Industrial Instrumentation

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Lecture - 39
Control Valve - II

Welcome to the lesson 39 of industrial instrumentation. In this lesson, we will continue with the control valve. So, control valve we have started in lesson number 38. So, in the lesson 39 also we will continue we will go in the deep details of a control valves, because as I told you earlier that the control valves actually means the final control element in any industrial process. They are actually, whatever the measurements techniques we have seen or we have studied so far like temperature pressure flow pH humidity so many so on and so forth.

We will see that ultimately is to all these things are basically and this measurement is necessary to control the temperature control the flow control the process parameter. So, basically I mean the either you can make the heater power control, but most of the cases we will find that we have to control a flow whether it is a gas fluid it does not matter. So, we will control the flow. So, by controlling the flow I can control the temperature by controlling the flow I can control the level and so on. So, we will continue with the control valves. So, this is the control valve 2 of lesson 39. Let us look at the contents control valve 2.

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Contents are types of control valves. We have seen that we have we have last time in 38. We have seen that we have considered there the equal percentage valve and quick opening linear, but those are not the types of control valve. Those are basically the characteristics of the control valve I mean flow characteristics. But there was versus the stem movement. I mean if you vary the stem movement how your flow characteristic varies? Accordingly with the equal percentage linear or quick opening, but the overall the different types of control valves are available in industry. So, we will study those in details in this particular lesson.

Types of control valve that is the contents then control valve selection how you will select the control valve? This is the very important criterions how we choose the control valve, because you will find the varieties of the control valves in the process according to need we have to select the particular control valves. Then the cavitation is a problem you will find in industrial process that it is you must prevent. We have to prevent the cavitation otherwise that the erosion of the control valve will start and is very common in a petrochemical industries or hydrocarbon industries.

Where you will find that whenever there is a pressure drop, because always you will find and in this suppose in the, for an example that LPG plant when the liquid petroleum gas is flowing through a pipe. So, there is a mixture of the liquids and the vapour gas, because the now, when it is passing through a control valve there is a differential pressure. So, upstream pressure is slightly higher than the downstream pressure. Now, whenever this the liquid will flow through this one. In the downstream what will happen due to the low pressure there is a large vaporization of the liquids into vapour.

And those will I mean start to flow in a high speed, because the pressure is there. So, all these things will make the problem. We will study the details of the cavitations in the control valves. There is a formation of the bubbles then the collapse of the bubbles all these things will create lot of erosions in the controller. And usually there is no way that you can you have to make either routine maintenance or replacements of the control valve or by any means of the others by some means of other you have to stop this cavitations. One of the good example, you will find in the process industry that an LPG plant you will find that suddenly a control valve stars to what happens?

So, you see that valves starts to sweating in the outside. It will you can see that the control valve outside is moist you can immediately say that the cavitation is started. That means, the liquid is flowing with the high velocity on a downstream I mean the gas is flowing. So, there is a fall of temperature that is there is an outside air is condensed. Outside I mean your humidity is getting condensed form and it is depositing on the outside body of the valve. So, this is one very rough estimate or rough I mean indications of that the cavitation will start within the control valve.

Then we will start we will study the control valve accessories. There are various accessories, but we will find that the valve position is one most important thing you must learnt. Because valve positions will give you we will eliminate the hysteresis of the valve of the stem of the valve. As well as it will make the make the precise control of the position, which is not there? So; that means, hysteresis can be completely removed if you use a valve position it is additional control excuse me, this is additional control it is basically a proportional control. We will find it is working as a cascade control in a with the main control look. So, it will make the better positions of the stem of the control valve.

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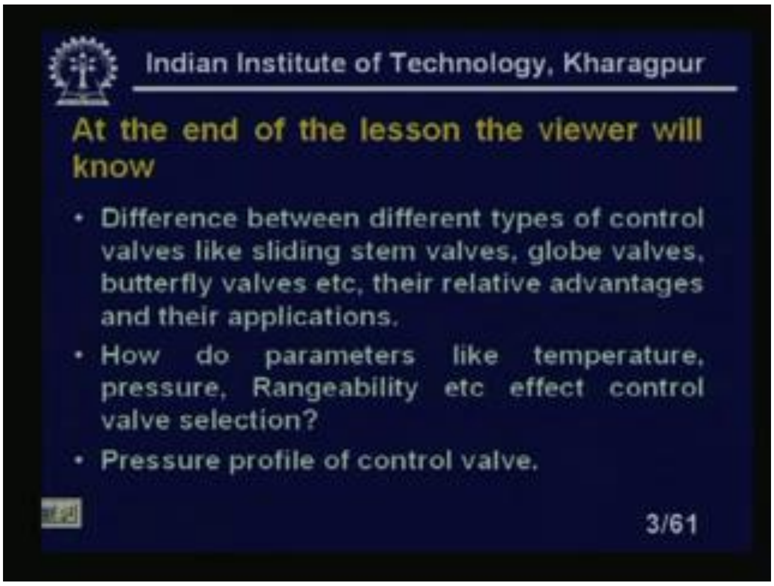

Now, at the end of the lesson the viewer will now, the difference between different types of control valves like sliding stem valve, globe valves and butterfly valves etcetera and their relative advantages and their applications. So, with this will know because, these are the different types of control valves available. Globe valves, butterfly valves. I mean this will study in details and relative advantages and disadvantages and typical applications in the process industry. How do parameters like temperature pressure, rangeability etcetera effect the control valve selection?

This; obviously, come in the selection of the control valve how the temperature pressure of this rangeability? Rangeability means total range or the capacity. Sometimes we call capacity of the control valves, sometimes we call rangeability these are same basically effect the control valve selection. Pressure profile of a control valve, that means, how what is the pressure profile? How does it look? The pressure profile as you go we have seen that in the case of orifice there is a pressure profile. Similarly what type of pressure profile exist inside the control valve if you if I proceed from the upstream.

That means, from inlet point to the outlet, how the pressure inside the control valve looks like? That is actually we will also look at. Advantages of the valve positioners as I told you this is the necessary. So, what is the valve position is the necessaries for the control valve? Actually it is installed fixed to the control valve itself; that means, that pneumatic signal control signal will not come directly to the control valve it will come first come to the wall positioners. Wall positioners will make some additional control signal which will we to correct the according to the positions, it will make some signal that will go the diaphragm of the control valve. The diaphragm all this things we have studied in details in the case of the lesson 38.

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Types of control valve; let us look, at control valve here means any power operated valve whether used for continues or on-off control. We have control valve usually, but mostly we are talking of the pneumatic control valve. Even though we are saying the control valve means any power operated valve because I need pneumatic power from a control. I need a electric power in the case of solenoid valves, solenoid valves usually it is on-off type of valves that we are not discussing. We are discussing basically control valves control I mean we are basically discussing the pneumatic control valves. Excluding varieties such as motorized gate valves plug valves pinch valves etcetera control valves can be broadly classified into 3 main categories. What are this 3 main categories?

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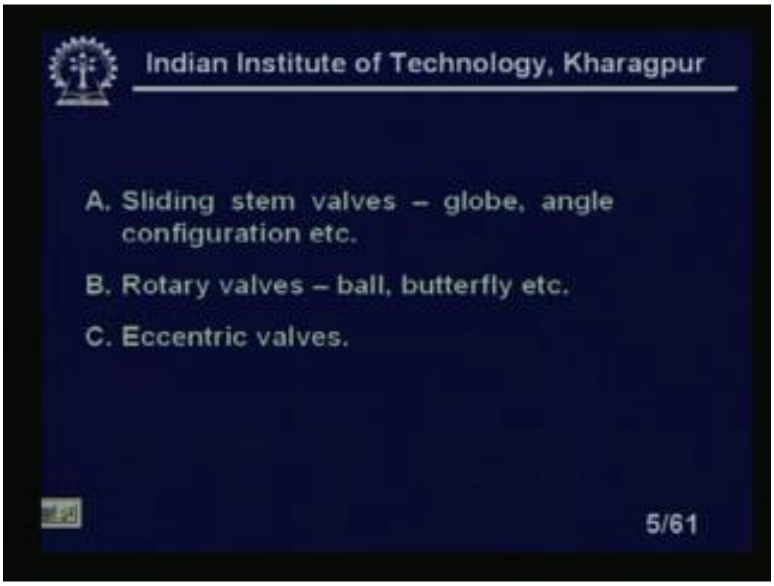

Let us look at a sliding stems valves, we have seen that the sliding stem; that means, what is this? We have seen that.

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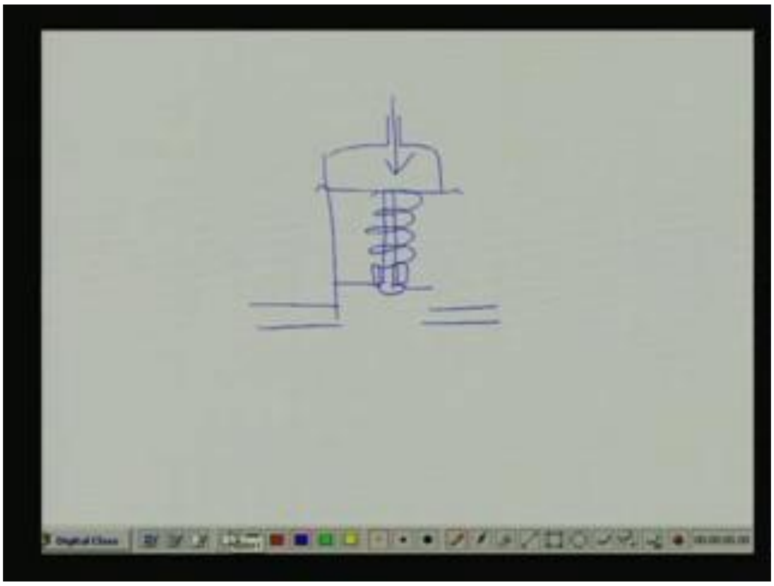

I have a diaphragm. So, this valve sits on a seat, this inlet outlet of pressure is coming. And there is a spring action there is a plug here or packing this is a packing. So, if the pressure comes, so the stem will move this stem will move up and down. And it will control it will control the position of the seat in the provision of the position of the plug in the seat. So, that thereby is controlling the flow of the liquids, so it will look like not this one. It will look like this right this one let me take a new page. So, it will look like a.

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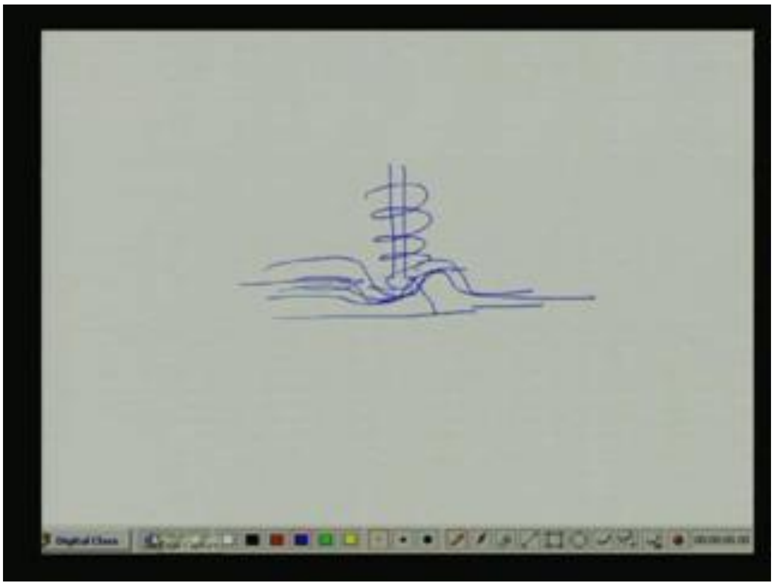

It has a have a stem here, so stem is like this one. So, liquid is flowing through this one and liquid is flowing out because there is an inlet here. We should erase this part, so it will look like this. So, liquid is flowing through this one, so there is a path and liquid is flowing out through this one. So, it will look like this one; that means, it is like this liquid is flowing this it is stopped here. And it will look like this one actually now, what will happen? You see when the liquid is flowing through this one. So, liquid will come through this one and it will flow through this directions. If the valve moves upwards, so there is a restriction here. So, the flow will go like this one, so it will come like this it will go like this one; that means, it will come like this it will flow and through this one.

So, position of the stem there is a spring here, so position of this is already we have discussed in details in the lesson 38. So, you can see the better pictures there, because these are pictures a little complicated we can see very nicely in lesson 38 anyway. Let us come to the sliding stem valves or globe valves or angle configuration, etcetera. This is the sliding stem valves globe valves angle configuration etcetera all comes under the under the sliding stem valves. Then rotary valves these are ball and butterfly valves; butterfly valves are used in many processes where I need a quick shut off like nuclear industries even though butterflies has leakage. But with the Teflon coating and all this Teflon liner inside the pipe you can make it Teflon liners in on the stem itself.

So, we can make a tight shut off otherwise I mean butterfly valves is used, because it needs action is very quick compare to the other valve like the step sliding stem valve. If you compare sliding stem valves I mean very roughly it will save the time constant. It is much faster response butterfly valve is much less. It is sorry I mean not less I mean saying that very fast. That means, the time of response will be very less in this case in the case of butterfly valve in the case of butterfly valve or rotary valve. Then you have a eccentric valve also we will study all this. These are the three different categories of the control valve sliding stem valves, rotary valves and eccentric valves. These are the 3, I mean different categories of the control valves then sliding stem valves. Let us look at the details.

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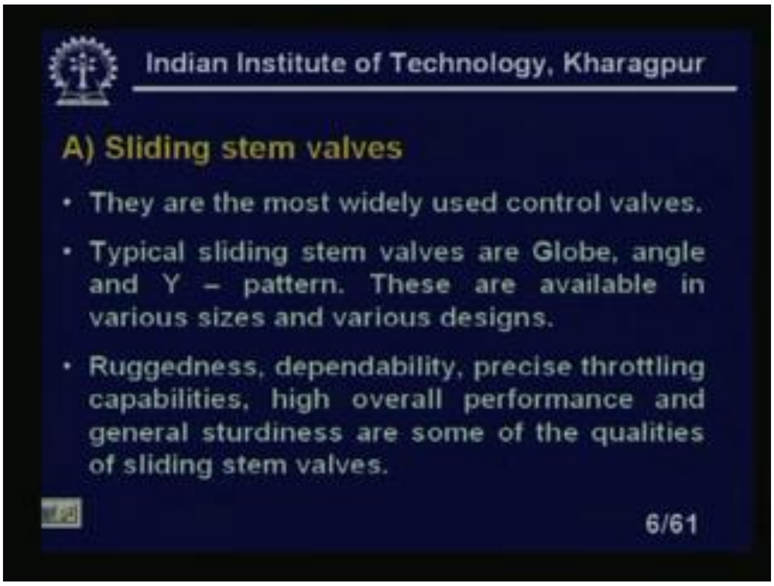

They are the most widely used control valves. As I told you sliding stem valves, most of the time we have seen that when we were giving examples of the control valves we are going to the sliding stem valve. Typical sliding stem valves are glove valves angle and Y pattern these are the 3 different patterns we will see. We will see the sliding globe angle and Y pattern these are the available in various sizes and various designs, very widely used control valve.

Then ruggedness dependability, precise throttling, capabilities throttling means I mean precise passing of the liquid. That means, if I say that the for this particular position this much of liquid will flow or this much of liquid will this will be the volumetric flow of the liquid that can be precisely achieved in the case of this type of valves sliding stem valve. High overall performance and general sturdiness are some of the qualities of the sliding stem valves. It is very rugged very sturdy, so it is widely used in industry.

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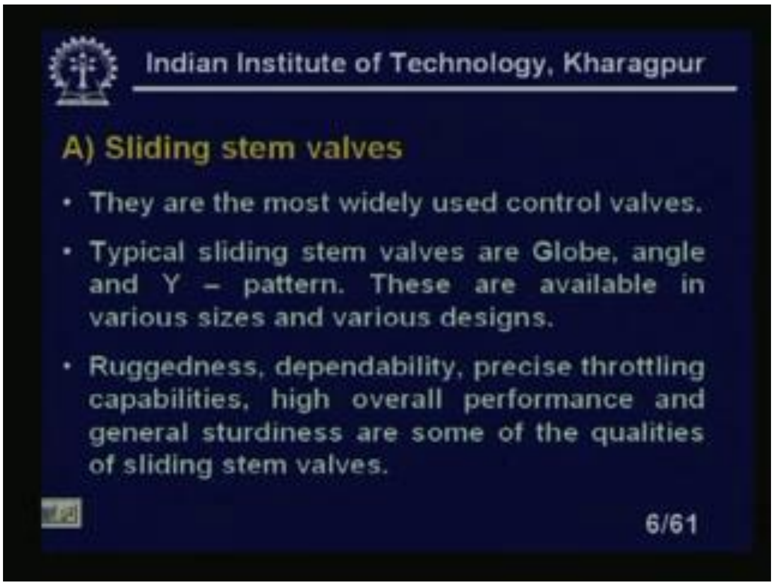

They are more suitable for extreme applications, which involve high pressures, high temperature, high noise and cavitational controls. Cavitations are we are telling it repeatedly cavitations we will study details after few slides. You will find that it is very important for the control valves you must know it very details. So, they are more suitable for extreme applications which involve high pressure high temperature, high noise and cavitations. They can also be differential differentiated as a single port and double port. All that you have seen there are two types of valves we can have double port valves we have a single port valves. In the single port valves a shut off is tight. Whereas, in the case of double port valves shut off is not tight. But in the most of the industrial process as you know this never we have I mean tight shutoff always it is within a range of liquid inflow.

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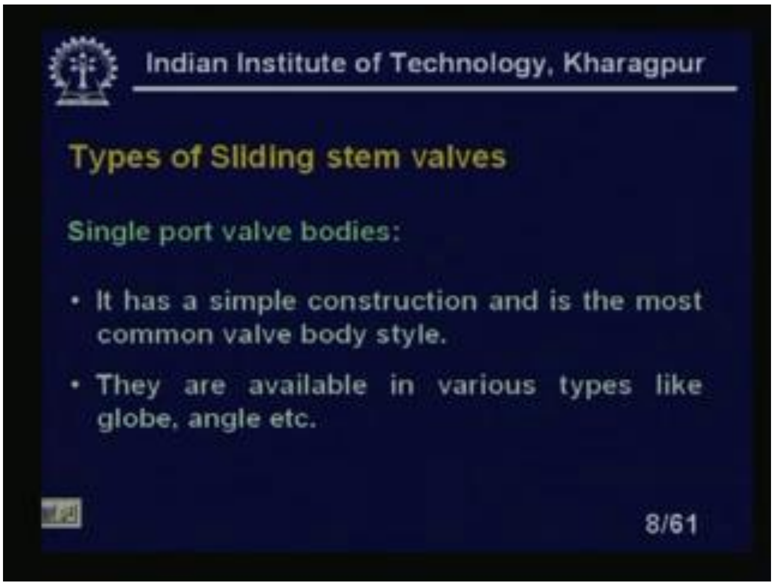

Types of sliding stem valve, single port valve bodies: It has a simple construction and is the most commonly valve body style. We have seen that in the case of 38, whatever the examples we have given which is which a single port valve. They are available in the various types like globe angle, etcetera.

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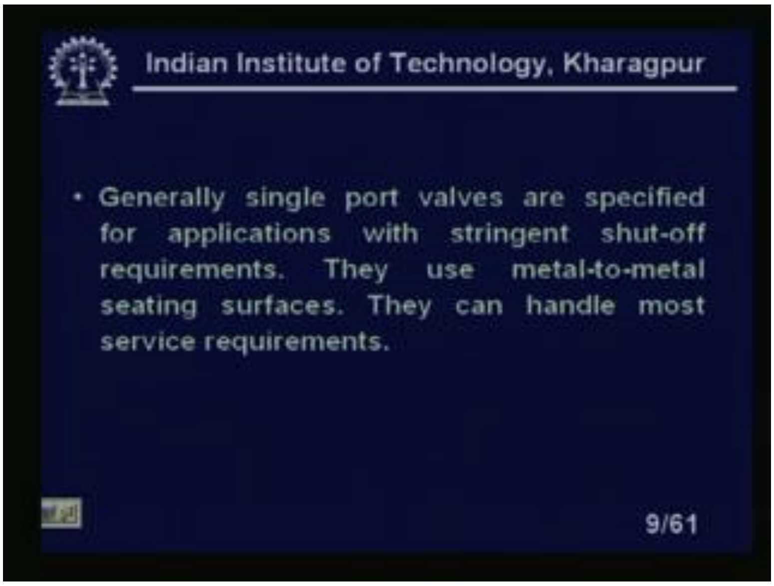

Generally single port valves are specified for applications with stringent shut off requirements require the shut off is very tight. I need this type of valve you may say that why should use then butterfly valve? As I told you the response time of the butterfly valve is an I mean very less; that means, it is a very quick action. It will take whereas, in the case of sliding valve single port valve even though as it is single I mean sliding stem it will takes more time.

But the off I mean if the shut off is very tight though if a need a very I mean tight shut off I have to use a single port valve. They use the metal to metal seating surface and they can handle most service requirements. So, metal to metal surface; that means seat is metal as well as plug is a metal. So, handle more service requirement; that means, corrosive requirement high temperature all those things can be withstand. Though now nowadays Teflon can also withstand high temperature, but not high as; obviously, the metals like steel.

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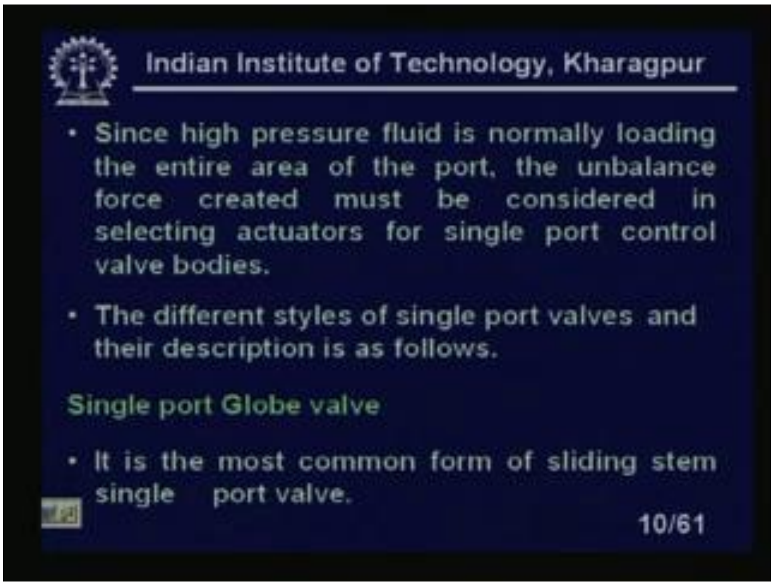

Since high-pressure feed is normally loading the entire of the port the unbalance force created must be considered in selecting actuators for single port control valve bodies. The high pressure if the liquid is coming as a high pressure, so quite. Obviously, it will occupy the entire port of the inlet port of the valve. Entire area of the inlet port and unbalanced ports created must be considered in selecting the actuators for single port control valve bodies. The different styles of single port valves and their descriptions are as follows. Single port globe valves, it is the most common form of sliding stem single port valve.

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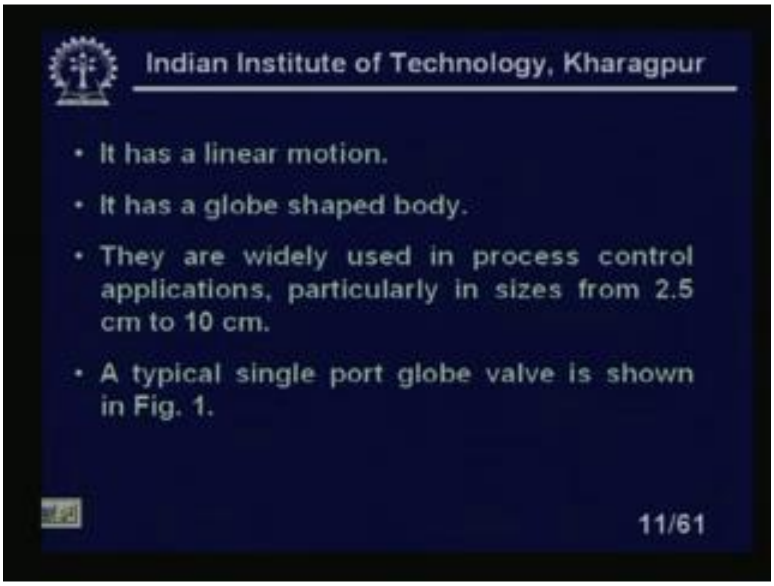

It has a linear motion; it has a globe shaped body. The inside shape of the body I mean valve is a globe shape that is the reasons we are calling it globe. They are widely used in process control application particularly in the sizes of 2.5 centimeter to 10 centimeter. That is 1 inch to 4 inch size you will get, because you see that we are converting in SI units or in a in a CGS unit. But most of the valves I mean valve the details you will find like the Fischer's and all those who are the making of control valves in over the years. You will find they are giving the specific inches since these are American valves usually I mean makers the American manufacturers they still consider in those LPS system, but still in a we are telling it in CGS or SI units. A typical single port globe valve is shown in figure 1 you can see here.

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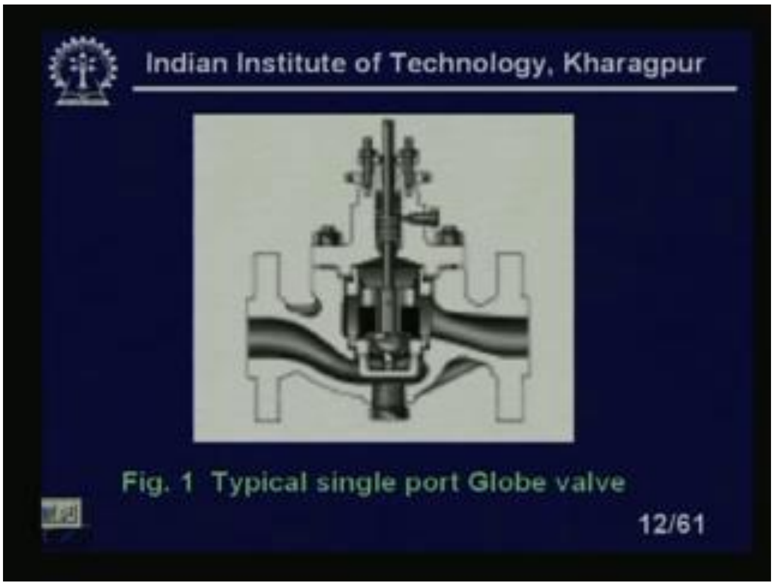

A single port globe valve you can see here. It is the inlet body inlet it is coming here there is a seat, so here is a seat. So, if the seat closes the liquid cannot flow. This is the stem of the valve there is a spring you can see. There is here you see where you can see here that is there is a packing. So, spring is there, so diaphragm is not shown here. This is a typical single port globe valve.

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Single port angle valve angle valves are nearly always single port. So, you will see that it is a angle the liquids are it is like an elbow. Let us see they are commonly used in boiler feed water and heater drained service. And in piping schemes where proper utilization of space is very important, because not always we can use an I mean linear I mean there is a linear pipe when I need a bending. So, that time that time you can use a single port angle valve. They can also serve as an elbow it is a working as a elbow. So, instead of using an elbow I can use an I mean angel valve. Which will make the flow control as well as it will make the, it will save an additional elbow in the process pipeline. The valve shown has caged style caged style construction.

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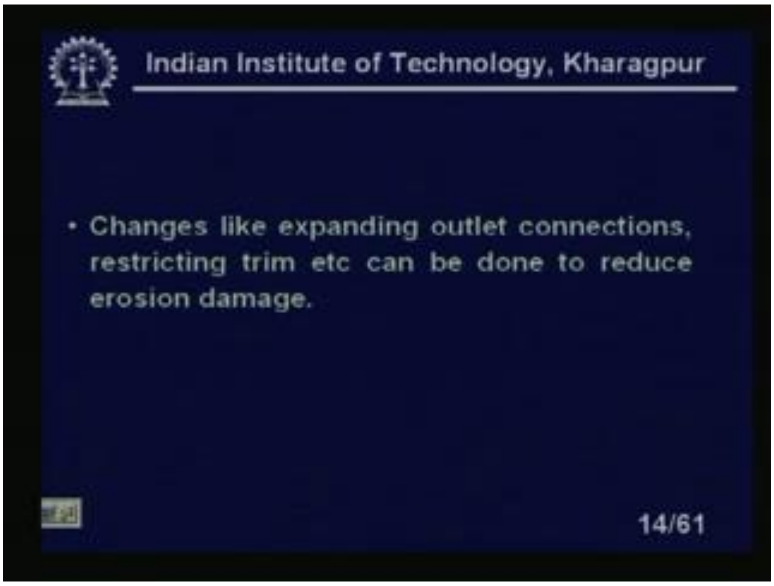

Changes like expanding outlet connections, restricting trim etcetera can be done to reduce the erosion. Damage erosion is a common problem you will find in the control valves. We will see the cavitations of the cavitation are there; obviously the erosion will be there.

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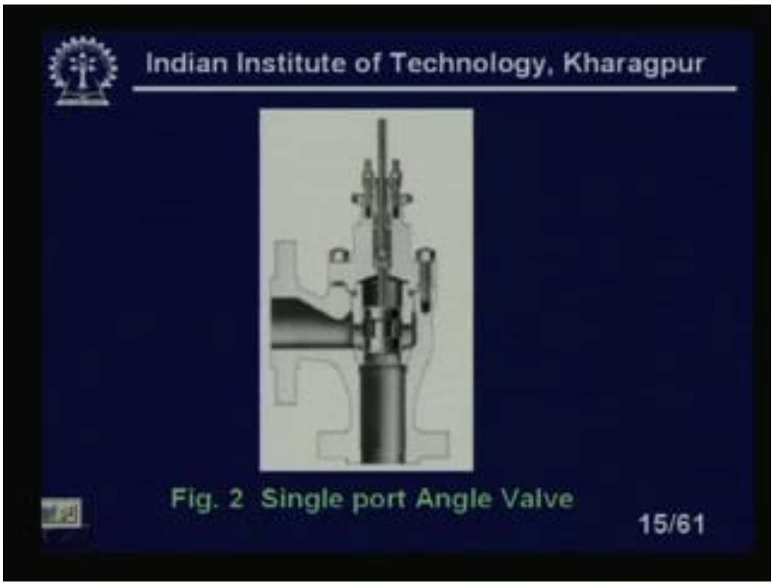

This is the single port angle valve, you can see here. It is inlet port and this is a outlet port. This is the stem of the control valve you can see here this is the stem and this is a we have a spring here. This is a inlet and this is the seat this is the our plug and this is the seat. So, if it is seat tight, so the liquid cannot flow, so it is like an elbow. So, it will save 1 elbow in the process. That means, I if I need proper utilizations of the phase is very important. So, I can use this type of angle valve. It is single port angle valve.

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Single port bar stock valve they can they are small range from few centimeters to 7.5 centimeters. And they can be made a machined from any metallic bar stock material and from some plastics. From any bar I can metal bar I can we can machined it and it is from some plastics also you can make it. Their flow capabilities are generally lower than those of the general purpose valves. It is not for the high capacities in as it case of the globe valves not convention globe valves, but for the low capacities.

These valves are used more often when there are special corrosion considerations in chemical industries. In chemical industries you see though you are saying stainless steel we can use, but stainless steel machining stainless steel is very difficult as you know. So in that type of cases where we need a valve; where it will not react with the fluid, which is flowing through the pipe. So, because any metals you know sometime some metals reacts with some chemicals. So, those types of cases chemicals are more inert I mean I mean these plastics are more inert in that sense. So, we can use that these type of valves.

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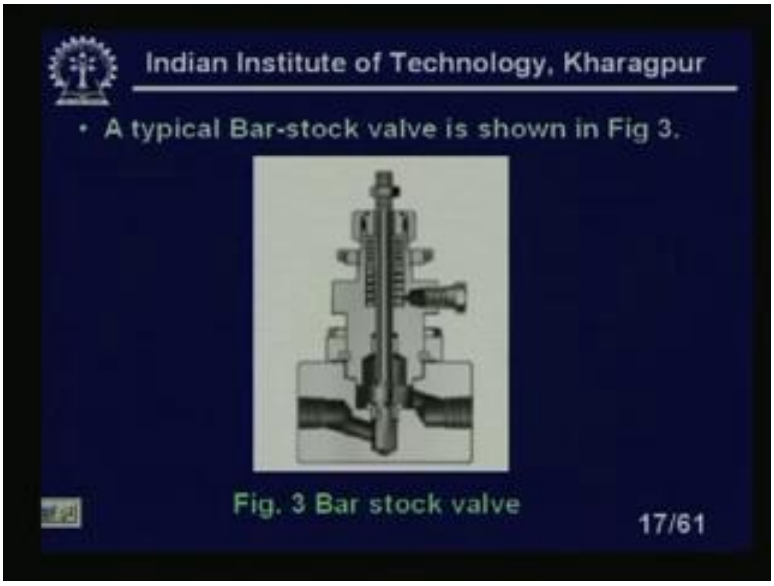

A typical bar stock valves you can see here is shown in figure. This is a bar stock valve the same thing stem spring is there and you can see this is a bar. So, we are calling it a bar stock you see here. It is coming through here and this going through this one. This inlet this is outlet.

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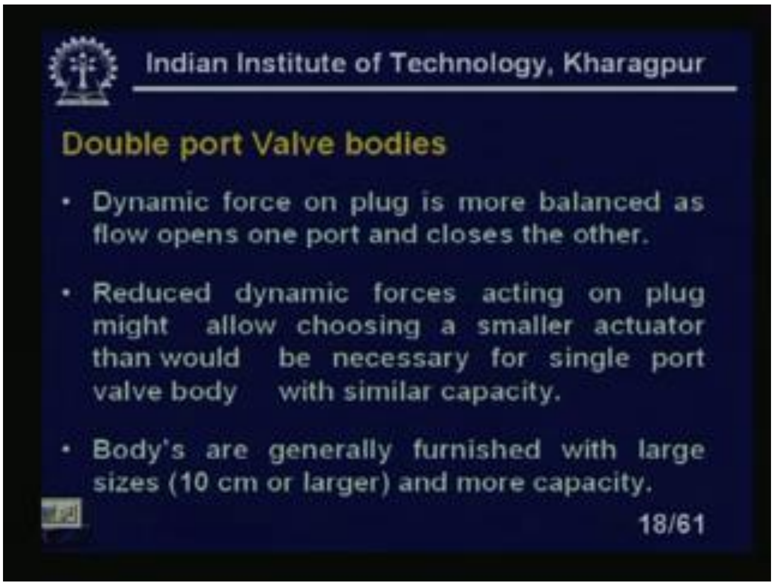

Double port valve bodies: Double port valve already we have seen in that lesson 38. So, we will we will look at details. The dynamic force on the plug is more balanced as flow opens one port and closes at the other. So, dynamic forces 1 on the plug is more balanced as flow opens 1 port and close the other. So, there are 2 valves, so obviously, if in1 port liquid will flow in other port liquid will stop. Reduces dynamic forces acting on the plug might allow choosing a smaller actuator then would be necessary for single port valve body with similar capacity. So, I need a lesser powerful actuator that is the reason single double port valve is referred. Body’s are generally furnished with large sizes 10 centimeter larger and more capacities also more for this type of valves.

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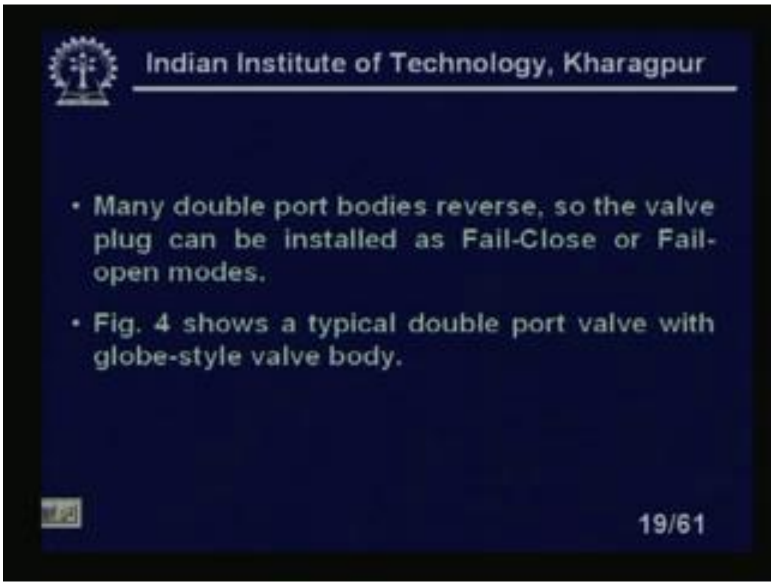

Many double port double port bodies reverses, so the valve plug can be installed as a fail close of fail open modes. We have seen that the valve can be used as a fail open air to open or air to close. Since double port bodies reverse. So, I can find the reverse. So, that I can use it for that I mean fail close or fail open modes. This is the great advantage of the double port body, which we do not have in the case of single port valve. So, same valve can be used whereas, in the case of single port valve we have seen that we have to make that total. We have to change the total valve itself, which is not necessary in the case of double port valve we can use it either in an air to close or air to open. Figure 4 shows a typical double port valve with a globe style valve body this is a globe style valve body and this is a double port.

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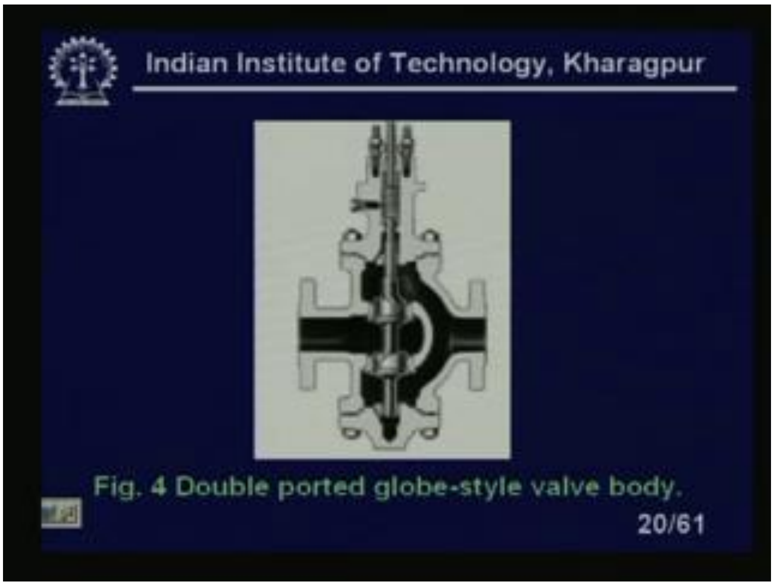

You see here this is a double port valve. So, it is you see here there are 2 ports. And 2 seats liquid can flow through this one or liquid can flow through this one. So, always when different position liquid will flow either through this one or through this one. So, it is a single port double port globe style valve body.

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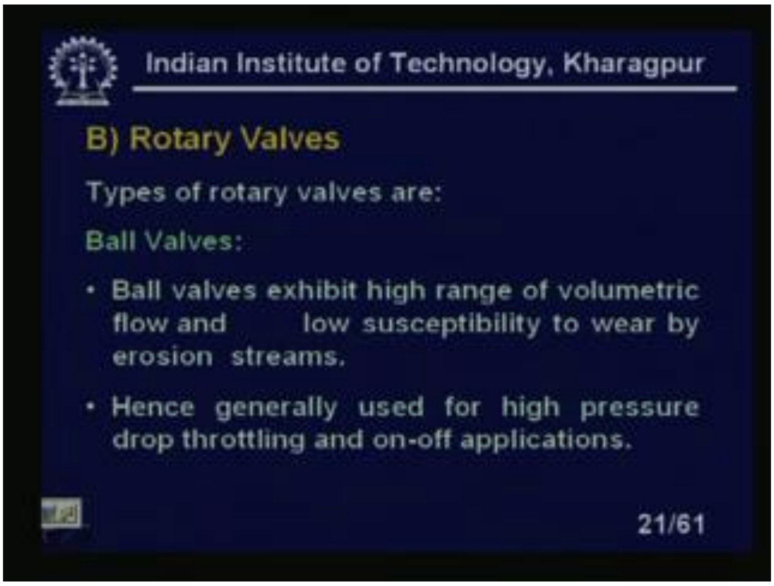

Rotary valves types of rotary valves are ball valves. Ball valves show high range of volumetric flow and the low susceptibility to wear by erosion streams. This is important this is also true for the butterfly valve we will see that. Hence generally used for high pressure drop throttling and on off applications. If we need a high pressure drop, because whenever there is a high pressure there is a problem of the cavitations will be very severe in the case of high pressure drop. Because whenever it is comes to the outlet point there will low vapour pressure. I mean pressure there is a pressure drop and there is a formations of the vapour and it will start to corrode the, or I mean erosion will start at the outlet ring. So, the seat and all those things will be damaged. Hence generally used for high pressure drop throttling and on-off applications

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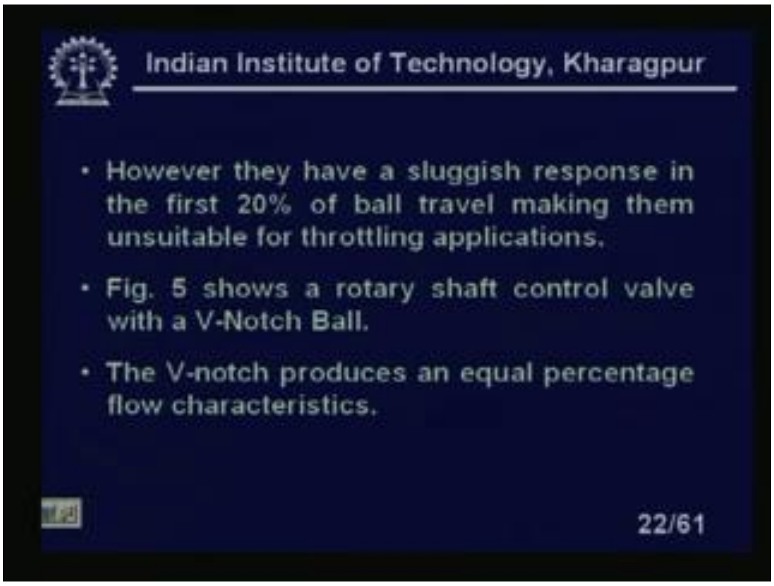

However, they have a sluggish response in the first 20 percent of the ball travel making them unsuitable for throttling applications. Continuous throttling is not necessary I mean and either you can stop it on-off sort of that type of situations I can use it. But the continuous control of the liquid is not possible, because of this inherent problem that is they have a sluggish response in the first 20 percent of the ball travel; that means the stem travel and making them unsuitable for throttling applications. Figure 5 shows a rotary shaft control valve with a V notch ball. The V notch produces an equal percentage flow characteristics. This V notch will make a V notch an equal percentage flow characteristics.

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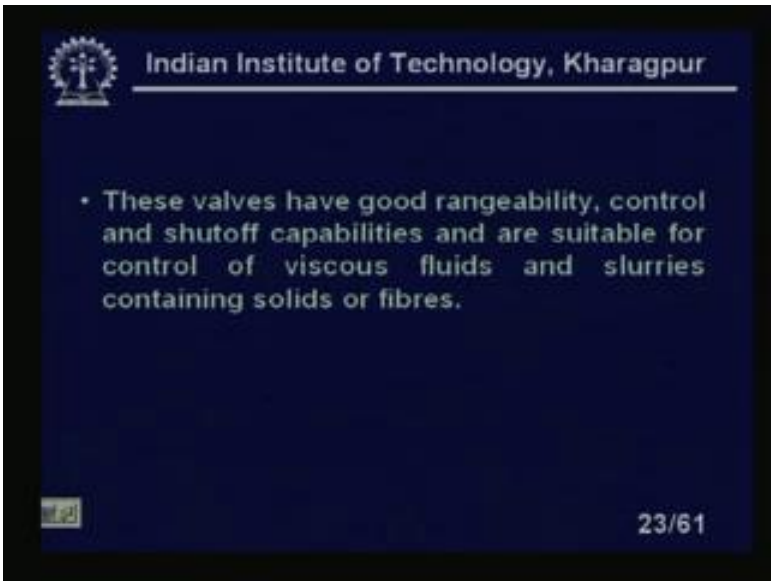

These valves have a good rangeability, control and shutoff capabilities. The range is higher; that means, it has a wide range this is very important. And it is a control and shutoff capabilities are also high. These are the advantages of this type of valves and it is also suitable for the control of the viscous fluids and slurries containing solids and fibres. This is the very common form of I mean situations we will see in the process industries. That means, it will always not necessarily you will find always water there is any viscous liquids may flow. It may contain slurries and other fibres, so that type of situation globe valve is very important. I mean valve type of valve should be important.

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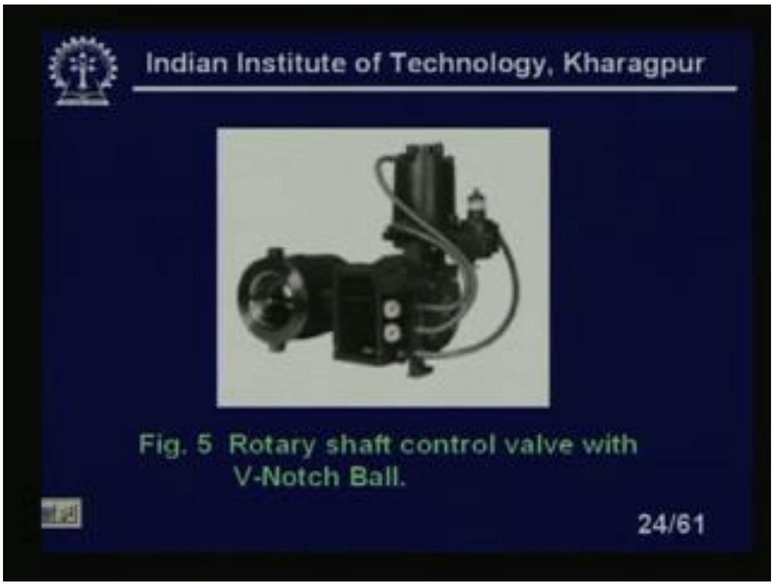

This is you see, this is the wall type of valves rotary shaft; control valve with a V notch valves. You can see here this is a V notch ball valve.

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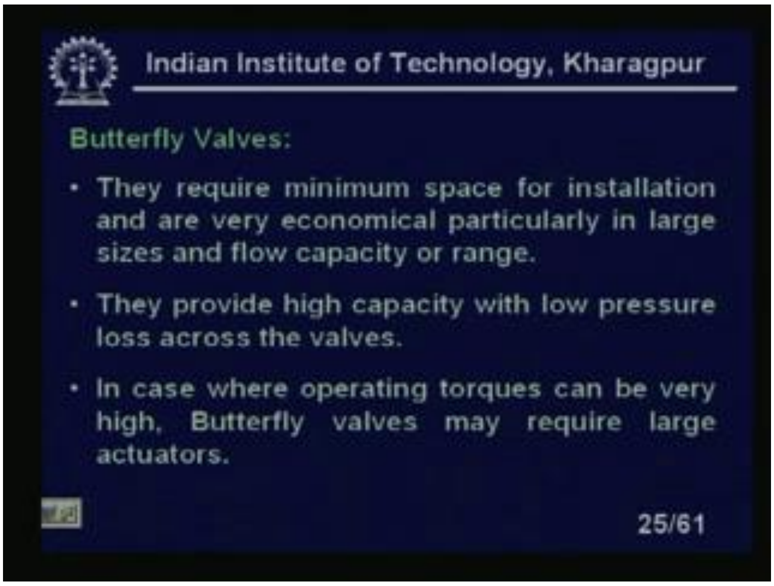

Now, butterfly valves you can see this is a very common. This is a widely this is also not very widely used, but it is used for some particular I mean industry because if it is a suspended particles to avoid cavitations all those things butterfly is very suitable for that type of situation. They require minimum space of for installation and a very economical particularly because you see since it is a butterfly. So, you will have an only a valve motors. So, we do not have stem sort of thing only the butterfly I mean that there is a disk sort of thing which will rotates if it rotates it will allow the liquid to flow otherwise it will stop.

That is the butter and a very economical particularly in large sizes and flow capacity or range. So, if you need a large range that is great advantage; that means it has usually typically butterfly valves comes with a large range which is not possible in the case of typical globe valves. We need if you want to larger in the size of the valve will be enormously weak, because in the valve there is a restriction the stem size you stem size sorry the plug size and the seat size actually will control the range of the valves also. So, those type of distinct there is no as such seat or plug in the case of butterfly valve.

That is the great advantage that is; obviously, will lead to the higher range of the control valve. They provide high capacity with low pressure loss across the valves. They provide high capacity with low pressure loss across the valves. In case where operating torques can be very high butterfly valves may require large actuators. That is another problem if we need a large torques we need a large actuators, because they have to rotate. We will see that how it works we will show the butterfly valve. So, that I need a large actuators otherwise it is a very good from valve.

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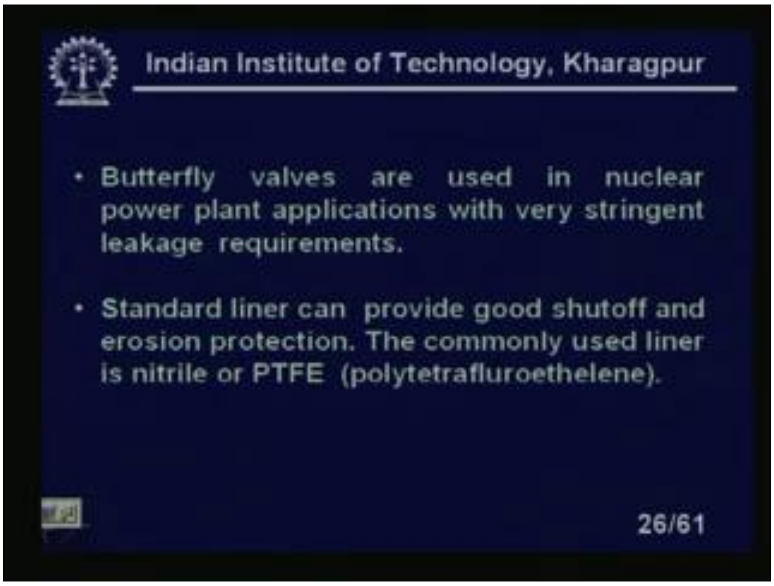

Butterfly valves are used in nuclear power plant applications with very stringent leakage requirements. It is the applied, because in we have a very I mean time constants of the valve should be I mean very small. That means, it should be immediately shut-off of immediately start to flow. That type of situation, but the problem is if you want to make a complete shut-off butterfly valve is very difficult because there is no such plug and seat. So, there is always some leakage, but nowadays with some special applications we can make it we can make the leakage almost zero. The standard liner can provide good shut-off and the erosion protections. Erosion is not very important here it is the good shut-off is very important. So, the commonly used liner is nitrile or PTFE which is polytetrafluoroethylene or Teflon. This can be used as a liner.

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And this you can see here this is actually a butterfly valve. So, that this pneumatic signal you can see you can see here this is actually it will rotate and will this will rotate. And it looks like this one; that means, I have a valve.

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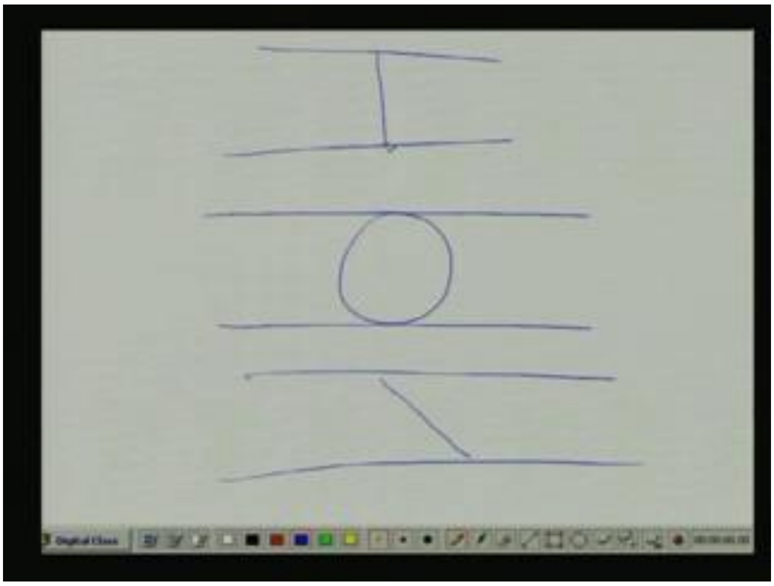

So, pipe is there it will look like this one. Either it will come to this position or it will completely shut-off like this one.

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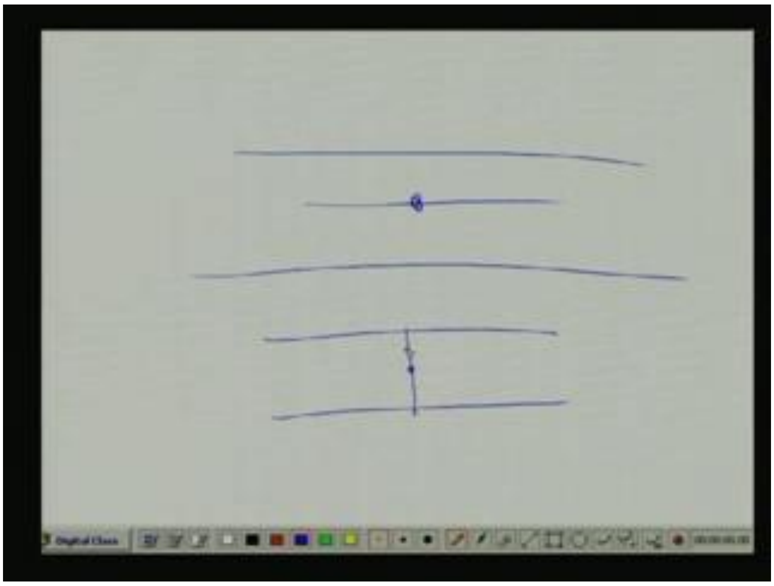

If it is goes like this one there is no shutoff at all. So, this; that means, you have to rotate it. It will rotate this one to this one; that means, if the pipe is there. So, if I rotate like this one there is a total shutoff, so it will rotate like this one it will rotate like this one.

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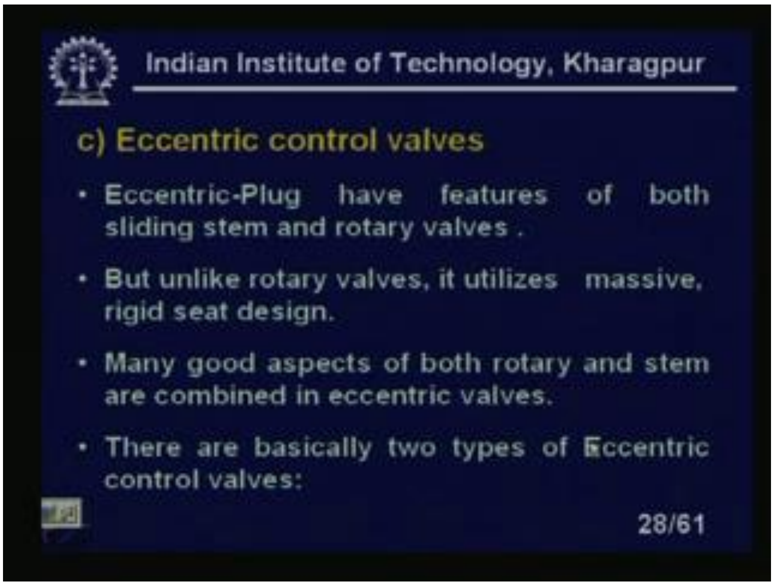

Eccentric control valves eccentric plug have features of both the sliding stem and rotary valves. There are the features of the rotary valves as well as sliding stem valves. But unlike rotary valves, it utilizes a massive rigid seat design. Seat design should be very rigid here. So, let us look at many good aspects of both rotary and stem are combined in eccentric valve. So, both the combinations are there so; obviously, some applications this is very stringent. There are basically 2 types of eccentric control valves.

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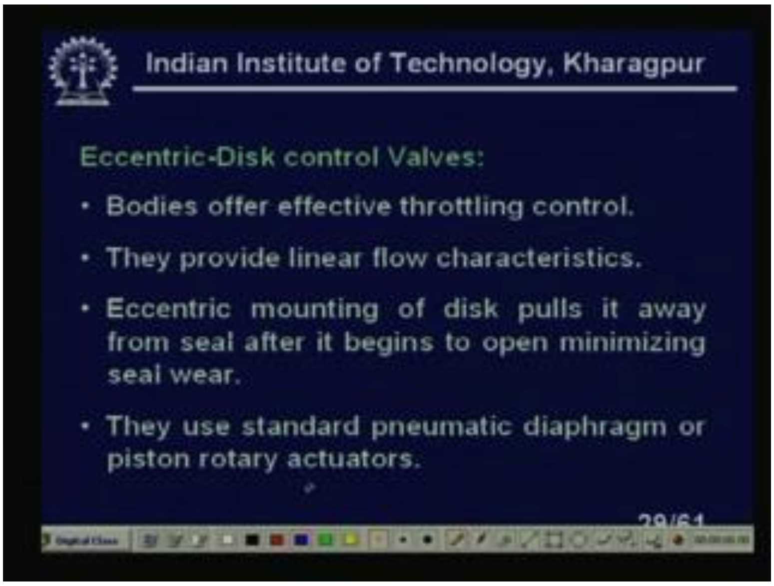

Eccentric disk control valves; Bodies offer effective throttling control. They provide linear flow characteristics. An eccentric mounting of disk pulls it away from seal after it begins to open minimizing seal wear. So, that is the great advantage, because seal is always wear. They use standard pneumatic diaphragm or piston rotary actuators. I think this will be seat wear.

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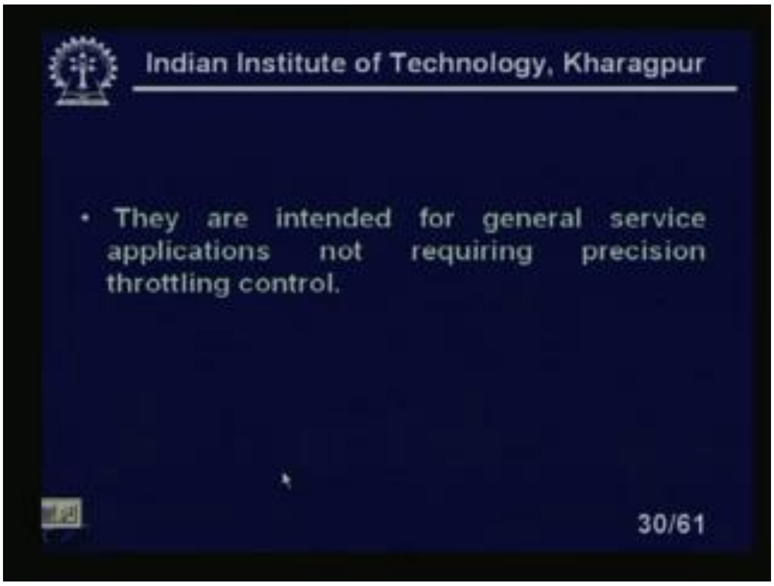

They are intended for general service applications not requiring precision throttling control. Precision throttling control is not possible it does not matter.

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So, this our extrinsic disk control valve. You see here.

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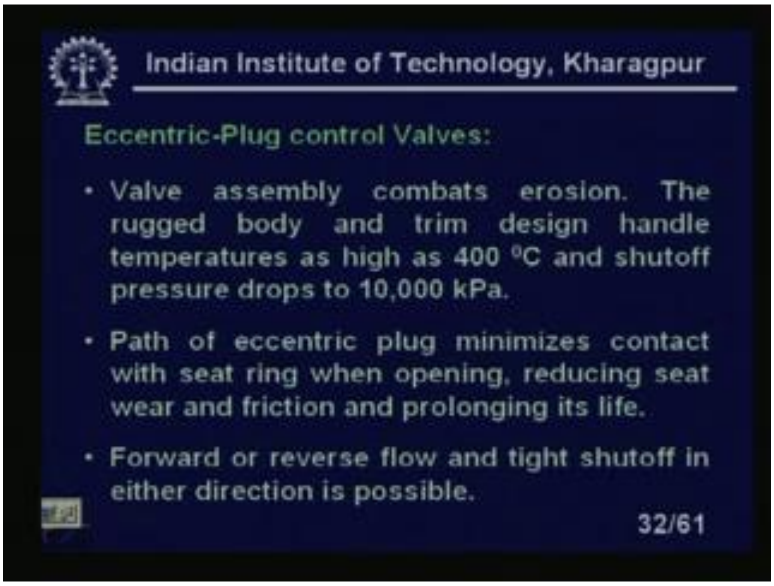

Eccentric plug control valve: Valve assembly combats erosion. In a rugged body and the trim design to handle the temperature as high as 400 degree centigrade and shut-off pressure drops to 10,000 kilo Pascal extremely high pressures we can see here. And path of the eccentric plug minimizes the contact with the seat ring when the opening and reducing the seat wear and friction and prolong prolonging it is life. Forward or reverse flow and the tight shut-off in either direction is possible. Forward or reverse flow and tight shut-off in either direction is possible. So, this is a great advantage though it is very uncommon in any process.

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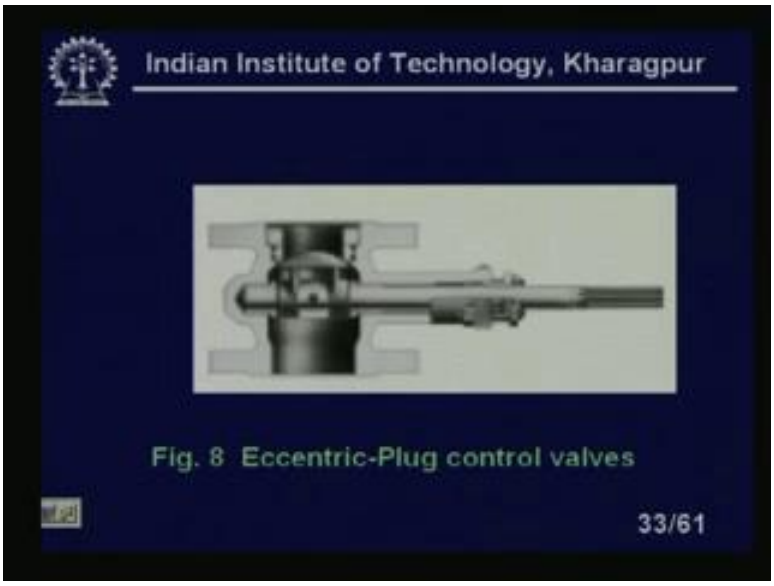

Eccentric plug control valve: you can see here

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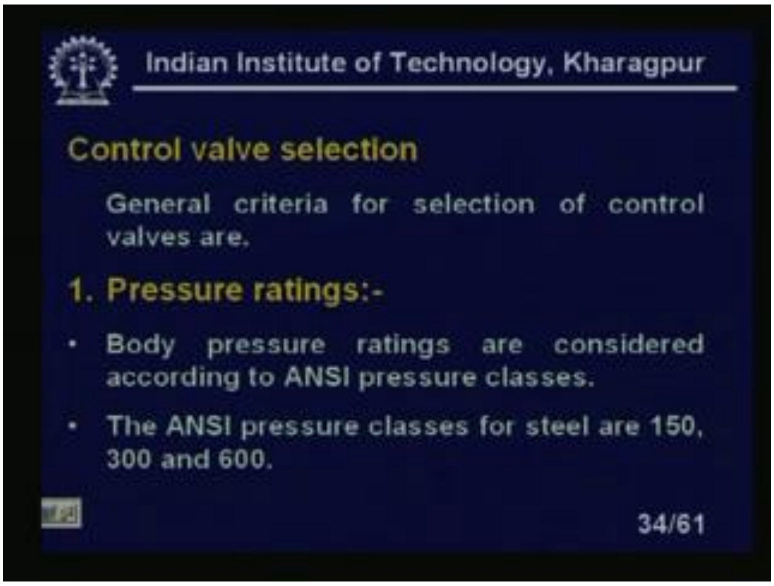

Control valve selection: General criteria for selection of control valves are the pressure rating this is most important. Body pressure ratings are considered according to the ANSI pressure classes. The ANSI pressure classes for steel are 150 300 and 600.

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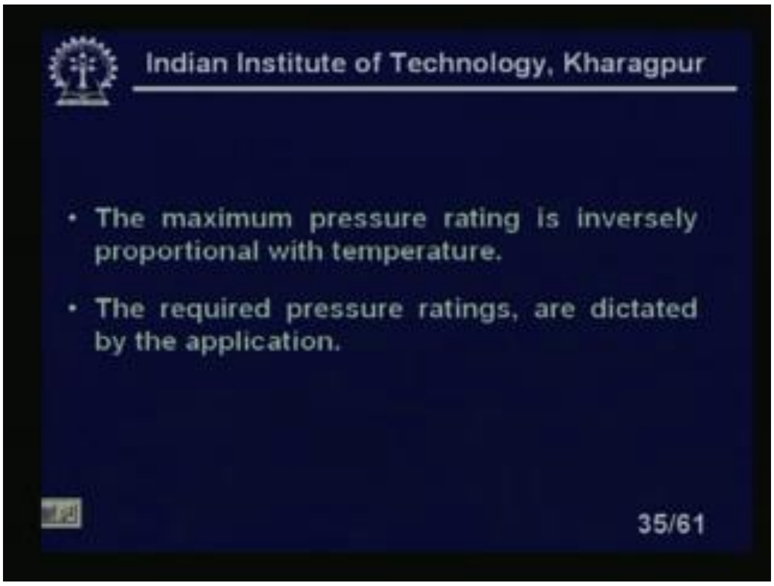

The maximum pressure rating is inversely proportional with the temperature. The required pressure ratings are dictated by the application.

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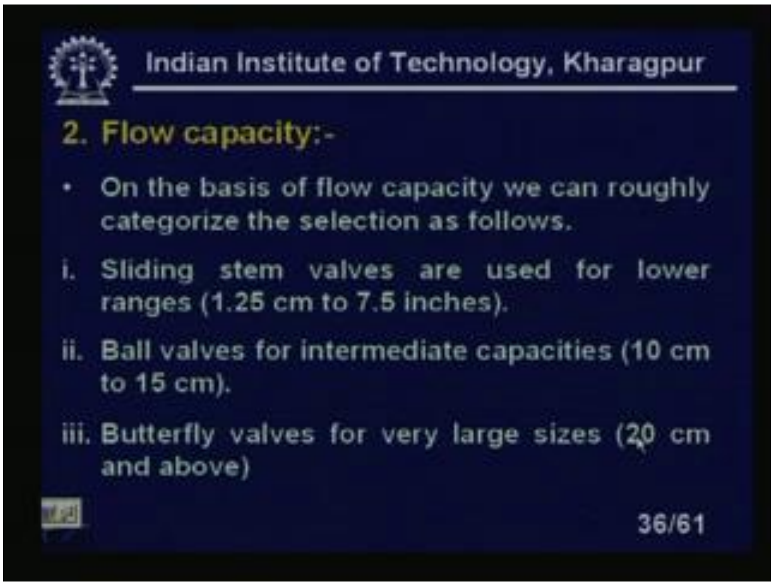

Flow capacity or the range of the I mean range of the valve that is also important. On the basis of the flow capacity we can roughly categorize the selection as follows. Sliding stem valves are used for lower ranges 1.25 centimeter to 7.5. I am sorry this will be in centimeter this will be centimeter. Ball valves in intermediate capacities it is coming on 10 centimeter and to for 15 centimeter. Butterfly valves for a very large sizes 20 centimeter and above.

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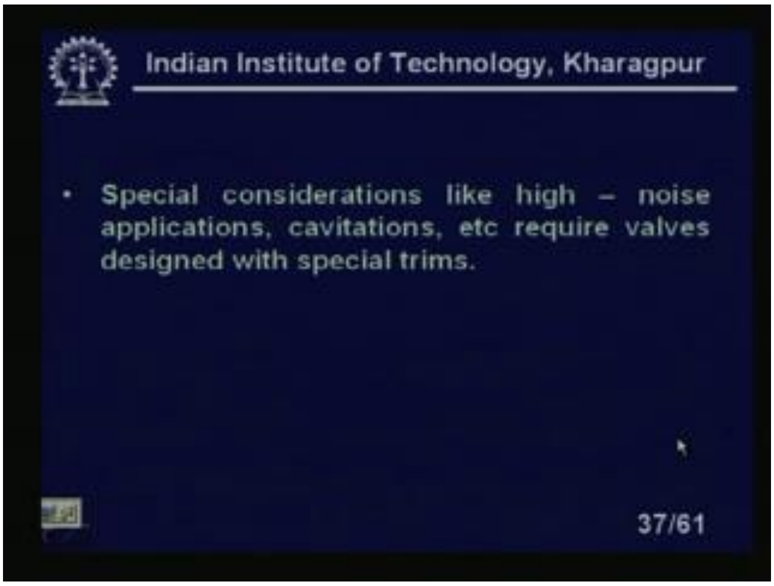

Special consideration like high - noise application, cavitation, etcetera require valve designed with a special trims. Trim as I told you it is a entire assembly we are calling about the trims.

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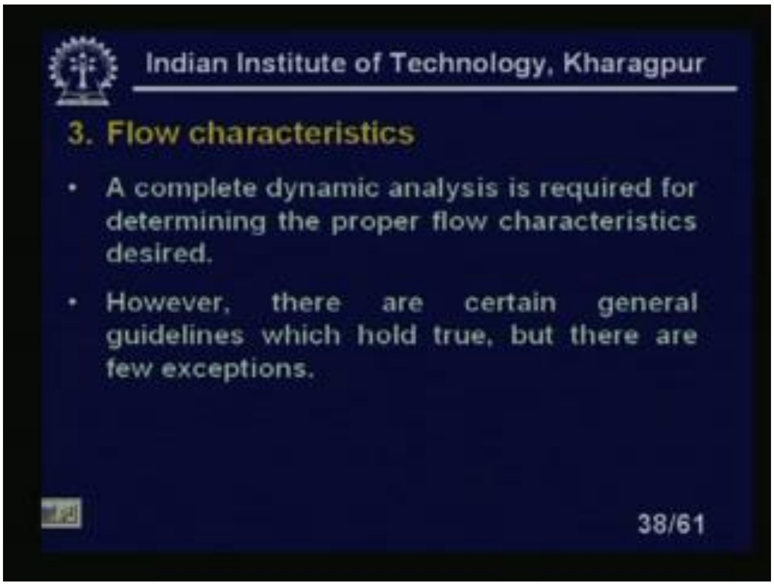

Flow characteristics a complete dynamic analysis is required for determining the proper flow characteristics desired. What are the typical flow characteristics I need? Equal percentage linear or quick opening these is basically flow characteristics. However, there are certain general guidelines, which hold true, but there are few exceptions.

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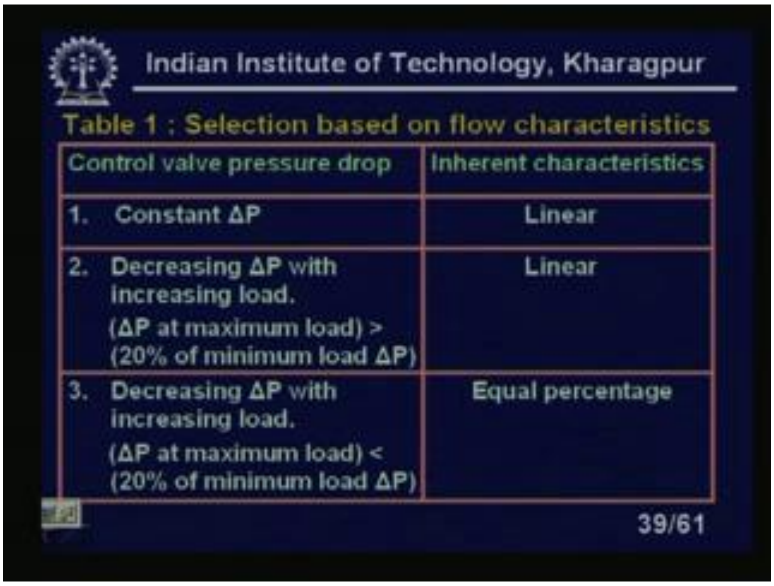

You see we are seeing at the constant delta P, this is the table a selection based on the flow characteristics, selection of the control valve, control valve pressure drop that is the pressure drop across the control valve. Inherent characteristics constant delta P linear, decreasing delta P with the increase load linear we will we will use linear control valve delta P at a maximum load decreasing delta P with increasing load equal to percentage. Increasing delta P with increasing load delta P at maximum load 200 percent of the minimum load the linear, increasing delta P with increasing load it is quick opening.

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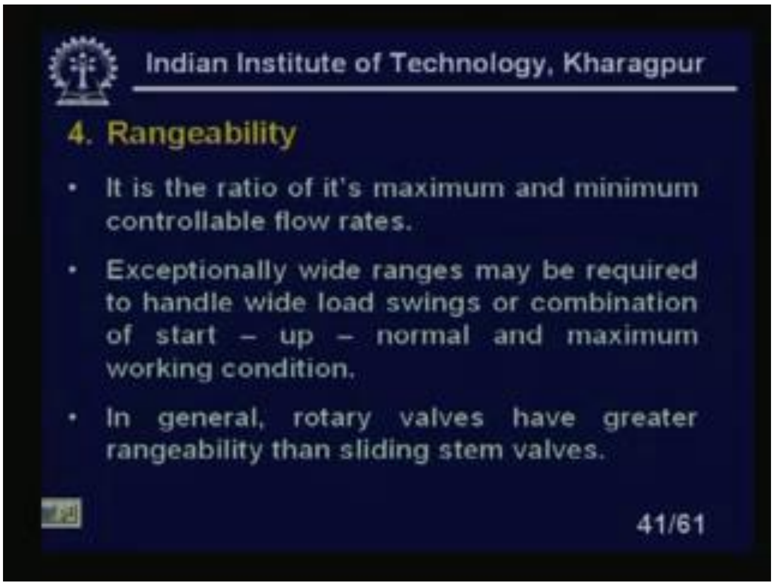

Rangeability: it is the ratio of it is maximum and minimum control flow rates. it is the ratio of the maximum and minimum control rates. We have seen these things while we are doing the analysis I mean at the equal percentage valves in the lesson 38. Exceptionally wide ranges may be required to handle wide load swings or combination of start up to normal and maximum working condition. But usually you know rangeability is not very important we have actually the variations of the flow capacities it is not that wide in any process. The rangeability is obviously; there I mean it depends on what type of fluid is flowing? You may have a very high range you may have a small range, but the variations of the flow capacity is not very common in any process. In general rotary valves have greater rangeability than the sliding stem valves right quite obvious.

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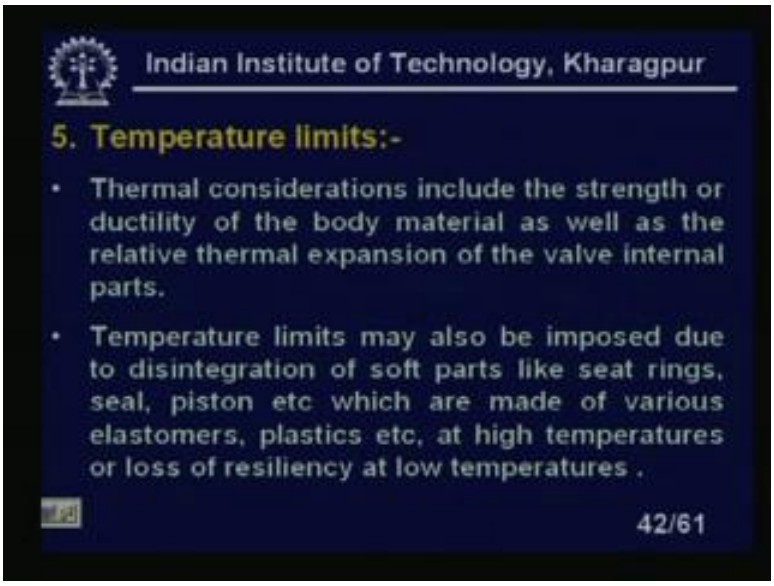

Temperature limits the thermal considerations include the strength or ductility of the body material as well as the relative thermal expansion of the valve internal parts. Now, this it does not matter much if I use a I mean I mean metal like a steel and all those things. This ductility and all those things will not matter much, but sometimes it will have if that liquid temperature is extremely high. I mean this is you should consider this thing also what type of material is to be used to make the seat to make the plug. And all those things to the inlet I mean through which the liquid is flowing that is all those things to be considered. Temperature limits may also be imposed due to disintegration of soft parts like seat rings, seal, piston etcetera, which are made of various elastomers plastics etcetera. At high temperatures or loss of resiliency at low temperature, this is also important.

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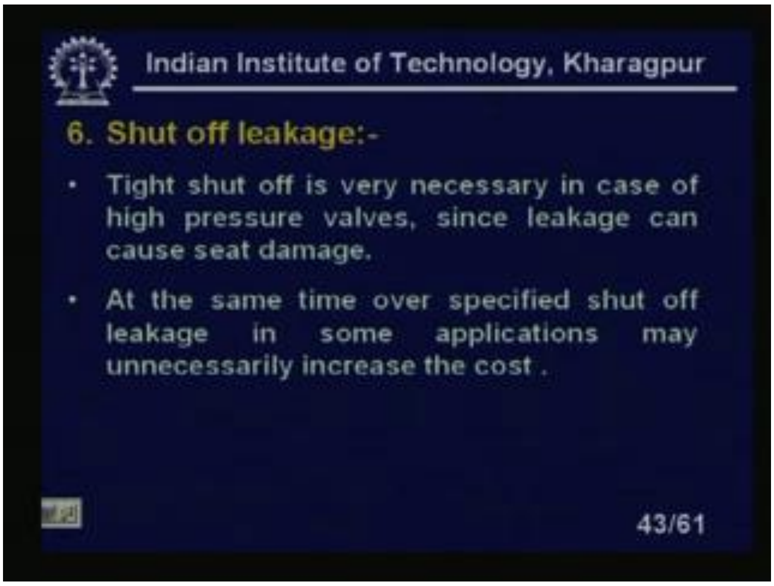

Shut off leakage; this is very I mean we should consider tight shut off is very necessary in case of high pressure valves, because leakage can cause seat damage. So, the tight shut off is necessary in case of high pressure when the pressure is high. Obviously, if the shut off is not tight there will be always leakage. So, since leakage can cause seat damage. At the same time; however, we must consider we should not over specify the shut off leakage in some application may unnecessarily increase the cost.

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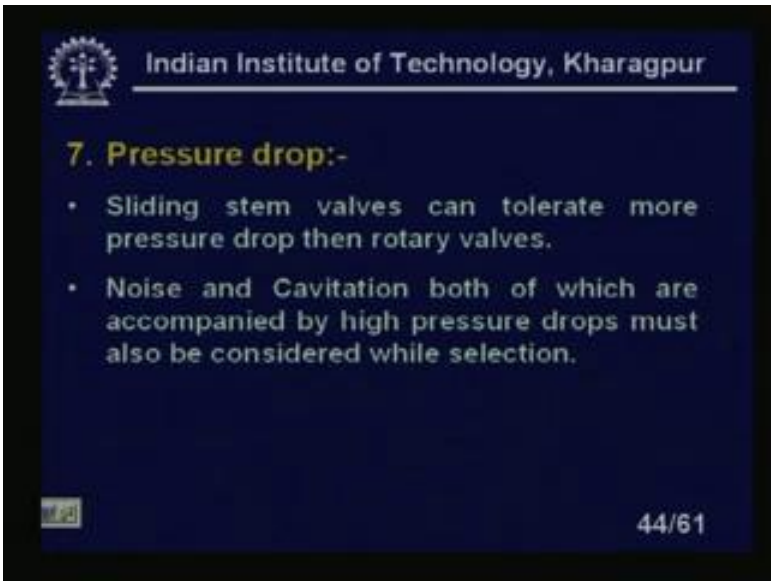

Pressure drop this is another important thing pressure drop across the valve. Sliding stem valves can tolerate more pressure drop then the rotary valve. Sliding stem valves can be tolerated more pressure drop then the rotary valves. Noise and cavitation both of which are accompanied by high pressure drops must also be considered while selection.

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End connection requirement this is another important thing. End connections desired are important considerations, because sometimes the desired connection style is not available and the valve style being considered. This is another important thing what type of pipe you are installing that type of what is the end connection. That means, inlet connection and the outlet connection to the pipe is to be considered also not always all the valves. We have the same all types of end connections you can make it according you have to choose the one there is a choice of valves obviously. If piping specifications calls for welded connection only, the choice is limited to the sliding stem valves welded connections only since rotary valves available are expensive.

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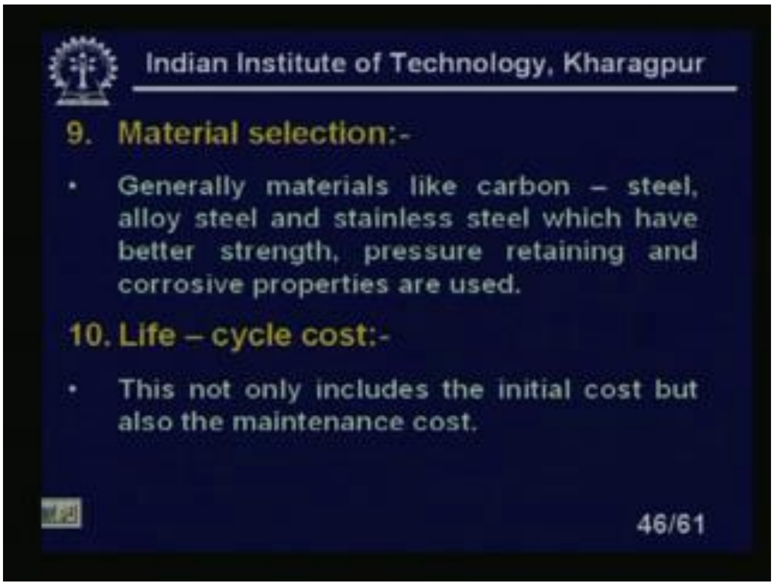

Material selection generally materials like carbon steel, alloy steel and stainless steel which have a better strength pressure retaining and corrosive properties are used. Stainless steel I earlier also told it is not very easy to machine the stainless steel. I mean alloy steel carbon steel; obviously, the stainless steel is also a low carbon steel basically. The life cycle cost this not only includes the initial cost. But also the maintenance cost, because control valve is to be maintained very regularly. Usually all control valves will be bypassed by a globe valves always, because during the routine maintenance a plant a 24 hours when the plants is running you cannot I mean shutoff the plants. So, that the global the actual control valve is removed, and you will put a globe valve there.

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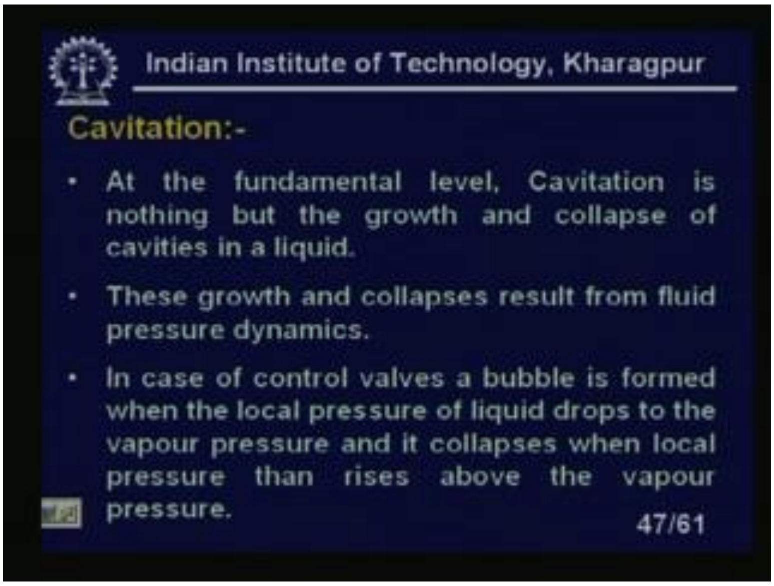

Cavitation; we have talked about the cavitation so much. What is this cavitation? Let us look at every detail, because this is very important you must stop the cavitation. Otherwise the erosion will start and valve will be entire calibrations whatever the typical flow characteristics, you have desired; you may not get these things ultimately leading the poor product qualities. So, those things are very important. So, cavitation must be you must study the cavitation in details and you must we have to stop the cavitations inside the wall. At the fundamental level cavitation is nothing but the growth and collapse of cavities in a liquid growth and collapse of a cavities in a liquid. These growth and collapses result from the fluid pressure dynamics as I told you high pressure to low pressure.

In case of control valves a bubble is formed when the local pressure of the liquid drops to the vapour pressure when the bubble will be formed. That means, when a local pressure of the liquid drops to the vapour pressure, because at the outlet of the valve or the just when it crosses the seat or the seat of the valve then the pressure will drop that there. So if the pressure drops; obviously, the bubble will be formed, and it collapses when the local pressure, because as it proceeds to the pipe I mean it will collapse. So, it will collapse in the local pressure, because the pressure will be recovered once we proceed to the and outle. The pressure drop the pressure loss will be recovered as it happens in the case of orifice venturi same thing here also. Then that bubbles will collapse again, because pressure is increase the bubble will collapse clear rises above the vapour pressure.

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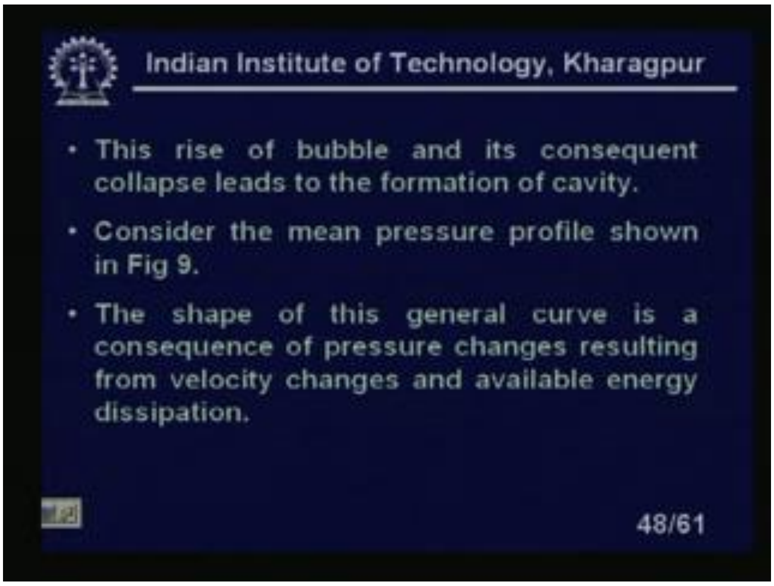

Now, these rise of bubble and it is consequent collapse leads to the formation of cavity. That means the formation of the bubble rise of bubble and it is collapse will lead to the formation of cavity. Consider the mean pressure profile shown in figure nine in the next figure we will see. The shape of the, this general curve is a consequence of the pressure changes resulting from the velocity changes and the available energy dissipation. There is a energy dissipation inside the pipe and the shape of this general curve is a consequence of the pressure changes velocity changes and the dissipation.

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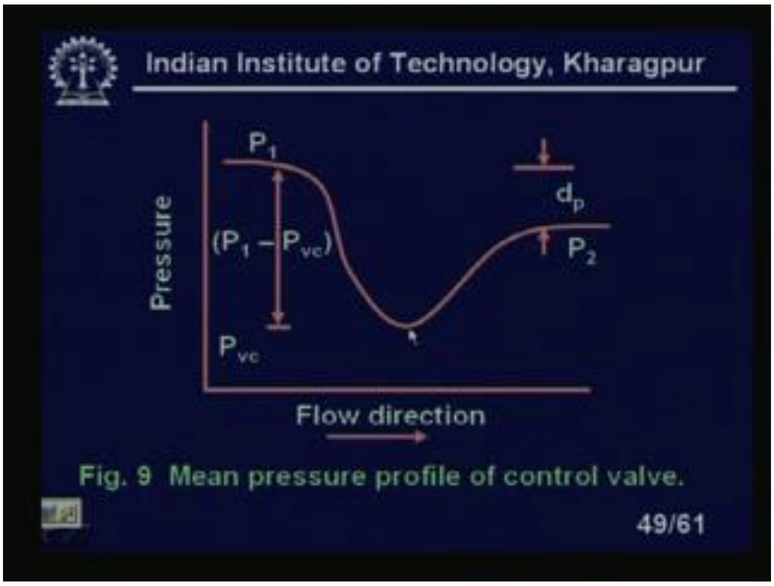

This you can see mean pressure profile of a control valve you see here pressure is here then of pressure is there. There is a large pressure drop and it will increase little bit at the outlet it will come to the P 2, but inside there is a large pressure drop. So, the cavitations will start here when the pressure drop is high when the pressure difference is high. So, the cavitation will start here this is P 1 minus Pc this is the minimum pressures here. So, you can see there is a large pressure drop. So, the pre-cavitation will start here right. So, this is a flow direction; that means, I am proceeding from the inlet to the outlet of the valve this inlet this is to the outlet of the valve clear?

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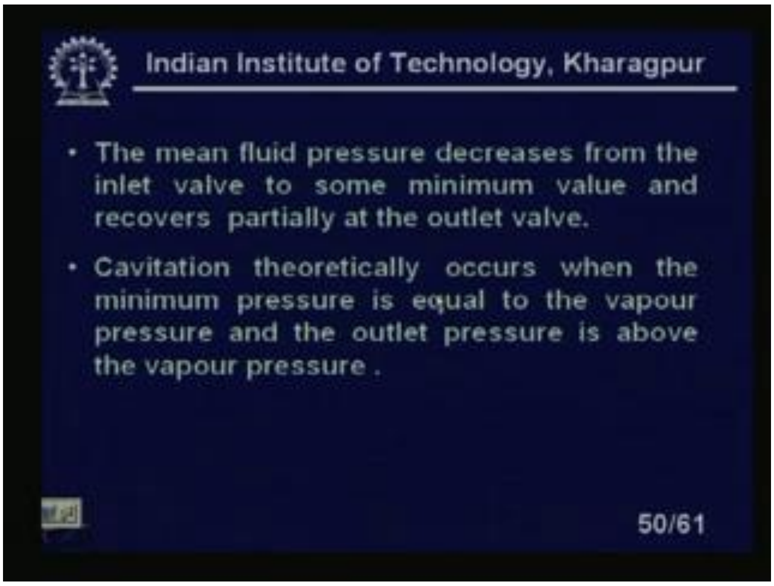

Now, the mean fluid pressure decreases from the inlet valve to some minimum value and recovers partially at the outlet. That is I told you like Orifice it is the same thing there is the restriction is not it valve is very similar to restrictions we have seen the orifice venture. All these things we have a restriction there we have seen in the case of venturi the restriction. I mean the valve pressure recovery is better pressure drop is not that here you see the pressure will be fall is a restriction again it will be recovered to some extent. This mean the fluid pressure decreases from the inlet valve to some minimum value and recovers partially. This is the minimum value PV what we have seen this is our minimum value PVC. So, this is P 1. So, P 1 minus PVC is this much this is the minimum value of the control where is the pressure.

Cavitation theoretically occurs when the minimum pressure is equal to the vapour pressure and the outlet pressure is above the vapour pressure. Now, where it actually happens you see there is it is what I am saying cavitation theoretically occurs when the minimum pressure is equal to the vapour when it happens it actually will happen when the liquid coming in through the inlet point. It is going through the going through the plug going through the seat through the plug plug will I mean make the control and to the outlet. So, the cavitations will start where cavitation will start just when it will leave the leave the seat of the valve clear just when it will leave the seat of the valve the cavitations will start, because at the as it proceeds to the as it proceeds to the outlet.

So, that is the portions actually when the cavitation will occur. Cavitation theoretically occurs when the minimum pressure is equal to the vapour pressure minimum pressure is equal to the vapour pressure very common in the case it is very common in the case of LPG industries where the vapour pressure is little less . So, whenever this pressure falls then; obviously, cavitation will start and the outlet pressure is above the pressure when the above above the vapour pressure. What will happen to the outlet pressure? Because pressure will be recovered that time that bubbles will be collapsed. So, the cavitation will start.

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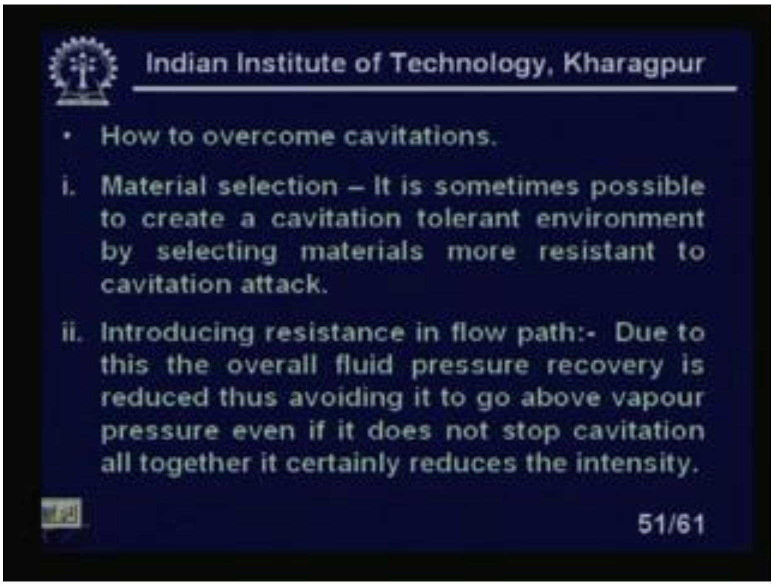

How to overcome the cavitation, so cavitation is there you must I mean check how to overcome the cavitation. Material selection it is sometime possible to create a cavitation tolerant environment by selecting materials more resistant to the cavitation attack we have to see the inside the valve. So, that it will more resistance to the cavitation that is number 1 number 2 introducing resistance in flow path due to this the overall fluid pressure recover is reduced.

Obviously, the pressure drop will be there is a pressure loss; obviously. So, this pressure loss actually will lead to the more pumping cost; obviously, but the, we can avoid the cavitation. Introducing resistance in the flow path and due to this overall fluid pressure recovery is reduced thus avoiding to above the vapour pressure. Even if it does not stop cavitation all together it is certainly due to it is intensity intensity of the cavitation will be reduced.

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Now, accessories of the control valve there are accessories I talked about at the initial stage. So, let us discuss little bit of accessories. There are many accessories associated with the control valves like valve positioners, limit switches, solenoid valve, manifold, supply pressure, regulator, fail safe systems, pneumatic lock up system etcetera. But most of important of these all these things are the the valve positioners. These accessories help the control valve function better with more accuracy and also act as a safety precautions. This is also safety is very important as a safety precautions also will be used. Out of all these valve positioners are the most important are the out of all this valve positioners are the most important accessories we will study the valve positioners in details clear?

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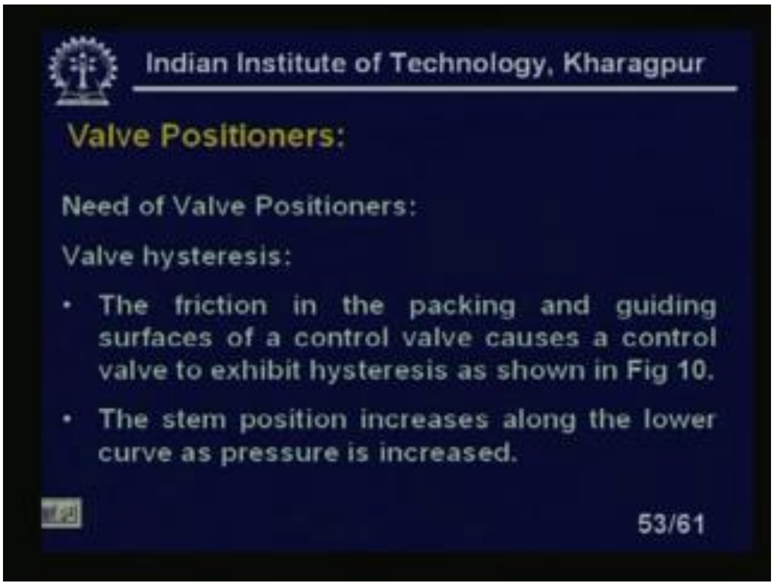

Now, valve positioners what is these valve positioners you see that is as the name implies actually it will position the position the stem position the seat position I am sorry position the plug on the seat of the valve more precisely much better way right. So, that there is no stress the valve positioners is necessary due to the hysteresis we will first look at what is the control valve hysteresis we will look at that. Need of the valve positioners; valve hysteresis; this is mostly the friction in the packing, because we need a packing, why because you see the inlet pressure inlet liquid is coming inside the valve which is might be globing shape. Or whatever it may be through the through the seat it is in the plug the space between the seat and the plug liquid is flowing through the outlet line, but this plug actually connected to the stem.

So, the plug must this entire globe should be separated from the other part of the control valve from the bonnet all those things. So, what will happen? We need some packing. So, pack packing will prevent the liquid flowing out there is only one path of the inlet or one path of the outlet if there is improper packing. Then what will happen? Liquid will flow through the packing region that is not allowed, because the high pressure liquids. So, the, is a very good packing. So, the packing the problem is there packing will introduce a frictions. So, that will make the hysteresis of the control valve. The friction in the packing and the guiding surfaces of a control valve causes a control valve to exhibit hysteresis as shown in figure 10. The stem position increases along the lower curve as pressure is increased, let us look at…

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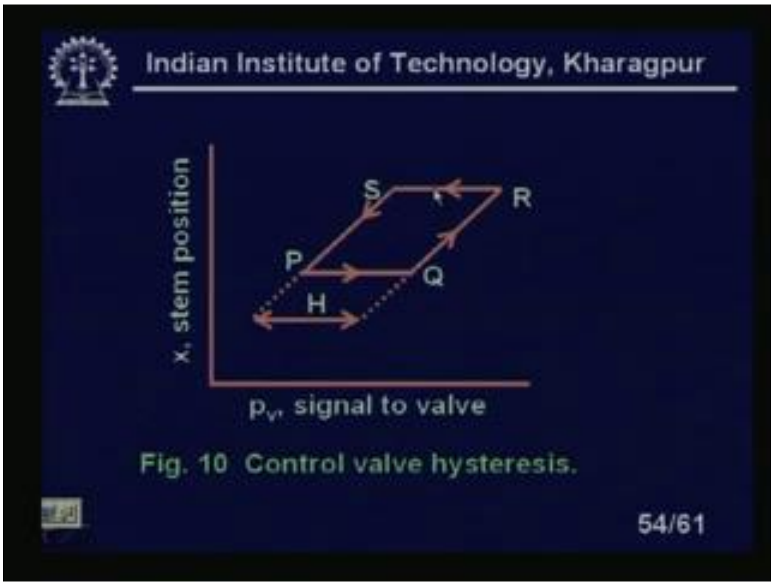

You see I have signal to the control valve Pv and this is the stem position or lift what we call it something. Sometimes we call it life y axis I am placing lift and x axis the control signals pneumatic control signals I am giving the control signals. But I am getting any stem position suddenly there is a stem position it is increasing I am changing the signal. Now, it is not now when it is friction overcome the friction it is going like this while I reducing you see while I reducing the I mean this signal to valve. Because x axis is signal to valve we are reducing the signal pneumatic signal the stem position is not coming down it will remain for sometime the same position after that it will go. So, this is H hysteresis of the control valve to kill this hysteresis I need a valve positioner let us look at.

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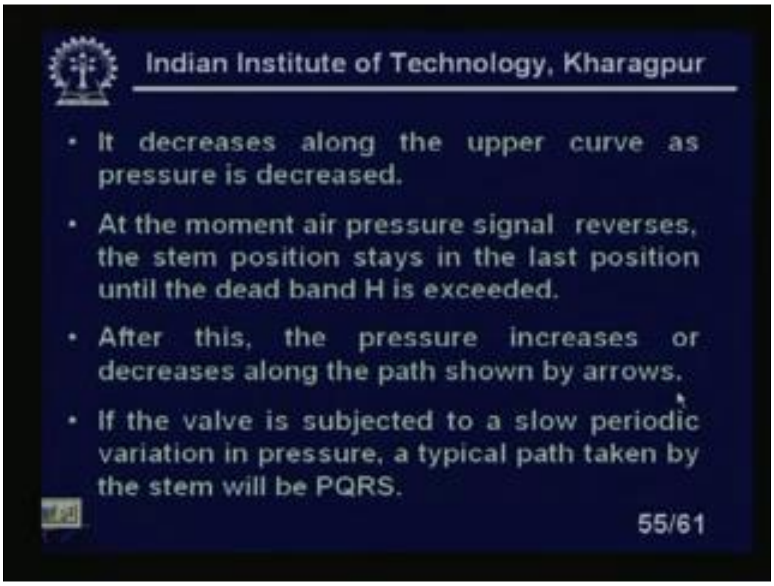

It decreases along the upper curve as pressure is decreased we have seen as the moment air pressures signal reverses the stem position stays in the last position until the dead band H is exceeded. This H is exceeded until unless I cross the H H is the dead band of the pneumatic signal. After that it will start to react right both in the when it is going in the stem is moving up and moving down might be this H is small whatever we have shown that I mean to understand. So, that you will understand nicely, but it usually quite small even if you do not use valve positioned

After this the pressure increases or decreases along the path shown by the arrows we have seen where pressure is increases stem position; stem position changes this is the pressure. If the valve is subjected to slow periodic variations in pressure a typical path taken by the stem will be PQRS. If I now give a slightly cyclic variations of the pneumatic signal Pv we will find that there is a typical path taken by the stem will be PQRS clear? What is PQRS? You can see the hysteresis curve clear?

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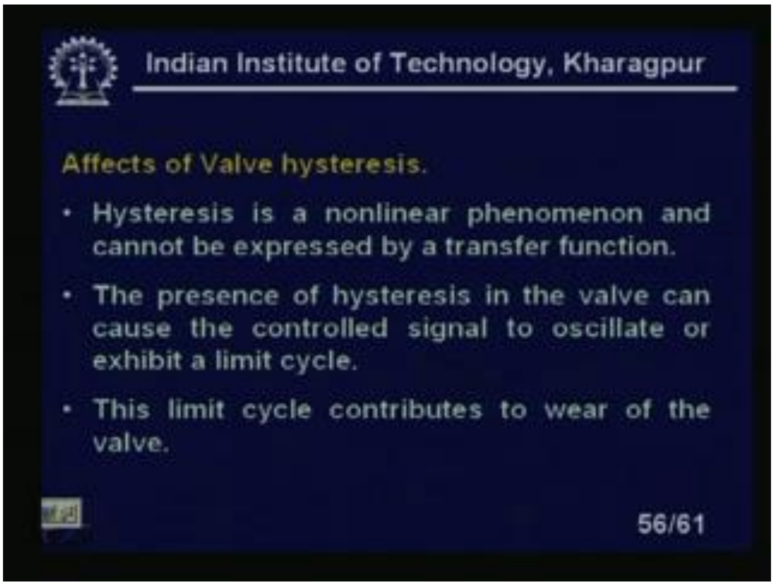

The affects of the valve hysteresis; what is the affects of this hysteresis? Let us look at the hysteresis is a non-linear phenomenon. I cannot be expressed by a transfer function the presence of hysteresis in the valve can cause the controlled signal to oscillate or exhibit a limit cycle it is show a oscillate or limit cycle. This limit cycle contributes to wear of the valve; that means, valve will be damage very quickly.

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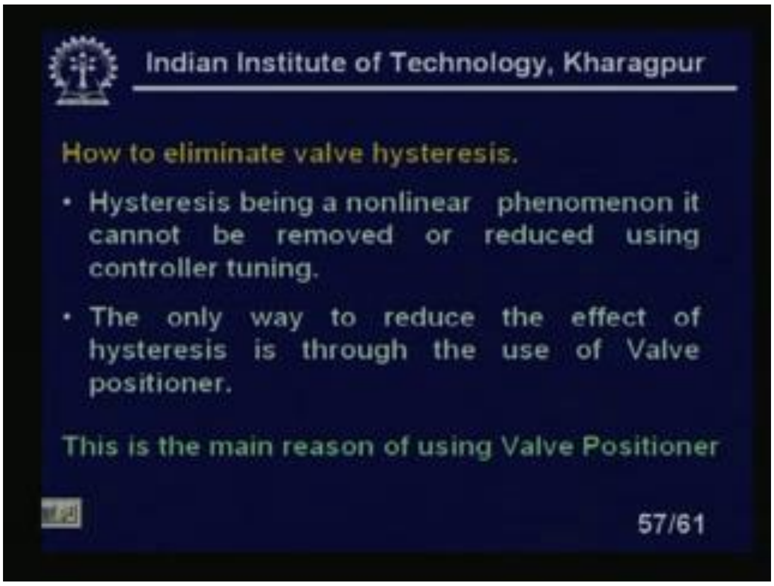

Now, to eliminate the hysteresis valve hysteresis let us look at. Hysteresis being a non-linear phenomenon cannot be removed or reduced using controller tuning controller tuning will not do which is non-linear phenomenon, what we can do the only way to reduce the affect of the hysteresis is through the use of the valve positioner. We can valve positioners you will see is a another control loop which is with the proportional control which will control which will position the valve precisely at the position where we need. This is the main reason of using valve positioners; this is to kill the hysteresis. Let us look at about the valve positioners.

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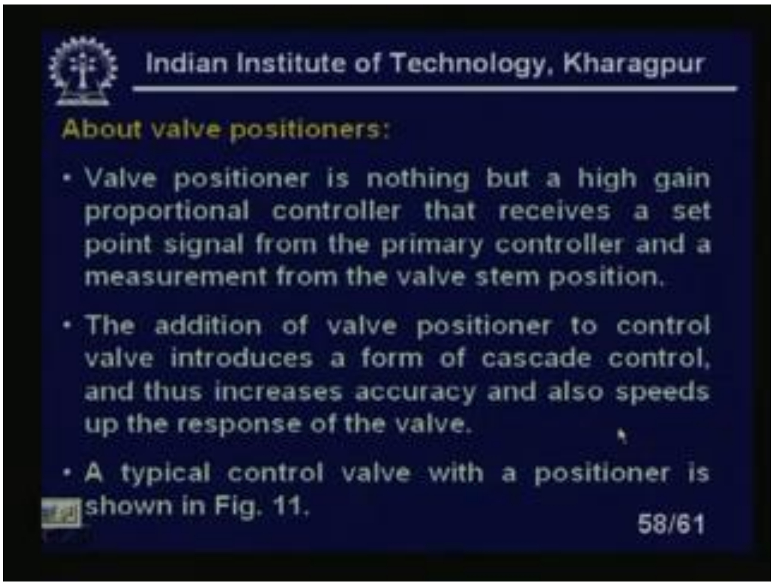

Valve positioners is nothing but a high gain proportional controller receive a set point signal from the primary controller and a measurement from the valve stem position. I am getting a set point signal from the main controller and I have a stem position if there is an error. It will make some I mean it will make proportional control signal we will go to the diaphragm of the control valve. So, by these I can get a precise. So, that now the stem position also is to be measured this is most important previously we have seen that we are not measuring the stem position. But if I install the valve position valve position is the integrated part of a valve body it is actually rigid to the valve body.

But I need a if I need a valve positioners then what will happen? Obviously, I need a I mean I have to measure the position of the stem if the actual position which is coming from the control signal or controller does not match with the position which is showing by the valve stem positioner position sensor. So; obviously, I have to take some action I have to move up and down until unless this position I mean exactly matches with a with the correspondence to the control signal which is coming from the controller let us look at this. The addition of the valve positioner to control valve introduces a form of cascade control. This is basically a cascade control we have seen the cascade control two loops in nature.

So, we have seen the cascade control extensively use in process thus increasing the accuracy and also speeds up the response of the valve. So, the addition of the valve position to control the valve introduce a form of cascade control and thus increases accuracy and also the speeds of the response of the control valve. So, the control valve response also will be increased by this position. This is very important that is the reason people are using the valve positioner most of the controllers. Specially if the valve is a large in size we need a controller the only pneumatic signals may not be sufficient to. So, I need a valve positioner there right. A typical control valve with a positioner is shown in figure eleven you can see here.

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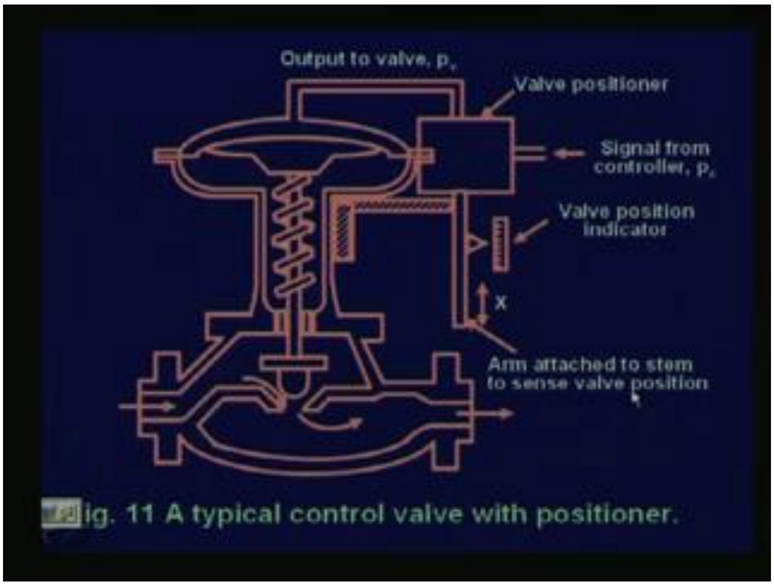

Fig. 11 A typical control valve with positioner.

You see this is our a control valve a control valve already you have seen in many situations. But you have not seen the valve positioner this is the valve positioners of the control valve you see what will happen you see here. So, this is our valve typical valve body I mean the liquid is coming in through this flowing through this one which is going to the outlet fine. This is the stem; this is the, our plug and this is our seat you know this is the seat and this is spring. And you see here is a packing this packing should be very tight in the case of control valve. Otherwise, that is a problem, because if there is a packing why I am saying repeatedly about the packing you see what will happen if the pressure liquid is high.

So, it will go through this one. So, that is not allowed. So, this packing should be very tight right. Now, if I use a tight packing there is a large of frictions of the stem. Because stems will move only the stem of this control valve will move nothing else the stem will move the spring is squeezed. If it goes up now when the pneumatic signal removes this it will go down right clear? Now, what will happen? You see if I if I now sorry if the pneumatic signal is I mean removed actually the valve will go up. So, it is air to close if the pneumatic signal this is a diaphragm. So, diaphragm give the pressure it will go like it will squeeze and it will come otherwise what will happen? It will go like this one.

Now, what will happen? You see here there is a valve positioner. So, there is a friction now the valve positioners is a device is a cascade controller. So, I am getting a signal pneumatic signals of Pc from the controllers that is 3 to 15 Psi of the signals. I am getting it is coming to the now I am measuring the valve positions also through this one stem position the stem positions I am measuring. So, what will happen? It is getting signal and this is also this if this is not matches then what will happen if it does not matches it will produce some control signal it will produce some control signal. And this will this process will continue until unless this valve position whatever it is showing when the indicator or measurement system will exactly matches with the signal control signal Pc. Pc is basically corresponds to some valve position stem position, right.

So, this way, so the control loops I mean this way I can use a output of the control will come here. So, this way I can make the valve positions and make the systems very steady I mean I can make the system. So, that it will work I mean without any error in the stem position this is very common, because if it is a large friction. Obviously, what will happen that there will be a some mismatch of the position now that can be. I mean recovered that can be exactly valve can be positioned valve stem can be precisely controlled by using the valve positioners right. So, this is all about I am talking about these I mean valve positions and all these things you see here these arm attached to the stem to sense the valve position. And this is arms it is sense the stem of the valve position this will come to travel and this is the valve position signal from the Pc will come right.

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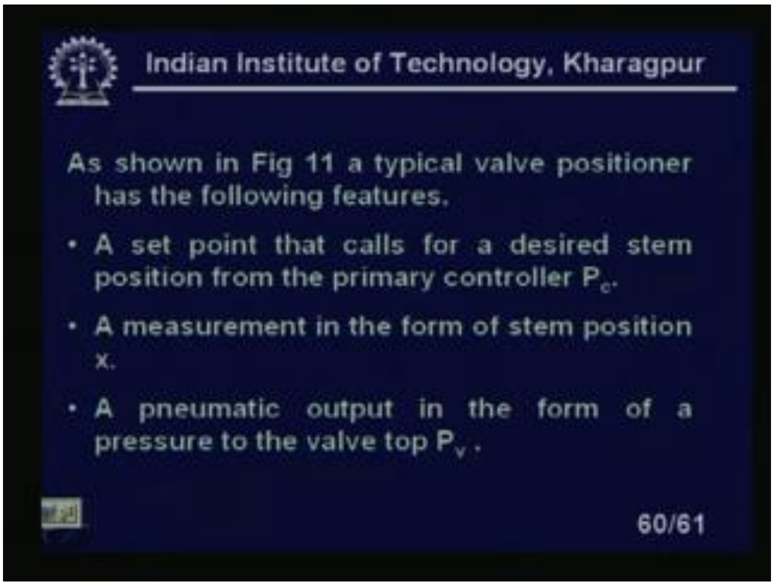

And as shown in figure eleven a typical valve positioners has the following features what are the features of the valve positioners let us look at. A set point, that calls for a desired stem position from the primary controller Pc, which is coming from the primary controller, a measurement in the form of stem position x. So, these two will be I mean these two will be compared this Pc will be compared with x. Obviously, Pc will be compared with x in a valve position accordingly it will generate a control signal Pv which will go to the diaphragm of the control valve.

A pneumatic output in the form of a pressure to the valve top Pv will go this will actually give the proper position of the control valve. So, this is all about the positions of the control valve and the control valves I mean and most of the, you see the most the figures. Actually we have taken from the Fischer control they are the largest manufacture of the control valve this is available in the web sites. So, there is no problem those who want to look at the details of the figures they can go to the particular site and look at those figures right. And with this I come to the end of the lesson 39 of the industrial instrumentation.