Mining Machinery
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Module - 02
Lecture - 07
Pneumatic Power for Mining Machinery

Welcome back. We have been discussing regarding the pneumatic and hydraulic systems in Mining Machinery. Now, before going to study the mining machineries and their use in different operations, some of the basic of the fundamental things of mechanical engineering is very much essential.

As a mining engineer, you should be knowing this basic mechanical engineering for better control and better management of the mines and machinery deployed. So, this today, we will be discussing about the Pneumatic Power for Mining Machinery.

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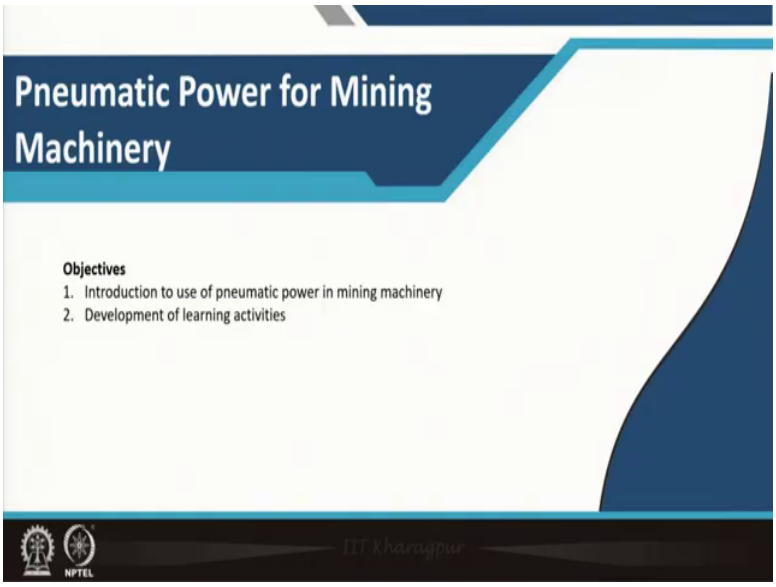

Now, the objectives of studying pneumatic power for mining machinery is to just introduce to use of pneumatic power in mining machinery and we will be trying to develop some learning activities on the use of pneumatics in mining machinery so that, it help you in understanding how the pneumatic power and pneumatic controls are introduced in machines.

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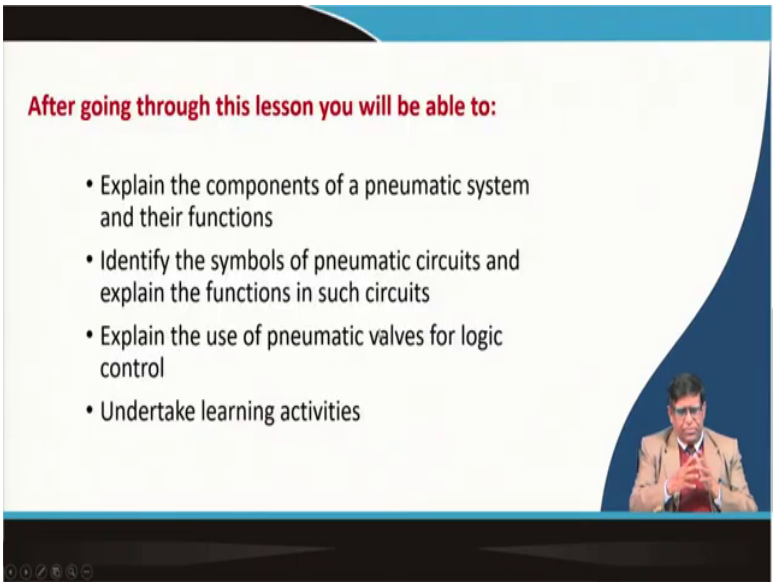

So, after going through this lesson, you will be able to explain the components of a pneumatic system and their functions in a as you know a mining machinery is for particular operations under particular conditions and each machine comprising of different subsystems.

So, pneumatic subsystems how it functions that you will be learning the basics today and identify the symbols of pneumatic circuit and explain the functions of such circuits. So, if the your any hydraulic operations or pneumatic operations, there are different components are made to work in the form of a circuit using the components as a different symbol so, you will be learning how these symbols are to be read or that is basically you will be learning how to read a pneumatic circuit.

And then, you should be able to explain the pneumatic valves for logic control because whenever a machine is controlled or operated, it is exactly working on certain logic if then

rules so, those logic you will be able to understand after this lectures and that as we will be taking some learning activities after this class so that, you can yourself feel that you are learning this subject.

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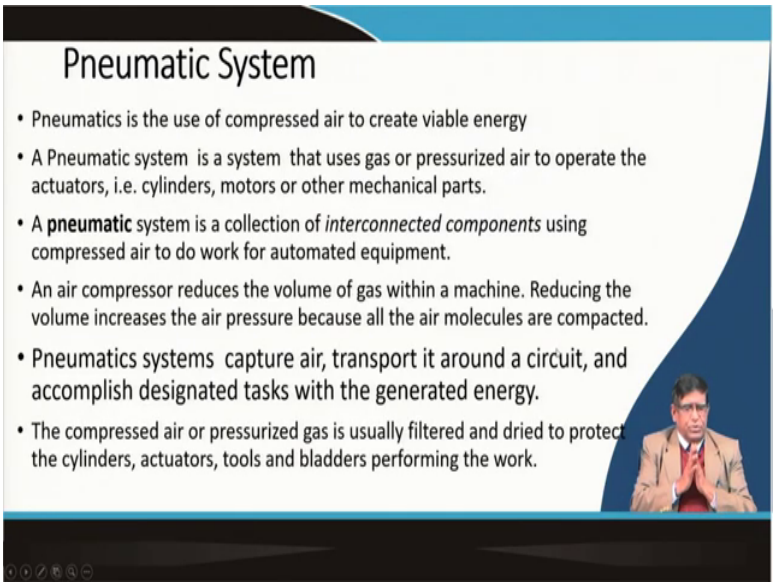

So, what is a pneumatic system? So, this is a pneumatic system is to use compressed air to create viable energy. So, it is sometimes compressed air, sometimes you can use compressed inert gases also.

Now, in this system basically, you use this air under pressure. So, you pressurize it and then, you let it to work some actuators, you will be sending it with there will be some that pneumatic actuators could be cylinders and then, there could be air motor and other parts and then, you will be controlling the whole thing.

So, these components whether it is a compressor's or the cylinders, they will be forming a system where there will be number of other interconnected components. So, they these interconnected components, they exactly perform the required work.

Now, an air compressor it reduces the volume of gas within a machine. So, the basic principle of compressor is to reduce the volume of the air and then, make it in a containment so that, the things are at under pressure and then, you can transport that or this fluid under pressures it can flow and then, it will be actuating the other components.

So, this pressurized gas or that air is a will have to be used in the system so that it will have to be filtered and it so that no dusts or other corrosive particles go into the components and also it need to be dried so that the water droplets are all will not go inside the components of the circuit and also, it sometimes you will have to use some additives in that air so that the corrosions or other things do not happen. So, that way you will have to protect the system by keeping the air cleaned. So, these are the basic things in a system.

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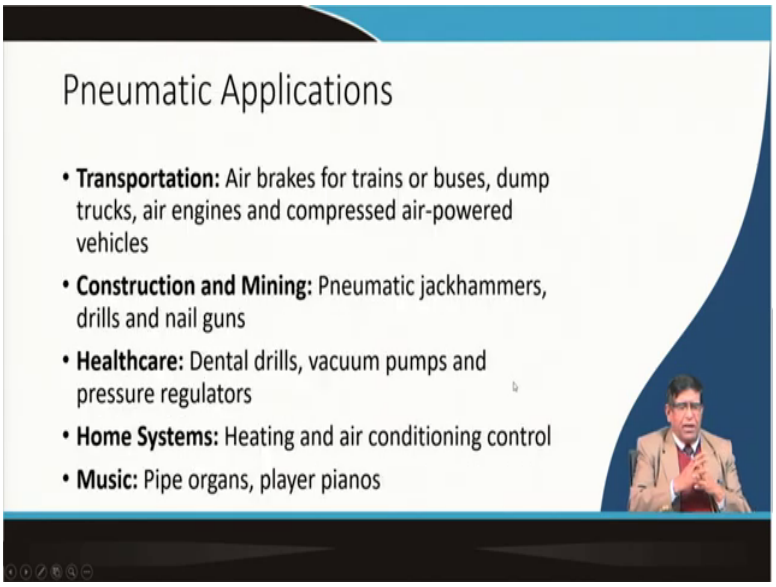

And therefore, the a pneumatic applications, we can say that there are various machinery they use in your all bus, trains, then your dump trucks you might have seen there, your compressed air is used.

In a in mining and constructions, you have got pneumatic jackhammers that is your compressed air will be giving the percussion motions to a drill bit, so that you can do the drilling on a small holes. Sometimes even in the blast hole drilling, you use this compressed air to run a the air motor by which exactly you will be giving a rotary motion to do a rotary drilling operations.

So, there are also that other sector they use in many of the dentists, you might be seeing that they use for making a drill in your teeth, they will using this compressed air operator drill and then, sometimes you may see that say you have seen a pneumatic system like your vacuum

cleaner and all, they are exactly using this their with a air they take it off then, similarly you have got in some cases the blowers for cleaning and doing things like that.

So, also you might have seen musical instruments like your different type of pipe organs, balloon pipes and all; those are exactly some with the pneumatic system by which they can do. So, that as a scientific explorations and in that engineers have been working with this pneumatic system for a long time, it is a old system.

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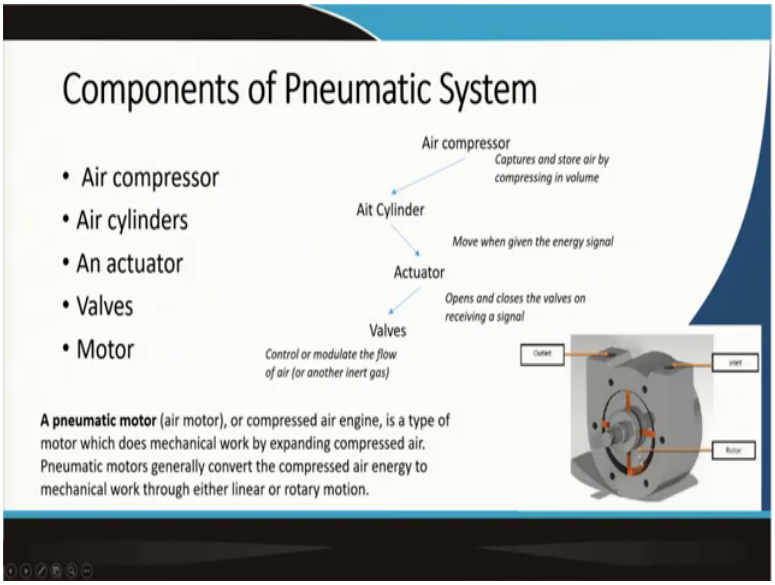

So, coming to a in a mining machinery, when you will be using a pneumatic system, the basic components which are there it will be the air compressor which will be capturing and storing the air in a compressing the volume so that this is the main job of the air compressor and then, they will have to use it.

For using that compressed air which will be flowing through some your air tight pipes so, sometimes we say it is a hose pipes and then, they will be working to the air cylinder and their actuators, they move and give the energy signal which can be used for doing the functional elements. Now, from there, they will be opening and closing the valves that will be receiving that signal and accordingly, it will work.

So, that valves they will be having depending on your logic, how that operation will have to be done whether you want to do a sequence control? Whether you want to do a directional control? Those logics and then, exactly under what conditions a particular that is say component will be working now ascertaining those conditions by deploying these valves to perform a particular logic, this is done in a machinery.

And of course, there will be some air motor this where you are exactly the air motor this compressed air will be going and then, it will be generating the rotary motion. That as I said in a rotary blast hole drill, the air motor is used for making the drill rot to rotate over there. When you will be studying this pneumatic drill, you will be using this thing.

So, there exactly in a air motor, you can see there compressed air will be going that through an inlet and there will be a this rotary cramps where you have got this the this rotor part will be and then, it will be air will be going outlet that means, this say while the compressed air is going, then the device inside this air motor is get rotated and for that you have got a vane type of motors, there are different types of air motors are there so, these things are used for it.

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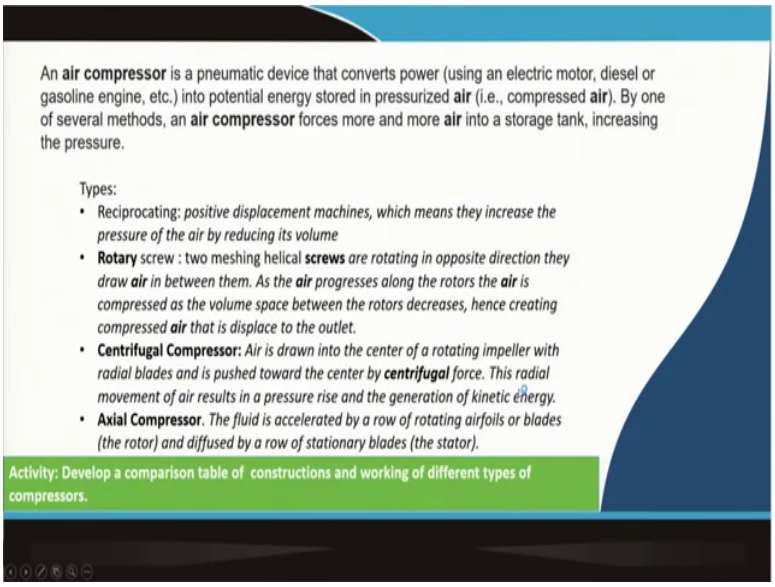

So, the basically the main things which you will be learning in the machinery is the air compressor which; which is exactly a pneumatic device that converts power into a potential energy stored in a pressurized air.

Very simply the statement of a definition, but though these compressed compressions or the that breaking the valve, reducing the volume and keeping it in a container, this can be done by various ways depending on that the compressors are classified into different type. They call that reciprocating compressor, rotary screw compressor, centrifugal compressor or axial compressors.

Now, these compressors the in reciprocatic; reciprocating compressors, you might have seen that is the same principle of your reciprocating pump which you studied even in your school days so that is exactly a it is a positive displacement machine in which that is they increase

the pressure by air in reducing its volume, you can give with the pistons movement, it will be coming over there.

In a rotary screw, exactly two meshing helical screw are there, they will be rotating in the opposite directions and then, the air will be trapped and then, it will be pushed and then, they will be putting it and, in the container, you will be compressing it over there. Similarly, in a centrifugal compressors that is dynamically, when the air is dropped brought through the eye of these compressors and then, there exactly allowing to a particular part to store it into the container.

In an axial flow that it is different from the your rotary or the centrifugal is in other cases, the air is moving and at a perpendicular to the container, but here the where the rotor is there, your flow is also in parallel to the axis of rotations and that is why it is called your axial flow.

Now, these different type of compressors they have got if you got any text book, you will find about their constructions and operations so, as an activity, please develop a comparison table of these different type of compressors and then have the basic general knowledge about the types of compressors.

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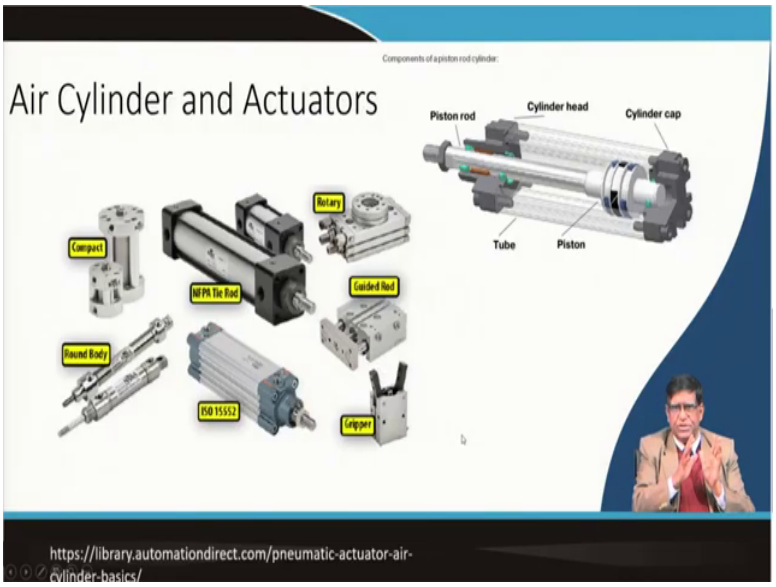

And you will be able to see that in a general that how the different type of cylinders and actuators are there. So, their design and these the basic principles and all are not as a mining engineer, you will not be going to that detail, but how they are to be selected for a particular machines or how they are to be maintained by your engineers, you need to know.

So, you will have to know that there are different type of actuators are there whether you are using in a hydraulic excavator, whether you are using it in a your the pneumatic breaking of your off highway trucks or you are making it for parking brake, then what type of cylinders you will be using that you need to know.

So, there are quite a large number of manufacturers are there who develop different type of your cylinders and actuators you can have a just search internet and you can study about this to know the basic ideas that how they look like and what they work.

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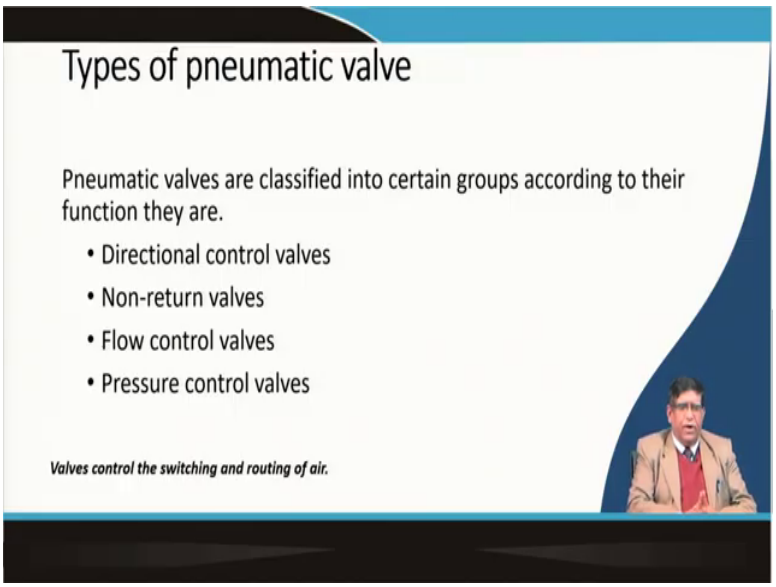

But most important type is the valves. As you have studied in our hydraulic system also that the whole fluid power in machinery is controlled by this different types of valves. To basically, the your pneumatic valves of four types are very commonly used, these are directional control valve, non-return valve, flow control valve and pressure control valves.

Now, exactly the valves job is it is just like a door, you are just allowing the air to come and not allowing and then, sometimes you main job of this will it distribute it.

So that means, if the air is coming and whether you are making that same air to go to two part and doing two operations simultaneously say for example, while you are applying a break to two wheels that means, the air will be going and then, applying the break to the two wheels simultaneously, sometimes your air is going it is allowing to go to give your horn or sometimes you are just applying the parking brake so, there will be different type of jobs to be done and these are controlled by these different valves.

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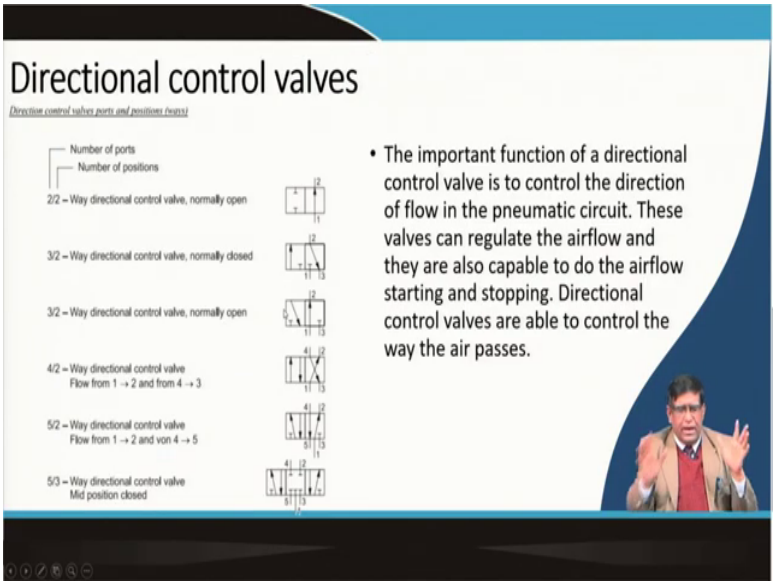

Now, whenever you see a machines that is the circuits that what are the different types of valves used are very very important. As a sometimes you may find that it is a 2 by 2 or 3 by 2 that valve and then, the symbols of valve just like in your hydraulic circuits, we talked earlier class that similarly in pneumatic circuits also these valves are there.

The 1st number, it shows the number of ports and the other is your number of positions. So that means, exactly when we see it as a 2 by 2, you can see that there are two ports are there and they can be there in the two positions.

Similarly, a 3 by 2-way directional control valve is it is having three ports and then, it has got on this two that is your two number of positions. In this positions only, they you make the valves to move by a spooling lattice that is exactly, when you are operating the valves, you are opening or get closing the ports.

So, the important function of a directional control valve is to control the direction of flow of the pneumatic circuit that in that circuit, in which directions the air will flow. These valves can regulate the air flow and they are also capable to do the air flow starting and stopping. The directional control valves, they are able to control the way the air passes.

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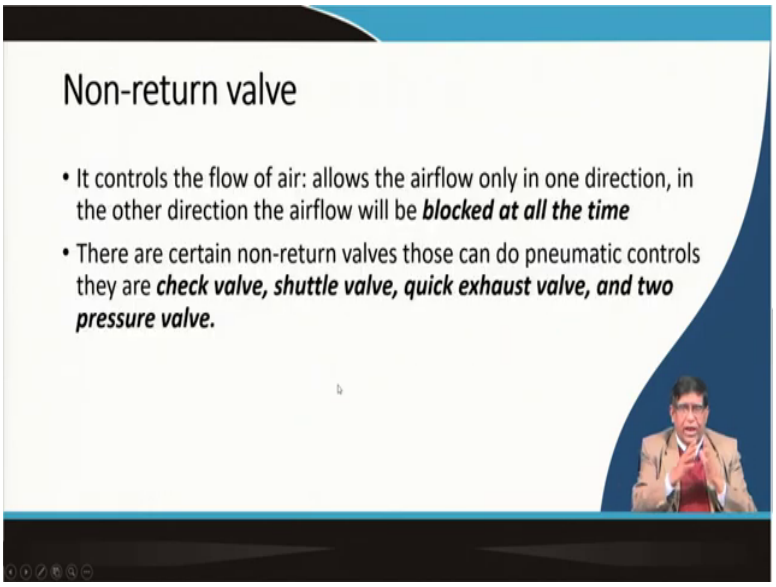

So, that is exactly the main thing used by the direction control valve, but there to give the operations in a proper way, you will have to see that the air does not come back to or does not return. So, sometimes, it will have to move all the time in one-way so, there you will be using this non-return valve where the flow of air they are allowing, the air flow only in one direction, in the other direction the airflow will be blocked at all the time.

Similarly, there are certain non-return valves which can do pneumatic controls. There are other type of valves like your check valve, shuttle valve, quick exhaust valve and two pressure valves.

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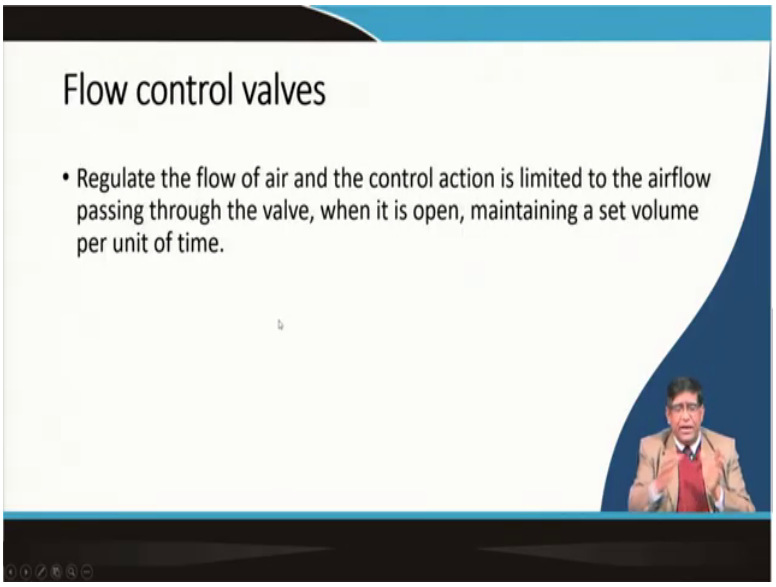

These valves are there, but then, other thing is your flow control that is they will be controlling the flow of air and it is a that is your in a the airflow that will be passing through the valve and when it is open, maintaining a set of volume per unit of time so that means, the controlling the flow, the whole operations can be carried out with this that that the energy taken by the air can be imparted to the functional element or the working tool which you are looking for.

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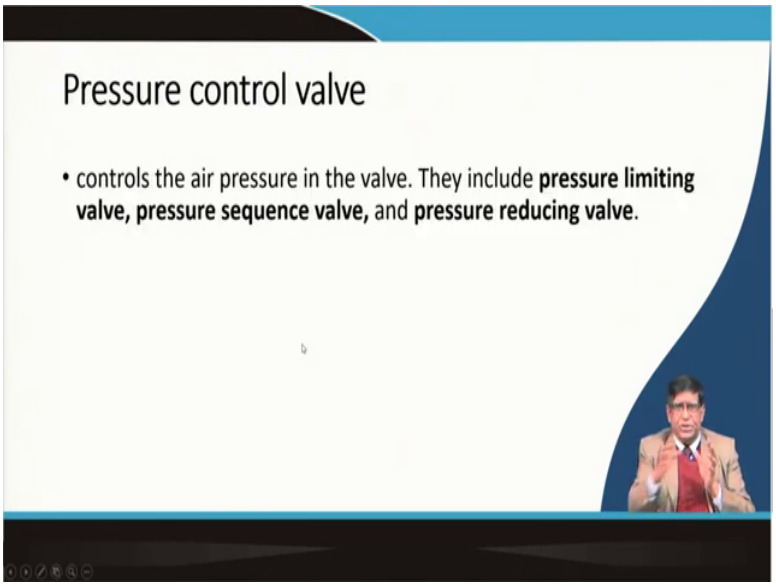

And then, the pressure control valve, it controls the pressures in the valve that they include pressure limiting valve, pressure sequence valve and pressure reducing valve.

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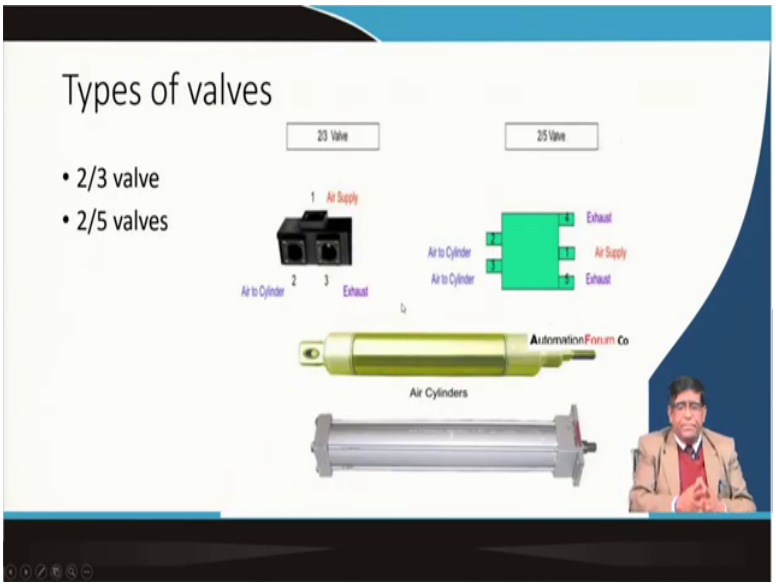

So, these valves they are exactly used say you can see that when we say a 2 by 3 valve means we have got air, exactly supply is coming, and we have got these two exhaust that is air will be going to the cylinder. Similarly, a 2 by 5 valve that is your we are having air to cylinder coming by these two ports and then, it has got exhaust and the supply. So, all these things they will be inside a cylinder, how the air will be entered into, they will be given by different valves.

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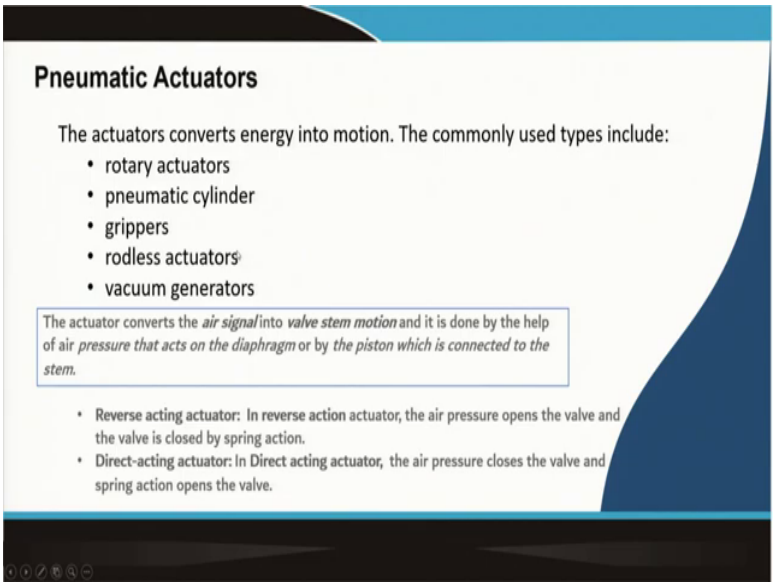

So, the pneumatic actuators that is exactly, when the valve will be allowing the your pneumatic power to go and then, do the things which will be doing the mechanical work. Now, to do that mechanical work, there could be a rotary actuator and the pneumatic cylinder, grippers, rodless actuator, vacuum generators different type of depending on the how the converts energy into motion depending on that different things are designed.

So, this basically, the actuator converts the air signal into valve stem motion and it is done by the help of a air pressure that acts on the diaphragm or by piston which is connected to the stem. So, basically, it is just transfer of energy from that your fluid to a mechanical component.

And then, there is also a reverse acting actuator where the air pressure opens the valve, and the valve is closed by spring actions. Exactly, there are a whether there will be direct acting or

reverse acting. If the air pressure closes the valve and spring action opens the valve, then it is called your direct actions and if the air; air pressure opens the valve and the valve is closed by, when the closing is done by the spring, then it is called reverse acting actuator. These two type of actuators are used in a of pneumatic circuit.

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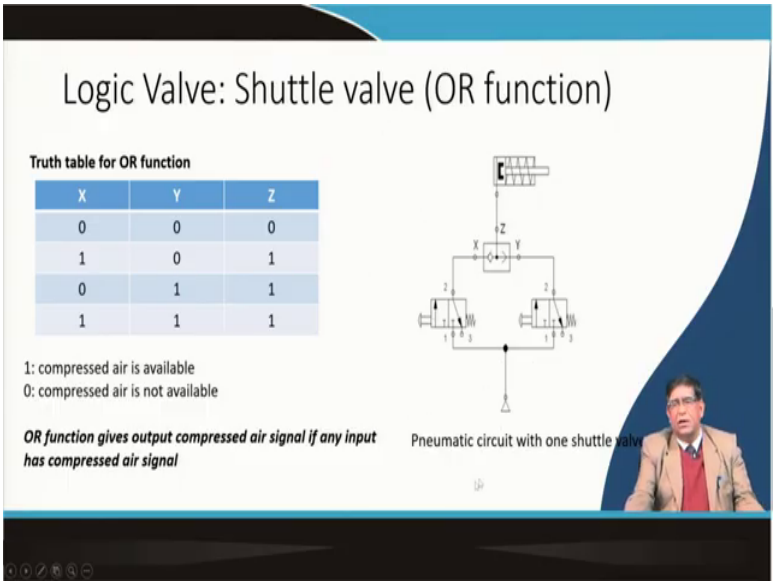

Now, the main thing is here, let us see what is that logic valve or as you have studied in your electronics that you have studied the AND gate, OR gate, NAND gate, this type of control systems with different type of logic gate can be started with the help of this valves.

For example, here you see this is a symbol of a non-return valve where exactly you are this working as a shuttle valve. So, you are having this the two ports action, Y port and the output is given is Z.

So, now, to we are having these two valves, when your compressed air from here, this can go from this that is inlet two inlet is there, in that whether you are getting; if you are not getting that compressed air at X and Y, then both are not getting any flow, then Z there will not be any output.

Now, if there is one export that means, we are by putting this knob, you can allow this air to go through this. When it will be pushed like that, this particular one will get connected and then, this air will be coming over here at that time even if it is at 0 positions not allowing any flow, there will be flow and this piston will get actuated, this cylinder will get actuated.

Now, similarly if X is this is not given, but the other one is given, then your that we will get the operations here. Just like your any logic circuit, we are using either this or this if any one of them are used or both are used, both the knobs are now pressed, when both this knob here and here will be pressed, then also the air will be coming over here and it will go over this. So, this is just a logic table for an OR gate.

So, there is a compressed air signal, if any input of any one has given that means, either this work of this valve or this valve, they are in a OR mode and this is the way how a shuttle valve work.

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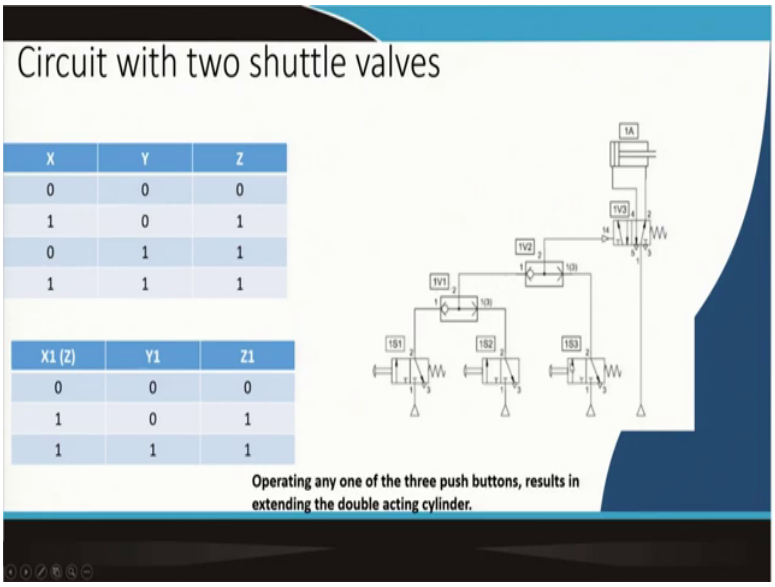

Similarly, there can be two shuttle valves coming over here. Now, you can go on developing a different type of conditions. Now, suppose you are having this shuttle valve, now you have got another shuttle valve and then, you have got a third systems you have placed over here. Now, in this case what happens? Then, if your any of this is these two are there, this or this then it will come over here.

Now, these functions will be leading to now, if this or this whenever this one or this one is present, then it will be, your this piston will be actuated. So that means, your this will be reducing to that means, your if one this one is your action signal that is this Z signal which is coming over here, then we can find under the condition of these valve exactly this the third valve will be making it weather this one will be on or not.

So, this is the way how you form different type of logic circuits and that control operations for where this will be connected to an actuator.

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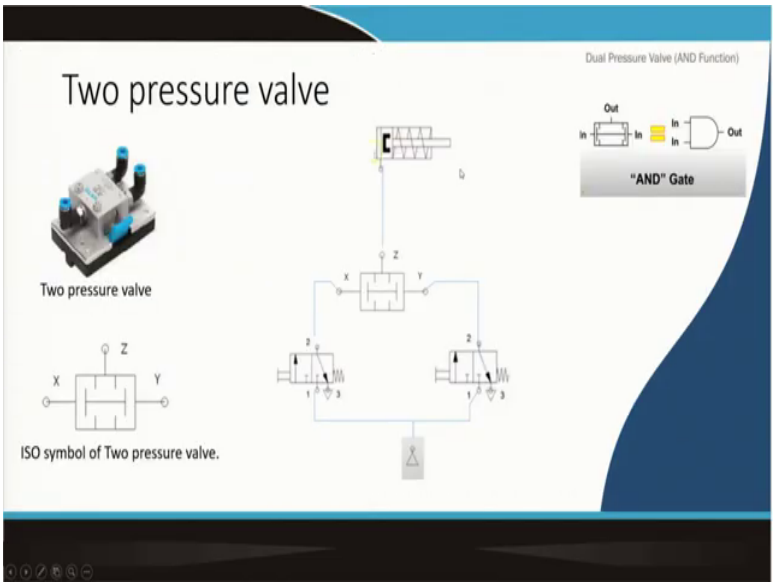

So, now, that means, exactly you can see here the different type of valves, this is a two-pressure valve. A two-pressure valve you can see that these signals, if this one and this one is pressed, then only it will be coming over here. So, this can give an AND gate that means, when this and this both the ports, this port and this port are getting compressed air coming from this valve, if this X and Y both are placed, then only your this will be going.

So, unlike that other one, there were either this one or that one, that is why that was a OR gate, but a two-pressure valve, it will be working just like an AND gate that means, your this logic is applied over here.

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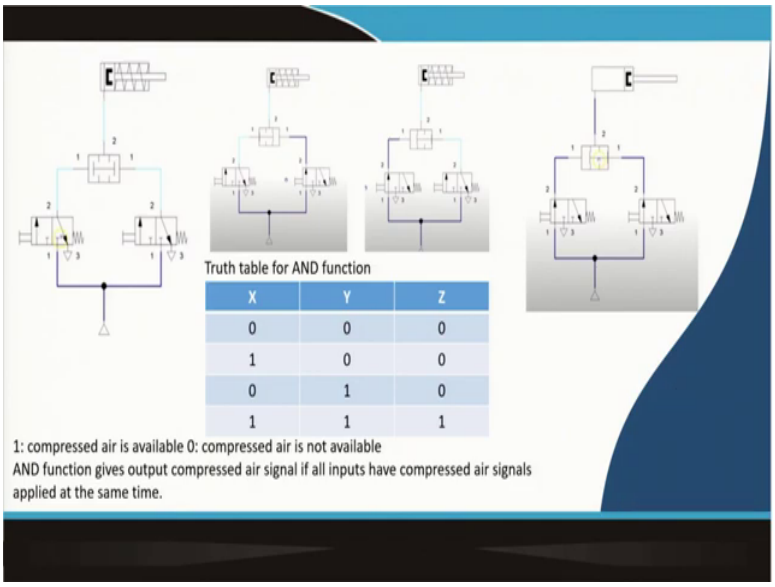

So, this if you can see further that how this AND gate is there, now, you can see this thick blue color is giving as a pressurized fluid. Now, that pressurized flows both these things that is knob is not pressed. Now, if you press the knob, this press, this you press this knob so, what is happening? Your this particular one it is now pushed, it is pushed and this port is getting open into the line and then, it is coming over here, but though it is coming over here, this has got pushed to this, but the port is not opening.

Now, if you are pressing the other one similarly, then also it is not going, but when your now both this knob of these two valves are now actuated or pressed, then you can get this air and then, you can see this one the actuator, this cylinder's actuator has now moved to this.

So, now, in any pneumatically powered system, this way the in a circuit by the valves you control. Here, you can see here that is your if you see the logic gate, when both are 0, Z will

not be there, but only when both of them are there X and Y is working, then only Z is in the on conditions.

Now, the questions comes, in your machinery, your main job is to put this knob so that your there is compressed air is allowed or not allowed. Now, that can be done by hydraulically or it can be done electro hydraulically or sometimes it done by electronically or it can be done by electro pneumatically so, that operation in design depending on the design of the machine, these knob operations can be different.

Now, as for example, you have seen in a car, you have got the pedal, you give a pedal when you are pressing the your brake pedal at that time exactly the hydraulic fluid is actuating to give the that your push to those compressed air button and then, it will be releasing the air which will be going to that if you are having a pneumatic brake system or a parking brake system, whatever whichever the brake you want to apply as in case of your dump trucks or highway trucks or also in your agricultural tractors, there you can do the things.

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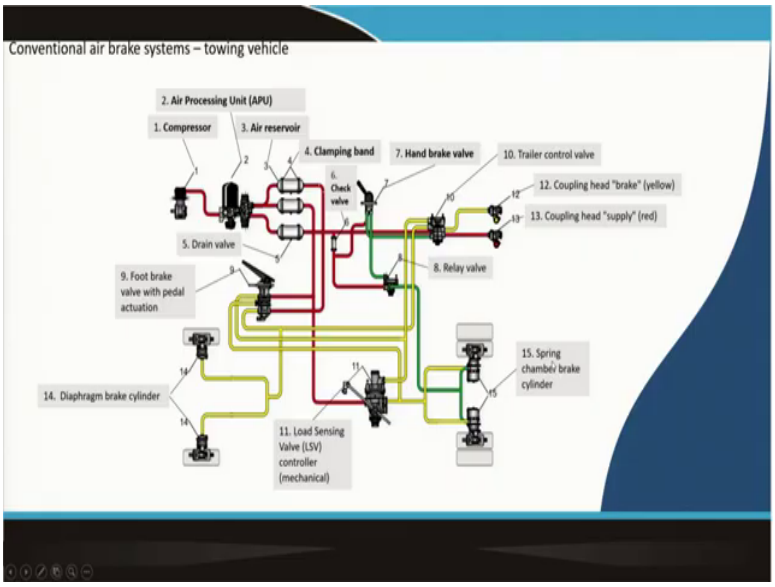

Similarly, you can find out another thing is that your that in a conventional break systems, now you look into how the circuit work. Say for example, you have got this foot brake.

When you apply this foot brake with a pedal actuations, then you can see that your how the pressurized fluid is working over here and then, you can see that for the your brake line that is your yellow line is your brake line and this your air compressors, this compressed air is being kept over here, these are the that your reservoir where compressed air is there and there is supply line, the red line is there air pressures are pressurized fluid is there.

Now, when your brake is applied, then your this yellow line will be pushing them to work and then, you have got a hand brake lever here, this will also open this ones and it can push that air to this. Similarly, that your when this pressure is going, you can have say for example, this

pressurized fluid will go and the diaphragm brake cylinder will be working and then, you can do the operations here.

Similarly, this fluid will go over here and then, it can give the spring chamber brake cylinder at the rear wheel. So, this is the way these four wheels where the brakes are there can be actuated either for the parking brake with a handled brake by this lever operations or these operations. So, basically in the vehicle or in that machine, you will be having this components in a circuit form it will work.

And then, there will be also sometimes this for giving other signal so, for your trailer control, if it this is exactly for a towing vehicle just like a trailer tractors in the agricultural machinery so, you have got a load sensing valve by which you can also know that how much force, how much it will be going there. So, this is just an example.

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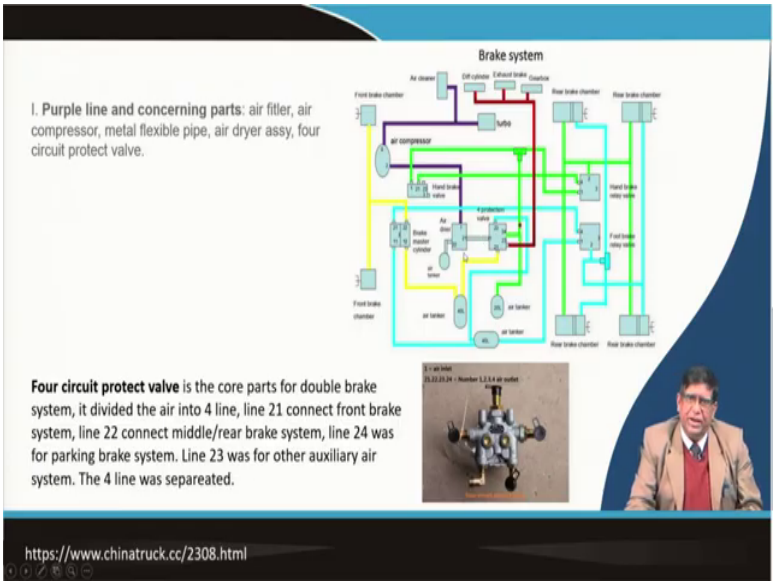

You can see also how in your dump truck the different this brake systems are there, you can have this how air compressors, you have got the front brake chambers here and you have got this rear brake chambers here. With this four, we can have a three axial vehicles. Depending on this, the circuit will be changing.

You can see here, we have got that different type of lines, colors is shown depending on the function. So, these type of diagrams and circuits are there in all machinery whenever your you will go to any mining machinery workshop, when you will be talking with the maintenance personnel, they will be having maintenance operations are managed with the help of this.

So, there are four circuit protect valves, there how that exactly the one is that input it is written over here, you can see that there are 22, 23, 21, 24 these are all the output valves and by that, they give the whole control of this air flow which will be going to the apply the actuators.

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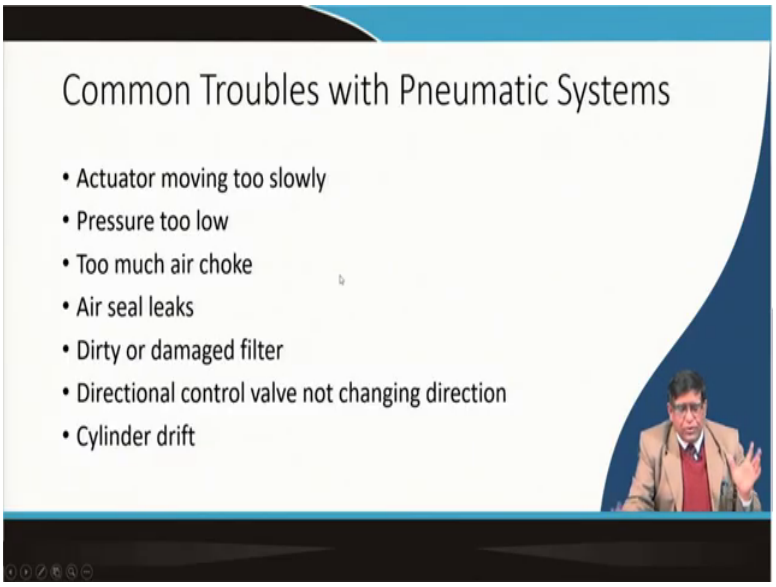

So, there will be different type of troubles in that pneumatic systems that exactly you need to know when you go to study a mining machinery. There could be the actuator moving very slowly, pressures will be too low, too much air choke, air seal will leak, dirty or damaged filter, directional control valve not changing the directions, cylindrical drift this type of problems are there.

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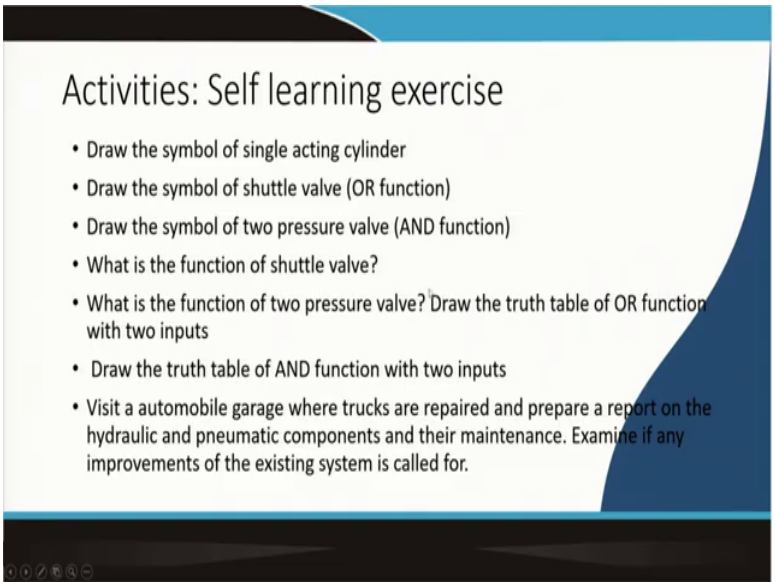

So, you will have to do the troubleshooting how you can do? Now, for this I just give you after you know this much, you can take some yourself learning exercise.

So, draw the symbols of the single acting cylinder, you can use these things any textbook you can find it. Draw the symbol of a shuttle valve or OR function, how it is done an on AND function, you draw different logic circuits, you also explain what is the function of a shuttle valve, how they do it?

And what functions to two pressure valve do? By studying the circuit, you can do it. Draw the truth table for AND functions or different type of truth table for different logic valves and visit a an automobile garage where trucks are repaired and prepare report on the hydraulic and

pneumatic components and their maintenance. Examine if any improvements of the existing system is called for.

So, you please visit to a neighboring truck repairing one or when you are here back into the if your after your offline classes will start, if you get an opportunity, go to the maintenance transport system say transport sections maintenance work and you can do a work over there. Then, during your practical training in the mines, you will have to do this learning activities with the pneumatic circuits.

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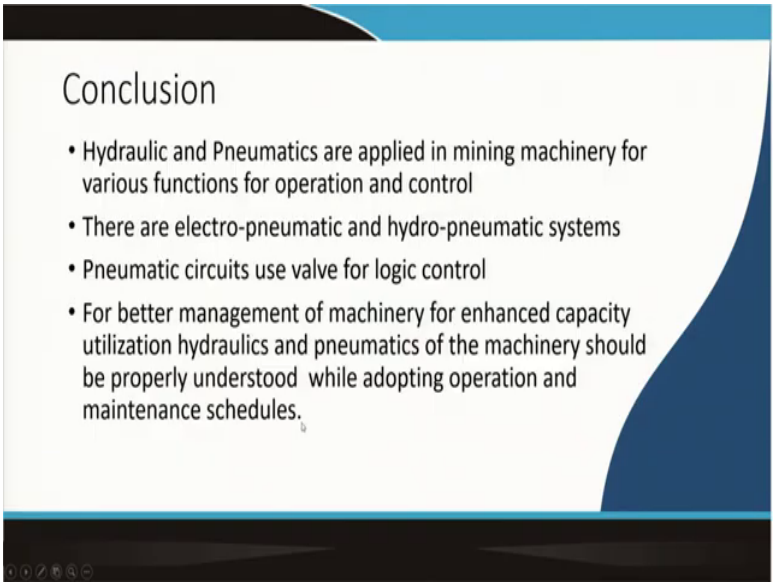

So, to conclude here, hydraulic and pneumatics are applied in mining machinery for various functions for operation and control. There are electro-pneumatic and hydro-pneumatic systems. Pneumatic circuits use valve for logic control. For better management of machinery

for enhanced capacity utilization hydraulics and pneumatics of machinery should be properly understood while adopting operation and maintenance schedule.

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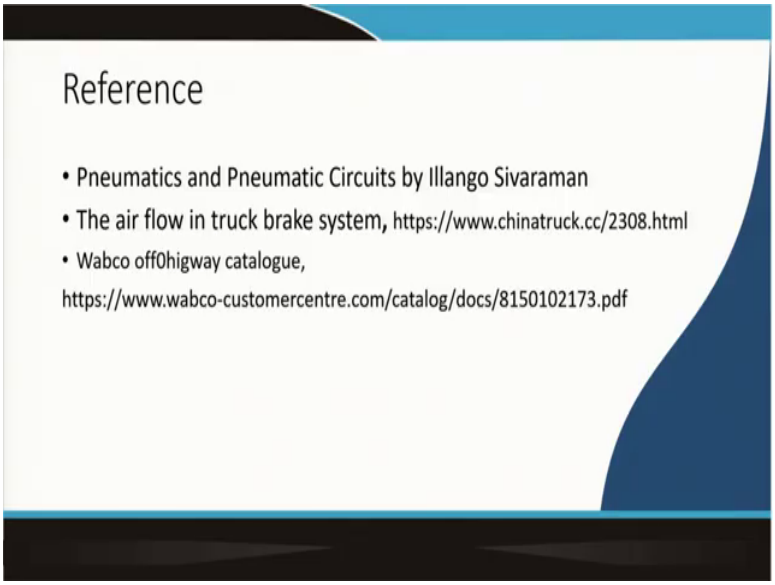

Now, this should be giving you a background of how the different mechanical systems are there in a mining machinery. Our basic job will be when we will study different components and different mining machinery at that time, your this learning will have to be very carefully utilized. Let us hope we will be going to the study of the machines soon and there we will be apply our whatever we are learning of this hydraulic and pneumatic system.

Thank you very much.