Oil Hydraulics and Pneumatics
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Part 1: Pneumatic Control System-Introduction,
Air Preparation-Primary and Secondary Air Treatment
Lecture - 23
Pneumatic Control and Pneumatic Power Source

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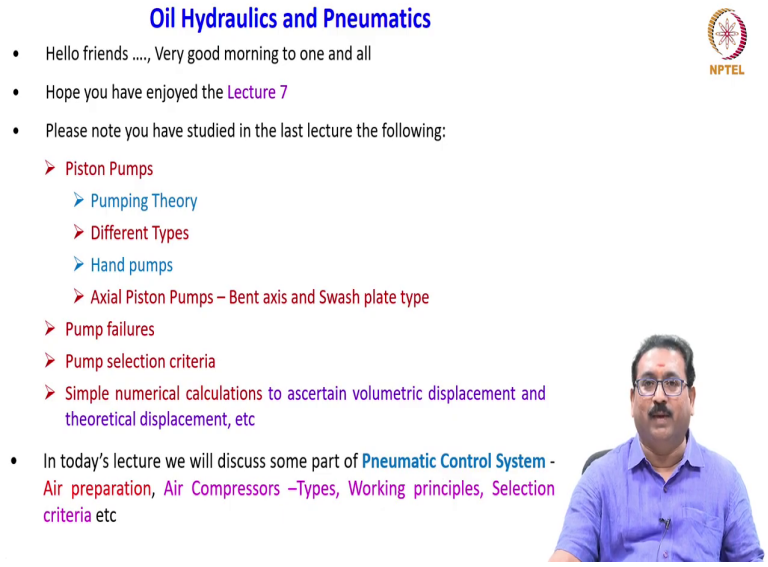

My name is Somashekhar course faculty for this course. Hello friend's very good morning to one and all. Hope you have enjoyed the lecture 7. Please note you have studied in the last lecture the following contents: Piston pumps pumping theory, different types of piston pumps, hand pumps, axial piston pumps.

In which we studied bent axis type, swash plate type, pump failures pump selection criteria, simple numerical calculations to ascertain volumetric displacement theoretical displacement. In today's lecture we will discuss some part of pneumatic control system. In which we will discuss mainly on air preparation different types of air compressors their working principles and selection criteria.

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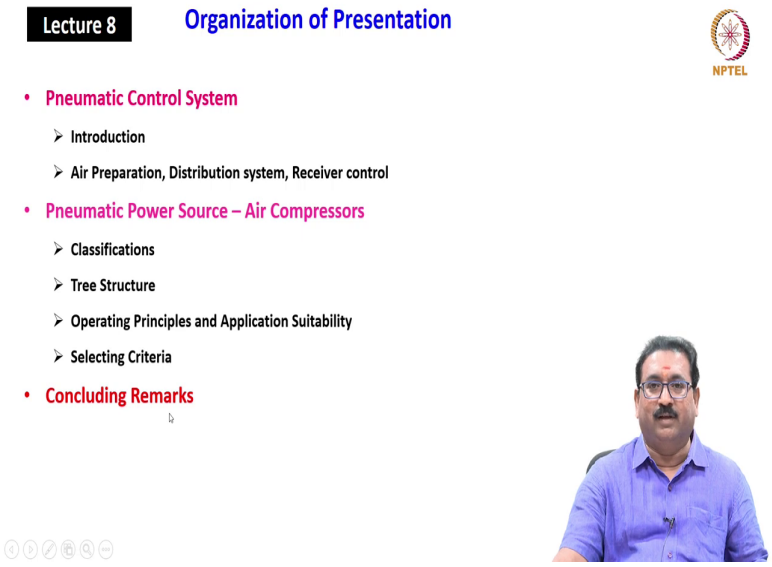

Let us we will see quickly the organization of presentation which basically includes pneumatic control system in which we will discuss why it is required what is the significance of this? Move on to air preparation, distribution system and receiver control. Move on to pneumatic power source which is an air compressor.

Hydraulic power source is a hydraulic pump as we discussed in the last class the different types of hydraulic pump. Which is a device which converts the mechanical energy into hydraulic energy?

In today's class we will discuss the air compressor here we will discuss different classifications. How they are classified? Tree structure of compressors, operating principles and application suitability, selection criteria then finally, we will conclude this lecture.

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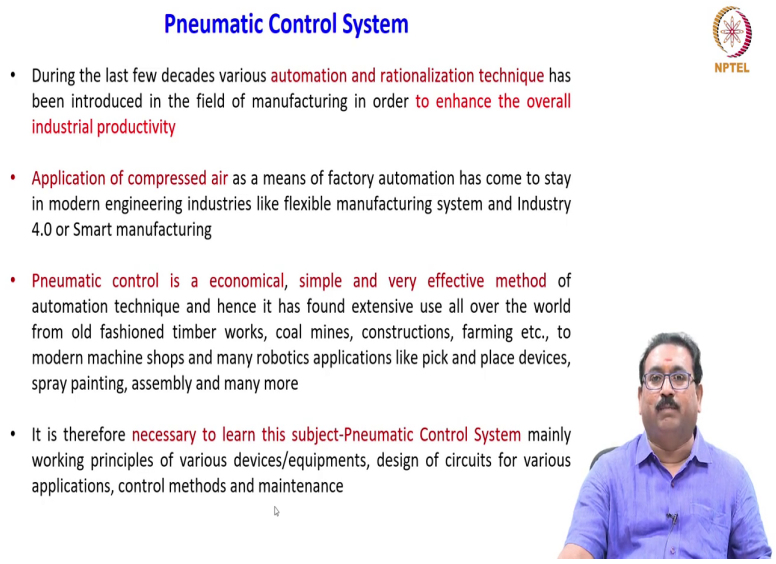

During the last few decades various automation and rationalization technique has been introduced in the field of manufacturing in order to enhance the overall industrial productivity. Application of compressed air as a means of factory automation has come to

stay in modern engineering industries like flexible manufacturing system and industry 4.0 or a smart manufacturing.

Pneumatic control is a economical, simple and very effective method of automation technique and hence it has found extensive use all over the world from old fashioned timber works, coal mines, constructions forming equipments, and many to modern machine shops and many robotic applications like pick and place devices, spray painting, assembly and many more.

It is therefore, necessary to learn the subject pneumatic control system mainly working principles of various devices, equipments, power tools and design of circuits for various applications, control methods and maintenance of pneumatic systems. These are very essential in the pneumatic control applications and systems.

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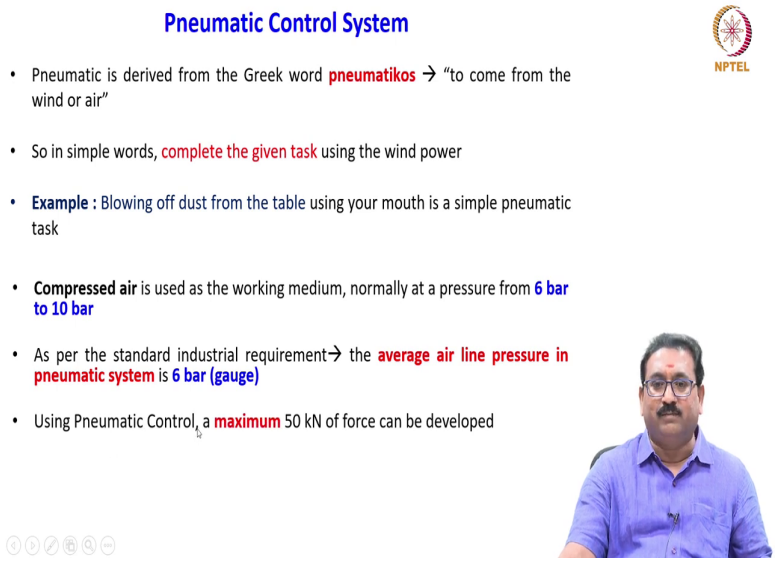

Friend's pneumatics is derived from the Greek word pneumatikos "to come from the wind or air". So, in simple words complete the given task using the wind power. Example, blowing off dust from the table using your mouth is a simple pneumatic task.

Compressed air is used as a working media in a pneumatic system normally at a pressure ranges from 6 bar to 10 bar. As per the industrial requirement the average airline pressure in pneumatic system is generally 6 bar. Using pneumatic control a maximum 50 kilo Newton of force can be developed.

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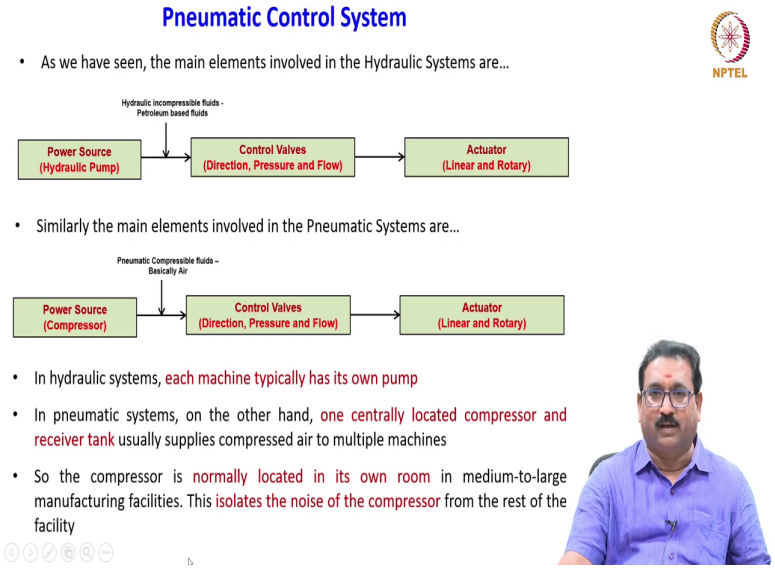

As we have seen the main elements of oil hydraulics in the last classes, which includes the power source as I told you hydraulic pump is a power source. In which hydraulic

incompressible fluids petroleum based fluids are used as a working media. Then control valves are there direction control valves pressure control valves and a flow control valves.

And finally, the actuator includes the linear and rotary. These are the very important elements in the hydraulic system. Similar to this friends the main elements involved in the pneumatic systems are power source here it is a compressor, which requires the basically an air; air is a working media here.

Again similar to here control valves are there direction pressure and a flow control valves and finally, an actuator which includes a linear and rotary similar to here. In hydraulic system friends each machine typically has its own pump.

In pneumatic system on the other hand one centrally located compressor and a receiver tank usually supplies compressed air to multiple machines in the factory. So, the compressor is normally located in its own room in medium to large manufacturing facilities. This isolates the noise of the compressor from rest of the factory environment.

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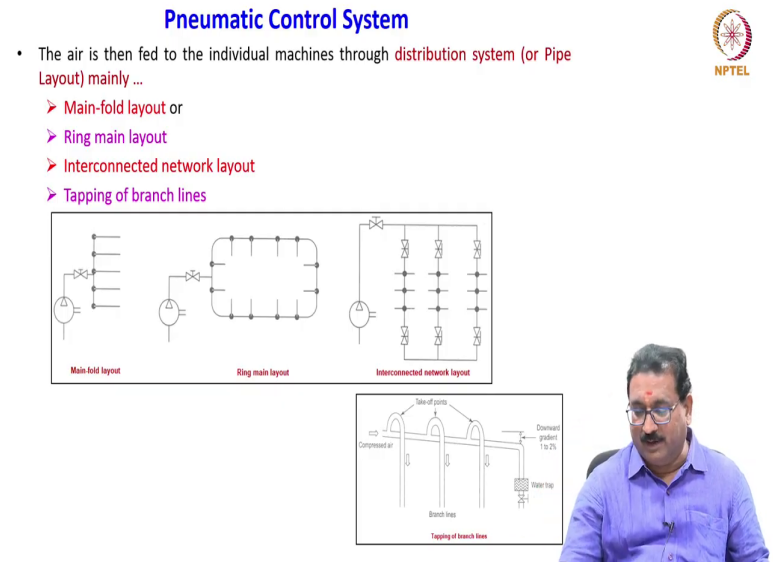

The air is then fed to the individual machines through the distribution system, which is a very important the pipe layout. Which is inside the factory the compressor is somewhere else here we are tapping to do the various works in the factory environment. You will get through compressed air main fold layout or ring main layout, interconnected network layout, tapping branch lines.

What are these friends I will show you here you will see this is a compressor? Then shut off valve is there manually, which will supplies the compressed air to the various machines this is called a main fold layout fatter. You will see friends here the ring main layout in which a compressed air supplies in the ring pattern. Where there are various pneumatic tools are there which requires the compressed air.

Again you will see the control his main shutoff valve is there. Similarly, you will see here interconnected network layout the each branch here you will see has the manual shutoff valves based on the requirement you will on and off these main shutoff valves to supply the air to the different lines. You will see here friends always here the tapping of branch lines you will see here.

Compressed air will run through this piping and these are the takeoff point's parallel takeoff points where it will go to the different lines meaning branch lines. See friends always the compressed air will flow to the pipe you should not keep straight always it is inclined 1 to 2 degree.

Then as we know it is a compressed air when it is flowing due to the temperature variation the moisture will form this will be taken out through in the water trap. Also you will see one more looping system I am showing in the pneumatic control.

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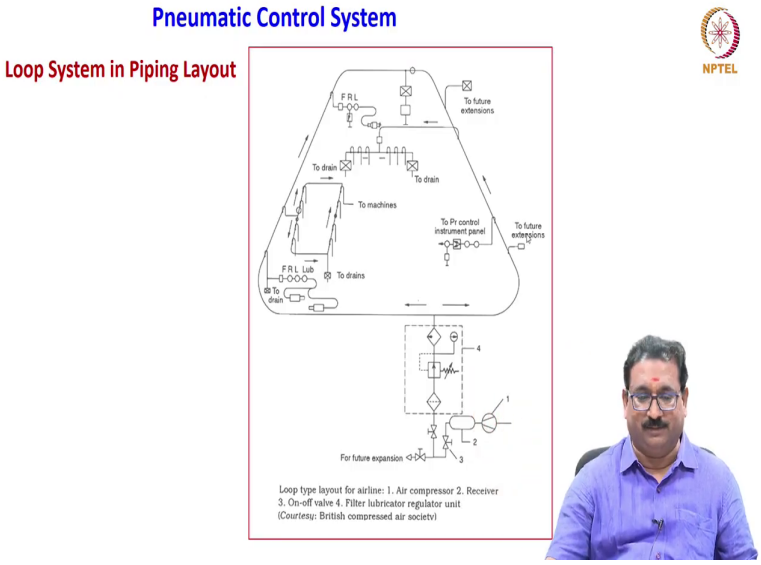

See here friends it is the compressor receiver tank as I have told you so, many manual shutoff lines. For future expansion also you will keep it where it required. Then it will go to this fourth one is a FRL unit. What is this FRL unit?

I will tell you then it will go to the circuit where various machines are there you will see various machines which requires the compressed air. Please take care friends this FRL units as many as you will use to provide the clean dry air to the various machine tools.

Otherwise pneumatic system components will perform not good meaning the efficiency will goes on decreasing if moisture will enter in the pneumatic components because, of the corrosion formation wear and tear and many things will happen to the system. That is why you will see here?

There wherever it will trapping to the any system so, many FRL units you can use it. This is called a looping system air will flow in both directions based on the requirement. Then also you will see the further future expansion you will keep the tapping lines then no need to pay attention later then directly will tap the air wherever you required.

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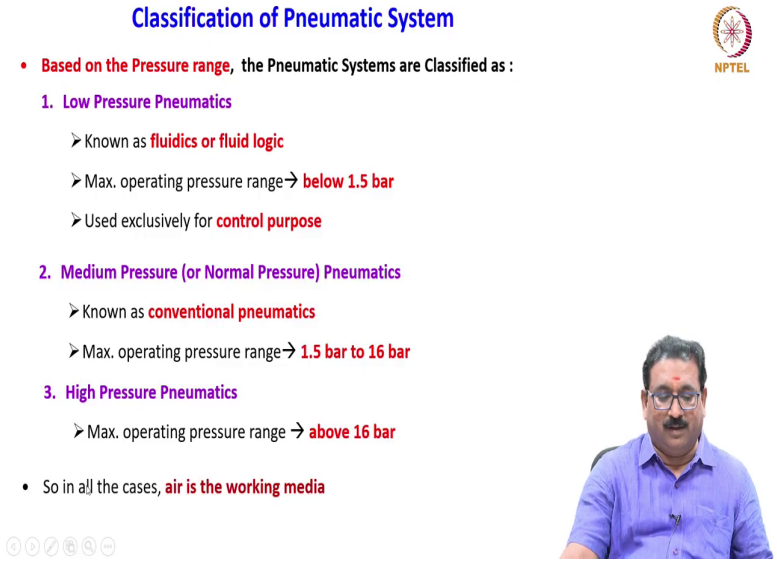

Now, we will see the classification of pneumatic system. How rare they will use in industries? Based on the pressure range the pneumatic systems are classified as: low pressure pneumatics. What is this? It is also known as fluidics or a fluid logic. Here maximum operating pressure is below 1.5 bar. Used exclusively for control purpose low pressure pneumatics.

The medium pressure pneumatics are also known as normal pneumatics here the pressure limitation is 1.5 to 16 bar. They are known for the conventional pneumatics. One more is high

pressure pneumatics here the maximum operating pressure range is about 16 bar. So, in all cases air is a working media please remember friends then question arises why air alone?

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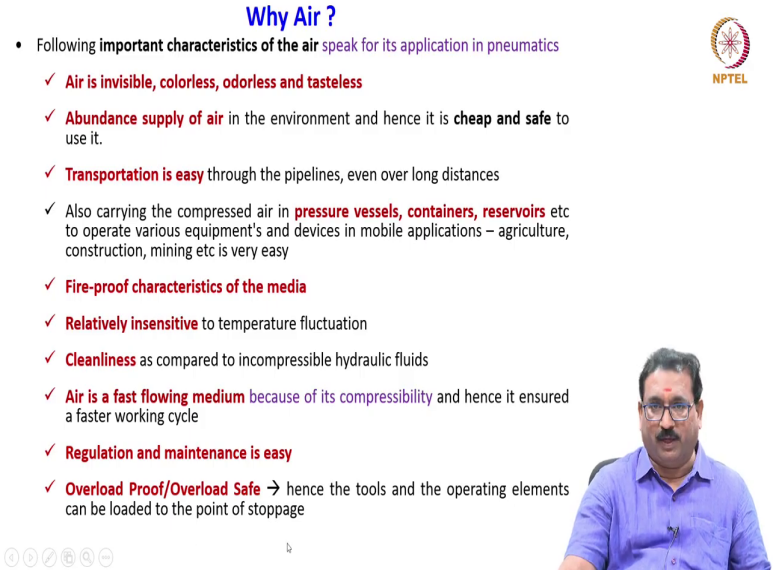

As I have told you in some of the systems like in aerospace and many other places where the by product is some of the gases they will store in the vessel and they will use as a working media also. But most of the places in industry air is a working media. Then question arises why air? The following characteristics of the air speaks for its application in pneumatics. As we know air is invisible, colorless, odorless and tasteless.

Abundance supply of air in the environment hence it is a cheap and safe to use it. Transportation is easy through the pipelines, even over long distance. Also carrying the compressed air in pressure vessels, containers or receiver to operate a various equipments and devices in mobile applications.

Like agriculture, construction, mining etcetera is very easy to carry the compressed air no need to worry. Then air is fireproof characteristics of the media. It is relatively insensitivity to temperature fluctuation it is a very in sensitivities. Cleanliness as compared to incompressible hydraulic fluids.

Air is fast flowing media because of its compressibility hence it is ensured faster working cycle. Regulation and maintenance is very easy in pneumatic control because the pressure rating is very low. Overload proof and overload safe hence the tools and operating elements can be loaded to the point of stoppage.

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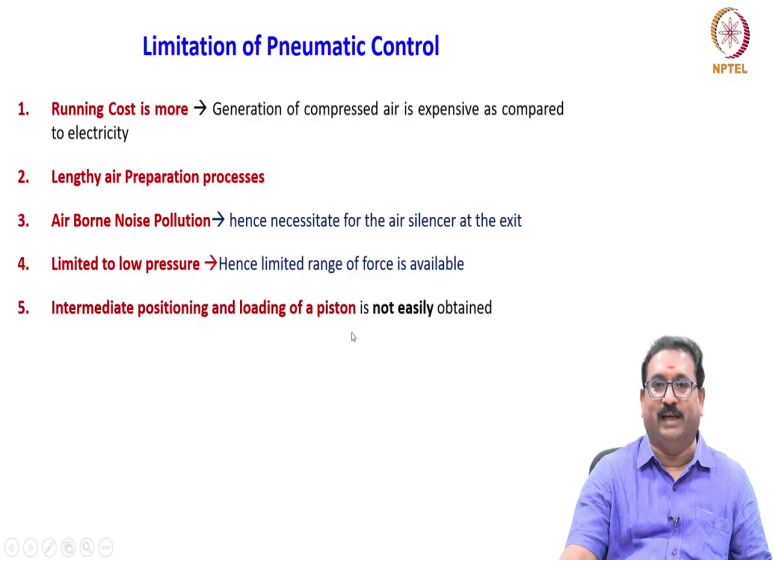

Apart from the advantages of the air some of the limitations of the pneumatic control are running cost is more meaning here generation of the compressed air is expensive as compared to electricity because we need the air is clean dry air.

How to get it this? Because atmospheric air is contaminated how to get the clean and dry air? Air preparation is a very lengthy process and costly also. As I have told you lengthy air preparation process. Air borne noise pollution hence necessitates the air silencer at the exit. Limited to low pressure. Hence limited range of force is available. Intermediate positioning and loading up piston is not easily obtained.

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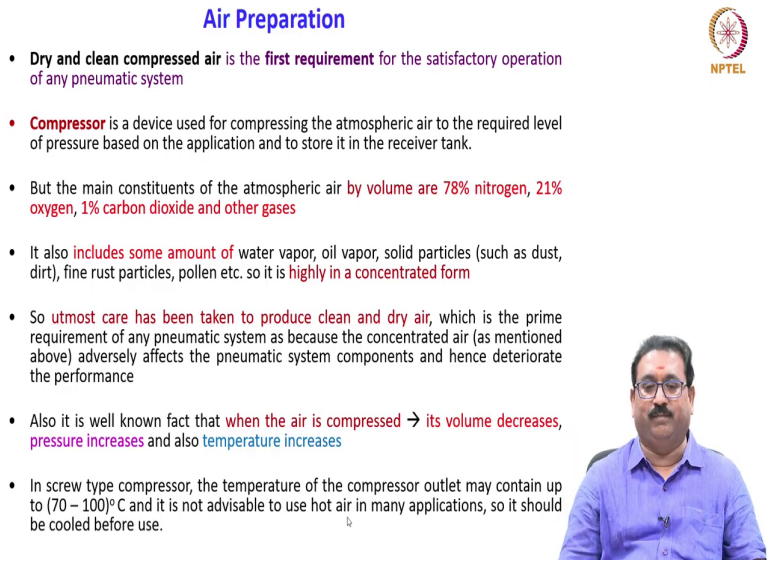

Now, we will see now as I have told you we required a dry and clean compressed air is the first and foremost requirement of the satisfactory operation of the pneumatic system. So, for this what we are using? A compressor which is a device used for compressing the

atmospheric air to the required level of pressure based on the application and store it in the receiver tank.

But the main constituents of the atmospheric air by volume or 78 percent nitrogen, 21 percent oxygen, 1 percent carbon dioxide and other gases. It also include some amount of water vapor, oil vapor, solid particles, fine rust particles, pollens and many more. So, it is highly concentrated form in the atmosphere you cannot use directly atmospheric air as a working media.

So, utmost care has been taken to produce clean and dry air. As I have told you it is a prime requirement of any pneumatic system as because the concentrated air adversely affects the pneumatic system components and hence deteriorates the performance. Also it is well known fact that when air is compressed what happens? Its volume decreases, pressure increases and simultaneously the temperature also increases.

In screw compressor itself the temperature of the compressor outlet may contain up to 70 to 100 degrees centigrade and it is not advisable to use hot air in many application so, it should be cooled before to tap the air for operations.

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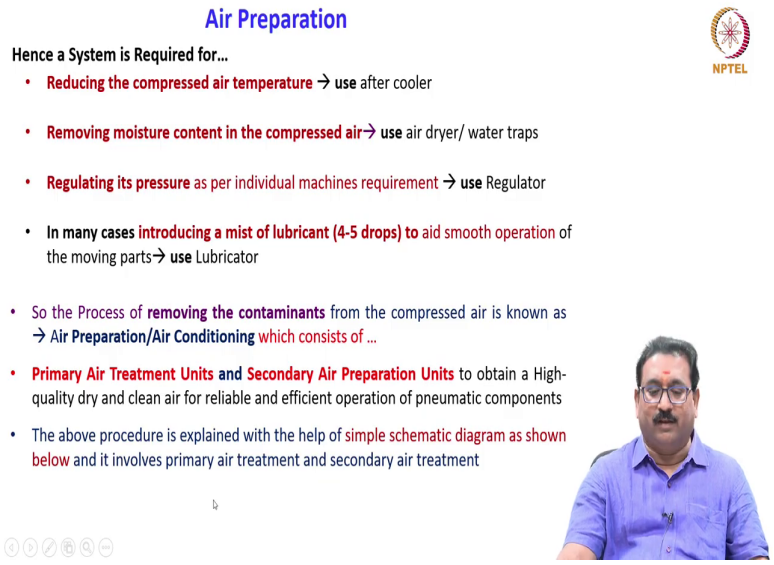

Hence a system is required for reducing the compressed air temperature there are many ways are there we are using the after cooler. Removing moisture content in the compressed air we are using the air dryers and many places water traps. Regulating its pressure as per individual machine requirement that time we are using the regulator air regulators.

In many cases introducing a mist of lubricant for smooth operations as because there are many moving parts are there we are using the lubricator to introduce 4 to 5 drops of oil into the dry and clean air. So, the process of removing the contaminants from the compressed air is known as air preparation are also known as air conditioning.

Which consists of primary air treatment units and secondary air preparation unit to obtain high quality dry and clean air for reliable and efficient operation of pneumatic components.

The above procedure is explained with the help of simple schematic diagram as shown in the figure below which includes the primary air treatment and secondary air treatment.

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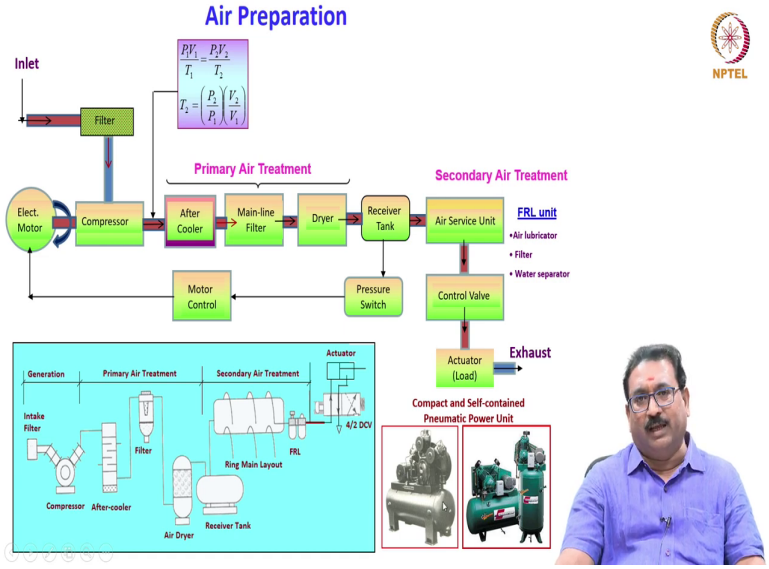

Let us we will see friends here what I have shown here is a compressor drives through the electric motor? And what it will do? What is the duty of compressor here? You will see generation what it will do compressor will sucks the air from the atmosphere through the filters these filters are known as intake filters.

Then what it will do? It will compresses the air then what happened volume decreases, pressure increases, temperature increases, then what happened the outlet of the compressor contains the hot air also you remember friends the atmospheric air is its, the contaminated air the many times the pollens dust particles; dust particles also enters in the compression process.

So, our outlet it cannot guaranteed it is the only pure and dry air. Due to outlet of the compressor contains the hot air then what you will do we will use the after cooler? It will cools the air then if it will cools what happens friend hot air it cools automatically the vapor moisture vapor will form.

Then what we will do there are many water traps you have to use after coolers or also before going to next step the main line filters are there they will removes again the contaminants entered in the compressed air ok. Then what you will do? Then again you have to dry the air once you will cool what happen moisture content will form.

Then even though water traps are there in between the some amount of moisture again existing in the compressed air then what we will do we will use a dryer; dryer is a device which is used to cool the air dry the air. We will discuss different types of dryers in the next class.

This is what you will call? Then it will enter to the receiver tank. Please remember friends after cooler mainline filter and dryer receiver tank it is called a primary air treatment. Meaning the receiver tank contains a dry clean air here please remember friends.

Then all receiver tanks having the certain capacity after storing the required volume with required pressure what you will do you have to switch off the compressor running. For that we are using the pressure switch, which is known as a motor control and many things are there I will tell you how to control the compressor once the required quantity of air is filled in the receiver tank.

Then friends you will remember here after this air is going to the system actuator through the secondary air treatment as you have seen it is also known as air service unit. What is this FRL? What is FRL? Filter regulator lubricator it will do all the three functions in one unit.

Then it will pass through the control valves then to the actuator once the air will do the required work here it will exhaust to the atmosphere no feedback here correct friends. These

are the, what you will call air preparation units? The compact and self contained pneumatic power source compressor which includes; the compressors electric motor receiver tank.

This receiver tank is horizontally mounted sometimes vertically mounted also based on the requirement.

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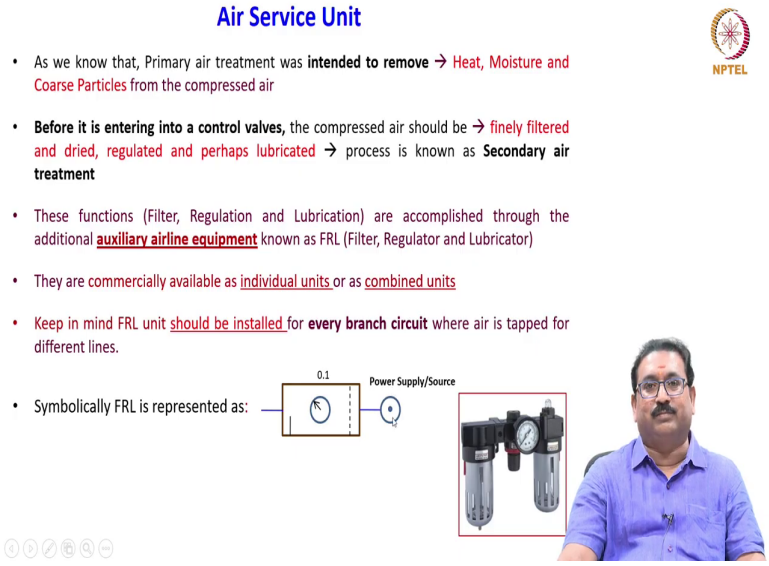

As I told you FRL unit is a very; very important what is known as air service unit? What it will do? As we know the primary air treatment was intended to remove the heat moisture and a coarse particles from the compressed air. Before it enter into the control valves, the compressed air should be again.

Finally, filtered and dried regulated and perhaps lubricate it the process is known as secondary air treatment. These functions filter; regulator and lubrication are accomplished through the additional auxiliary airline equipment known as FRL.

They are commercially available as a, individual units also you will get to the filter separate regulator supplied lubricator operate then you will combine or else they will available in the combined units also. Keep in mind FRL should be installed for every branch circuit where air is tapped for different lines.

Symbolically FRL is represented like this as I have told the rectangle, regulator, filter and lubricators how to represent this is a power source.

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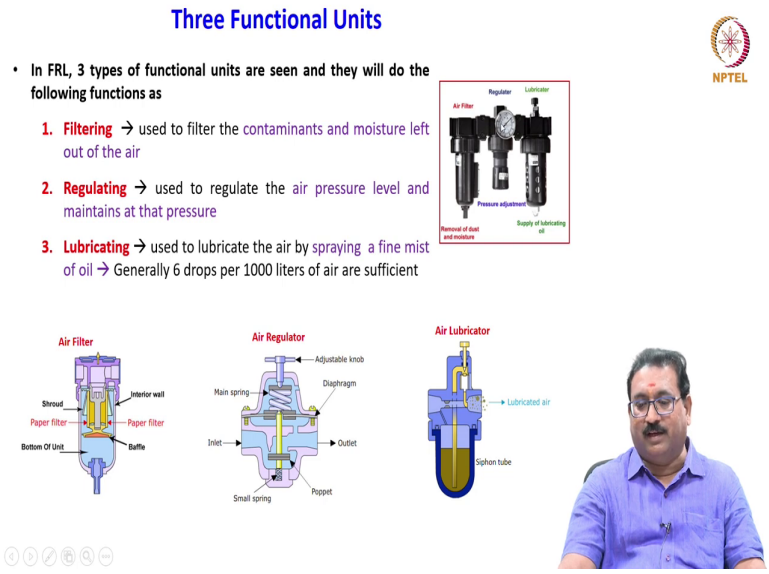

As we know in FRL three functional units are inbuilt. What are those the objective is filtering through the air filters? Correct the air filter filtering element is different types of filtering elements are there correct. What for it is used to filter the contaminants and moisture left out of the air. Regulating this is the regulator used to regulate the air pressure level and maintains at that pressure.

Air lubricator you will see here lubricator, air lubricator used to lubricate the air by spraying a fine mist of oil. Generally 6 drops per 1000 liters of air or more than enough. This is what we will call separate units air filter regulator and lubricator or they will available individually also.

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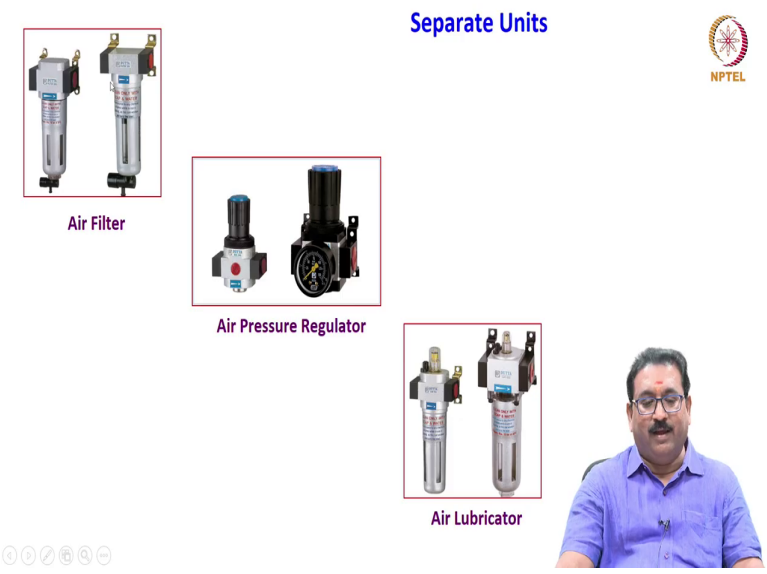

You will see here separate units are also available. This is the regulators set whatever the pressure required.

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Or the combined units are also available in the market which is known as a FRL unit.