Fundamentals of Industrial Oil Hydraulics and Pneumatics
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Module03 Lecture09
Hydraulic Circuit and Valves

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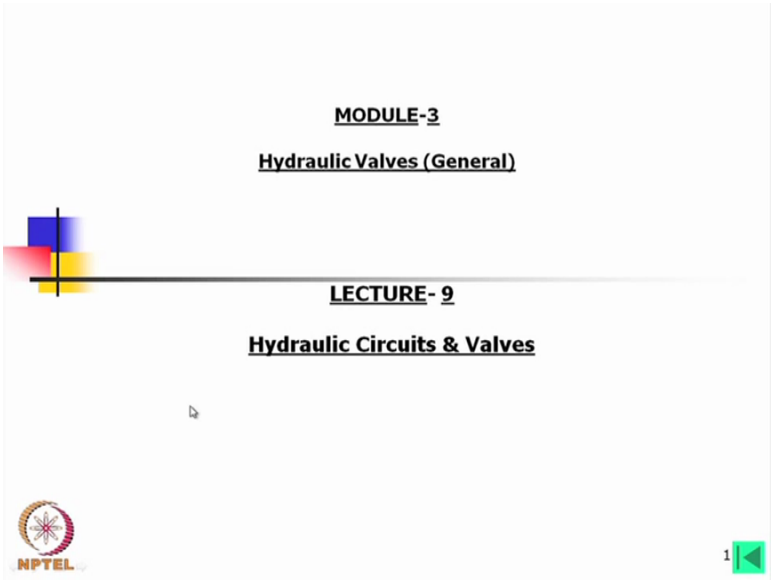

Good evening everybody, todays lecture is hydraulic circuits and valves. This is under module 3 hydraulic valve in general.

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Now today I shall discuss that how the circuit is designed using pressure control and flow control valve or using a set of valves how we can make various possible hydraulic circuits. Some exemplary circuits also will be discussed next. Actually, we can make various circuits in fact whatever work we like to do we have to select the valves and we have to place that valves at proper location to achieve the performance.

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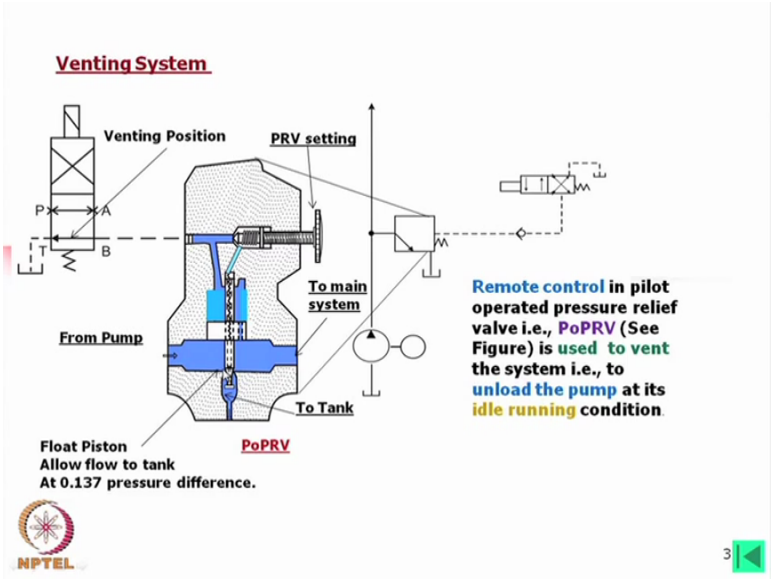

Now first I shall discuss a venting system. This is with mostly pressure control valve. Why I should say mostly, it is with the pressure control valve. Apparently, it will look like a pressure

relief valve, but we will find there is some constructional difference with a ordinary pressure relief valve and these valves what I am going to show in this lecture. Now we know the meaning of venting. Venting means we should bypass oil or in case of gas due to some reason. In this case, venting is done usually when we are not operating the load. How it is done? What I have shown here a circuit.

Here as if this is from the symbols as we know this is a pressure relief valve, okay. Now this pressure relief valve can be operated from the remote by allowing a flow through this valve and then the flow to the main system will bypass to the tank. In more details, the inner construction of this valve, which is being used for venting, which is a pressure control valve. Almost the function is like a pressure relief valve looks like this. Now here first of all if I compare with the circuit then, in this valve usually instead of connecting like this usually there will be through passage that means we can directly put one end of this line here and other end on the other sides. Now I have a written here from pump. So oil is coming from pump and it is going through the main system, okay.

Now what I find inside there, a stem or a cylindrical body is there. In that cylindrical body what we find there is a piston. If that piston there is another hole which is like an orifice, okay and at the bottom, what we find that this passage is connected to another path in which, there is this stem is extended this piston is extended and apparently it is closing this valve. What else we look into this stem that there is a hole also inside and as if some sort of light spring is there. This one is a light spring and there is a hole. That means this is directly connected to end of this, okay.

Now ordinarily this will work as a pressure relief valve, as long as this is closed. Now we should call venting along with this valve, but basically you can say this is working for the venting process. This is again with a non-return valve with a check valve so that no backflow is possible to this side. Now what happens? Let us consider it is initially closed then, the oil is flowing through this, oil is also coming this side. This point is closed that means it can cannot go oil cannot go this side. There is no flow, there is a setting pressure. This is pressure relief setting pressure say 10 mega pascal's. So first thing what will happen when the pressure in the system exceeds 10 mega pascal's then this will open. Once this opens then there flow will be in. As there is a flow in this side then there is a pressure here. So this piston which is having exposing equal areas from both the sides will have a thrust upward.

So with this upward thrust this will move and oil will go to the sorry, this oil from here, it will go to the tank. So this is actually you can call pilot operated pressure relief valve, okay. Now with that how we are doing the venting while we want a venting then a remote control actuates this one then, this is this opens. So venting position opens. Now this venting position opens means the oil start flowing there, but this is not open. Once oil start flowing there, again this will open and this oil will go to the tank. That means at that time it is pressure may not be the set pressure, it is may be below set pressure. Usually it is ideal conditions when we need to vent the oil; this is used with the fixed displacement pump. Why we use fixed displacement pump? This to keep the circuit always ready with high pressure oil and frequent operation is there, but when we due to some reason we want that to vent the oil and we keep on running the pump, but we would like to vent the oil at low pressure, then we operate remotely operate this one and then oil is passing through the tank through these valve.

Now here another note I have written float piston allow flow to tank only at 0.137, it will be mega pascal sorry, this 0.137 mega pascal difference. This is or in other words it is 1.37 bar 1.37 kg per centimeter square. So I have forgotten to indicate that pressure unit, okay. So is that clear to you that how it is venting system is working. Now usually you will find that in pressure relief valve, the construction is almost same only there will be a drain passage are shown. This internal reading is also there in PRV, but sometimes external drilling will be there.

However, another important thing is that whatever may be the pressure this side that will try to pull this one, because if we think of the load balance, this side load and this side load that is a differential load which we balancing the piston in or normal case when there is a no flow equal pressure, but there will be pressure from this side. To balance this there is a hole and other side also same pressure is there. This area and this area is same. So this will at the condition when there is a no flow, it will be in its position steady state position equal force from both the side with the light spring, it is closed and oil is not going through this passage, okay.

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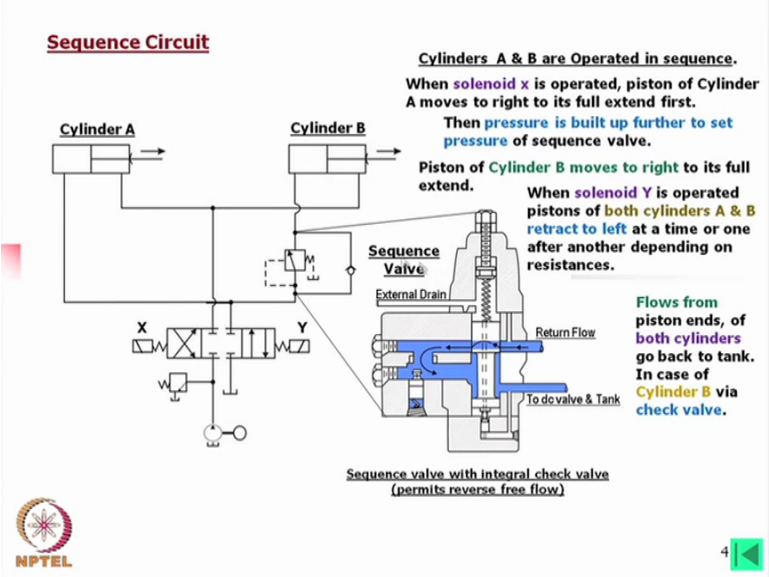

Now we will come to the next operation that is called sequence circuit. Now here I have drawn a circuit you can understand that there is a cylinder A, there is a cylinder B and from 4 by 3 dc valve. This is 4 by 3 dc valve and X,Y are the solenoids we have solenoids both sides and both side we are having the spring that means it is a spring centered, okay. Now this straight connection that means when we will be in the right side then, this is connected to both the cylinder rod end side whereas, for the cross connection this pump will be connected to other side. That means the piston side, okay.

Now cylinder A and B are operated in sequence we need to operate this in sequence either cylinder A first or cylinder B. in this case actually cylinder A first and then cylinder B. This means that if they are of equal size definitely there will be some pressure difference for operations, okay. So what we do we use a sequence valve here. Again it is the basically the principle wise more or less same as that of the pressure relief valve. Now in this case, first of all let me explain the valve. If we consider that the flow say first of all at what time the flow will start. The initially there is no flow, because this is a closed centre, okay. Now what we do we say we have connected the X, the X solenoid is operated, piston of cylinder A moves to right to its full extends.

Now this oil is going like this, this cross connection is there. So oil is going through this. It is going through this valve. It is trying to go here. It also trying to go here. Now at this position

what is there? There is some setting is there this setting is there. So unless we reach that setting this oil will not go through this point. Then pressure is built up further to set pressure of sequence valve. We have set a pressure setting is there. So oil is now will try to pass through this, but it cannot it will move the cylinder A to its extreme positions and now pressure is building up. Once the pressure is build up then oil will go through this, then it will operate the B. piston of cylinder B moves to right to its full extend now, okay.

Then when solenoid Y is operated that means we are allowing oil in the opposite side then, the both cylinder A and B retract to left at a time or one after another depending on resistance. It might be some residual load is there. If they are perfectly alringht, they can return at a time or depending on the resistance, one will return to the other. In that case say this we have connected now this the oil is going back through this one, which is almost no resistance is there. Now this means that this return flow is shown here. Oil is returning here okay, but to go the oil to this side what will happen due to this pressure balance there. It is like a relief valve. This will open this path will be closed and then oil will go to this side that path is not shown of course, but this oil no through this path through this path it will go, this will go okay. This will open and it will go.

Apparently, this position is shown, this oil is passing through it is bypassing not to this passage. It is going through this check valve. This is not very understandable with comparison to this, but actually for operating cylinder B, this spool has to open and then oil will go like this and what the path is shown this is return path, okay. In case of this forward flow to cylinder B, this will be opened which also can be actuated by a remote control. Here, this is this is there; say sometimes we may need to operate cylinder B out of sequence. In that case this path is connected, okay. Now flow from piston ends of both cylinders go back to tank in cylinder of B via check valve, okay. So this is for the return path I have written this note.

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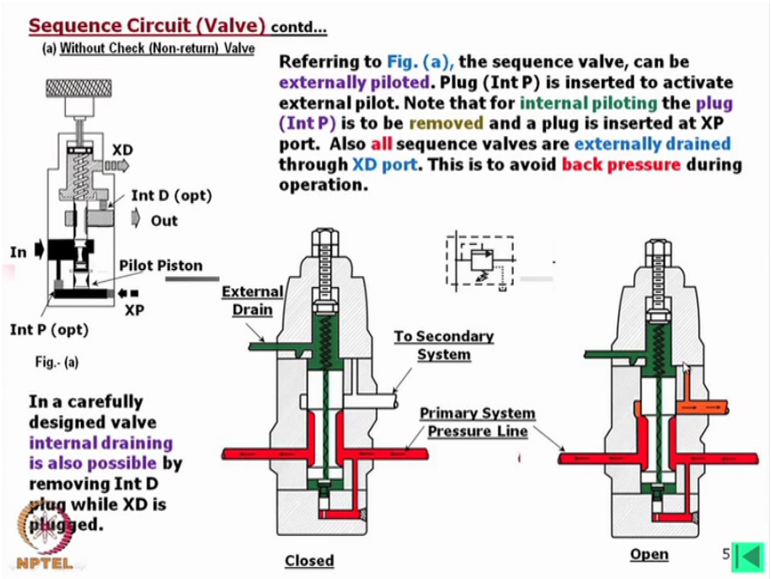

Now we are coming to the sequence circuit valve actually. Now this valve already we have studied that this valve may be without check valve. The sequence valve may be without check valve that is for only one side flow. Of course that we have to see that is when oil is coming back in that case; we have to find out some other path. Here what we have done in this case? We have used check valve which is apparently integral part of sequence circuits the earlier which I have shown. If we would like to use only I mean this valve only sequence circuits without non-return valve, in that case we have to use a separate path for return oil from the cylinder B. That might be low pressure; pressure relief valve that is possible or separately we can connect the check valve there. It is possible okay.

Now this function already we have learned. This is nothing but just like a pressure relief valve, the flow is coming in, okay. Now referring to this figure, the sequence valve can be externally piloted we can externally operate this one. This means that when we are giving the signal here, this is moving and oil is going out, okay. Now basic principle is that here the connection this in case of external operation we have to first of all we have to plug this one, then oil is coming here and this side and this side pressure are same. So it is not moving. Now if I excite externally then this will move and oil will go. At what pressure it will work depending on the setting we have done here, it will work.

Now there is an external drain also. This oil is always will go through the external drain passage. In some cases, this external drain is not prefer and in that case we put the internal leakage path, okay then oil will go through this. Now this is only in one directions without check valve if we look into this, it will operate in the only in one directions. Now if I want to operate this with the internal pilot in, in that case we have to plug this one and we have to open this one, okay. Then oil will come here again we will find this side balance and the there is a very small passage and here is also this is not very clear, but again if we allow the oil from this side also, this will be balanced it will not move, but when certain pressure will increase that means here this pressure differential will be such that it is able to move this one, then again it will open. So in this case what we find both internal and external piloting is possible.

Now external draining. Draining is must to avoid back pressure, okay. Now here I have shown a little detail that if we look into this valve this is closed okay. So flow is coming in we look here the flow is coming in from this side, okay. Now then this is internal piloting, it has come over here. This is being balanced, it is not very clear from this, but it is being balanced by the pressure here and here and also here and here, look into this pressure is going through this, oil is going through this. It is coming over here. So this side and this side is balance and oil pressure is here and here, this side is also balanced unless there is a flow.

Now how the flow will begin? When this pressure reach a certain level so that it can move through this. There will be a little opening and external drain will start flow will begin, pressure will drop here, then this will open. So this is the open position when this is opening then oil is going to this side, it might be secondary circuit. Again here I would like to say that this valve is construction in that way instead of side fitting or tap fitting we can directly fit one side input side here and output side to the system here, okay and you can have a look into the symbol, how the symbol is. Is it clear somewhat, I will give you this picture and you can study this? So system is like that here it is not shown, but here it is shown clearly that there will be a passage, in fact there is also a passage. So oil is going like this oil is going this side.

So initial condition we should draw that everything is red here, but anyway they have used these two colors. So this means that all side pressure are equal it is in balance. When only this pressure exceed to move there will be a this pin is there, it will move and then oil will start flowing through this and then it will go to this path and this is for external draining in any ways it is

shown here closed. In a carefully designed valve internal draining is also possible by removing internal D plug while XD is plugged. We can this is plugged and we can internal D that means we can have this passage connected. It is not shown here.

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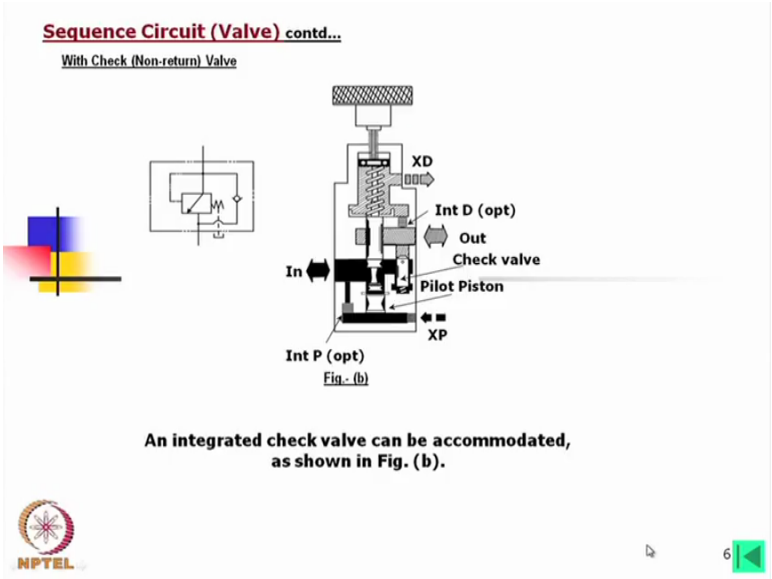

Now this the same valve if you look into this construction what we find here only a check valve is used there otherwise construction wise it is same as before. Now this check valve, once we use this check valve what you find that the flow in from both the sides and out from both the sides. This means that with this check valve we can allow the flow from this side to this side. Now this check valve is operated with the external ports. We externally operate this check valve to flow to both the directions. So oil is going from this side to this side as well oil can come from this side to this side. So this is the sequence valve, which we can use the circuit already we have shown, okay.

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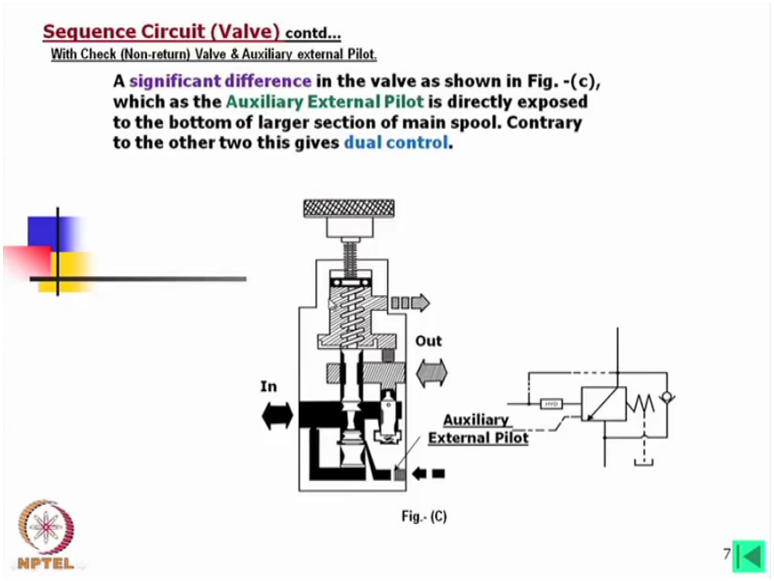

Now in this valve what this check valve is there as well as there is auxiliary external pilot. In this case, what we find this valve is normally with internal piloting, but as well there is also external piloting. This means that we can change the sequence knobs (())(25:36) that means whenever we need we can externally operate that and we can also operate the cylinder B not in sequence or according to our desire, but according to our desire. A significant difference in the valve as shown in this figure, which as the auxiliary external pilot is directly exposed to the bottom of the larger section of main valve, okay. Contrary to other two this gives dual control we get dual control, one is that the sequence what for we are using this valve as well as external control.

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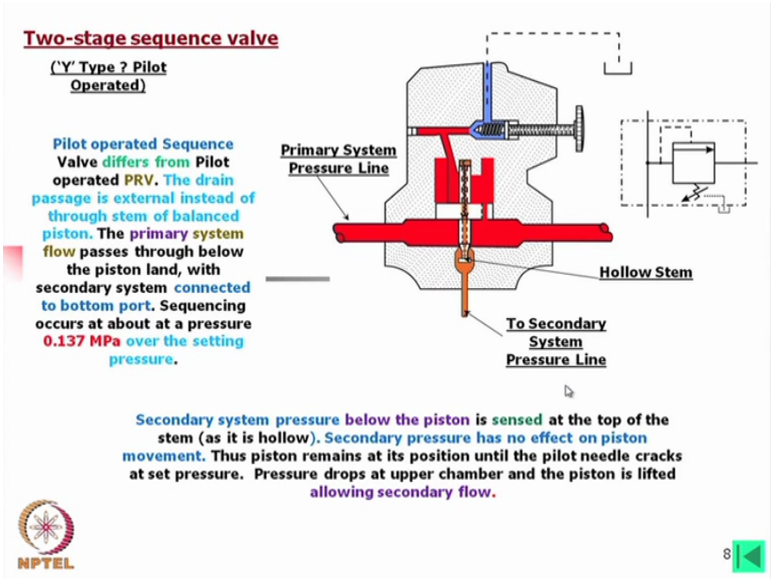

Now there is also a two stage sequence valve. Now in that 2 stage sequence valve, it is also named as 'Y' type. Now here if we look into that venting system, if you remember that venting system. What is the difference between that venting system and this valve can you say? The basic difference is that we do not have connection here, we have an external drain. In this case we have external drain not it is connected to there. Venting system this was connected to there. In pressure relief valve also this connection will be there. Let us read it what it is there. Pilot operated sequence valve differs from pilot operated PRV. The drain passage is external instead of through stem of balanced piston. This is called balanced piston.

The primary system flow passes through below the piston land that means this is the primary system. This is going to the system, okay I have already explained that these are available in the valve system that we can connect direct to the system. With secondary system connected to the bottom port, okay. Sequencing occurs at about a pressure of 0.137 mega pascal that is 1.37 bar over the setting pressures. Now in this case what is happening that we are keeping it closed? Now only when the pressure setting pressure reaches here. In that case, this piston moves and the flow begins to allow to the secondary circuit and here also as I have explained to keep this stem in balance, there is a small hole so that pressure this side and pressure that side remains same, as well there is also spring, because this is actually this will be balanced piston. In ordinarily when there is no flow this is completely balanced. There is no force acting on that except that spring

forces that is just to allowing these two seat on this position. So when this flow is there, the seat is like that.

Ordinarily it will not leakage with a small force it will remain closed and there will be no leakage, okay only if there is a flow, then this will move and this will be operated and for operating this only we need a very small pressure difference and as we need small pressure difference only then it remains balanced for longer time otherwise as we know that once this flow begins this gradually this pressure will also drop, you see in a system once you say in a tank, there is a pressure. Now if you make a hole there immediately inside pressure also will drop. Now secondary system pressure below the piston is sensed at the top of the stem. Here secondary pressure has no effect on piston moment which I have discussed. Thus piston remains at position until the pilot niddle cracks at set pressure and pressure drops at upper chamber and the piston is lifted allowing secondary flow. This flow we call secondary flow that is to the say cylinder B, okay.

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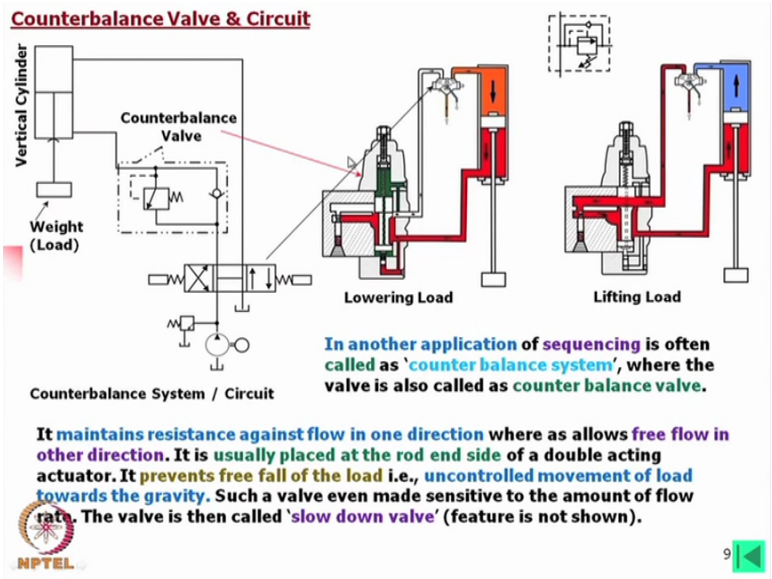

Now we shall study some circuit with pressure valve. This is counter balance valve and counter balance circuit what I have shown. This is the counter balance circuit and system. Now this is also we can call this is somewhat sequencing and called as counter balance system. This system is called counter balance, but the valve principle as you see there is a pressure relief I mean non-return valve and the same as pressure relief valve. So this also some sort of sequencing valve, but

here the purpose is different. In that case, it maintains resistance against flow in one direction whereas allows free flow in other directions. It is usually placed at the rod end side of double acting actuator. This is an double acting actuator and the cylinder we have placed in vertical direction, it can be upside (())(32:14) down also, but this is not for horizontal one.

Normally where we are lifting load there this counter balance is used. Why the counter balance is used? This prevents the free fall of load that is uncontrolled moment of load towards the gravity. What will happen you know that you have must have seen in a crane, suppose when we release the break of the load lifting hook or the drum then, it will start falling and as you know due to the gravity, it will start accelerating and when it touch the ground, there will be savior impact. To prevent that we must control the load in that case. In case of crane mechanical system we use the break. There is a break that when it start falling at higher speed automatically that break will be engaged. Once this is engaged then again the force will act on that to release that one and the load will fall and by that they it will balance, it will control the moment, okay.

Now this circuit is shown here, it is something like that. So when it is lowering load, let me explain what it is there? First of all we have used a dc valve directional control valve which is fully open and again it might be solenoid, I have not shown here it might be manual or it might be hydraulic that does not matter, but what we have used here, this is a open centre valve. Now this flow is normal conditions when we will not operate this valve, then oil will go to this. Now this is again we do not need very fast response here, we can slowly lift the load and lower the load. This purpose is main purpose is that handle this load not very fast operations. So we can go for open centre to save the energy, right.

Now we are now think of lowering load, because that is the main purpose. So while we are lowering load we allow this to tank. That means we will go to the left hand side. So it is connected to there, I mean this side is connected to the tank and the pump side or pressure side is connected to the other way. Now while this load is being lowered how much pressure we need. Practically we do not need the pressure what we need we need the flow; because this is to be filled otherwise it will not move. One the other hand to prevent the load free falling this oil will try to come this way, but it will not be able to go, because this is a non-return valve, then oil has to go through this pressure relief valve and the setting is such that depending on this load this

setting is there. So this might be again controlled from the remotely controlled and the load will come down by blowing this valve that means there will be restricted flow.

Now if there is a suppose if it wants to speed up then there will be due to this flow we need to have pressure increase in that again this will be closed. Now here we have seen the we have shown this valve. This is the direction control valve here and this is the counter balance valve. This one is the counter balance valve. Now what is happening that what I have explained if you look into this then oil is through this valve is going to this side whereas oil coming through this and through this restriction, it is going to the back to the tank. This is tank path is not shown, but if you look if you study this, this is nothing but some sort of a sequence valve. Operation principle is same and here as well you can see that external draining and internal draining is shown. If for external draining we have to open this, we have to close this. This path is there and as well as also internal piloting and external piloting is also possible. So this is basically a sequencing valve, but application is different.

Now also it is possible that while we are using this valve we can use another valve, which is called slow down valve, but the feature is not shown. In that slow down valve, it is a there is spool that with the increase in velocity that spool will experience a load and that will close the path. Once it closes the path again the velocity of fluid will decrease again the force will reduce and that will open that is a very simple in comparison to that, but this is having the external control, but that valve is not having external control. Usually that slow down valve is used where the loads are limited, say in case of truck (())(38:32) when the load is being lifted there we can use that slow down valve, but that feature is not shown, but basically that is also called counter balance valve.

So at least you can understand what is counter balance valve and what is their applications. Now if I here perhaps it is why is to discuss that in your question what will be there, say probably you have to the what is short note or may be a part of the question is that what is counter balance valve? Explain with a circuit? You can draw a circuit and you can explain this few words, okay that you have to first of all you have to understand how it is be working. Internal feature of this valve and how it is working, okay.

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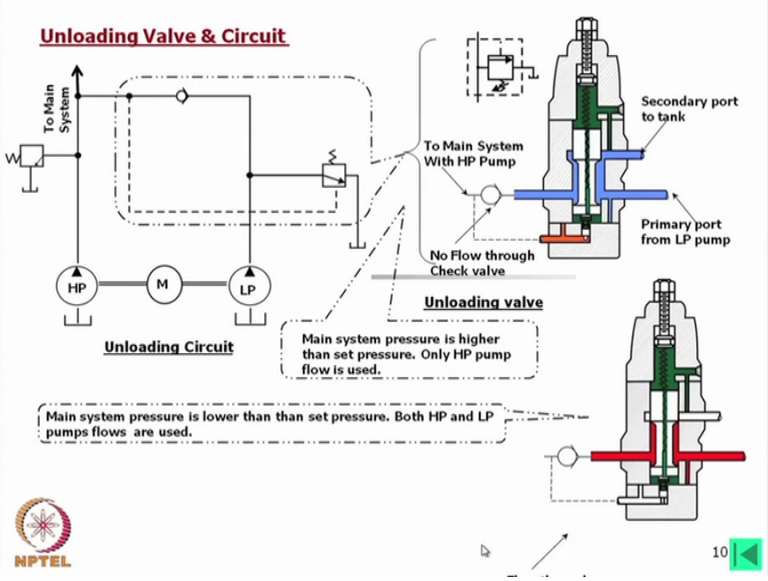

Now we will go for unloading. That was a counter balance, now we are going for a unloading valve. What is unloading? Now usually in any fluid power system we need to go for energy saving process. Now in many operations you will find that there is sometimes a we need to actuate more load and other time may be lower load. Once there is a low load, I mean low consider load, then we can increase the speed we can have this, because we have a fixed motor. That motor full energy we can use for that purpose. If it is allowed that we can move the load at higher speed then in that case, there should have some system that we can either control the flow or we can have system when there is a high pressure only certain amount of flow, when there is a low pressure we can increase the flow. That is possible variable displacement pump, but variable displacement pump is costly, expensive as well as that control is also difficult in comparison to this system where, there is a high pressure pump and there is a low pressure pump.

Idea is that when there is a load is more than full power of this will be utilized full or the maximum power will be extracted from this motor to run the HP motor and that will work and load will move at slow speed and then, but this is connected to low pressure pump also. This low pressure pump oil has to go somewhere. What it will do? It should bypass the oil, it should drain the oil at a very low pressure relief, but if we use that very low pressure relief here then again it will not be work when we need this flow. Suppose the load has decreased, in that case it should automatically work such that both this flow and this flow should mixed up and should operate that one the load.

Now let us see what is there. This is call unloading valve. Now what I have shown here, say this unloading valve. This is the symbol and we can see, this whole unit is called unloading valve, it is also a pressure relief valve, but it looks like this. Now primary port from LP pump. Basically here what we are doing this unloading means we are unloading the flow of low pressure pump to the tank. This is the purpose of unloading. It is no connection with the high pressure pumps. Now how it is working? Now you have to compare this with this figure. This is the check valve and this is the connection to this to operate this one. This is the pilot connection.

Now this primary port from LP pump is connected to here. So ordinarily when this is a high pressure. This is blocked, the no oil is coming to this side, but only it is remotely trying to control this valve, okay. Now again this pressure is not sufficient to open this one. If it is not sufficient to open this one then this will remain closed, but if there is a high pressure this will be this will open and then oil will go to this. Is not it (())(43:33) say let us consider that this pressure setting here is 10 mega pascal and system pressure is more than that, then this is not being operated sorry, I have made a mistake , this is 10 mega pascal, it is working at a high pressure. Now the same pressure is coming over here and then at that condition, this is being opened rather this is being opened. Do you understand? Pressure here more than here the setting is 10 pressure pressure here more than 10 mega pascal's. So this si being opened 11 mega pascal. So it will open, so flow is going to this and so this is unloading. This coming from here to here.

Now this is secondary port to tank. Now this is the main system I have already discussed. Now main system pressure is higher than set pressure, only HP pump flow is being used. So no flow through this check valve and this is being operated, I have discussed already. Now we will come to the other positions. Now suppose this pressure has come down below this set pressure, say it has become 9 mega pascal's. Once it is 9 mega pascal's, then this cannot open this valve, okay then this flow can go through here it will be mixed up. Now it should be it is interesting that this is a basically low pressure pump and usually this is a high flow and this is a low flow, but it is like that when this will operate and this will operate at pressure say, setting pressure below 10, then total power of this will be equal to the motor power. So this is by this way we use I mean optimize the energy consumptions. So this means that unloading valve is to unload a usually a low pressure pump when there is a high pressure and load is being used only from the high pressure side. Now this is one application. Here might have some other applications also, okay.

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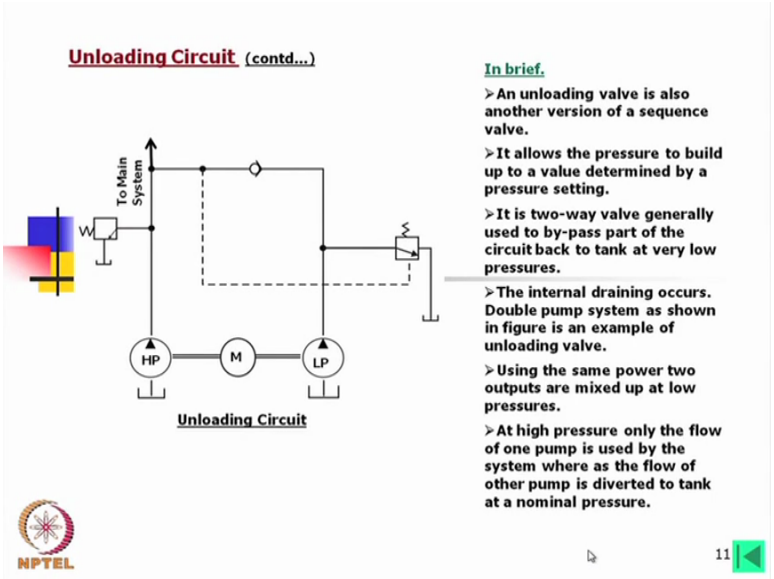

Now in brief we can say that an unloading valve is also another version of sequence valve what we have studied earlier. It allows the pressure to build up to a value determined by a pressure setting, okay. Then it is 2 ways valve generally used to bypass part of this circuit back to tank at very low pressure. So 2 way means that we have shown that there is a passage which interconnected and it is also connected to the high pressure side and low pressure sides. So construction wise it will be slightly different from the sequence valve or pressure relief valve. The internal draining occurs and double pump system as shown in figure is an example of unloading valve. This is one example, using the same power two outputs are mixed up at low pressures and at high pressure only the flow of one pump is used by the system whereas, the flow of other pump is diverted to tank at a nominal pressures.

Now again I would mention here that what might be the type of questions, you have to draw a circuit like this, you have to write this few words and if it is additionally mentioned, you have to draw the internal features of that valve. Now usually if the internal features of the valve are asked to draw that is usually a full question, but this might be a part question or short note type questions. So again I suggest you to read it thoroughly to look into the construction of the valve so that if you ask to write that you can write these words and as well as you can show this figure.

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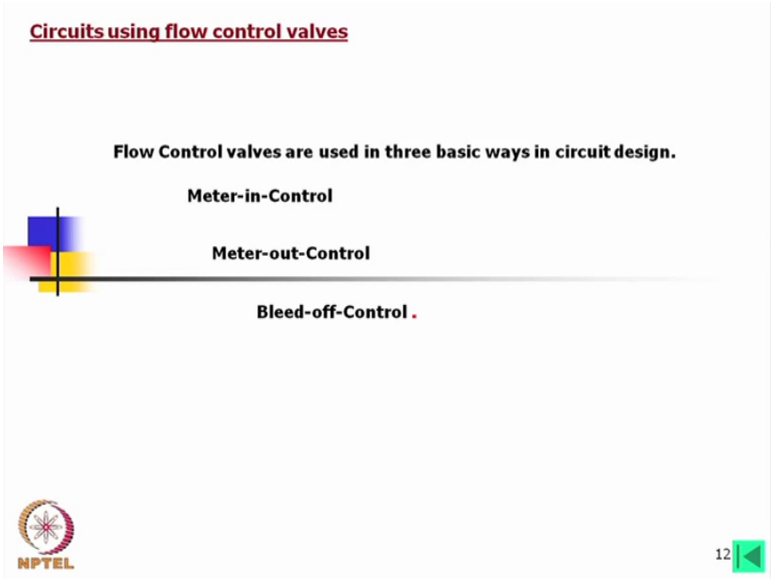

Now next circuits using flow control valve, so far I have used that pressure control valves. So now we will come to flow control valve. Flow control valves are used in three basic ways in circuit designs. One is that meter in control, you understand from the words that meter-in-control that means while we are allowing the flow inside the system, it will be metered. Then meter-out-control and then bleed-off-control. These have specific applications.

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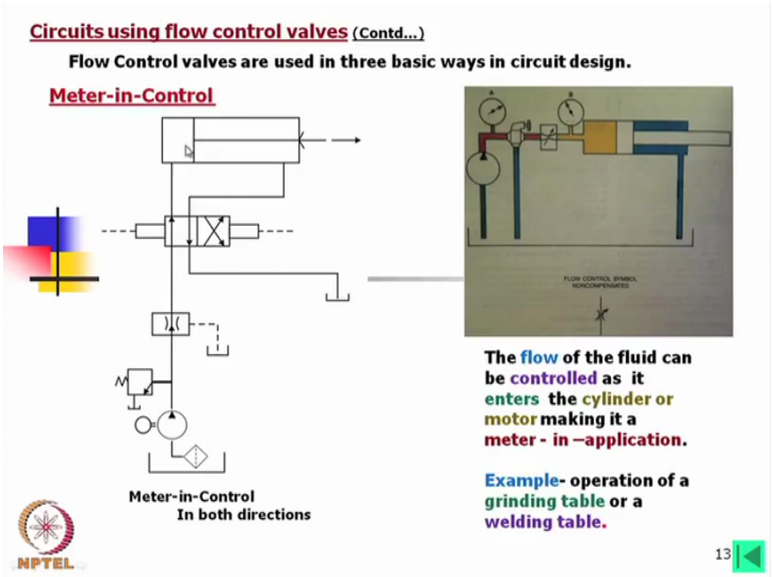

Now let us consider the meter-in-control. In that case what we find what is this valve? This valve is 4 by 2 valve, it is just operating this double acting cylinders but we have put a flow control

valve inline, okay. Now the flow of the fluid can be control as it enters the cylinder or motor making it a meter-in-applications. Example, operation of a grinding table or a welding table. That means when we are grinding we need to control the speed while the grinding operation is being done whereas, for the of the other on the other hand, it can move faster. In that case although there is the control I mean it is a this control in both directions, but at that time there will be low pressure. So and also as well as the area is less in that case it will return very fast. So while it is grinding or welding that will operate at slow speed and with a controlled flow.

Now this is a picture as you can see, the high pressure oil is going and then it is being controlled. Always you should remember that when this is control mean this side pressure becomes equal to the pressure of this relief valve set pressure say, if it is a 10 mega pascal this side 10 mega pascal. Whereas, this side it will be less pressure will be less.

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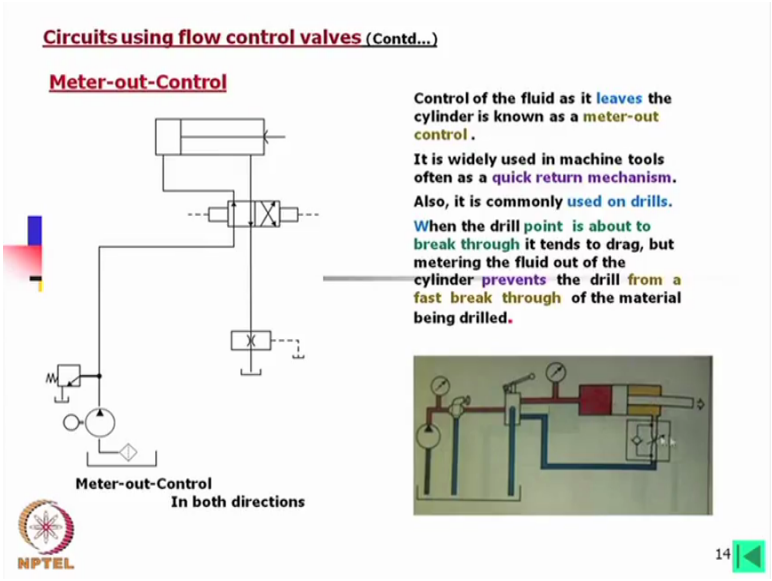

Now meter-out-control, as you see that you have used the flow control valve in other side. Now meter-in-control that fluid leaves the cylinder with a control flow is meter out. Now it is widely used in machines tools often as a quick return mechanism, because we can control this and we can vary this return time. Also it is commonly used on drills. When the drill point is about to break through it tends to drag, but metering the flow out of the cylinder prevents the drill from a fast break through of the material being drilled. This sentence it might be difficult to understand, but I am explaining that this is like that, while this is being operated, this side pressure and this

side pressure will balance this force. That means this is not for the rotation of the drill, rather the feeding of the drill.

Now this is controlling the force, but still it is moving in the forward directions not applying much force only it is applying the required force. Suppose there is it requires more force, then this will be controlled in such a way that there will be pressure difference and force will drive the drill through pass through that. So usually this is again we should have better knowledge of cutting material removing process by drill. In that case what happens when it gets struck, then there is a back force on the drill. So to this can be controlled better way by meter out, okay. Now this is again a meter out circuit, you can see this how this is a pressure this side, there is a low pressure this side, because of this flow pressure will be, but still pressure will be generated if we do not use this one no pressure will be there, but if we use this flow control valve, there will be pressure as well as the motion will also be controlled.

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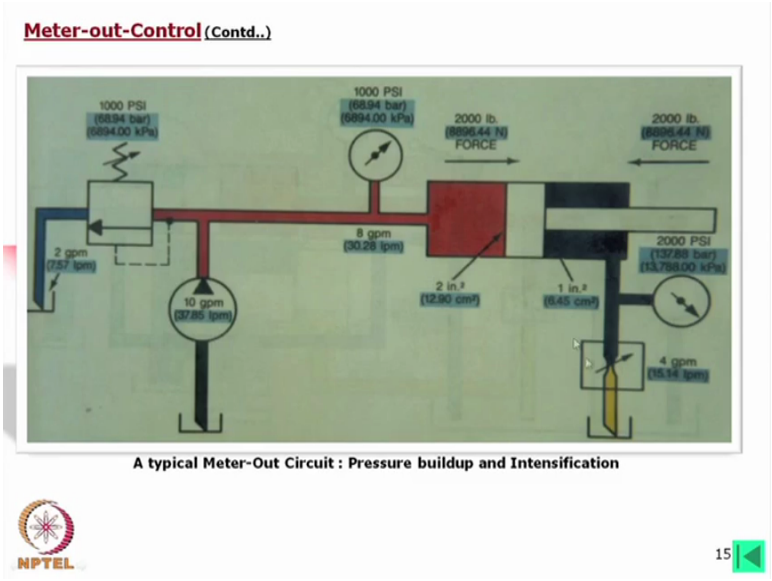

Now here I have shown you can see this figure, I will give you the note from there you will have a better understanding, but if you look here that it is 1000 PSI this pressure relief valve set. Here it is a 10 Gallon 37.85 liters per minute flow is there and here pressure is 1000 PSI setting pressure. So as this is a flow control valve, it will normally go to the set pressure and there will be some flow from this side, because this is being controlled position is being controlled. So some flow has to go this side and it is at whole pressure.

Now here the two inch piston. Therefore, force is 2000 pound. Now this side in normal codes, it can go upto 2000 pound that means here pressure if you look into this. This will be very high pressure this side, because there is a only one inch piston. This rod will be subtracted from the pistons. So what will happen in normal codes when the drill is moving) if you have operated a drill if the material is good you will find an drill is properly surf (())(55:05) and you may not applying much forces, but whenever a due to some reason or you have given a more feed by hand , you will feel that it needs more force. Once it is there then there will be force balance and this motion will be restricted, it will not be moved further as well as this pressure difference will be there. So automatically again it will try to give more force, but it will not allow much moment. So it is the meter out is the meter out is used in this way.

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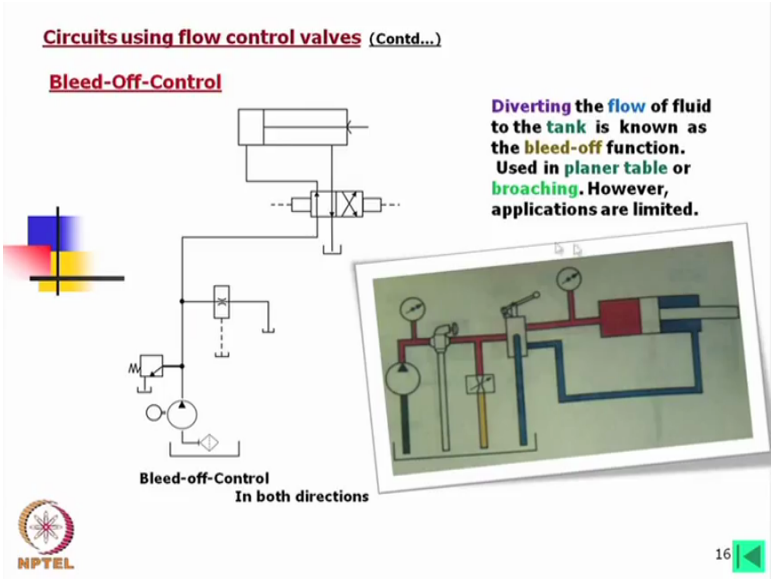

Now we will come to bleed-off-control. In bleed-off-control what we find that this is externally we have used a flow control valve. Now if we operate this one then flow will pass through this valve and this can be used for both directions while that means this is a combination of meter in or meter out, okay. What we can do instead of allowing control flow we are controlling the drain flow here. Now diverting the flow of fluid to the tank is known as bleed-off functions used in planar table or broaching. Broaching machines and planning table, you would have seen, in case of planning machine or broaching machines what moves. In case of broaching machine of course the broach moves. In case of planar table, the table moves not the job and if we in brief if we study. So this is a bleed-off circuit is shown here.

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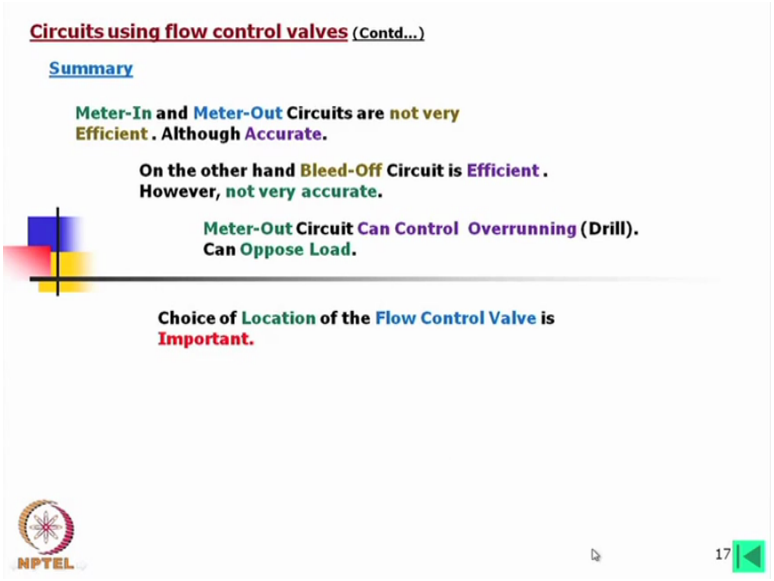

If we in summary we can say that meter-in and meter-out circuits are not very efficient although accurate. These are not efficient not energy efficient we must say, but these are accurate operations both meter-in and meter-out. On the other hand bleed-off circuit is efficient those are efficient, but not very accurate we cannot have accurate control over there. So we must think of specific applications. The meter-in circuit can control overrunning only this meter-in circuit that can overrunning say in case of drill what we need and can oppose loads, as I explained little bit and in other two cases that mean meter-in and bleed-off, they cannot handle opposing load, I mean if the load is there then, they cannot make much control over that. Only they can control the flow.

The choice of location of flow control valve is important. We have to put these valves in proper positions to make it meter-out, make it meter-in or make it bleed-off. So may be the same flow control valve you are using and the same circuit, same cylinder, but using this flow control valves at 3 different positions you can make meter-in, meter-out and bleed-off and you can handle the load in different ways depending on the purpose. If you look into the planar machines, there is purpose is different, if you look into shaping machines, where the tool head is moving there is it is different and load is also different. In case of drilling as you know that if you allow the feed is increases then more load will be experienced and particularly at the time of break through means when the drill is being finished, suppose we are making a through hole you may not get problem when while it is a mid-positions, but when it is just finishing the hole that time

you will find that it is required extra load and thrust. So and it is going for overrunning and at that time meter-out flow will be the best. So thank you, here we end todays lecture.