, does not simply refer to individual hydraulic components, but to the interaction between the applied closed loop control, power transmission hydraulics and a data processing electronics. So, in order to understand and access the closed loop electro-hydraulic control and it is power limits, it is necessary to examine, closed loop control, electronics, hydraulics and measurement technology are very much essential to understand this closed loop system.

How they will differ from the open loop system. Even, though electronics is used in the both the cases.

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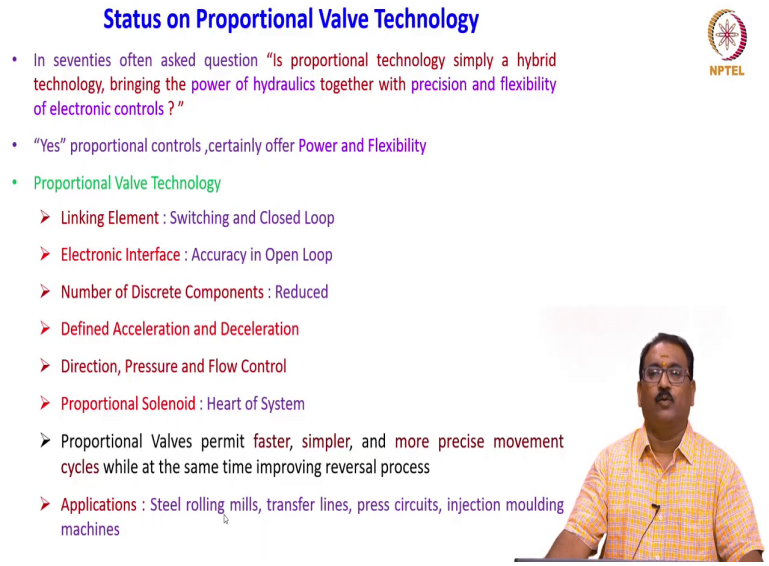

Now, we will see the status on proportional valve technology. In 70s often asked a question "is proportional valve technology, simply a hybrid technology, bringing the power of

hydraulics together with precision and flexibility of electronic controls?" Yes, proportional controls certainly offer power and flexibility.

I will give you some of the characteristics of proportional valve technology, the linking element between the switching and a closed loop, electronic interface accuracy in open loop. Number of discreet components reduced, defined acceleration and deceleration is possible. They are available directional, pressure and a flow control valves.

Here proportional solenoid which is the heart of the system. Proportional valves permit faster, simpler, and more precise movement cycles while at the same time improving reversal process. Application of proportional valve technology you will see, the steel rolling mills, transfer lines, press circuits, injection moulding machines, and many more. Then question arises what is this technology, proportional valve technology.

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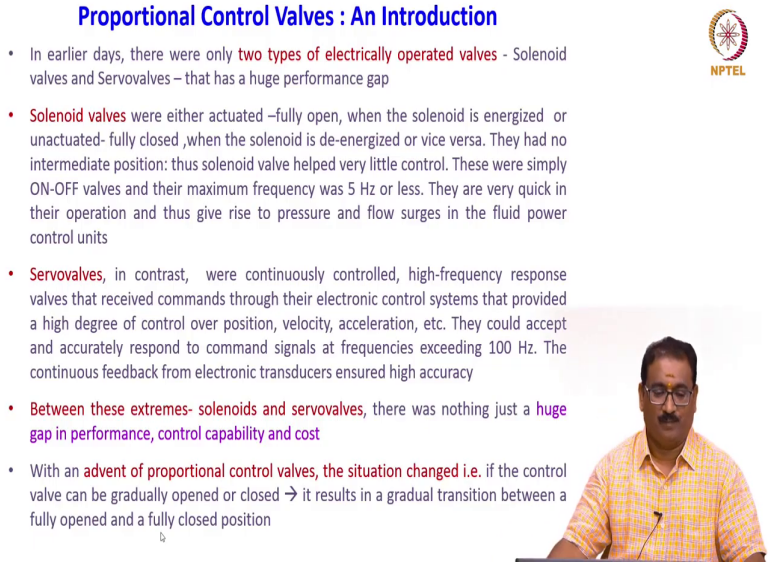

Let us we will see, how it is developed? How it differ from the servo valve technology? In the earlier days, there were only two types of electrically operated valves. Solenoid valves and servovalves, that has a huge performance gap. Solenoid valves were either actuated fully open, when the solenoid is energized or unactuated meaning it is fully closed, when the solenoid is de energized or vice versa.

They had no intermediate positioning, thus solenoid valve helped very little control. Only they will switch on sending the full flow to the actuator or switch off meaning closed the full flow to the actuator, in between is not possible in the conventional solenoid valves. So, these were simply on off valves. And, therefore, a maximum frequency was 5 Hertz or less.

They are very quick in their response and thus gives rise to pressure and flow surges in the fluid power control units. Servo valves in contrast were continuously controlled. High frequency response valves, that received a commands through their electronic control systems. That provided a high degree of control over the position velocity and acceleration of the valve the intern actuator. They could accept and accurately respond to the command signals at a frequencies exceeding 100 Hertz.

The continuous feedback from electronic transducers ensures high accuracy between these extremes meaning the solenoid and servo valves. There was nothing just a huge gap in performance, control capability and a cost. With an advent of proportional control valves, the situation changed, that is if the control valve can be gradually opened or a closed. It results in a gradual transition between a fully opened and a fully closed position of the valve.

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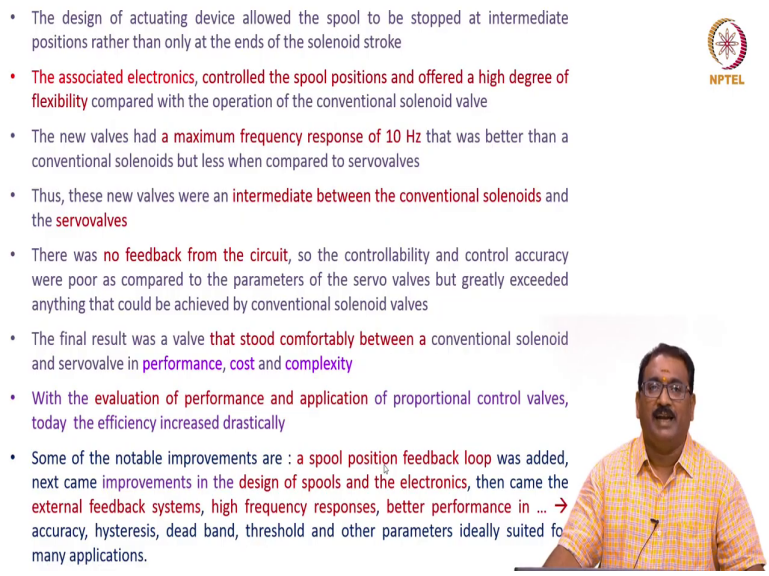

The design of actuating device allowed the spool to be stopped at intermediate positions rather than only at the ends of the solenoid stroke. The associated electronics controlled the spool positions and offer a high degree of flexibility compared with the operation of the conventional solenoid valve.

The new valves had a maximum frequency response of 10 Hertz, that was a better than a conventional solenoids, but less when compared to servo valves. Thus these new valves were an intermediate between the conventional solenoid, meaning on off valves and the servo valves beginning there was no feedback from the circuit.

So, the controllability and a control accuracy were poor as compared to the parameters of the servo valves, but greatly exceeded anything that could be achieved by the conventional on off

solenoid valves. The final result was a valve that stood comfortably between the conventional solenoid and a servo valve in performance, cost and complexity.

With the evolution of performance and application of proportional control valves, today the efficiency increased drastically. Some of the notable improvements are a spool position feedback loop was added, next came improvements in the design of spools and the electronics. Then came the external feedback systems, high frequency responses, better performance in accuracy, hysteresis, dead band, threshold and other parameters ideally suited for many applications.

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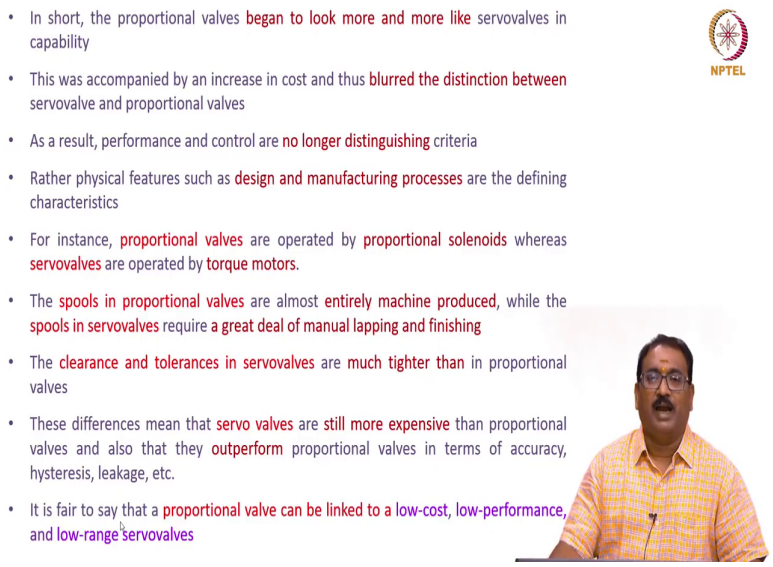

In short the proportional valves began to look more and more like servo valves in capability. This was accompanied by an increasing cost and thus blurred the distinction between the servo valves and a proportional valves. As a result, performance and control are no longer

distinguishing criteria. Rather physical features such as design and manufacturing processes are the defining characteristics.

For instance, proportional valves are operated by proportional solenoids whereas; servo valves are operated by generally torque motors. The spools in proportional valves are almost entirely machine produced. While the spools in servo valves require a great deal of manual lapping and finishing. The clearance and tolerances in servo valves are much tighter than in proportional valves.

These differences mean that, servo valves are still more expensive than proportional valves. And, also that they outperform proportional valves in terms of accuracy, hysteresis leakage, and many more parameters. It is fair to say that proportional valve can be linked to a low cost, low performance, and low range servo valves.

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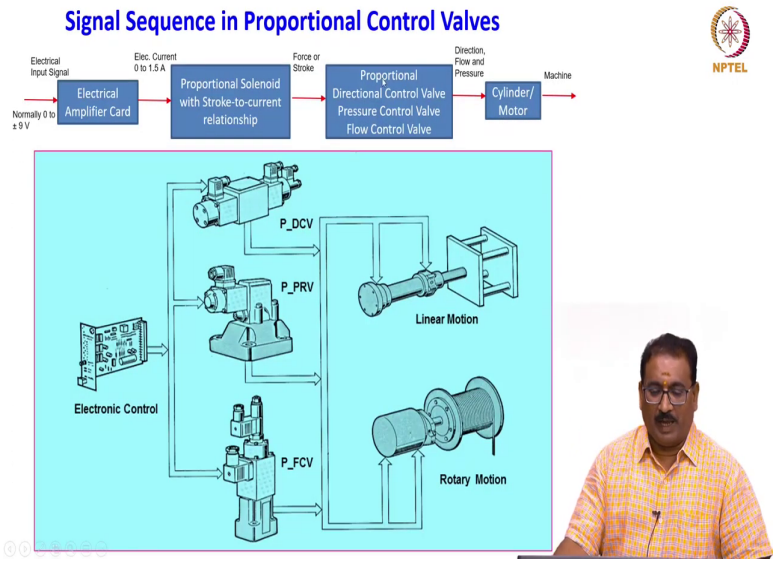

Now, quickly I will show you the signal sequence in proportional control valves, or a proportional solenoid valves, all are same it is friends. You will see here, now friends I have shown you the top block diagram, which will show the signal sequence. Here you will see, here down you will see the electronic, which has a electrical amplifier card and many other items.

Here you will see the pressure proportional, proportional direction control valves proportional pressure control pressure reducing valve or a pressure control valves. Here pressure controlled. Now, let us we will see signal sequence in proportional control valves.

Here, I have top I have shown you the block diagram, down I will show you the schematics of the electronic valves and a proportional directional control valves, proportional pressure control valves and proportional flow control valves, which is connected to the actuator linear motion or a rotary motion, then some of the operations performed by the machines.

Now we will see here to the electrical amplifier card, electrical input signal. This is normally 0 to plus or minus 9 volt, electrical current 0 to 1.5 ampere, which will goes to the proportional solenoid with stroke to current relationship. Force or a stroke, please remember friends here. The force controlled proportional solenoids are there also stroke controlled proportional solenoids are there.

Here proportional directional control valves, pressure control valves and flow control valves. Finally; it will go to the actuator, direction flow and a pressure. Finally it reach to the machine. Like the signal will flow from the electrical amplifier card to the actuator in terms of flow and a pressure also the direction.

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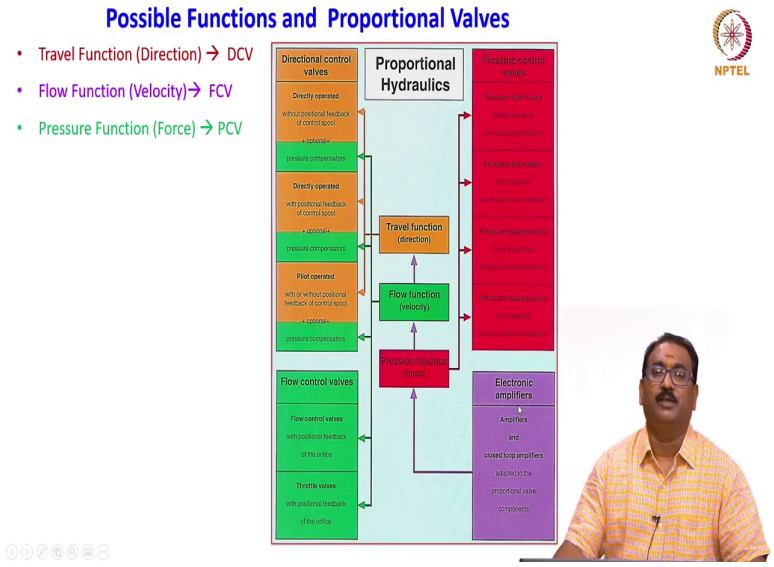

Possible functions and a proportional valves; travel function using the direction control valves, flow function the flow controlled valves, pressure function using the pressure controlled valves. All categories are available in a proportional valves. Now, this will show you the proportional hydraulics a travel function there are many things are there here, the flow functions the many things are there here.

And, also you will see friends here the pressure control valve there are many things for all these thing is electronic amplifier is very essential.