Oil Hydraulics and Pneumatics
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Part 2: Pneumatic Power Source - Compressor, Classification
Air Receiver and Control Methods
Lecture - 24
Pneumatic Control and Pneumatic Power Source

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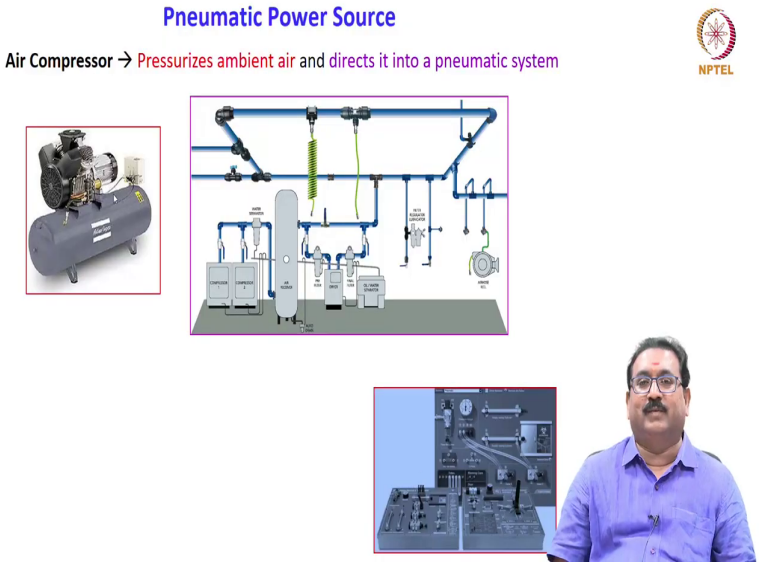

My name is Somashekhar course faculty for this course. After knowing the air preparation which involves the primary air treatment and secondary air treatment. Primary air treatment after cooler air filters then dryers up to the receiver tank. Then secondary treatment after the receiver tank before going to the control valves we are using their FRL unit.

Now, we will see the pneumatic power source. What is the pneumatic power source? Air compressor. The objective is pressurizes ambient air and directs it into the pneumatic systems correct friends.

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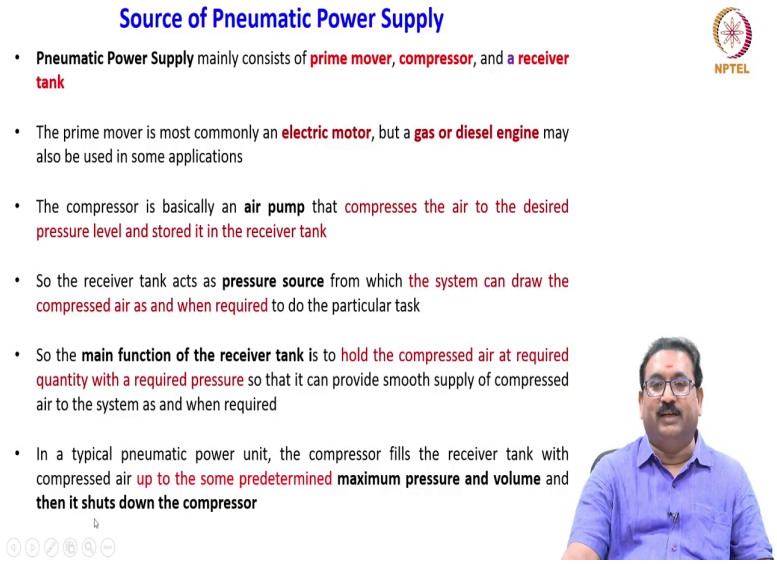

Let us we will see this source of pneumatic power supply. The pneumatic power supply mainly consists of prime mover, compressor, and a receiver tank. The prime mover is most commonly an electric motor, but a gas or a diesel engine may also be used in some applications. The compressor is typically an air pump that compresses the air to the desired pressure level and stored it in the receiver tank.

So, the receiver tank acts as a pressure source from which the system can draw the compressed air as and when require to do the particular task. So, the main function of the

receiver tank is to hold compressed air at required quantity with required pressure. So, that it can provide a smooth supply of compressed air to the system as and when required.

In a typical pneumatic power unit, the compressor fills the receiver tank with a compressed air up to the some predetermined maximum pressure level and volume and then it shut downs the compressors.

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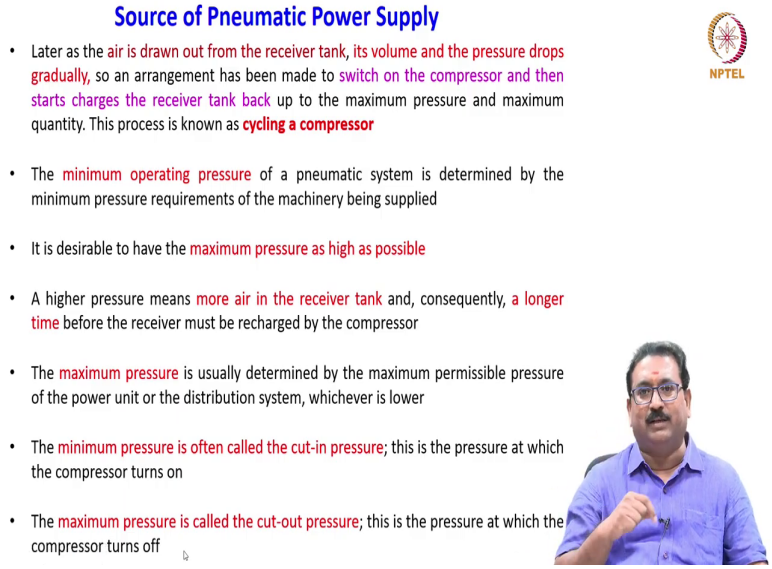

Later as the air is drawn out from the receiver tank, its volume and pressure drops gradually. So, an arrangement has been made to switch on the compressor and then starts charging the receiver tank back to the maximum pressure level and maximum quantity.

Then once it is filled automatically switch off. This process is known as cycling a compressor. The minimum operating pressure of the pneumatic system is determined by the

minimum pressure requirement of the machinery being supplied. It is desirable to have a maximum pressure as high as possible. A higher pressure means more air in the receiver tank and, consequently a longer time before the receiver must be charged by the compressor.

So, the maximum pressure is usually determined by the maximum permissible pressure of the power unit or the distribution system, whichever is lower. The minimum pressure is often called the cut in pressure; which is the pressure at which the compressor turns on. Similarly, the maximum pressure is called the cut out pressure; this is the pressure at which the compressor turns on and off. Please remember friends this arrangement is made in the compressor and receiver to maintain the required quantity of pressure and volume in the tank.

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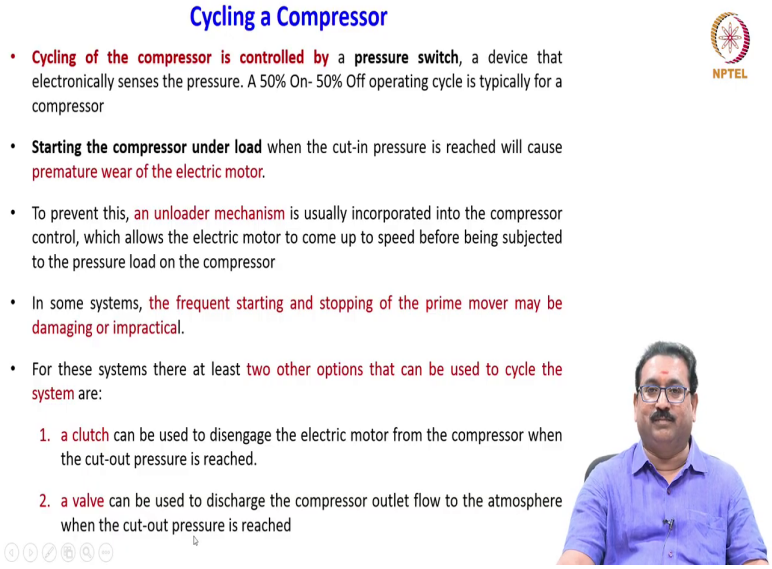

So, you will see the cycling a compressor how they will do. Cycling of the compressor is controlled by the pressure switch, a device that electronically senses the pressure. A 50 percent on and a 50 percent off operating cycle is typically for the compressor.

Starting the compressor under the load when the cut in pressure is reached will cause the premature wear of the electric motor. To prevent this, an unloader mechanism is usually incorporated into the compressor control, which allows the electric motor to come up to the speed before being subjected to the pressure load on the compressor.

In some systems, the frequent starting and stopping of the prime mover may damage or impractical. For these systems there are at least two other options that can be used to cycle the system; they are a clutch can be used to disengage the electric motor from the compressor when the cut-out pressure is reached. Or a valve can be used to discharge the compressor outlet to the atmosphere when the cut out pressure is reached. Any arrangements you have to use I will show you with schematic how they will achieve this.

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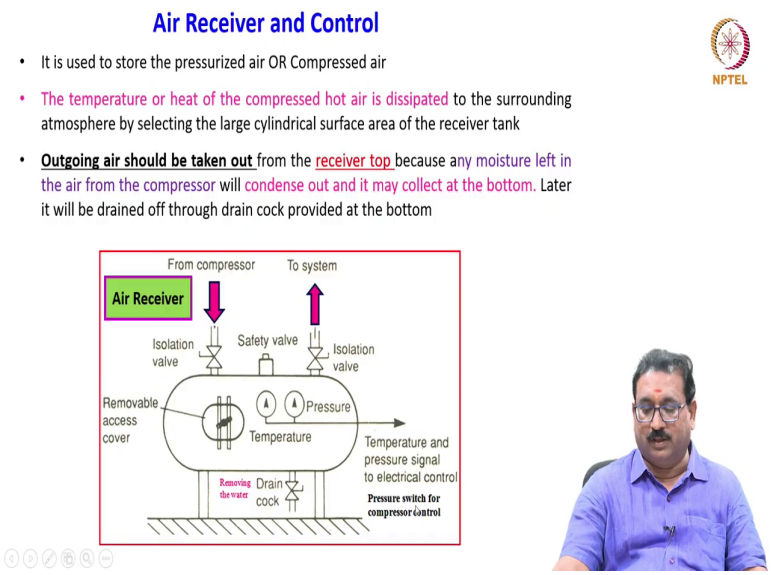

Now, quickly we will see the air receiver and control as I have told you. Air receiver is used to store the pressurized air or compressed air. The temperature or a heat of the compressed air is dissipated to the surrounding atmosphere by selecting the large cylindrical surface area of the receiver tank. That is why it is horizontal or vertical you will see the larger surface area is there as because the air stored in the receiver tank is a very hot.

Outgoing air should be taken out from the receiver top because any moisture left in the air from the compressor will condense out and it may collect at the bottom. Later it will be drained off through the drain cock provided at the bottom. If you will not use the air in the compressor it may drain out using this is air receiver. From the compressor it will enter isolation valve is there, then if you store this air so, many days the water formation will takes place it will drain out here from the bottom

Air taken from the top side please remember. This removable access cover is provided for the maintenance purpose. These are the sensors temperature and a pressure signals to electrically control for the switch as well as compressor control.

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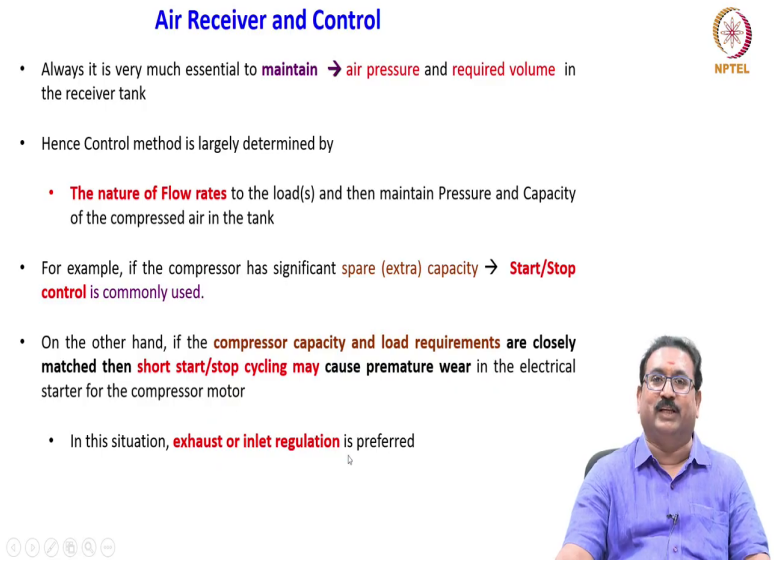

Air receiver and a control always it is very much essential to maintain the air pressure and a required volume in the receiver tank. Hence control method is largely determined by the nature of the flow rates to the loads and then maintain the pressure and capacity of the compressed air in the tank.

For example, if the compressor has a significant spare capacity start and stop control is commonly used. On the other hand if the compressor capacity and a load requirements are closely matched then start stop cycling may cause a premature wear in the electrical starter for

the compressor control. In this situation, what we will do? Exhaust or a inlet regulation is preferred once it is charged completely.

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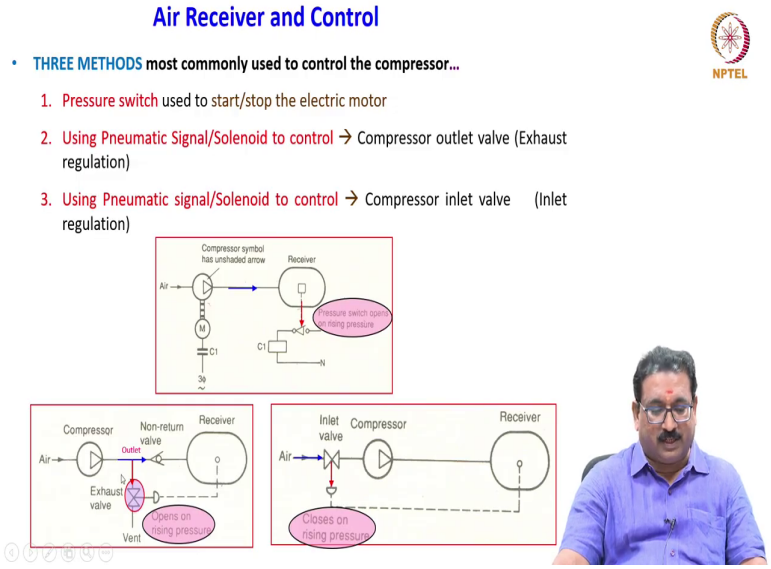

Three methods most commonly used to control the compressor what is that as I have told you pressure switch used to start and stop the electric motor meaning is a sensor sensing the pressure and quantity, then it will switch off the electric motor. Second one using the pneumatic signal or a solenoid to control compressor outlet valve it is exhaust regulation.

Another one is using the pneumatic signal or a solenoid to control compressor inlet valve meaning inlet regulation you will control exhaust regulation or inlet you will see friends here what I am telling you here it is a switch pressure switch which is used to switch on and switch off the compressor.

Here you will see this is air is used to exhaust regulation meaning the outlet of the air once it is filled it will go to the vent. Here you will see inlet once it is full the even though compressor will sent to the outside closes the air this is a exhaust and inlet regulations.

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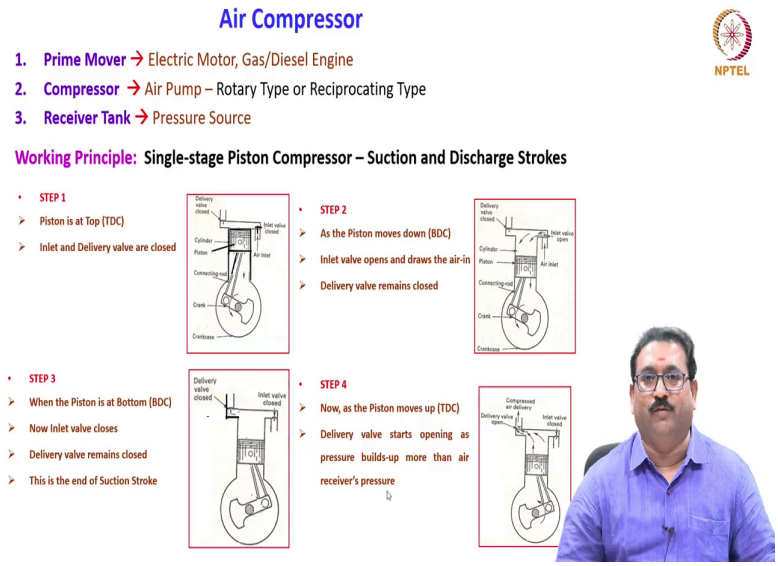

Now, we will see the air compressors will start different types of air compressor after knowing the how to control the required quantity of air and pressure in the receiver tank. Let us we will see how the compressors will work and we will see the operating principles. As we know the first and foremost important component in the air compressor is prime mover.

As I have told you generally the electric motor, but in some cases gas and diesel engine may also use to drive the compressor. Second one is a compressor itself what is known as air pump here you please remember friends the rotary type and reciprocating type similar to our

hydraulic pumps. Hydraulic pumps are also rotary type is their reciprocating type is there here also we are having that two categories.

Then third very important thing is receiver tank which is a pressure source. The working principles I will show you very quickly for the single stage piston compressor to understand the suction and discharge stroke how it is? Considered here friends here I have shown the piston and cylinder arrangement here correct..

See here this is a piston it is a connecting rod and a crank will rotate. Meaning if it will rotate what happens here you will see friends the inlet valve is there the outlet valve is there. Meaning what is the step 1? You will see also you will remember friends it is a top dead center when it will move bottom dead center. Similarly, what we have studied this thing in the two stroke and a four stroke engines.

Here we will see now piston is at that top dead center top what happen inlet and outlet valve both are closed. Step 2 as the piston moves down meaning how it is when the crank will rotate piston will moves from top dead center to bottom dead center. What happens? Inlet valve opens you will see inlet valve opens and draws the air in that time delivery valve remains closed. Step 3 when the piston is at the bottom BDC the inlet valve also closes. Delivery valve remains closed position only. This is the end of the suction stroke.

Step 4 now as the piston moves up meaning to the TDC delivery valve opens starts opening as the pressure builds up more than that the air receiver pressure. Meaning suction discharge is a one cycle when the piston will moves from top dead center to bottom dead center section then bottom dead center to top dead center is a compression the air will discharged with pressure.

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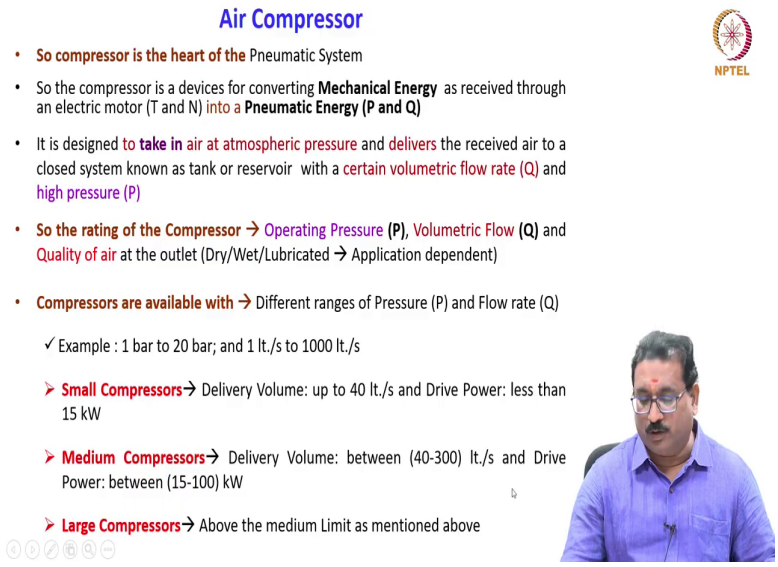

So, we will see so, the compressors is the heart of the pneumatic system. So, the compressor is a device for converting the mechanical energy as received from the electric motor and convert into pneumatic energy P and Q pressure and flow rate. It is designed to take in air at atmospheric pressure and delivers the received air to a closed system known as a tank or a receiver with a certain volumetric flow rate and a high pressure.

So, the rating of the compressor how they will rate it? Operating pressure volumetric flow and a quality of the air at the outlet whether it is a dry or a wet or lubricated this is again it is a application dependent friends it is a application dependent. The compressors are available with different ranges of pressure and flow rate. Example 1 bar to 20 bar you will get friends and a flow rate is 1 liters per second to 1000 liters per second.

Small compressors generally delivery volume up to 40 liters per second and a drive power less than the 15 kilo Watts. The medium compressors are there delivery volume is between 40 to 300 liters per second and a drive power between 15 to 100 kilo Watts. Large compressor above the medium limit more than the 3 liters per 300 liters per second and a drive power is more than the 100 kilo Watts for the large compressors.

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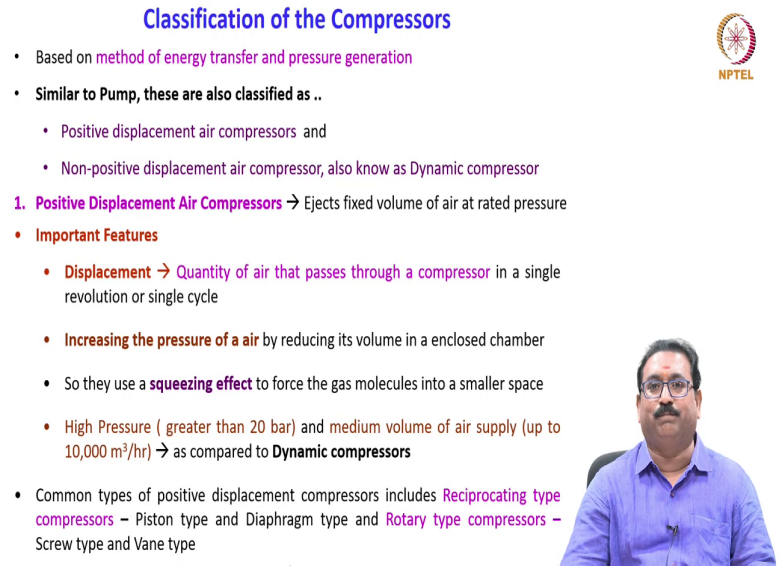

Now, we will see these friends how these compressors are classified? Already we know that the duty of compressor is sucks the air and compress it into the required level correct for this there are various types of compressors are there.

How they will classify let us we will see very quickly based on the method of energy transfer and pressure generation. Similar to pump these are classified as positive displacement air compressors and non positive displacement air compressor also known as a dynamic

compressors. In positive displacement air compressor what is the meaning here? Ejects a fixed volume of air at the rated pressure very important it is.

Ejects the fixed volume of air for every revolution or every cycle it is ensured. Important features here is displacement or a displacement quantity of air that passes through a compressor in a single revolution or a single cycle. Increasing the pressure of air by reducing its volume in a enclosed chamber. So, they use a squeezing effect to force the gas molecules into a smaller space.

High pressure meaning greater than the 20 bar and medium volumes of air supply up to 10,000 m cube per hour as compare to dynamic compressors. Common types of positive displacement compressor includes the reciprocating type compressors here we will discuss today the piston type and diaphragm type and a rotary type compressors again here screw type and a vane type.

Please remember friends here also the positive displacement pump how they are classified reciprocating and rotary? Rotary how many types are there you know gear type is there lobe type is there internal and external gear similar to that here also we are getting the similar types of air pumps based on the reciprocating piston and a diaphragm rotary type screw type and a vane type are more popular in the pneumatic system.

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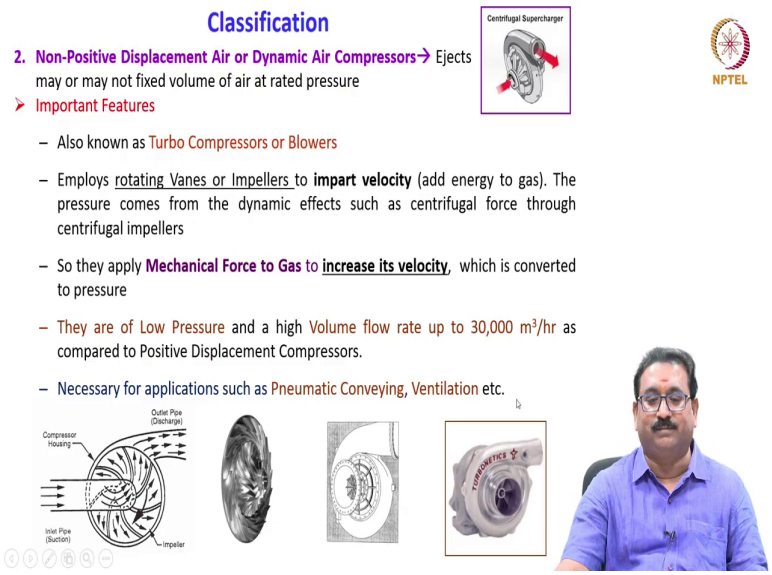

Let us we will see quickly the non positive displacement air or a dynamic air compressors. Ejects may or may not a fixed quantity of air at the rated pressure. Important feature here also known as a turbo compressors or a blowers objective is producing a large amount of flow not the pressure. Employs a rotating vanes or a impellers to impart a velocity that is a to add a energy to gas. The pressure comes from the dynamic effect such as the centrifugal force through the centrifugal impellers.

So, they apply a mechanical force to gas to increase the velocity which is converted to pressure. They are low pressure and a high volume flow rates up to 30,000 m cube per hour as compare to positive displacement compressors. Necessary for application such as a pneumatic conveying or a ventilation system etcetera.

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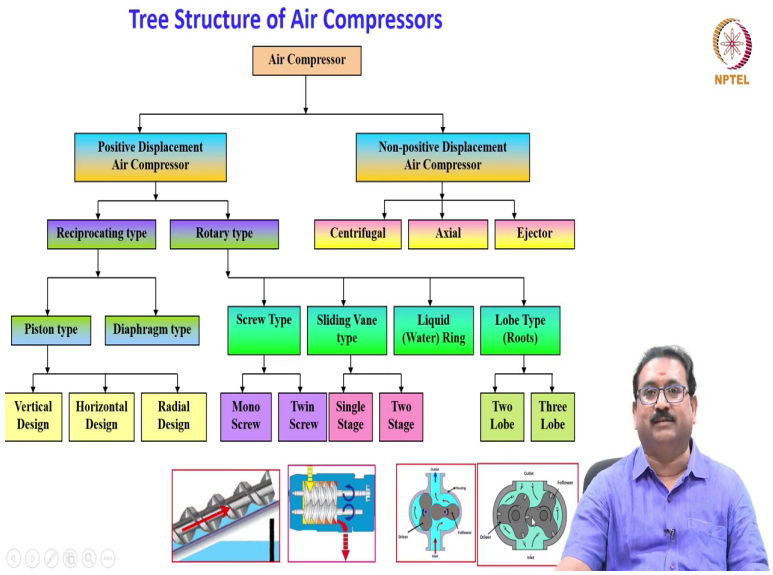

After knowing the positive and non positive displacement compressor let us we will see the tree structure how they are classified. As I have told you positive displacement and a non positive displacement are the main classification under air compressor. In positive displacement again as I have told you based on the motion reciprocating type and a rotary type mating elements. Here centrifugal axial and ejectors.

In reciprocating piston and a diaphragm type of compressors. Rotary screw type, sliding vane type, liquid ring, lobe type. In piston design based on how you will mount the vertical design, horizontal design and a radial design reciprocating type of compressors are available.

In a screw type mono screw or a twin screw. Mono screw means only one screw in the tube. Twin screw means the two screws one is a power screw another is a follower. In the sliding vane single vane and a single stage and a two stage compression. Here in lobe two lobes or a

three lobes both are available commercially in the market based on the lobes in the casing. This is a two lobe design and this is the three lobes. Curved paths what I will call curved.