Industrial Automation & Control
Prof. S. Mukhopadhyay
Department of Electrical Engineering
Indian Institute of Technology, Kharagpur

Lecture - 29
Pneumatic Control Systems – I

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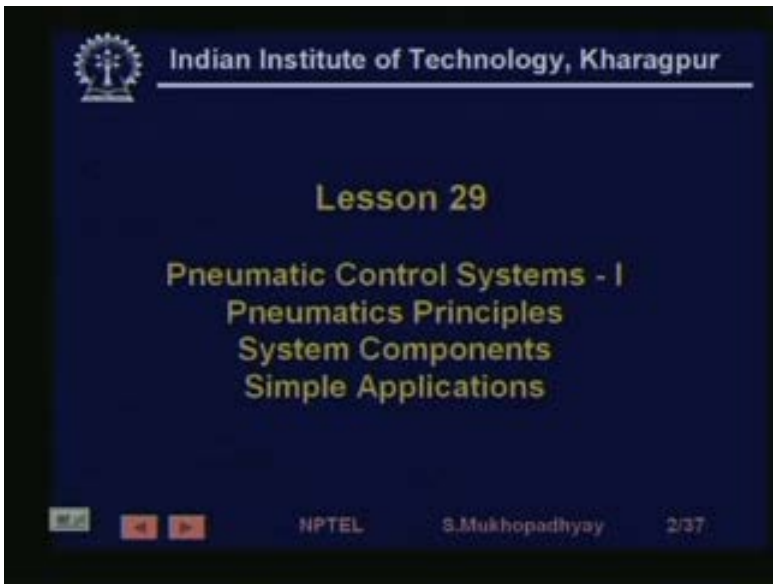

Welcome to lesson 29 of Industrial Automation and Control. Today, we will start discussing Pneumatic control systems and we discuss the pneumatic principles, the main pneumatic systems components, and some simple applications.

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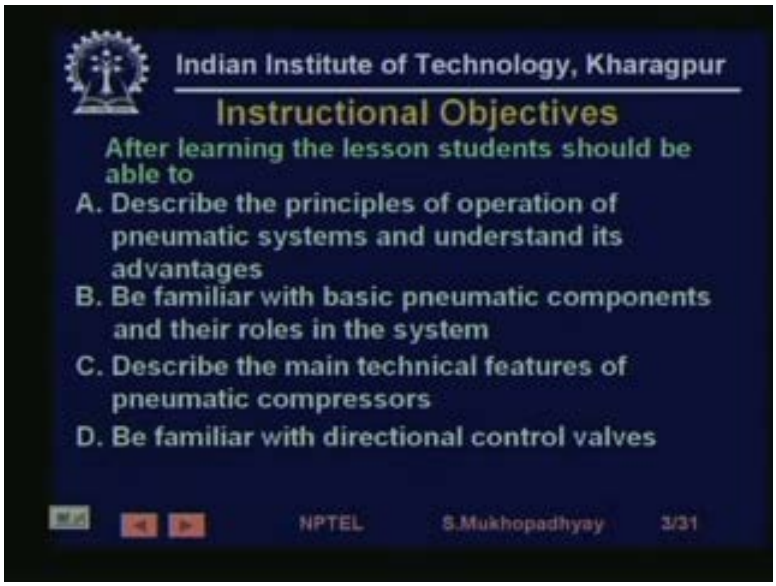

So, coming on to the instructional objectives, after learning the lesson the student should be able to describe the principles of operation of pneumatic systems, and understand it is advantages be familiar with basic pneumatic components and what roles they play in the overall system. Describe the main technical features of pneumatic compressors and it is exercise of course and be familiar with directional control valves. So, that will give us the first, a basic idea of a pneumatic control system.

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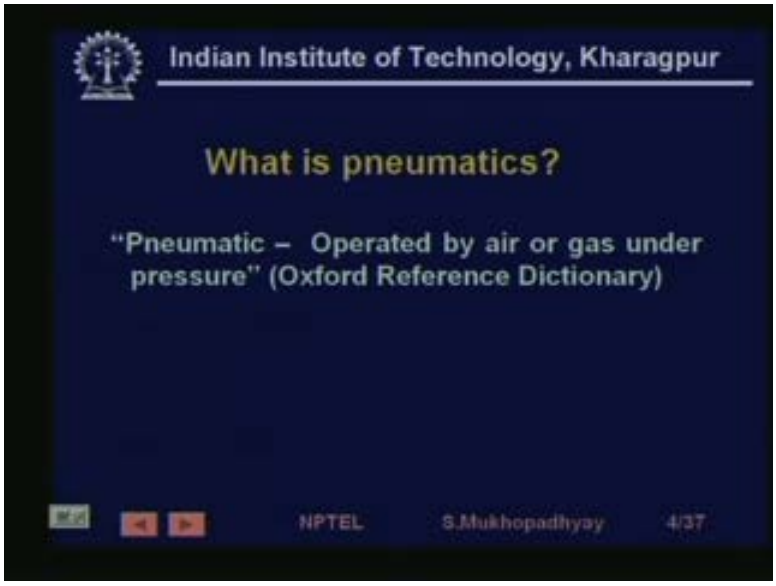

So, what is pneumatics, as I often do I checked up the oxford reference dictionary and pneumatics means operated by air or gas under pressure. So, since we have already had some lectures on lessons on hydraulic controls, in hydraulics controls, they are both hydraulics and pneumatics are fluidic control systems. Where a fluid under pressure is used to do work, in hydraulics this fluid is oil and in pneumatics it is air, it is compressed air, so there are certain advantages and disadvantages as well of using compressed air.

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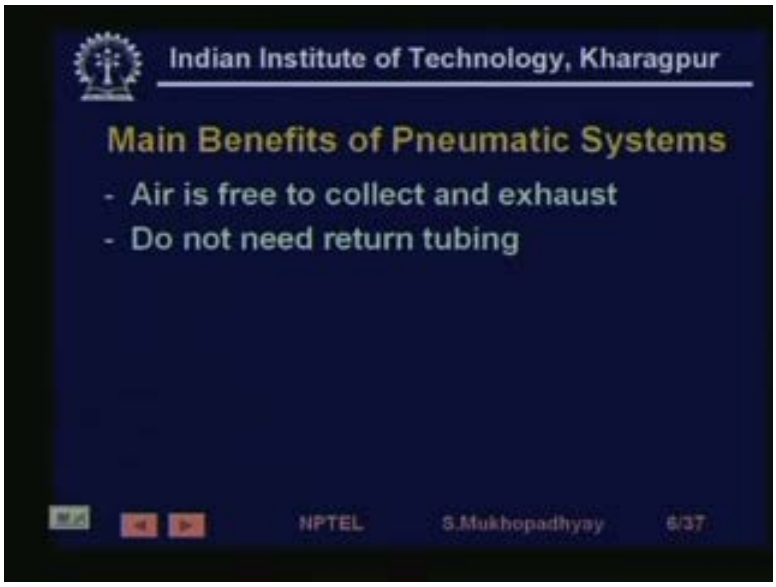

So, the main benefits of pneumatic systems is that, air is free to collect and exhaust, so you know, it is simply collected you do not need to buy it and therefore, it is cheap and it can be exhausted into the atmosphere, so you do not, so you do not need return tubing. So, you see that for hydraulics you need one pipe or tube for carrying the fluid to the place of work, namely the load and you need another pipe or tube to bring it back.

Now, this is not necessary for pneumatic, since you are using, when you are using air which is mostly the case, because you can directly exhaust it to the atmosphere right at that at the place of work and therefore, you save half the tubing costs, so that is quite a lot. There is another reason, why pneumatics is generally turns out to be cheaper, than you know electric actuation or hydraulic actuation. One of the reasons is that, in pneumatics the cost of the air handling equipment that is the compressor, basically the compressor.

Actually is shared among the application, so suppose in a factory if you go to a, let us say factory like a Telco, if you go to the assembly plant of Telco, then you will find that there are numerous places where pieces of, you know let us say pieces of the engine are getting assembled. So, in each one of these places, there you will find that, there are various kinds of tools are to be used, you know. So, like you know wrenches, screw drivers, now to ensure a uniform degree of performance with these tools and also not to exhaust the operator, people use pneumatic tools.

So, you will find that, every operator station actually has some compressed air supply and that compressed air supply, so you are, so you are using compressed air to do work at numerous places, but you possibly need only one big compressor and then run a line of compressed air through at different places. So, the cost of the compressor, actually gets divided and this leads to, you know cheaper system, compared to let us say electric, where you would have needed to, may be put a motor at each of these places.

So, therefore in such cases, where the there are numerous applications spread over some area, generally call the cost of pneumatic systems becomes cheaper. Now, there are, that is another important advantage of pneumatic systems is that, while electric systems are you know prone to fire because of electrics sparks and hydraulic oil is inflammable being from you know, petroleum derivative. Pneumatic systems are intrinsically safe and therefore often preferred in, you know places like explosive environment.

So, let us say a natural gas plant, would prefer would have a lot of application for pneumatic control systems, to be free from the hazard of explosion. Similarly, maintenance is easier, because of the fact that, I mean in hydraulic systems if there is a leak in oil which is a major maintenance headache, then first of all you are going to loose oil, so that is expensive. Secondly, it is going to, you know create general environmental problem, thirdly it is it is also inflammable.

But in pneumatics, if you if there are, you know small leaks here and there which are kind of inevitable, ((Refer Time: 06:37)) then apart from the fact that a leak all is, is always going to cause a loss of pressure. And therefore, some loss of energy, apart from that the consequences of that leak are minimal and therefore, maintenance need not be so stringent, so maintenance is generally little easier.

On the other hand, there are disadvantages of pneumatic systems as well, for example, first, these systems are slower in performance compared to hydraulics, their power handling ratings are also generally slower and compared to, I mean in terms sophisticated controls, it will they are inferior to electric controls. So, having said that, let us, so because of these there are quite of you uses of compressed air in the industry.

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And some of them are, you know pneumatic control valves, so basically pneumatically actuated control valves, that is what I mean, so you know have big valves, flow control valves which are operated pneumatically using air. Then there are air cylinder for actuation, then sometimes you need starting air for diesel and gas turbine engines, diesel generators and gas turbine engines, for there also you need compressed air, you need tools. So, various types of tools for screw driving, for drilling, for paint spray and for clamping, so for such operations, people often use compressed air tools. So, there are lots of in applications of pneumatics in the industry.

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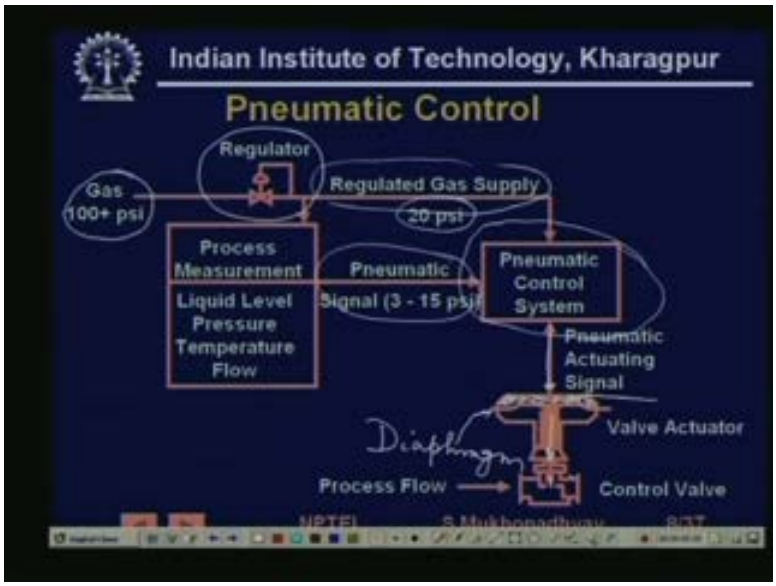

So, typical pneumatic control systems, block diagram wise, would look like this, so you have a source, you have a source of air or gas which is at high pressure, this source is generally coming from the compressor and then you have a regulator, this is actually a pressure regulator, this is a pressure regulator. After that you need, you actually get the gas at the pressure that the your equipment will require. Similarly, you can also have feedbacks, you can have pneumatic signal feedbacks, using you know things like I to P converters, current to pressure converters.

So, you can have pneumatic feedbacks, signals from you know various sensors and then you can have a pneumatic control system. So, this control system will consist of, you know various, may be direction control valves and various pneumatic logic valves and or we will see them in the next lesson. And finally, this is from the pneumatic control system and using this regulated gas supply, the actuation signals is given in this case, the application that we have shown is a valve actuator where, the this valve is actually moved using pressure on this diaphragm.

So, this is a diaphragm, so using this pressurized gas you actually apply pressure in this cavity. So, what will happen, is that this diaphragm will under pressure it will come down and it will close the valves here, so this typically is a kind of schematic, that is used for pneumatic controls and various kinds of technologies are used, so we are going to have a look at that.

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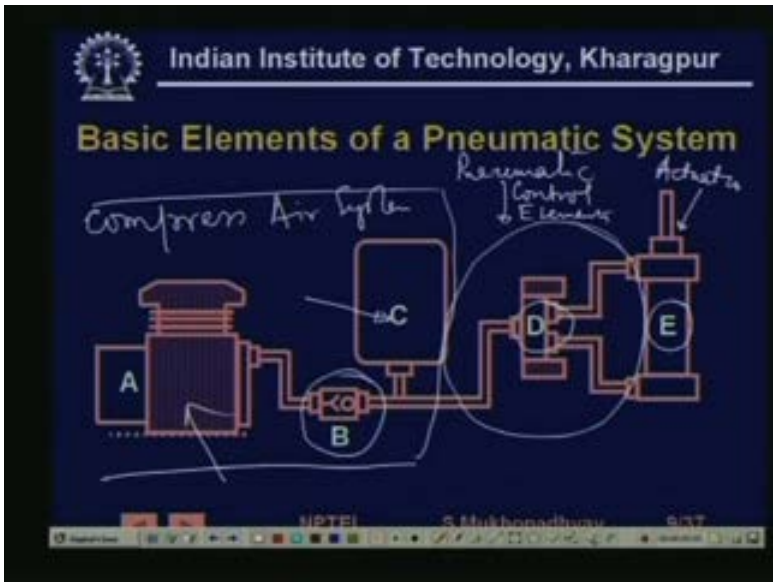

So, let us look at the basic elements, the basic equipment in a pneumatic system, so we start with the compressor, so this is the compressor A, then after the compressor you have a, you sometimes have a check valve B, then you have an accumulator or reservoir of compressed air, this is very much necessary in pneumatic systems to improve response speed, as we will discuss. After that, you have you can have a various kinds of equipment.

For example, in this case we have only shown a direction control valve, which is trying to drive A, an air cylinder. So, but this is a very typical and simple system, but in general you can have various other pieces of equipment like, you can have pressure regulators, you can have flow control valves, various kinds of valves apart from the simple direction control valve. So, you have your actual, you know control system elements here, these up to this is generally the gas compressed air system. This is the pneumatic control system, pneumatic control elements. And then finally the actuator, so these are the three types of equipment, which are typically used in pneumatic controls.

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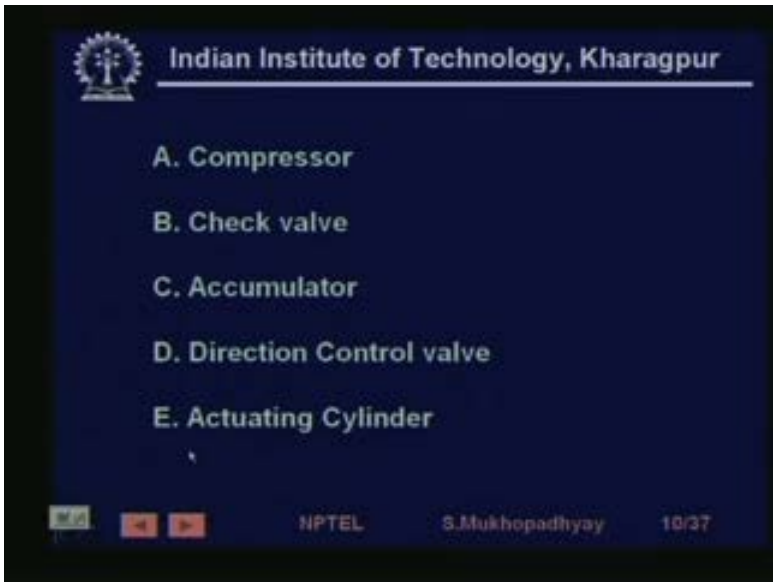

So, A compressor, B check valve, C accumulator, D direction control valve and finally E is actuating cylinder or actuator.

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Now, in system components, compressor is a pressure source, sometimes you can have a linear air cylinder or sometimes you can have also have a pneumatic motor, reservoir or accumulator, reservoir accumulator is very much necessary. Because of the fact that pneumatic system response tends to suffer, because suppose you want to move a cylinder, then you have to create the pressure create pressure on it.

Now, creating pressure actually take some time, because the air will have to flow into the cylinder chamber and then get compressed enough. So, and then then the pressure in inside the cylinder will build up and the cylinder will move. So, what happens is that, if you want to move the cylinder quickly, after you know let us say giving a control signal in terms of opening a direction control valve, then you want that quickly a lot of air can be supplied to the cylinder chamber.

So, that it is quickly the pressure builds up and the cylinder starts to move, now supplying this, a lot of pressurized air quickly, is the basic problem because compressors are devices which can create a steady source of compressed air, but a very, you know instant supply of large volume of air cannot be supplied from this from the compressor itself. So, in that situation, the accumulator comes into play and in such situation the large volume of air can directly come from the accumulator.

And then the accumulator can get slowly filled up by the compressor again, so this improves system response a lot. Therefore, in pneumatic control systems, accumulators are very much necessary, more than in hydraulic controls. Then we have the direction control valves and actuator, as we have already said and we naturally need connecting tubing and accessories like filters.

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There are a, just like in hydraulics there are various type of controls devices which are also used here, so you have pressure control devices like pressure regulators. You have check valves which control flow, that is allow flow in a certain direction and does not

allow flow in the other direction. Then there are flow control valves, flow control valves in this case, they are not, they are mainly used to control the speed of motion.

So, sometimes you know you, need that you, I mean for example, in the case of hydraulics, we have seen that when you are driving the load, typically you need slow motion and when you are returning without load, you need you can have fast motion to save time. So, in such a case, in such cases flow control valves can are used much, very similarly as to what you use in hydraulics. Then there are you know various kinds of, if you have feedback control, then you can have various kinds of feedback elements like pressure switches, you can have push buttons for operator commands. And of course, you have various kinds of, you know electrical interface devices like you have I to P converters, so to for interfacing between electrical systems and hydraulic systems.

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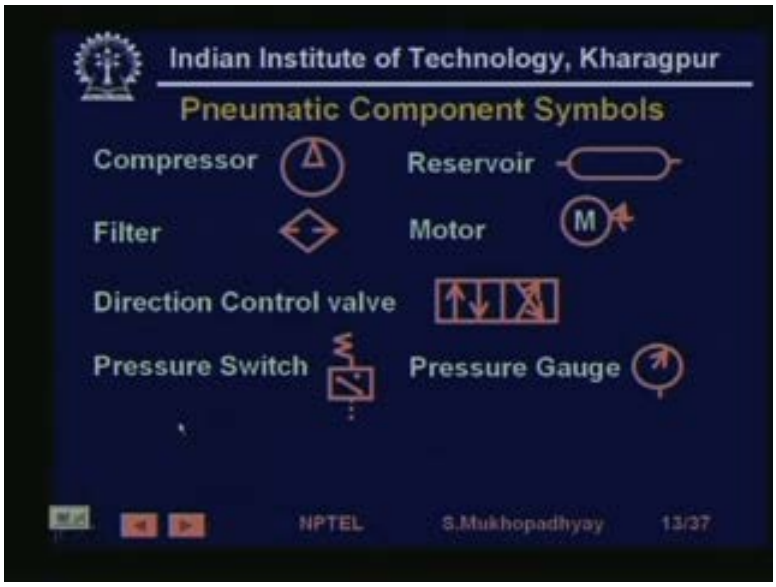

Symbols are very similar to the ones we used in hydraulic, so compressor is like this, only note that the triangle is hollow, in the case of hydraulics the triangle was solid, because it was oil. Then you have reservoir, you have filter, motor, hydraulic motor the same as electric motor or rather this pneumatic motor, then direction control valve, pressure switch and pressure gauge, now pressure gauges are used at various points in pneumatics to either to feedback pressure values are to read them and of course, the cylinders. So, these symbols are fairly common and very similar to hydraulics.

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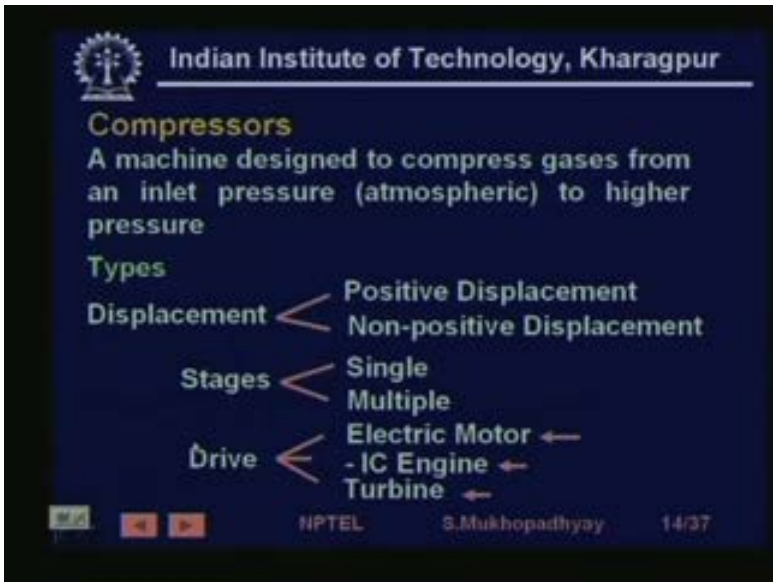

Then we look at compressors, compressors are the mechanics which are designed to compress gases from an inlet pressure which is generally atmospheric. So, it takes air from the atmosphere, filters it and then compresses it to a high pressure, and there are, this mechanism can be of generally of two types; one is positive displacement, where each kind a certain given volume of air is converted from the atmospheric pressure to high pressure.

So, every cycle of movement of the compressor, whether it is rotational or translational, converts a certain amount of gas from low pressure to high pressure. Then, when you and the other kind is non positive displacement which is basically, you know centrifugal type basically fans essentially types of fans and blowers, which are typically use when you need large volumes of air, but not at such a high pressure. So, typically for high pressure positive displacement type compressors are used.

If you want to convert to a very high pressure, something like you know 600, 700, 800 or 1000 psi, then use some often need to do it in multiple stages. So, you so a compressor can have various stages, single or multiple and it needs to be driven, so because it compresses the air, so therefore, it needs to be driven by a prime mover and that, there are various types of prime movers possible. It can be, the prime mover can be an electric motor or it can be an IC engine or it can be even sometimes it can be a, you know something like a turbine, with which this, with which the compressor will be coupled.

So, in places where you have, you know such turbines, then you can actually use that energy for running the compressor.

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So, positive displacement could have involve linear motion or could involve circular motion, so you can have a reciprocating piston type or you can have rotating vane types or rotary impeller. So, either you have rotational designs or you have translation designs, but in each case, one cycle of rotation or one cycle of, to and fro motion will take a certain given volume of air and push it take it to the low pressure inlet port and push it into the outlet port.

So, in the reciprocating piston type, you have a piston, you have a cylinder and you have some valves and there are two strokes, so one stroke is called suction and the other stroke is called compression. So, in the suction stroke you are taking an air from the low pressure side, which is typically atmospheric and in the compression stroke that volume of air, you are pushing onto a high pressure port and this sucking and compressing is actually guided by the set of valves, as we will see. This can also be singular or multiple stages.

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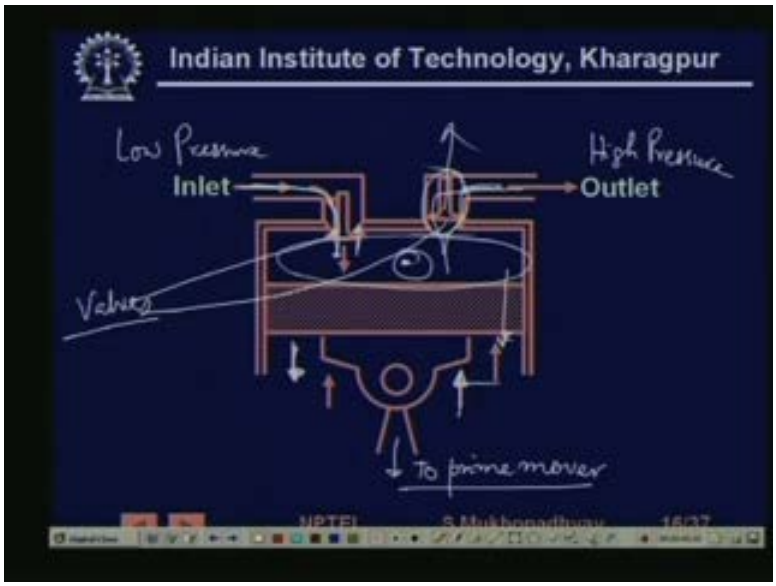

So, here is a diagram, so typically you know, see this is the low pressure inlet port and this is the high pressure output outlet port. So, and these are the two valves, you know which actually control the motion and this is coupled to the prime mover, so maybe it is a cam operated mechanism. So, in the suction stroke, this cylinder moves this way as shown here and then this valve is going to open, because the pressure here is going to fall, so this valve will open and air will flowing from the inlet.

On the other hand, this is not exactly I mean, this is only schematically shown, so since this is suction. So, therefore, this will seal this outlet, so no air will be sucked from the outlet. Now, after this has come to the lowest position, a certain given volume of air is going to be residing inside and that is at the low inlet pressure, after that this alternating motion, this cylinder will start going up, the moment it starts going up it creates a high pressure here, it actually compresses the air here.

So, what happens is that, this valve is now pressed up, so it will be closed, while this valve will also go up and then that will open the, that will actually open the, so the air will flow out, during that time through this path and this is, so this is what is happening. So, every stroke it is bring, it is sucking a given volume of air from the low pressure atmospheric side and it is pushing the air back into the high pressure outlet. So, this is a reciprocating type compressor mechanism.

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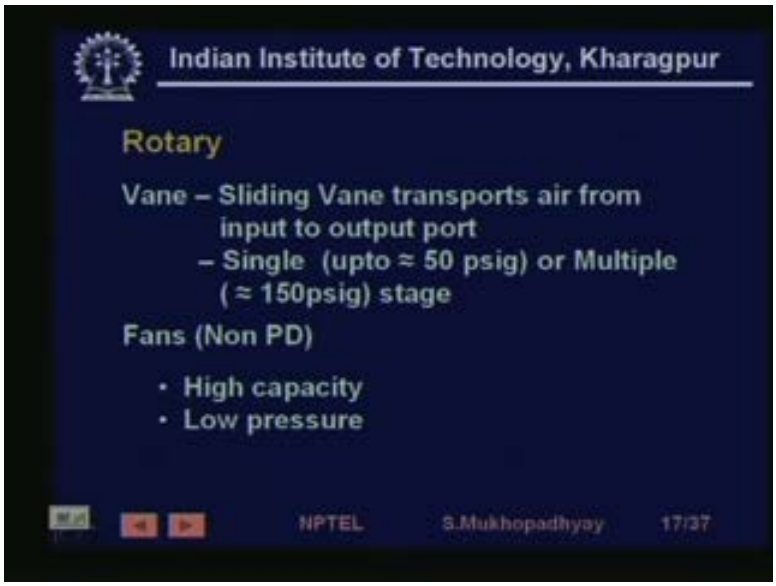

For rotary compressors, they are either, you know vane type where, as we have see in the case of hydraulics also we have seen vane type pumps, where the rotational motion of the vane inside a cavity will just, when the vanes move, air is sucked in from the inlet and that air is transferred back to the outlet at high pressure. So, here also you can have single or multiple stages, the other option which is non positive displacement ((Refer Time: 23:25)) fans, they are generally used where high flow volume capacities are needed, but at low pressure. So, in such cases, fans are used and they can be centrifugal or they can be axial.

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I am sorry, let us see what is here, so obviously compressors, apart from that mechanism requires other accessories like for example lubrication, lubrication is very important in pneumatic systems. Firstly, because they are not self lubricating, just like hydraulic, so you have to have special lubrication mechanisms here and second also because, there is the tendency of air to leak, is actually much more than the tendency of oil because of, because air has very low viscosity and oil has high viscosity.

So, oil does not tend to leak out as easily as air does, so therefore, all seals everything are much tighter to prevent air from leaking and that creates a lot of friction. So, lubrication is more necessary, similarly cooling, because the compressor is actually doing a lot of work source, a lot of heat is produced which needs to be cooled and you need unloading systems, you know compressors are energy guzzlers, so whenever you do not need, when you have adequate created, adequate compressed air supply, then there has to be mechanism by which this compressors are actually unloaded.

And finally, there has to be control mechanisms for shutdown, as well as for duty cycle control. Duty cycle control means that, especially stroke length control and for how much time you are going to, that is how quickly you are going to operate the piston. So, all these control devices are, will create will actually operate the compressor at, in such a manner that the current requirement of compressed air will be met at the, I mean with the best possible energy efficiency. So, the compressor is not run, generally not run, when the compressed air supply is not so much required.

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So, compressor, so is for example, this is a typical compressor where, you know this is we can see from the picture that this is a IC engine driven compressor and this is the compressed air supply. So, that is the accumulator and it looks like a portable just a picture which is downloaded from the net, so compressors are available at various, you know sizes or capacities and so 150 psi, up to 150 psi would be low pressure, 150 to 1000 is medium and greater than 1000 psi will be high pressure.

The capacity of the compressor, so there is a pressure rating, which is decided and then so compressed air is actually supplied at that rating and then the capacity of the compressor is basically decided by the volume of air, that it can deliver in minutes, at that pressure. So, it is a often in engineering, it is often described in terms of CFM, it is called CFM, cubic feet per minute. So, how many cubic feet per minute of air, the compressor can supply, so that generally indicates it is capacity.

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Now, we have pneumatic reservoirs, as we said, this is a typical picture, it is just a container with one inlet and one outlet and holds air under pressure and the capacity of the, basically that is the you know pneumatic energy, so the pressurized air is the pneumatic energy which is used to do work. And the amount of the energy that can be stored is basically decided by the by two quantities, that is at what pressure, how much air is stored and what is the pressure. So, they are generally a multiplicative relation because, I mean volume and pressure are both, if you have high volume and high pressure, then you are going to have high energy.

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So, as I said that it stores pressurized air, for fast delivery of air volume and it is like a capacitor somewhat, if you appreciate an electric analogy, then just like for supplying suddenly supplying large currents, without causing the voltage to drop, we always connect big capacitor across a power supply, because the capacitor can supply a lot of current instantly and therefore, I mean as long as it has the charge to supply the current, so therefore, capacitor is generally kept charge at the circuit output.

So, that current demands large transient current demands can be met without causing the terminal going to drop, so in that sense the accumulator is acts like a capacitor. Now, the pressure in the accumulator you see as, the pressure in the accumulator has to be control, because we, so as if air is really drawn from the accumulator at anytime, then the pressure in the accumulator will fall and then we, you know we need to make that make up for that loss of pressure and make the pressure again back to the standard one. And that is typically control using a relay with hysteresis and then used with pressure regulator to actually deliver to valve and cylinder at 6, ((Refer Time: 26:47)) around 60 psig is a very typical figure.

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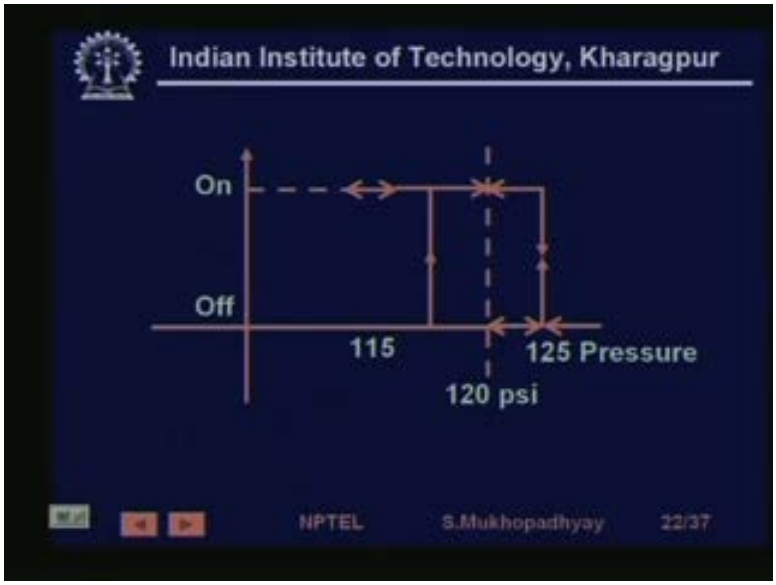

So, the control is somewhat like this, it is just like you know, it is just like level control very simple that, say suppose the regulator is actually design to work at 120 psi, then there is the hysteresis in the sense that, ((Refer Time: 30:21)) I do not know why this is happening, anyway just a moment, this is working, so you see, what we are trying to do

is that, if you have a if you have at a pressure setting, suppose if you have had a pressure setting, the of let us say 120 psi.

Now, as you are drawing load, so the this pressure will start falling and then at 115 psi, you again turn on the compressor, such that the pressure keeps rising and becomes, so that the pressure will. So, you actually make the, you touch it on turn on the compressor at this point time and then the pressure builds. Now, as the pressure builds, so you are moving along this line, the compressor is now on and then you actually although you want to keep it at 120 ((Refer Time: 31:52) p, 120 psi is the nominal voltage where you want to keep it.

But you actually let it build, up to a certain point, let us say up to 125 psi and then again, then at when it reaches 125 psi you actually stop it, so you come here and then again as the loads will draw the air, so the pressure will fall. So, you actually move around through this, what is called hysteresis rectangle.

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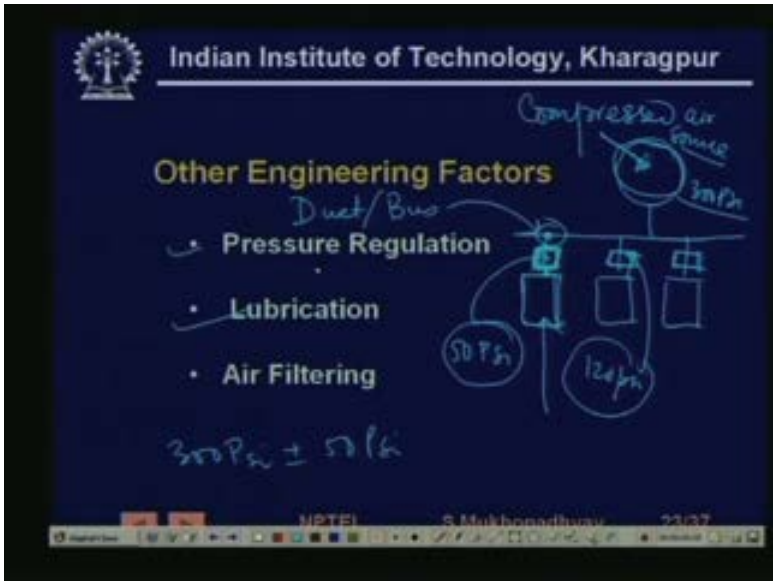

So, now but there are, so this is one, this is the way of you know controlling the reservoir or the accumulator, but there are many other some other pieces of equipment needed like, for example, you need pressure regulators, now why you need pressure regulator, is actually very simple. That is you see, generally in pneumatics you have one pressure source, so suppose of the, this is the compressed air source, so as we have just now seen that.

Firstly, and from there, generally typically up and a kind of duct or bus, runs which provide air supply to a number of equipment and firstly, all these equipment may not be operating the same pressure. So, some of them may be working at, let us say 50 psi, some of some may be working at 120 psi, whatever. So, but the fact is that, remember that we said that, why a pneumatic system is cheap, it is cheap because you are going to use one compressor, so the compressor cost is going to divide, which is going to get divided.

So, just because these require, are going to require, these are going to require different pressures, so we are not going to connect three different compressors which will individually supply this equipment. So, therefore we need a device here, which will take in this, may be this is some, you know 300 psi, so which will take in this 300 psi pressure and will convert it to 50 or 120. So, we are going to put, actually we are going to put different pressure regulators for all these equipment and have a single compressor.

So, firstly that is going to be cheaper, second thing is that as we have seen, just now when we saw the hysteresis controls of that, of the reservoir that the, this pressure source is going to fluctuate, but that, but for our operation, precision operation it is not good that the pressure supply of this equipment are fluctuating. So, therefore if we put a if we put a pressure regulator here, then the pressure regulator is firstly going to convert a high pressure level to a low pressure level.

And secondly it is going to, so even if the pressure here, so suppose this is the 300 psi bus, so even if the pressure here varies 300 psi plus minus, let us say plus minus will 50 psi, but the pressure here is, even if it goes up and down the pressure here is going to be regulated by the pressure regulator to exactly very close to 60 psi. So, the pressure regulator actually does these two jobs, it first converts pressure levels and secondly, it holds the pressure steady.

Secondly as I said that we need lubrication, so lubrication is needed as I said, ((Refer Time: 35:50)) the firstly is of self lubricating, secondly because of tightness of seals, you tend to increase friction, so therefore, lubrication explicit lubrication is necessary and we also need air, lot of air filtering because we are sucking an air from the atmosphere which contain many particulate matters and which are going to get clogged inside the equipment.

And then cause for the problems of maintenance in terms of you know, sealing misses, in terms of increased friction etcetera, so we need equipment to take care of these.

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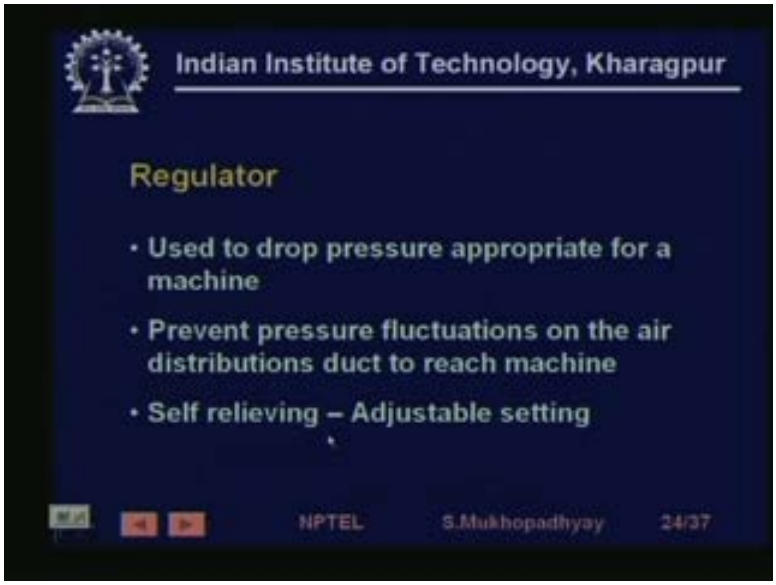

So, a regulator is used to drop pressure at to a level which is appropriate for a machine and it prevent pressure fluctuations on the air distribution duct to reach the machine and settings generally, for regulator settings can be adjusted and it is self relieving in the sense that, if the pressure I mean there is too much inlet pressure then it is it generally relieves that pressure.

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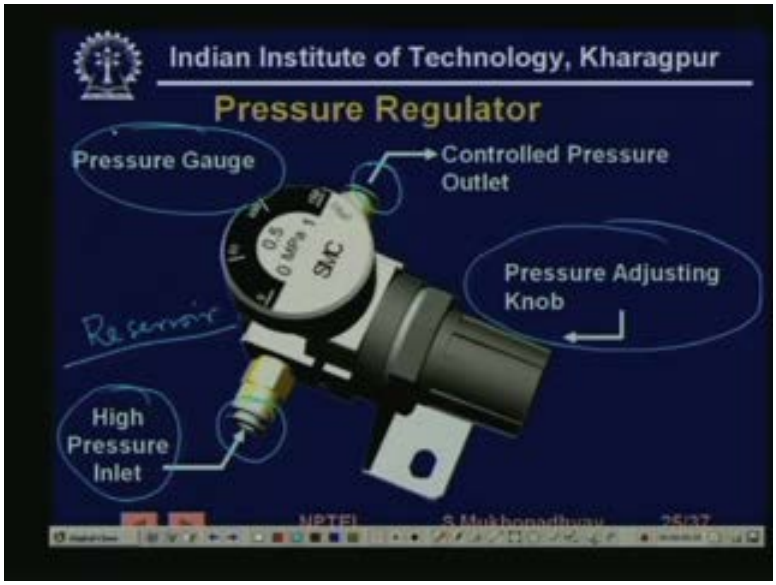

So, this is just a typical picture of a pressure regulator and so you have this high pressure inlet, you have the low pressure or the control pressure outlet, so this is going to the system or the equipment, where the pressure is needed, this is coming typically coming from the reservoir. So, now the pressure setting can be adjusted by this pressure adjusting knob and often there is a pressure gauge, so that you, one can see that the inlet pressure variation.

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So, then the filter can be connected at is generally connected at compressor intake and various types are possible, paper element type is a popular one and sometimes, you put additional filtering you need, just before the equipment to, you know ensure further that these are, that the that your components are protected and so it removes the large particles and it also removes moisture, because especially particulate matter and moisture.

You know creates a very sticky mix, which leads to all kinds of problems like, you know increase friction, sticking, so the terms stiction actually comes from that. So, the static friction may increase substantially, unless moisture and this particulate matter is not removed.

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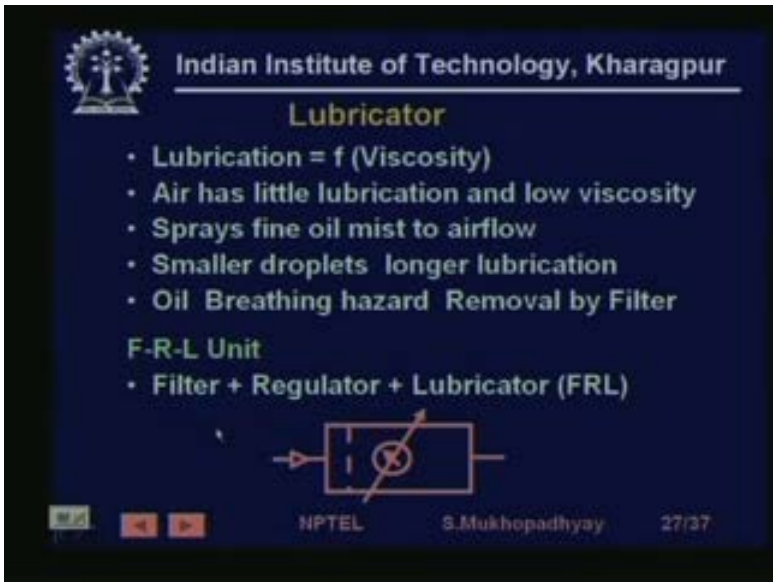

So, we have explicit lubricators, because air has little lubrication and low viscosity and so the lubrication is generally achieved, by spraying fine oil mix to airflow. So, you it is very difficult to you know, in a distributed system to lubricate the system, so just like in hydraulics, the oil itself is the lubricator, so as it travels throughout the system, it actually lubricates the whole of the system. In this case, air is not itself the lubricant, but it is nevertheless travelling throughout the system, so it will, so it is simple. So, the delivery of the lubricant can be easily done using the air itself, so therefore, oil lubricating oil is actually in an in a kind of atomized form, it is spread to the airflow and then the airflow takes it to various points and where it provides a lubricating function.

So, if you have smaller droplets you have longer lubrication and sometimes you can have a atomization, but this oils, remember that the moment you are going to put this oil mist, you cannot directly release it, you can release it you need not return the air, that is fine. But at the same time, you cannot release the air just like that into the atmosphere, because of that oil mist because it is going to be a health hazard. So, sometime, so you actually before releasing into the atmosphere, it must be this oil must be filtered, since this filtering regulation and lubrication are very, very common requirement. So, we have you know like we have like combo units, where this filter regulator lubricator are designed together. So, filter plus regulator plus lubricator unit, typically this is a symbol.

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So, you have regulators, lubricators and naturally filters, so typically some typical pictures of these equipment.

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Then we come to direction control valves, these are very similar to the direction control valves that we have studied in hydraulics and it, so it controls and changes direction of air flow from time to time. There are various functional types, as we know there it can be two way, it can be three way, it can be four way, even it can be five way. Then, there are various positions, so it can be a two position or it can be a three position valve, so what I mean is that, based on their functionality and based on their construction, there are various categories of these direction control valves.

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For example at, this is a typical 3 way valve, which is manually operated using this knob and it has three operational modes, so namely off-vent and on. So, it can be made off, in which case air will not flow, if it on then the air will move from inlet to the outlet and if it is in vent mode, then the inlet and outlet will be connected to the atmosphere.

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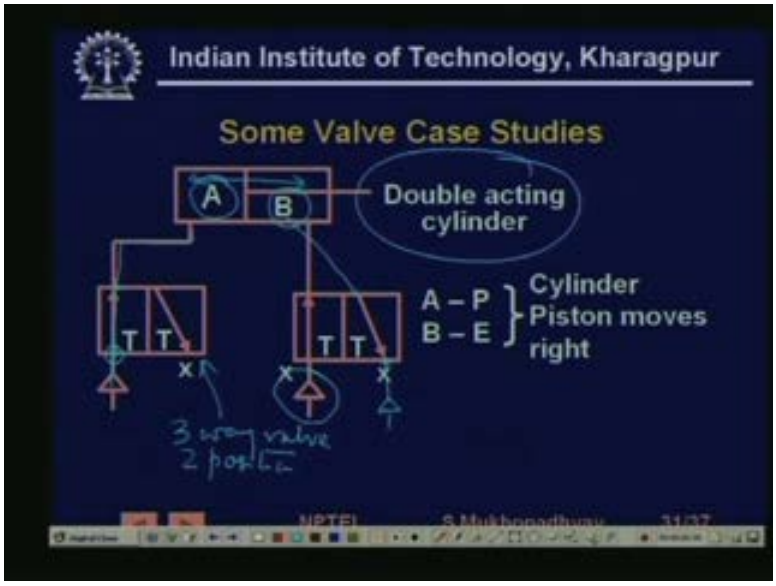

Looking at some very typical valve case studies, so very standard, this is a double acting cylinder and so double acting means, we need to move it this way as well as this way. So, here we have connected, this is a 2 port valve, this is a 3 port valve, this is a 3 way valve, 2 position, so it can connect either this to this, or it can connect, in this position will connect this to this and this side will be connect, can be again connected either, so they are actually independent.

So, depending on the positions of these valves, if they are in the position shown, then this side is also pressurized and this side is also pressurized, so the valve is locked. On the other hand, if you connect this end to this position and this end, if you connect to this position, then what happens is the then the piston will start moving right, because this chamber will be connected here, but this chamber will be connected at high pressure. So, the piston will start moving right and then there is vice versa.

If you connect it the other way, this in this position and this in this position will start moving the other way. If you keep both of them, so there are four combinations and if you keep both of them in this position, then actually the cylinder is floated, so it can move, it is free to move because both ends are connected to vent. So, A to A, B to P locks the piston and A B to E locks, E means exhaust, the piston is floated.

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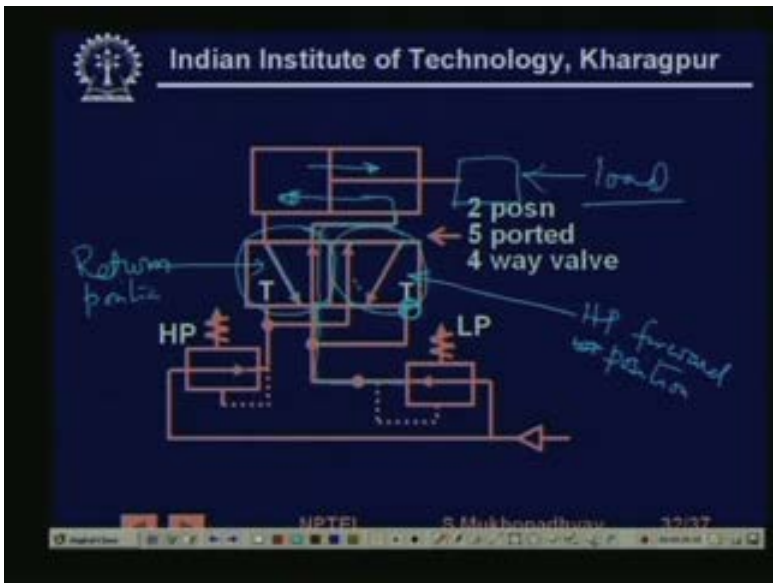

Similarly, this is a case where, this is the 2 position 5 ported 4 way valve, so 5 ports because 1, 2, 3, 4, 5; 5 ported and 2 position, because this is one position and this is the other position. So, what happens is that, sometimes you know these pistons, when they are moving the load they will require high pressure operation, because a lot of force is to be created and when they returning, then it is a lower pressure operation. So, what happens is that see, that the low pressure source is actually connected to this point, this is sealed.

So, this motion is going to actually occur and this is connected to exhaust, so this is the return position. On the other hand, when it is going moving this way, so the this is the rod, so the load is going to be connected to the rod, load. So, when it is pushing the load, at that time, it this is the high pressure position HP forward position, so in that case, you

can actually drive it using your high pressure source and so that will possibly save some energy.

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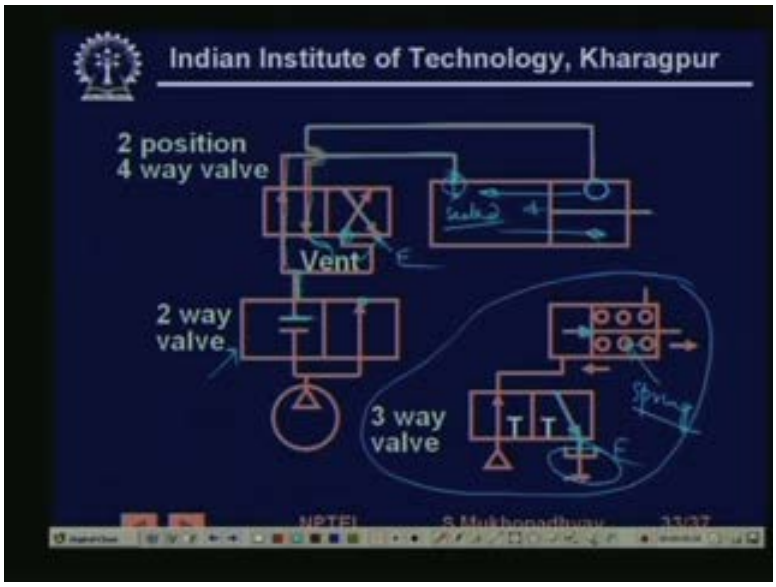

Similarly, this is another application where, for example see, this is a 3 way valve application, where if you connect it to this position, then the valve is valve will move this way, these are springs, so valve is spring loaded and so therefore, for the return, you do not need any pressure and you just shift the valve. So, this will get connected to this port, which is exhaust and then by spring action, since this side when it is connected to exhaust, this side pressure is low, so by spring action the valve can be done.

So, you need only apply pneumatic pressure for moving the valve to the right, for moment to the left is actually achieved by the spring. Similarly, if you connect it to this position, then what happens is that, the pressure gets connected, here and then when this valve is in this position you see, so this is sealed, while the high pressure will go and the low pressure will return. So, the cylinder will move this way, if you now shift this valve then what is happen, what is going to happen is that, the high pressure will go this way.

So, high pressure will go this way, so it will be applied here and the this other side will be applied here, so it will be exhaust, this is also exhaust, these two are vents, this is vent and this is vent, so then it will move this way. On the other hand, if this valve is shifted to this position, then what happens is that, both sides of the cylinder for example, then this of the cylinder is free, for example, in if the valve is in the position shown, then this is sealed, so therefore, this chamber is sealed, while this chamber is open.

So, what happens is that now, if you want to push the cylinder, then the air will get compressed and some force will be created, so it cannot be freely moved, you know. So,

it gets kind of soft locked that way, so you can have various sorts of such circuits and we will see some of them later, in our next lecture.

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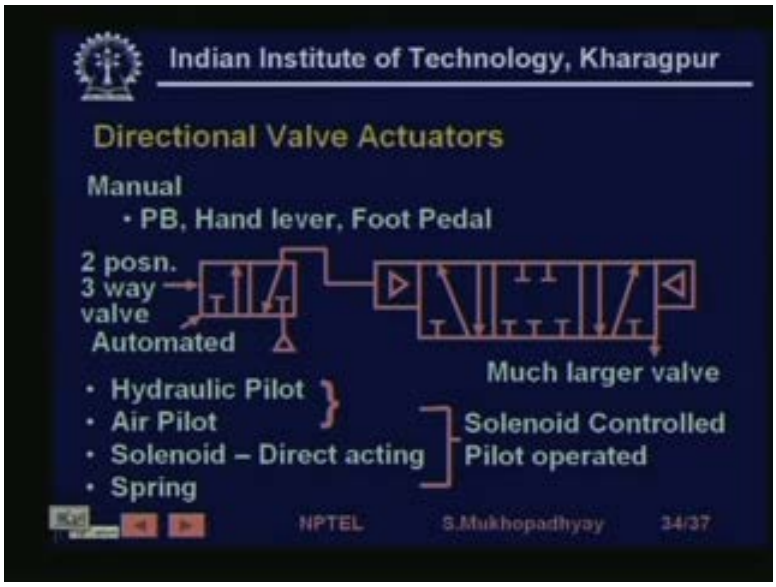

These directional valve sometimes, they have to be they have to moved you know, we were talking about moving the directional valve from this position to that position. So, how do we moves that, so there as just like in hydraulics there are various ways, so you can have manual, where you can have a push button, you can have a hand lever, you can have a foot pedal whatever you have or sometimes, for very large valves, we can for example, this is a you can have a pilot valve, so you know this is a large valve.

So, to be able to shift that position, you since you see pneumatic pilots are used, so this is a pneumatic pilot, which is used to shift this main valve, this may be a big hydraulic valve also and this hollow triangle indicates pneumatics. So, you can have hydraulic pilots, you can have air pilots, so even and large pneumatic valve can be driven by a small air pilot and the or otherwise, there may be solenoids. And sometimes, as we have seen that they may have, they may be spring loaded, such that the especially the return stroke, as such it does not require an actuation force. So, these are the various ways of actuating a directional valve.

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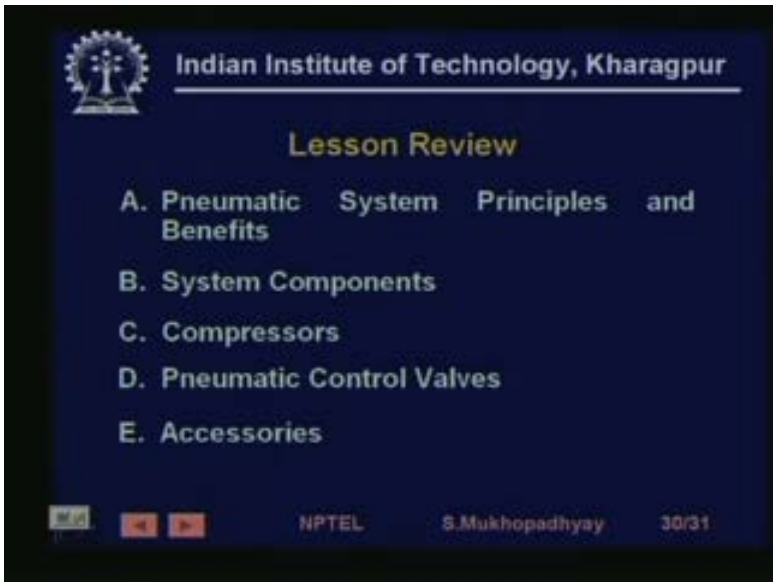

So, this brings us to the end of the lesson, so what we have seen is that, we have seen the pneumatic system principles and benefits, in particular we have seen that, we are going to, in pneumatic systems we are going to use compressed air and not only that, we are going to use compressed air we are, so compressed air you know has some benefits, that we I mean air is free and it does not require a return line etcetera, but on the other hand the, because of the compressibility of air, the system response to tends to be slower.

And the, there is another big benefit compared to hydraulics is that, the fire safety is much more intrinsic and so there are, so basically it means that there are certain very definite classes of application, we have also seen that, in certain cases where you need a lot of, you know low power applications spread over a large area, pneumatic systems come very much cheaper because it is, you can use one compressor and then you can use an air duct system to actually, you know reach the pneumatic power to large number of places without requiring too much ducting costs.

So, there are certain kind of applications, where pneumatic systems are quite well suited, compared to hydraulic systems, so it is just a question of the particular kind of application where these systems become more beneficial. We have also seen the main system components, in the sense that we have seen talked about compressors, talked about accumulators, regulators and some kinds of direction control valves as well as the cylinder.

Now, there are may be various other kinds of elements which we will talk about in the next lesson. So, we have seen the major kinds of system components, compressors we have seen, mainly the compressors are which are used a reciprocating or reciprocating

compressors. We have seen how they work and we have looked at some pneumatic control valves, a various kinds and we have also talked about accessories such as lubricators and filters.

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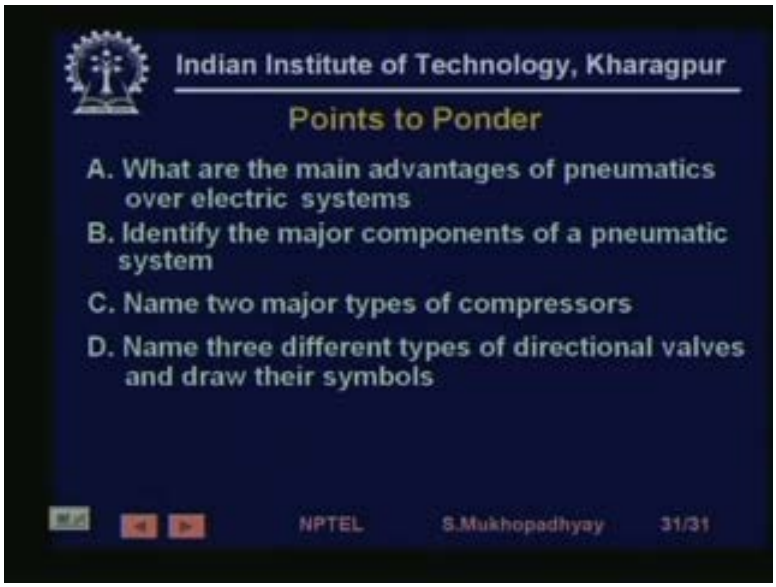

So, coming to the end, before the end let us look at some easy relative simple questions, what are the main advantages of pneumatics over electric systems and so what are the advantages of pneumatics over hydraulics systems and can you. So, for example, one thing could be, can you name some applications where a hydraulic system is preferred, can you name some application ((Refer Time: 54:19)) where are pneumatic system is preferred and identify the major components of a pneumatic system.

So, major components we have discuss this, name two major types of compressors, so two major types of compressors could be, you know reciprocating, could be rotary vent I, could be fan type, non positive displacement also. Then three different types of directional valves, so we have seen this and draw their symbols, so this is of course very similar to hydraulics, so that is all for today, thank you very much.

Industrial Automation and Control

Prof. S. Mukhopadhyay

Department of Electrical Engineering

Indian Institute of Technology, Kharagpur

Lecture – 30

Pneumatic Systems - II

Welcome to lesson 30 of industrial automation and control, in this lesson we are going to look at continue to look at pneumatic systems.

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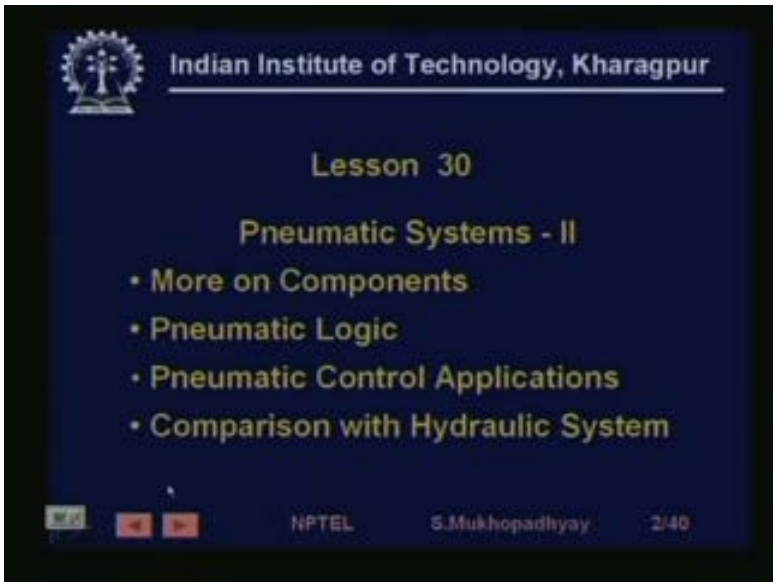

So, in lesson 30, we will look at more components pneumatic components, we will look at a kind of logic called pneumatic logic and we will see some control applications and finally, we will see a comparison with hydraulic systems.

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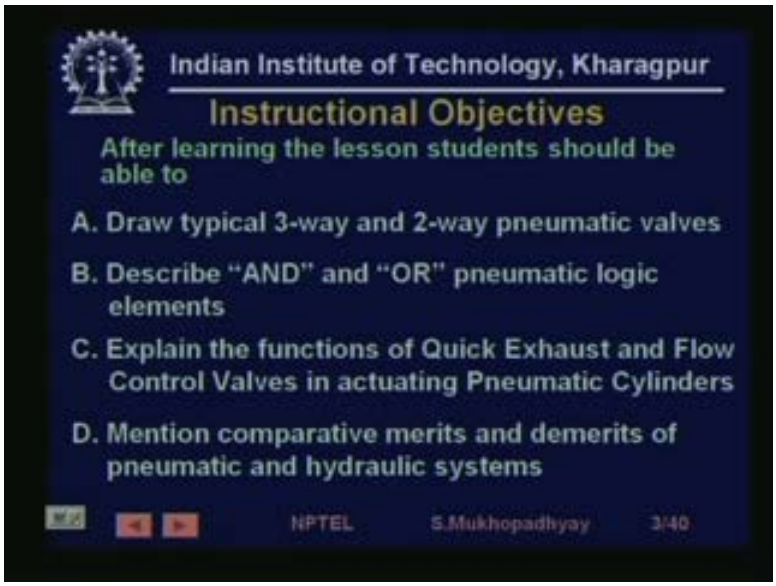

So, and the instructional objectives are, firstly to you know, be able to draw some typical valve constructions, describe AND, OR kind of pneumatic logics. Explain different functions of special kinds of valves which are used in pneumatics, like a quick exhaust and flow valves. Mention comparative merits and demerits of pneumatic and hydraulic systems and also be familiar with some control applications.

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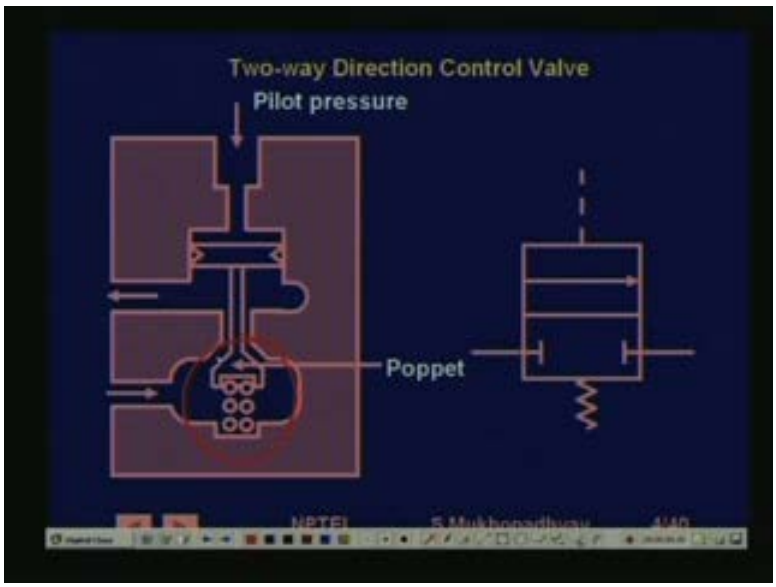

So, we have already seen direction control valves, we have also seen them during hydraulics, so there is nothing much new here. So, the valve is actually shown here, there

are, so you can see the inlet and the outlet ports, so you can see that, this is the when the pilot pressure is there this is, as you can see that there is a spring here, let me choose a proper pen here. So, this is the pilot pressure, so when the pilot pressure is not there, there is a spring.

I see this is selector as a eraser, I have to choose a pen first and then choose this color, so here, so it is spring loaded, so when there is no pilot pressure, then the spring is going to push it up and this is going to be closed, this. So, therefore, the valve is closed on both sides, so therefore, this symbol is shown and when the pilot pressure is applied, then this goes down, so there is flow, simple 2 way valve.

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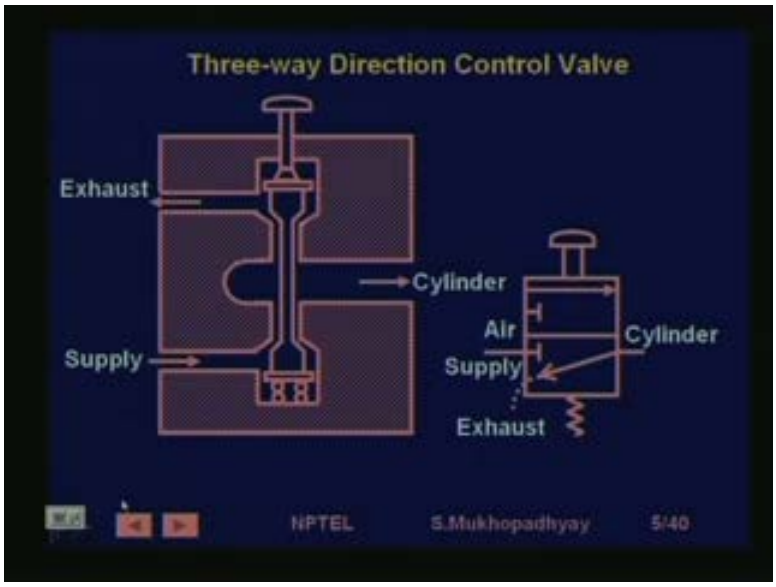

Then we come to 3 way valve, basically this is a, there are 2 ports, one is supply, the other is exhaust and again as you can see, this is also spring loaded, so when there is no this is when this is button operated, so when the push button is not pressed, then this is supply is closed and cylinder is connected to exhaust.