Oil Hydraulics and Pneumatics
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Part 2: Construction, Operating and Application of Single-acting cylinder, Double-acting cylinder, Cylinder cushion
Lecture - 52
Hydraulic Cylinders

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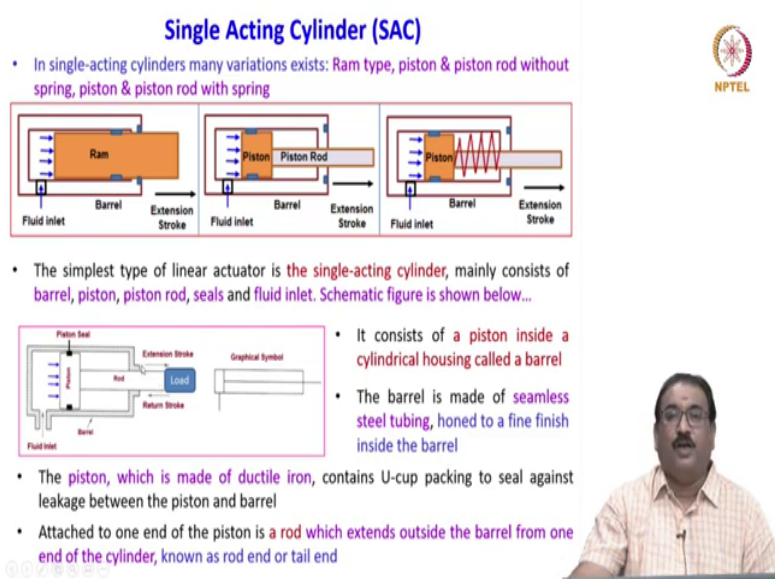

My name is Somashekhar, course faculty for this course. After knowing the details about the seals, we will go one by one the first and foremost thing is single acting cylinders. We will see the constructional details and application where it is used.

In a single acting cylinders, many variations exist for it. The ram type is there, piston and piston rod without spring. Piston and piston rod with spring, the spring may be used to bring back to the original position after extension. Let us we will see now here.

Here the schematic diagrams I have shown you, here it is a ram, the ram diameter is equivalent to your piston rods no piston rod here it is a ram which is moved with the fluid entry. Then no retraction; meaning retraction how it is? This is only by the self-weight, they will mount vertically, ok.

Now, we will see here, here the single acting cylinder because one port is there you will see, always one port, ok. Now, you will see here without spring it is again without spring, only extension with the fluid pressure. Return how it is? No mechanism, only you have to mount it vertically. By self-weight of the piston or the weight of the load it should move, always these two they are using in the vertical direction.

Now, we will see the third one here. The entry of the fluid makes the pistons to move the piston rods, then it will compresses the piston. Once you will cut off the fluid here and open to the tanker atmosphere, then what happen? The piston will move back here due to the spring. Using the spring force, it will come back. You may use this in the best suited for the horizontal direction. Extension with the fluid power and retraction with the stiff spring fixed at the rod side.

Now, we will see the simplest type of linear actuator is the single acting cylinder, mainly consists of barrel, piston, piston rod, seals and fluid inlet, only one inlet here, schematic diagram is shown here you will see. In the course of the study, you are seeing various figures which is comfortable for you, you will practice all sketching the different parts.

You will see here I have shown you the again the sectional view, here the fluid entry and a piston over which a fluid will act then extension will takes place. The retraction stroke is only due to the self-weight, you have to mount this in the vertical directions.

The graphical symbol we will see here, rectangle with one entry only, single acting cylinder. Please remember in the hydraulic circuit you will see only the symbols. That is why you will see the symbol is only one side. It consists of the piston inside a cylinder housing called a barrel. The barrel is made of seamless steel tubing, fine finish inside the barrel.

The piston which is made of ductile iron, containing the U-cup packing to seal against the leakage between the piston and the barrel. Attached to one end of the piston is a rod which extends outside the barrel from one end of the cylinder, known as the rod end or a tail end. Please note here this is a head side, this is a tail side. There are different names are there, as a hydraulic engineer you have to remember all.

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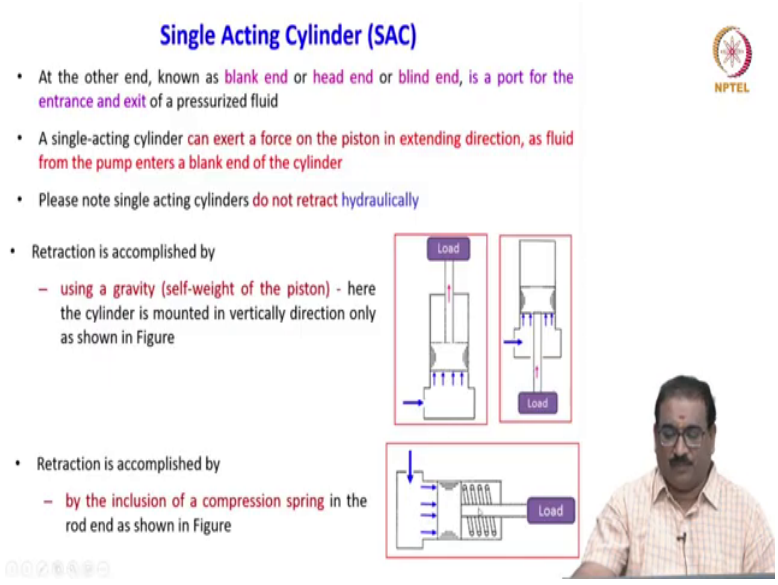

At the other end known as a blank end, also known as head end or a blind end is a port for the entrance and exit of the pressurized fluids. A single acting cylinder can exert a force on the

piston in extending direction, as fluid from the pump enters the blank end of the cylinder. Please note the single acting cylinders do not retract hydraulically.

So, what how to how to achieve the retraction? Retraction is achieved either by using the gravity, meaning how it is self-weight of the piston or a some dead weight. Here the cylinders is mounted in a vertical direction only as shown in figure. You will see here. Here fluid pressure is used to push the load up correct, then return is you will cut off the fluid or take the fluid here, then it will move down, retraction. Similarly, you will see the load is reverse direction here.

Now, what I am doing? I am lifting the load, and pulling the load with the fluid pressure. Please understand this. Then, once you will cut off the fluid here, what happens? It will due to the self-weight it will come down.

Here another method is as I have told you retraction is accomplished by the inclusion of a compression spring, in the rod end as shown in the figure here. In the rod end you will see friends here, the compression spring is there. The only the extension is due to the fluid and retraction is through the stiff spring.

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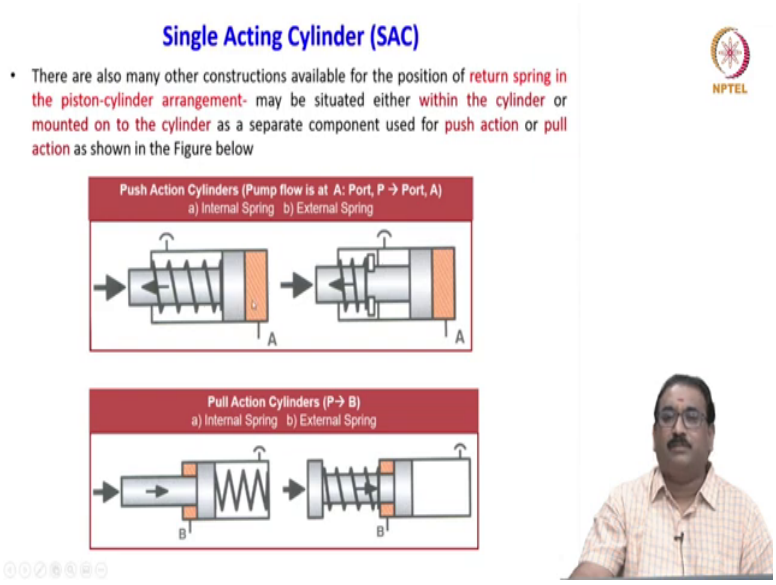

Now, we will see there are also the many other constructions available for the position of the return spring in the piston cylinder arrangement, may be situated either within the cylinder as you have seen, or mounted on to the cylinder as a separate component used for push action or a pull action as shown in the figure here. This is based on the how the stiff spring is placed, you will see now here. Here the push action.

The fluid is used to push the load here. Meaning, the pump flow is at the port A, what you will call the P port. Then, it is a, what is this here? The internal spring here, you will see the internal. Here you will see one arrangements is there, here it is a external spring. See the see the arrangements of the spring here friends, it is a internal spring and a external spring.

Then, you will see the pull action. Now, we will see the using the fluid I am pulling the load attached here, it is a pull action meaning cylinder P port is connecting to B here. Then it is a

internal spring see the inside the body. Here you will see friends outside the cylinder body, it is a external spring. Sometimes the exhaust ports are provided very small ports, ok. They are known as a vent port for the proper functioning of the single acting cylinders.

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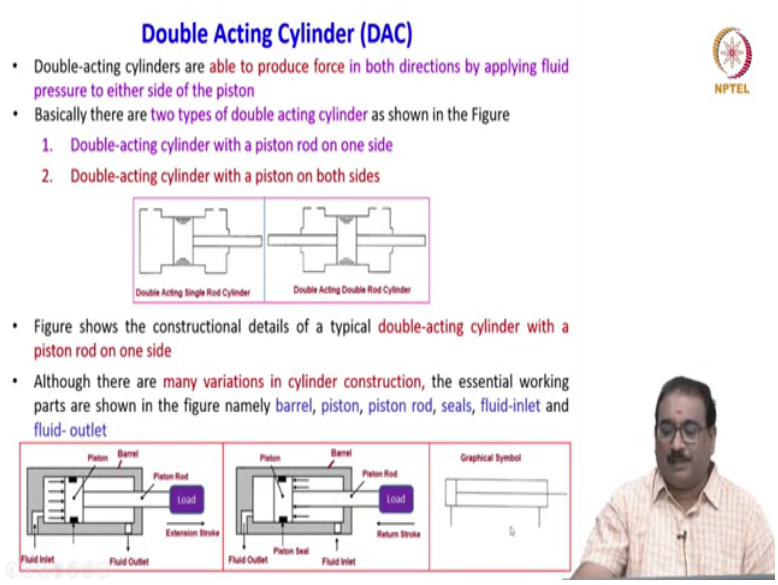

Now, we will go onto the double-acting cylinders. Double-acting cylinders are able to produce a force in both direction by applying the fluid pressure to either side of the piston. Basically there are two types of double-acting cylinders as shown in the figure here. First one is double-acting cylinder with a piston rod on one side. Double-acting cylinder with a piston rod on both the sides, of equal area or sometimes a different area also there, meaning different rod diameter are also available commercially in the market.

You will see here what I have shown you the figure, it is a single rod, only single rod. These are the entry and exits. Sometimes this is an entry it will push the thing here, whatever the

fluid is there it will go here that time is the exit. When you want to return back it is an entry and this is a exit, that is why I am writing in the all the figure entry exit port, entry exit ports, ok based on the movement of the piston and piston rods, double-acting cylinder single rod.

You will see here the rod is on either side. The working stroke you have to use it for the both places, movement of the loads. It is a double-acting double rod cylinders. Figure shows the constructional details of a typical double-acting cylinder with a piston rod on one side. Although there are many variations in cylinder construction. Now what I am telling is here friends you will see here, double-acting cylinder single rod, double-acting cylinder two rod on either side this.

Now, here it is a equal area may some may not be the need not necessary to be always equal area. Based on the customer requirement the rod diameter also varies. Now, we will discuss what I am telling is here the double-acting cylinder with a one rod we will discuss further.

Although there are many variations in cylinder construction. The essential working parts are shown in the figure here. It is a barrel. You will see the barrel and the fluid inlet and a fluid outlet during the extension stroke during the retraction. Now, this is a fluid inlet and this is a fluid outlet.

Please note here, the area over which a fluid acts. Please note here the area over which the fluid acts. It is represented graphically the two lines. If you will put one line it is a single acting cylinder. If you will put two line here it is a double-acting cylinder, it is a single rod. Double rod means you have to put one more line here.

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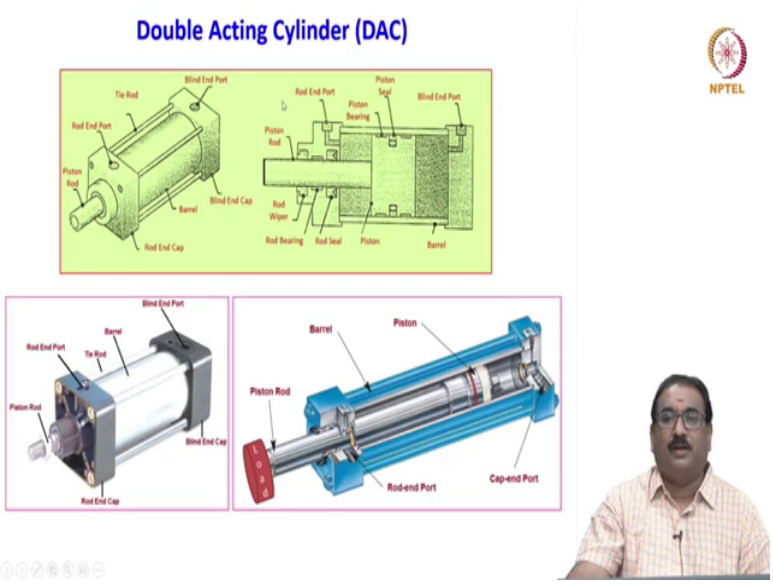

Now, we will see this the constructional details of double-acting cylinder single rod. See here friends how it looks, three-dimensional things I have shown you here. The schematic diagram as well as the actual double-acting cylinder it is a cut section model here. Here it is a piston rod, piston rod, piston rod, which will carries the load here, correct.

The rod end ports, here the blind end port, it is a blind end cap also known as rod end cap, this is a barrel, tie rods you will see the tie rods. The cut section of this I have shown you here, the piston rod, rod wiper, rod bearings, and the rod end port and a blind end port. Here these are the various types of seals. This is a bore diameter, the inside diameter of the cylinder.

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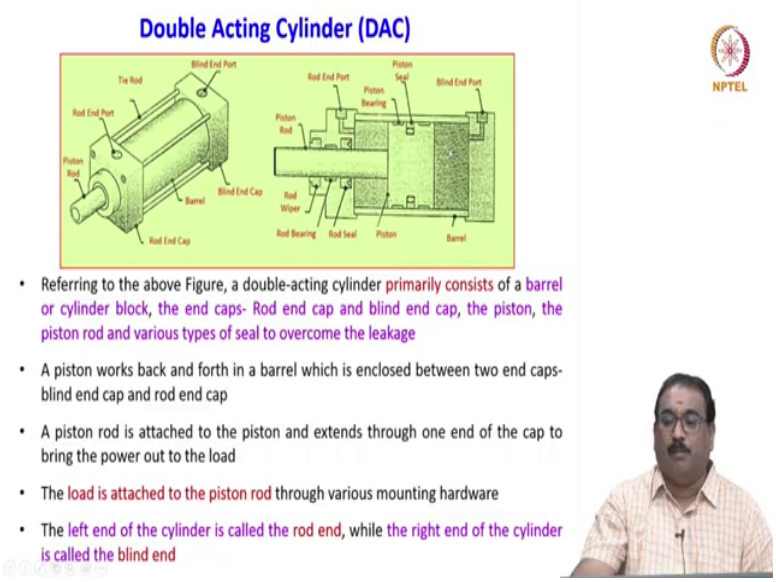

Now, let us we will see very quickly referring to the above figure, a double-acting cylinder primarily consists of a barrel or a cylinder block, the end caps; rod end cap and a blind end cap, the piston, the piston rod and a various types of seals to overcome the leakage.

A piston works back and forth in a barrel which is enclosed between the two end caps blind end cap and a rod end cap. A piston rod is attached to the piston and extends through one end of the cap to bring the power out to the loads. The load attached to the piston rod through various mounting hardware.

The left end of the cylinder is called the rod end, while the right end of the cylinder is called the blind end. You see the effective area how I marked here. The ports are located in the end

caps, the rod end cap ports you will see the port location, the blind end cap which are secured to the barrel by a tie rods.

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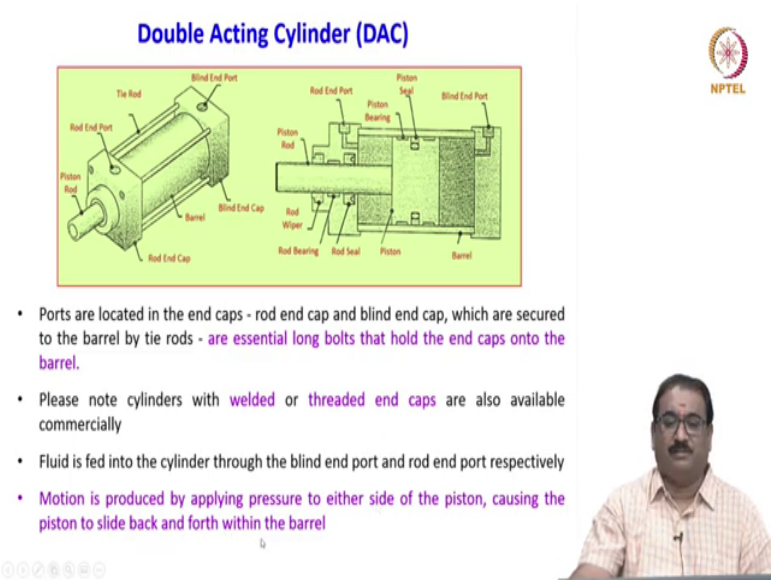

What are these tie rods? Are essentially the long bolts that hold the end caps on to the barrel. Please note friends, cylinders with welded or a threaded end caps are also commercially available. Do not think always that the tie rods they are using, need not necessary.

Fluid is fed into the cylinder through the blind end port and a rod end port respectively based on the piston movements, in turn the load movement. Motion is produced by applying the pressure to either side of the piston, causing the piston to slide back and forth within the barrel.

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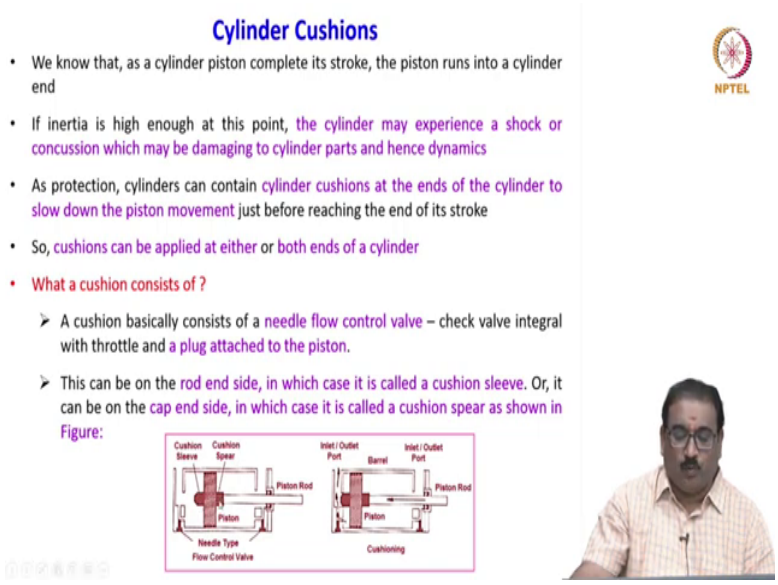

Now, we will see friends the cylinder cushions are playing a major role to overcome the impact of the piston when it reaches the two extreme ends. What are these? We know that as the cylinder piston completes its stroke, the piston runs into the cylinder end. If the inertia is high enough at this point the cylinder may experience a shock or a concussion which may be damaging the to the cylinder parts and hence effects the dynamics also.

As a protection cylinders can contain a cylinder cushions at the ends of the cylinder to slow down the piston movement just before reaching the end of its stroke. So, cushions can be applied at either or both ends of the cylinder. Then, what is this cushion and it consists of? A cushion basically consists of a needle flow control valve meaning a check valve integral with the throttle and a plug attached to the piston.

This can be of the rod end side, in which case it is called a cushion sleeve. This can be on the rod end side in which case it is called a cushion sleeve. Or, it can be on the cap end side in which case it is called a cushion spear as shown in the figure below here. You will see here the two side cushions.

This is a piston, correct. Piston inside the barrel and inlet outlet ports here. Here this side it is known as a cushioning sleeve. This is a cushion sleeve and this one is a cushion spear. How it will work I will explain to you in the next slide. Just you will think here what happens here when the piston rod is moving from right to left here in the cap, they made an arrangement here, you will see here when it is come near to that first cushion sleeve enters the cap.

Meaning it will cut offs the fluid here go to the outlet, then only passage is passed through the check valve which will slow down the outlet flow, in turn it develops the back pressure which will avoids the hitting the piston to this end. Similarly, when it will go it will happen from the cushions spear.

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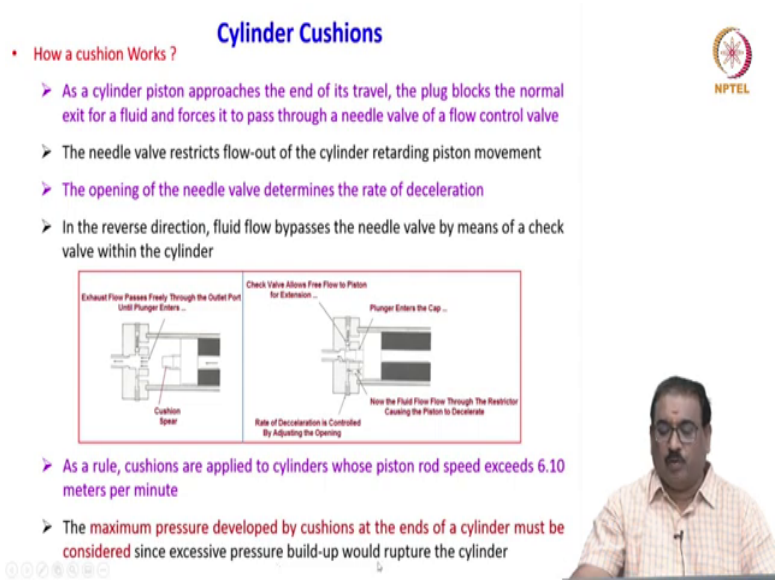

Let us we will see this also. I will explain to with figure. Same figure it is here. Here I am showing you the one side cushion spear, how it will work. As a cylinder piston approaches the end of its travel, the plug blocks the normal exist for a fluid and forces it to pass through the needle valve of the flow control.

When this will move beginning the amount of fluid is passing through the outlet, correct, it is passing through the outlet. As it nears to the cap end what happens friend? This plug enter, spear enters first, then fluid will be blocks, then it will pass through your orifice. How much you are open it will go.

The needle valve restricts the flow out of the cylinder retarding the piston movement. The opening of the needle valve determines the rate of deceleration you slowly you have to stop it or fast you have to pass it based on when this cushion enters and blocks the fluid flow. Then,

only option is the fluid will pass through the opening orifice, meaning throttling how much you are providing.

In the reverse direction, if it starts reversing what happens? The fluid flow by passes the needle valve by means of the check valve within the spear. As a rule, cushions are applied to cylinders whose piston rod speed exceeds 6.10 meters per minute. The maximum pressure developed by cushions at the ends of cylinder must be considered since the excessive pressure build up would rupture the cylinders.

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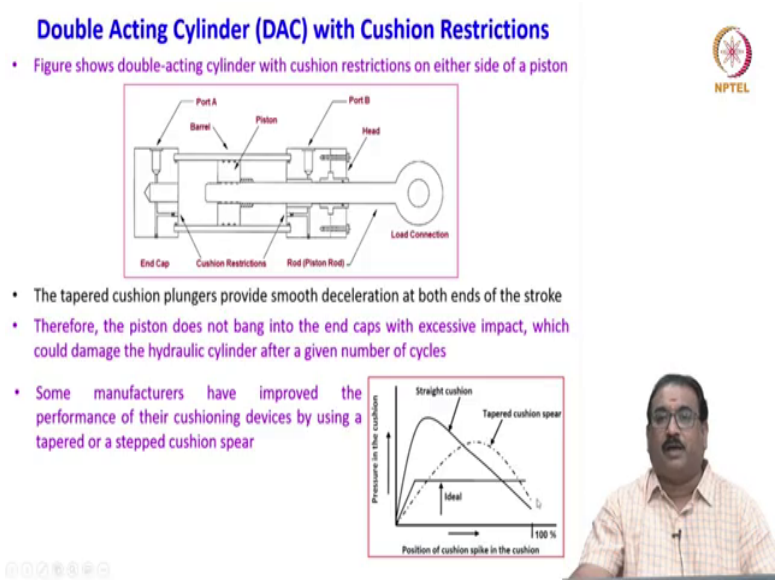

Now, I will show you the double-acting cylinder with a cushion restrictions on either side. You will see here the cushion restriction arrangements what they made here, cushion restriction arrangements what they made in the two end caps, end cap here and the rod end cap how they made the arrangement, ok. Here it will enters.

Now, we will see this. The tapered cushion plunger provide a smooth deceleration at both ends of the stroke. Therefore, the piston does not bang into the end caps with the excessive impacts, which could damage the hydraulic cylinder after a given number of cycles. Meaning when the fluid enters here then it will move here then this tapered end first enters then blocks the fluid then it will pass through the restriction how much it is opened.

When this will move this side again this fluid whatever the fluid is there, first this cushion will enter here then fluid will bypass through the cushioning restriction to the outlet. Meaning both side cushionings are there to slow down the piston movements either extension or a retraction.

Some manufacturers have incorporated the performance of their cushioning devices by using a tapered or a stepped cushioning spear. You will see the pressure in the cushion versus the position of cushioning spike in the cushion.

You will see here the straight cushioning performance you will see here, then you will see the tapered cushioning spear how it is, then you will see the stepped cushioning how it is. Meaning these are very very essential to safeguard the whole cylinder body, cushions are very very essential to overcome the dynamic impact when the piston is moving with the fluid pressure.