Oil Hydraulics and Pneumatics
Prof. Somashekhar S
Department of Mechanical Engineering
Indian Institute of Technology, Madras

Part 2; Poppet types vs Spool type, Construction, Operation and Application of Pilot operated PRV-Spool and Poppet type, Unloading valve
Lecture - 38
Pressure Control Valves

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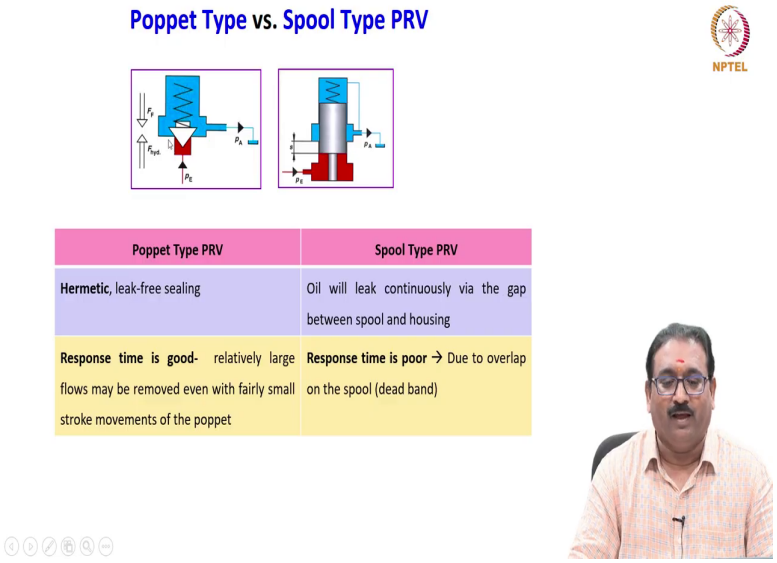

My name is Somashekar; course faculty for this course. Now, quickly I will show you the Poppet type and the Spool type what are the main differences.

This is as I have told you this is a poppet over the valve sheet; here spool over the valve sheet. Correct, here initially the hydraulic balance is there, F hydraulic equal to F F. When this is

increases, then only it will lift, then flow will go into the tank; otherwise no. Already I have told you this. Same way for the spool.

The poppet type PRV and a spool type PRV. If we will see, it is a hermetic or leak free sealing here; here oil will leak continuously via the gap between the spool and a valve body meaning always spool is moving inside, it has a diametrical clearance; through this oil will leak.

Here response time is very good because only one moving element; relatively large flow may be removed even with fairly a small stroke movement of the poppet. Here response time is very poor due to overlap on the spool meaning dead band as you are seen here the lap is provided. Until that, the valve will not opens that is why response time is very slow here. Here no need to worry, it will lift immediately; response time is very quick.

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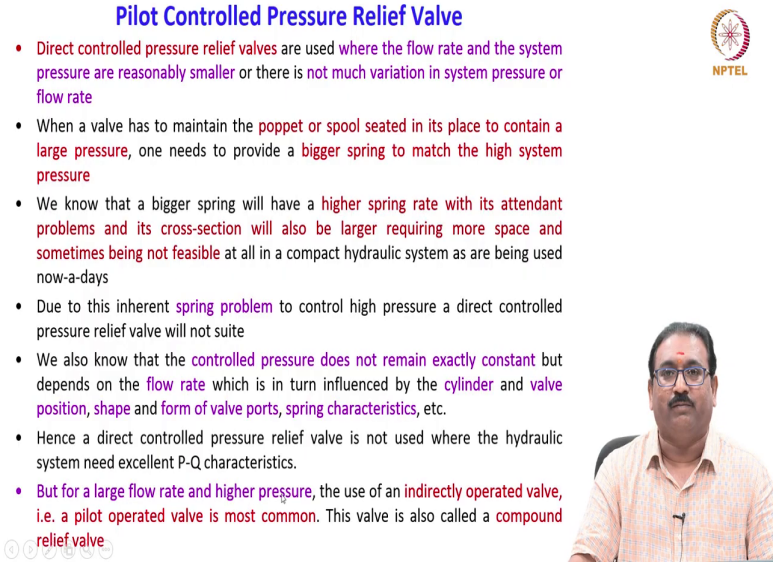

Now, apart from this, the pilot controlled pressure relief valves are there. Because as I have told you, you have to set the pressure using the stiff spring on the other side of the poppet or a ball or a spool.

If pressure you want to control very high, for example, 350 bar 450 bar. That time to control such pressure, what you have to do, the spring stiffness should be increased. How it is? You have to use a very large spring, the diameter is very big. Then accommodating this in the valve body, it is difficult.

Because, now we people are talking about the light weight hydraulics that time this will fails mean selecting the larger spring, larger diameter, very stiff spring not allowed in the light weight hydraulics. In such cases what they are doing is, they will go for the pilot controlled pressure relief valves.

As I have told you direct controlled pressure relief valves what we have discussed previous slide are used where the flow rate at the system pressures are reasonably smaller or there is not much variation in system pressure or a flow rate.

When a valve has to maintain the poppet or spool seated in its place to contain a large pressure, one needs to provide a bigger spring to match the high system pressure.

We know that the bigger spring will have a higher spring rate with its attendant problems and its cross-section will also be a large requiring more space and sometimes being not feasible at all in a compact hydraulic system as are being used now-a-days. Due to this inherent spring problem to control the high pressure, a direct controlled pressure relief valves will not suite in many applications.

We also know that the controlled pressure does not remain exactly constant but depends on the flow rate which in turn influenced by the cylinder and a valve position, shape and forms of valve ports, spring characteristics, and many more. Hence a direct controlled pressure relief

valve is not used when a hydraulic system needs excellent P-Q characteristics – pressure flow characteristics it is.

But for the large flow rate and a high pressure, the use of an indirectly operated valve that is what is known as pilot operated valve is common. This is also called a compound relief valve. Please understand friends, compound relief valve is nothing, but a pilot operated pressure relief valve.

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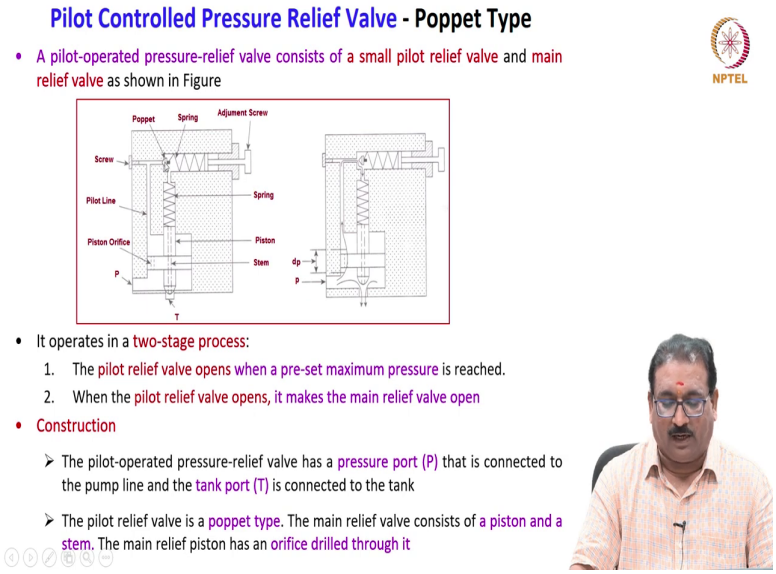

Now, let us we will see this how it looks. Now, first I will show you the poppet type of design how it is controlled using the pilot. Here you will see this, the sectional views are shown here. A pilot operated pressure relief valve consists of a small pilot relief valve. You will see here the small pilot relief valve it is, and a main relief valve here.

There are two valve are there here. Here generally it is a poppet type; here it is a spool. Here it is a what you will call the piston arrangement here. It operates in two stage process. The pilot valve opens when a pre-set maximum pressure is reached. When the pilot valve opens, it makes the main relief valve opens.

Constructional detail you will see now here; I have marked here. This is the whole valve body which is having the P-port, T-port. P and T always, T is blocked using this piston you know stem with stem correct here. Then on the top you will see it is a what you will call a small relief valve setting.

Here it is the poppet is fitted over the valve body, and this is adjustable type using the adjustment screw. Here you will see the spring stiff spring – larger spring compared to this. Then here you will see friends the pilot line is there. The pressure line is connected to this chamber using the piston orifice. The small hole is drilled in the piston.

See construction, the pilot operated pressure relief valve has a pressure port P that is connected to the pump line, and the tank port T connected to the oil reservoir. The pilot relief valve is a this is a pilot relief valve is a poppet type. The main relief valve, here this is the main relief valve consist of the piston and a stem. The main relief valve piston has a orifice drilled through it.

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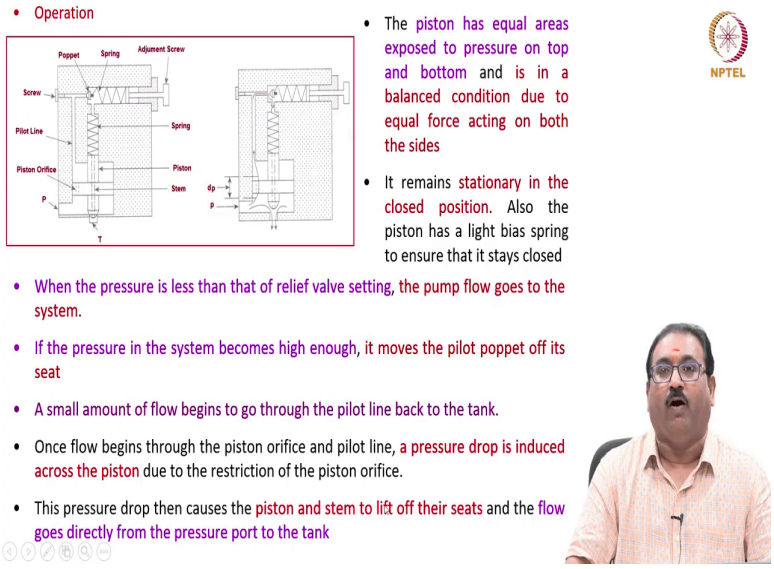

The piston has equal areas. Here you will see this area and this area full exposed meaning on the top side and a bottom side, the pressure going to the system is acting here.

The piston has a equal areas exposed to pressure on top and bottom and is in a balanced condition due to the equal force acting on both the sides of the piston. This side and this side, the oil will enter through the piston orifice, and then it will act over here. It remains stationary in the closed position. Also, the piston has a light bias spring to ensure that it is always closed.

When the pressure is less than that of the relief valve setting, the pump flow goes to the system as I have told you. If the pressure in the system becomes high enough, it moves the

pilot open of the valve seat. A small amount of flow begins to go through the pilot valve to the tank.

Once the flow begins through the piston orifice and the pilot line, a pressure drop is induced across the piston here and here due to the restriction of the piston orifice. This pressure drop then causes the piston and a stem to lift off their seats and the flow goes directly to the pressure port of the tank.

Please understand how it operates. When the pressure here and here, it is same, no need to worry. When the pressure increases here, what happens? The flow is also induced here. Then this pressure will lift the valve element. Then it will starts leaking. Flow is going to the tank. Then the pressure differential between this and this will lift the piston and stem, then flow is going to P to T. This is a constructional future and how it operates.

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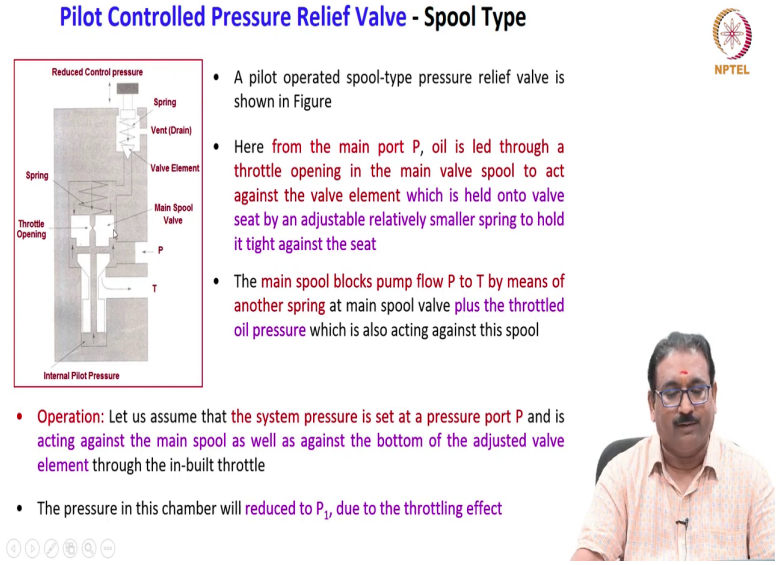

Then similar to that, the spool type friends, spool type. Here you will see the same it is a spool type it is. Here you will see the spool type here. All is a main spool valve and this is what you will call relief valve – small pressure relief valve pilot operated valve here. Again it is a valving element which is held on the valve seat using the spring. And this is a vent correct.

Here a pilot operated spool valve is shown in figure here. Here from the main port, here you will see the pump line is here now. Here from the main port P, oil is fed through the throttle here you will see throttle opening is there whatever the pressure line is there it will go here and it will exits it will come here and it will also here.

Meaning here the valve wing element is fitted over the valve seat by adjusting the spring here, meaning here you will see friends here the pressure here at the main spool and here always balanced that is why you will see here friends always P and T are blocked.

When the pressure in the system increases, what happen? The increase in pressure fluid is also available to the top side. Then what happens, which will lifts, then oil will leaks through this drain. Then due to differential pressure here and here, what happens? It will lift here the main spool valve. Then P is going to the tank. This is similar to previous one what I have explained.

Let us assume that the system pressure is set at the pressure port P and is acting against the main spool as well as against the bottom of the adjustable valve element through the in-built throttle. The pressure in this chamber meaning here will be reduced to P 1, due to the throttling effect, because here fully exposed here but here due to throttling.

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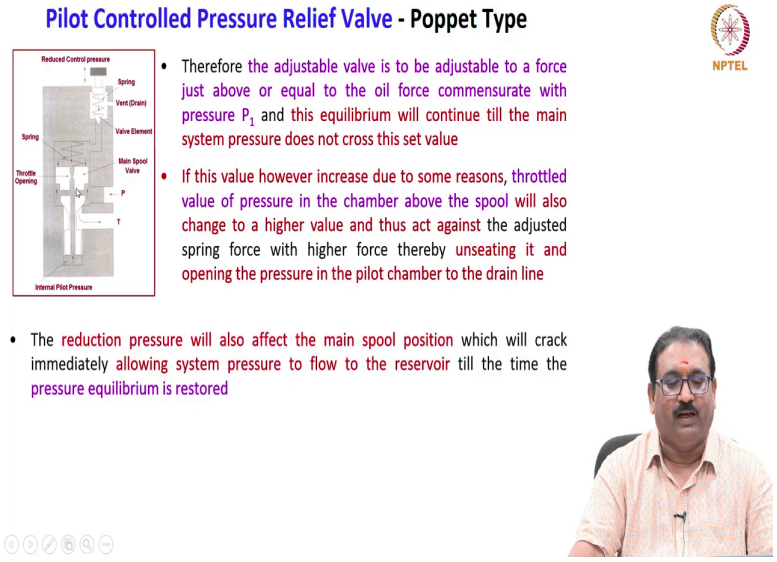

Therefore the adjustable valve is to be adjustable to a force just above or equal to the oil force commensurate with the pressure P 1 and this equilibrium will continue till the main system pressure does not cross the valve setting here. If this value however increases due to some reasons the throttled valve of pressure relief valve will opens. Then what happens? The reduction in the pressure meaning delta P here and here will lift the spool and the valve stem, then flow is going to P to T.

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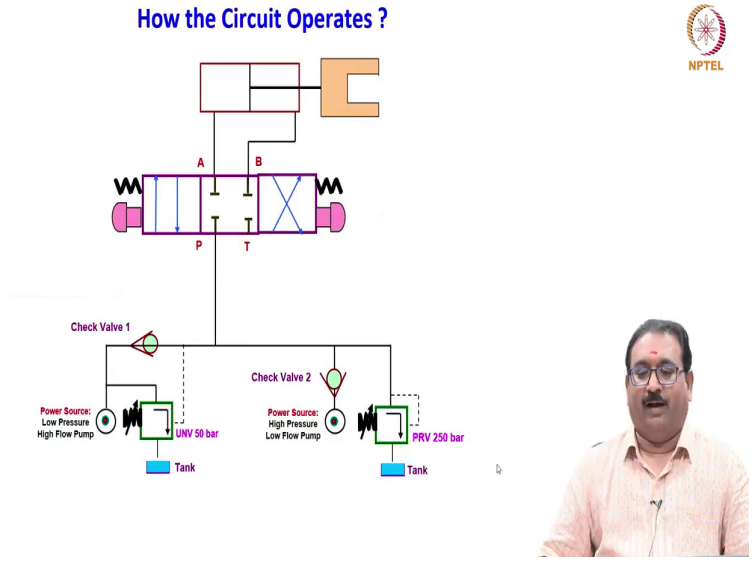

After knowing this, now I will explain to you, this unloading valve in one particular application which is used to control the double acting cylinder. This is a double acting cylinder connected to the 4 by 3 direction control valve, closed center push button actuation, spring centered. And this is connected to the power source 1 – here low pressure high flow pump; and one more is the high pressure low flow pump.

Here I am connecting the one relief valve in which I am opening this valve by monitoring the pressure level here that is unloading valve. I am setting pressure here in the spring 50 bar. And here directly I am reading the pump flow to make the valve open, it is a pressure relief valve.

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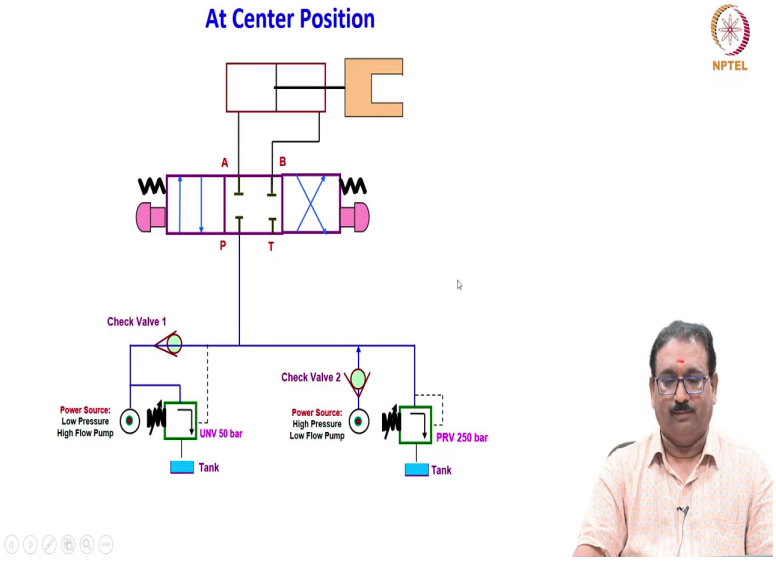

Here I am setting the pressure 250 bar. Then both are connected to the tank. Please note friends. Then we will see what happens, when I push this button, and what happens if I will push this button? Then what is the role of these two relief valve setting? We will see now. At center position, center position, no need to worry friends correct. All the flow will come here accumulate here, correct.

It is not a ideal situation, because energy will go as a waste. But at parallel configuration, when I will press this button, what happens friends? The actuator end will receives the flow from the low pressure high flow pump as well as high pressure low flow pump. Flow will come both, then it will move very fast, because the both they will send the flow to the actuator.

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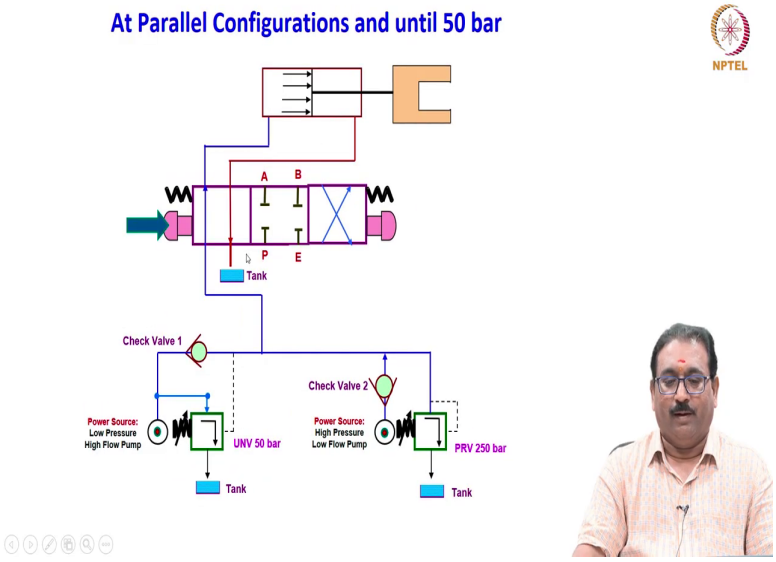

Until how many bar? Until 50 bar, because I have set the 50 bar setting here. After reaching the 50 bar setting, what happen? Automatically this will open. Then whatever the flow is coming from low pressure high flow pump will go into the tank. Only actuator after reaching, it will receives the flow from the high pressure low flow pump, then it will move very slowly as compared to previous one. Until how much it is? Until it is the pressure setting of 250 bar.

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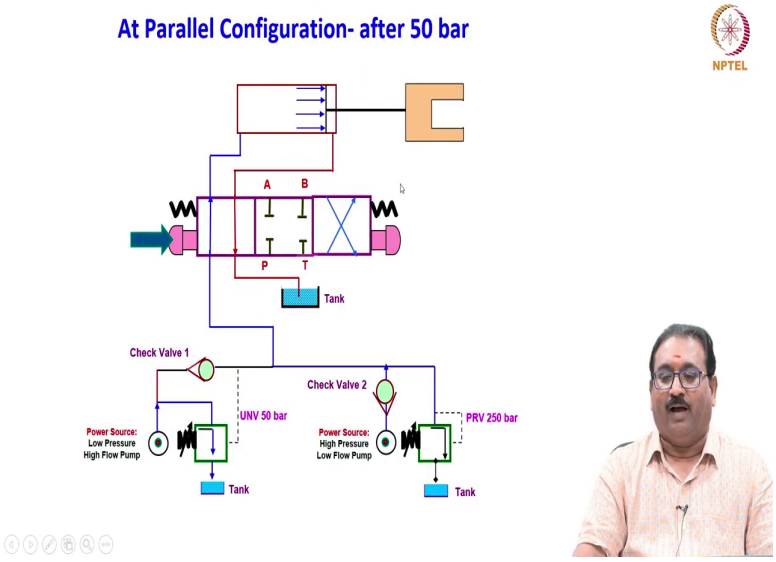

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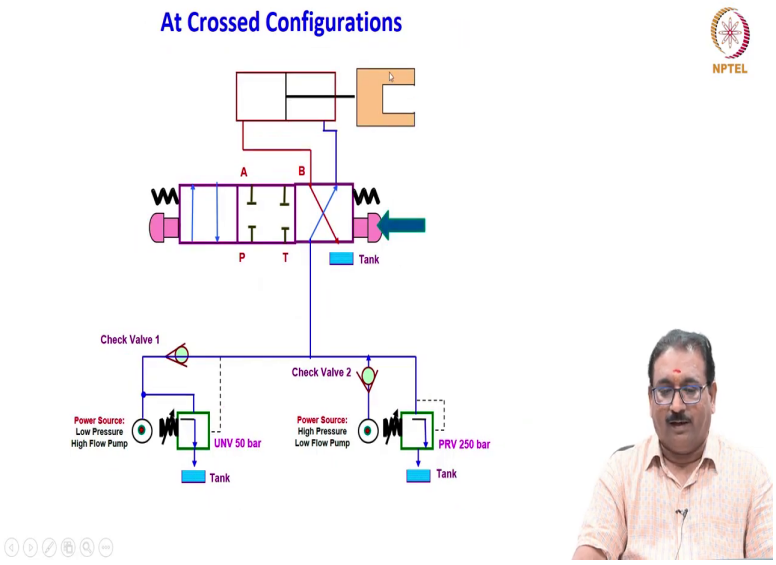

But when you will press the crossed configuration, what happens you will see friends. The both the pump will sense the flow, then actuator will retract very fasts. Until how much? Until it reaches the 50 bar. Once it reaches 50 bar, it will diverts the flow. Then how many pressure it will reaches? After reaching 250 bar, it starts unloading meaning when it is when the actuator is somewhere else, I want to move the actuator very fast that time I am receiving the flow from the high flow pump and low flow pump.

After reaching the work piece, I want to do the particular operation I have to press very slowly that time I am receiving the flow from the low flow pump alone, that time high flow pump is sending the flow to the tank that is the role of unloading valve.