Oil Hydraulics and Pneumatics
Prof. Somashekhar S
Department of Mechanical Engineering
Indian Institute of Technology, Madras

Basic Components. Application, Research Challenges, Status and Developments
Lecture – 05
Part- 2 Introduction to Pneumatic and its Basic Components, Applications-Stationary and Mobile

My name is Somashekhar, course faculty for this course.

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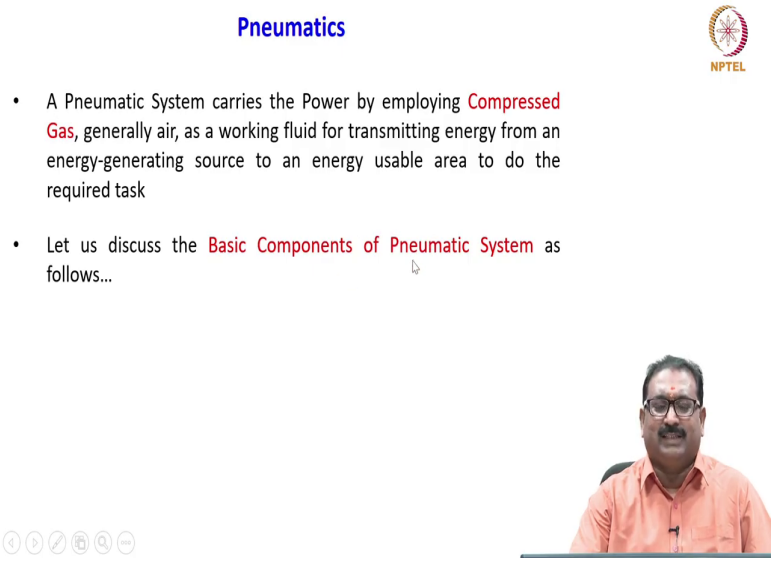

Now, we will move on to the Pneumatic system. A Pneumatic System carries the power by employing the compressed gas, generally the air, as a working fluid for transmitting energy from an energy-generating source to an energy usable area to do the required task. Let us discuss the basic components of the pneumatic system as follows.

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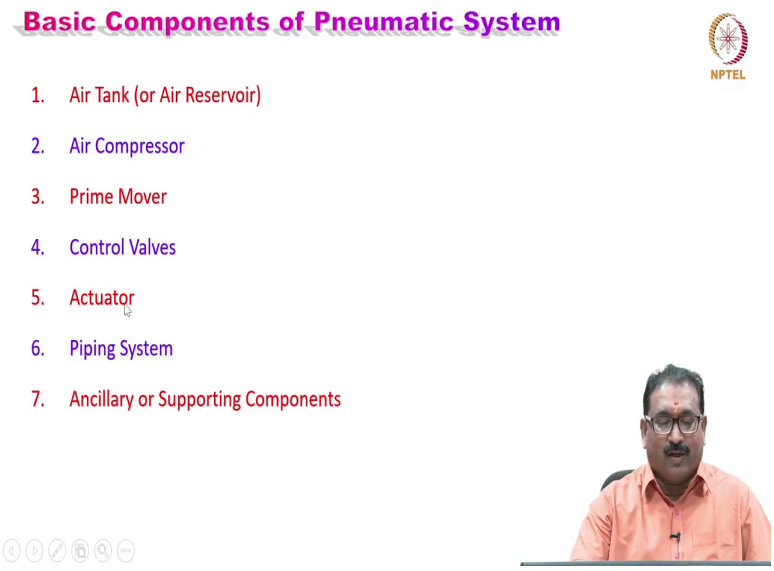

Please think both are used to do the useful work by converting the fluid energy into the mechanical energy. Here also, similar to the oil hydraulics, most of the components are same and only one component will varies. What is that? We will see now. First component is air tank or air receiver, which will stores the pressurized air with required volume.

Air compressor, prime mover, control valves, actuator, piping system and ancillary devices or a supporting components. Please see here, the basic components of pneumatics; but major difference here is what is that air compressor, there it is a hydraulic pump, there also tank is there, prime movers are there, control valves are there, actuators are there, piping system and ancillary devices are there.

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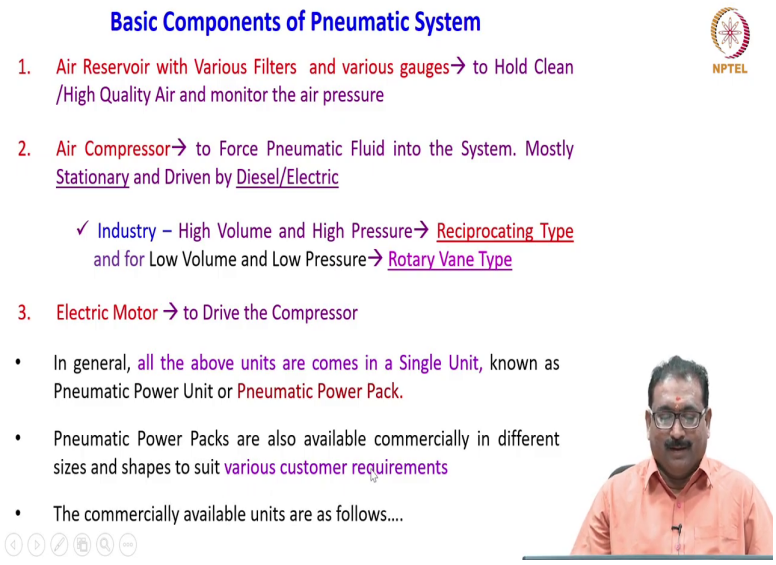

Air reservoir is equipped with the various filters and various gauges to hold clean and high quality air and monitoring the air pressure. Air compressor to force the pneumatic fluid; here, it is a air or any gas into the system. Mostly stationary and driven by the direct diesel or electric motors. In industry, high volume and high pressure are the main requirement. In such cases, we are using the reciprocating type of compressors.

If we required the low volume and low-pressure air that time, the rotary vane type of compressors will sufficient. We will discuss these things in the next classes. Third one is electric motor to drive the compressor. In general, all the above units are comes in single unit known as pneumatic power unit or a pneumatic power pack. The pneumatic power packs are also available commercially in different sizes and shapes to suit the various customer requirements.

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The commercially available units are like this. See here, oil-less air compressor, piston type air compressor for the heavy-duty application, the portable air compressors in the mobile applications, then oil-lubricated piston type air compressor.

These are only some of the; some of the diagrams I have shown; but air compressors are available in variety of size and shapes. Just see here friends, air compressor consists of the air tank, horizontally mounted or sometimes vertically mounted things are also available to save the space. Then, electric motor to drive the compressor.

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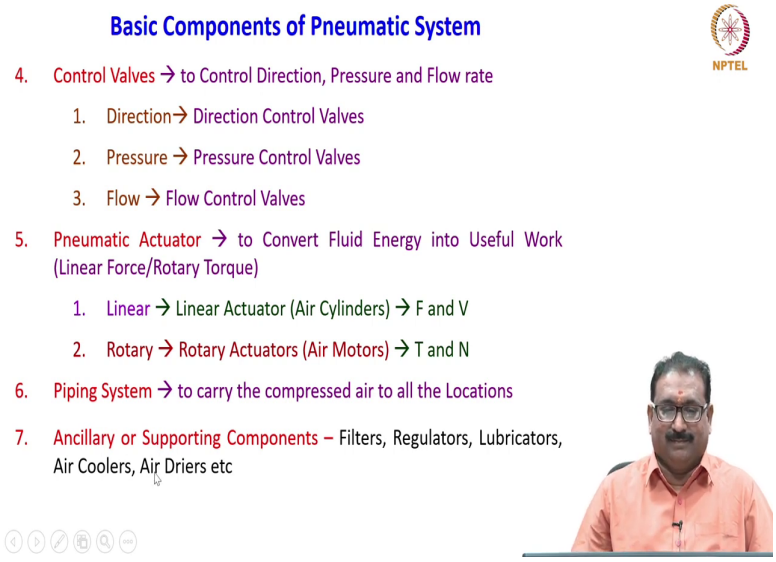

Here, the whole unit is the air compressor, power source, air tank, electric motor to drive the compressor. Fourth important component is control valves. Similar to the control valves in the hydraulics, pneumatics also very essential to control the direction, pressure and flow rate. If you will control the direction, they are known as direction control valves; able to control the pressure, they are known as pressure control valves and controlling the flow devices are known as flow control valves.

Fifth component is pneumatic actuator, to convert the fluid energy into useful work. What for useful work? Linear force and a rotary torque. For controlling the linear motion, we are using the linear actuator, they are also known as air cylinders.

The output is the force and the velocity of the actuator are very important. Again, please remember friends, force is controlled by the pressure and velocity is controlled by the flow

rate q. If you want to the rotary motion, you are using the rotary actuators or air motors, here the output is the torque and the speed.

Again, torque is related to the pressure and rpm is of the motor related to the flow rate q. Sixth one is a piping system, to carry the compressed air to all locations. Seventh one is ancillary devices includes the various filters, regulators, lubricators, sometimes you will get the FRL unit as a single unit, that is known as F filter, regulator, lubricator units commercially available in the market as a single unit. Air coolers, air driers are also comes under the ancillary devices. The schematic diagram is shown in the figure below.

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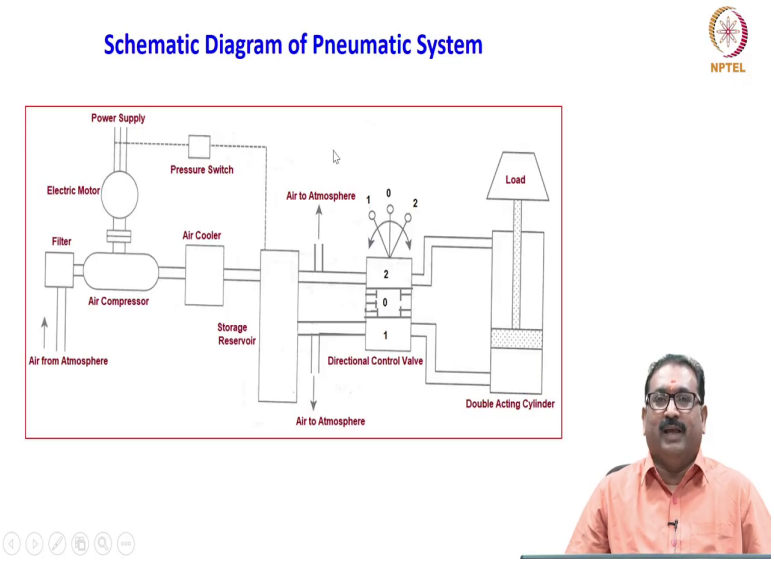

You will see (Refer Time: 07:12) here, again I am controlling the vertical movement of the load using the double acting cylinders. Here, you will see direction control valve having the

three position, middle position is a null position. All ports are blocked and first position is to move the load up. This position is move the lower the loads correct.

Again, you will see the receiver tank here, storage tank; air coolers are there, air compressor correct, electric motor to drive the compressor, the pressure switch is essential to switch on and off the electric motor, when the sufficient quantity of air with required pressure is stored in the storage tank.

The very simple here, the schematic will show you that the compressor sucks the air from the atmosphere and compresses to the required pressure in the air compressor and when air will compress, the temperature of the air increases which leads to the moisture content and the exit of the air compressor is very hot. So, you have to cool the air to the required level using the air coolers, then you will store into the receiver tank. Please understand this pneumatic circuit.

Here, you will see friends, when I want to raise the load, the air will comes from the storage because storage tank now it is, storage tank it will go here and it will enter the whatever the air is present in the tail side, it will moved here and then, it will go directly it will go to the atmosphere. See here, it will not go to the receiver tank. That is why it is open-loop in system; but in the hydraulics, you will see the oil used is recirculated back to tank after doing the work.

But here, you will see I have shown air to atmosphere; meaning, air will be tapped from the storage reservoir to raise the load or lower the load. During this operation, the air present in the head side or a tail side will go exhaust to the atmosphere, that is why it is a open loop in nature.

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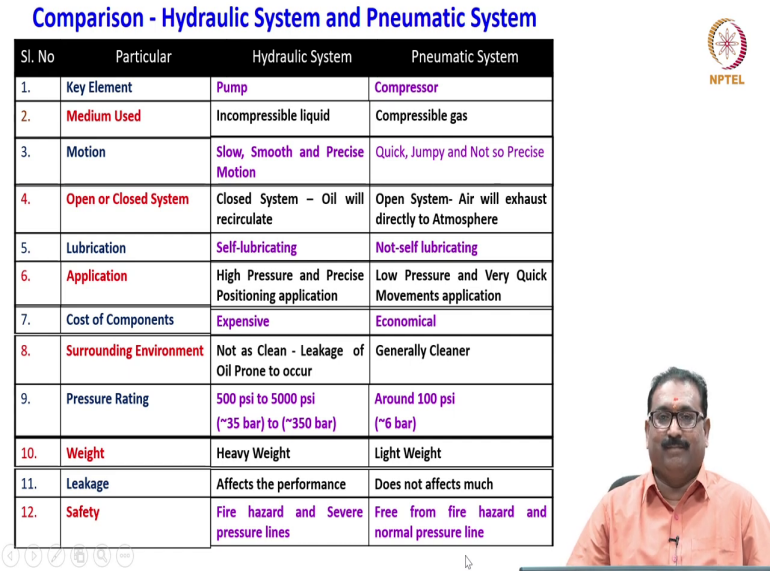

Sl. No	Particular	Hydraulic System	Pneumatic System
1.	Key Element	Pump	Compressor
2.	Medium Used	Incompressible liquid	Compressible gas
3.	Motion	Slow, Smooth and Precise Motion	Quick, Jumpy and Not so Precise
4.	Open or Closed System	Closed System – Oil will recirculate	Open System- Air will exhaust directly to Atmosphere
5.	Lubrication	Self-lubricating	Not-self lubricating
6.	Application	High Pressure and Precise Positioning application	Low Pressure and Very Quick Movements application
7.	Cost of Components	Expensive	Economical
8.	Surrounding Environment	Not as Clean - Leakage of Oil Prone to occur	Generally Cleaner
9.	Pressure Rating	500 psi to 5000 psi (~35 bar) to (~350 bar)	Around 100 psi (~6 bar)
10.	Weight	Heavy Weight	Light Weight
11.	Leakage	Affects the performance	Does not affects much
12.	Safety	Fire hazard and Severe pressure lines	Free from fire hazard and normal pressure line

Quickly, we will see the comparison between the hydraulic system and pneumatic system with certain parameters. What is a key element in the hydraulic system? Hydraulic system, the key element is pump; in pneumatic system, it is a compressor.

Medium used, in hydraulics incompressible liquids and here compressible gases; generally, the air. The motion; slow, smooth and precise motion is possible in hydraulics because the oil is incompressible in nature; but in pneumatic system, air is compressible in nature that is why we are getting the quick jumpy and not so precise movements; but quick movements are possible in the pneumatics.

Open loop or a closed loop, yes hydraulic systems are closed loop as because oil will recirculate back to the tank; but pneumatics are open system it is as because air will exhaust directly to the atmosphere after doing the work. Then, lubrication hydraulics are

self-lubricating because incompressible mineral oils or petroleum-based fluids we are using, they are self-lubricating; but in the pneumatics, air is dry and clean air is required, that is not self-lubricating.

Application wise you will see they are the high pressure and a precise positioning application hydraulics; pneumatics is low pressure and a very quick movement applications. Cost of components you will see hydraulics are expensive as compared to pneumatic system, they are economical in nature. Surrounding environment, as I have told you the moving parts are there, incompressible fluids are there in hydraulics that is why not as clean - leakage of oil prone to occur. So, the fire hazards are more here. Generally, air is cleaner no need to worry for anything.

But pressure ratings you will see here we are using 35 bar to 350 bar in hydraulic system; but in pneumatic system, generally 6 bar to 10 bar, we are using in the pneumatic system normal pneumatics.

Weight of the component you will see, as I have told you the hydraulic systems are meant for high pressure ratings that is why they are heavy duty, heavy weight; pneumatic systems are very light as because the pressure in the pneumatics is 6 to 10 bar in the normal pneumatics.

Leakage of oil you will see, here it will affects the performance; here leakage of air does not affect much. Safety, the fire hazard and severe pressure lines are there. As I have told you, here we are using up to 350 and more bar in the hydraulic system, very severed pressurized lines are there; but no need to worry here because air is not catching the fire, free from fire hazards and normal pressure lines like 8 to 10 bar.

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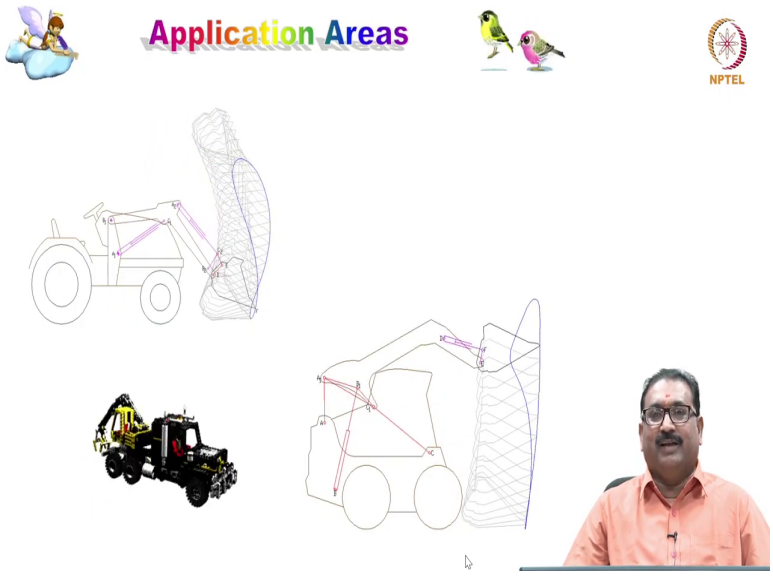

Now, we will move on to the application areas of this oil hydraulics and pneumatics, there are various applications are there.

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Let us we will discuss some of the application areas. Fluid power is extensively used in every branch of industry. Some of the typical applications includes automobiles, tractors, airplanes, missiles, boats, robots, machine tools, construction equipments, agricultural equipments.

In the automobile alone, friends, fluid power is used in many ways. See here, hydraulic brakes, automotive transmission, power steering, power brakes, airbags, lubrication, many ways the fluid power is used in the automobile industries.

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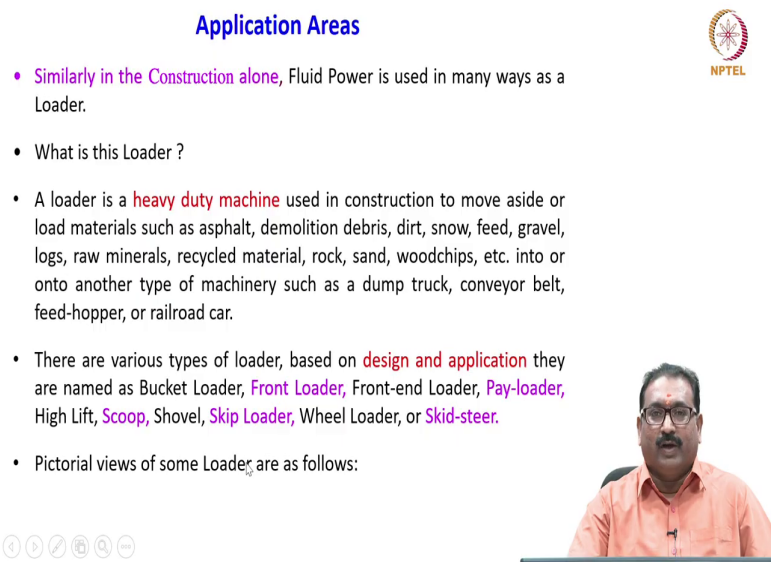

Similarly, you will see in construction alone, fluid power is used in many ways as a loader. What is this loader? A loader is a heavy-duty machine used in construction to move aside or load materials such as asphalt, demolition debris, dirt, snow, feed, gravel, logs, raw materials, recycled material, rock, sand, woodchips etcetera into or onto another type of machinery such as a dump truck, conveyor belt, feed hoppers or a railroad car.

So, there are various types of loaders are available commercially in the market, based on the design and application, they are named as bucket loader, Front loader, Front-end loader, pay-loader, high lift, scoop, shovel, skip loader, wheel loader or skid-steer. I will show you some of the pictorial views of the loader. Quickly, understand how they will look.

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See here, this is skip loader, hauler, drill rigs, wheel loader, fork lift, turf care, refuse collecting front-end loader, forest machine, truck mounted cranes like this, many friends. These are comes under the category of loader used in construction in one or the other work to do in the construction industries.

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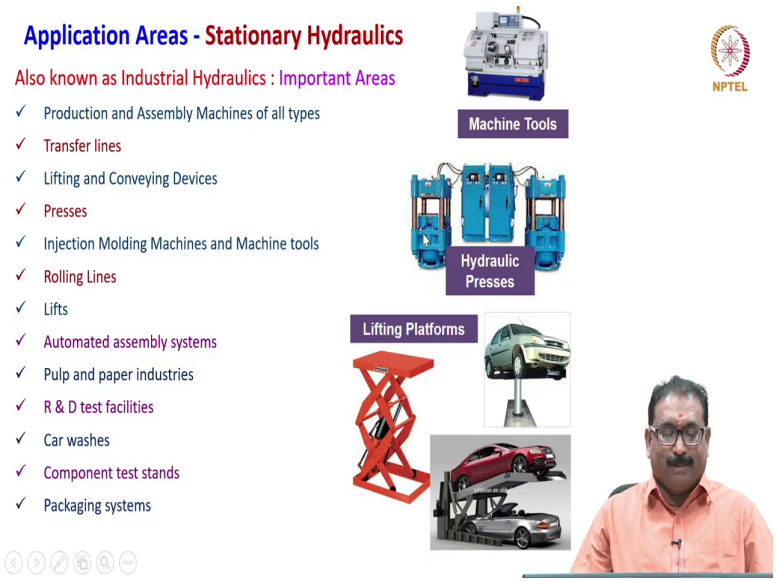

Another way of classifying the hydraulics and pneumatics application areas are you will see application areas corresponding to stationary hydraulics; meaning here, power pack cannot move from one place to another place. Large amount of applications are there in the stationary hydraulics.

Some of the important areas are production and assembly machines of all types, transfer lines, lifting and conveying devices, presses, injection molding machines and machine tools, rolling lines, lifts, automated assembly systems, pulp and paper industries, R and D test facilities, carwashes, component test stands, packaging systems many more.

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Similarly, the mobile hydraulics in which power pack can move from one place to another place, as we have seen already power packs are available in heavy duty to the portable compact movable from one place to another place. Now, I list you the mobile hydraulics applications.

Construction machinery as I have shown; tippers, excavators, elevating platforms; lifting and conveying devices; automobile alone the many task power steering, power brakes, automatic door closures etcetera; aircraft, the one example is landing gears, to control the flow etcetera; oceanography, agricultural machinery.