Oil Hydraulics and Pneumatics
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Part 2: Construction and Operation of Refrigerated Air dryers, Absorption Dryer, Adsorption Dryer, Membrane Dryer, How to Choose the Right Air Dryer?
Lecture - 31
Air Dryers

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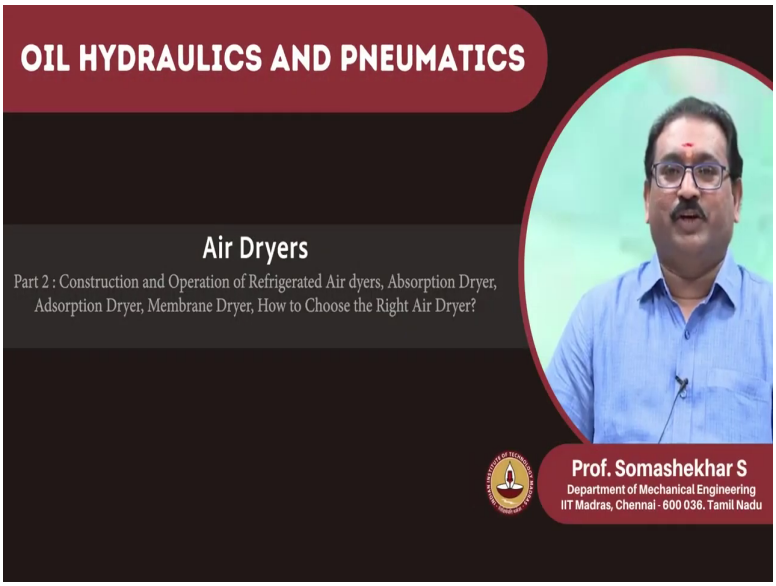

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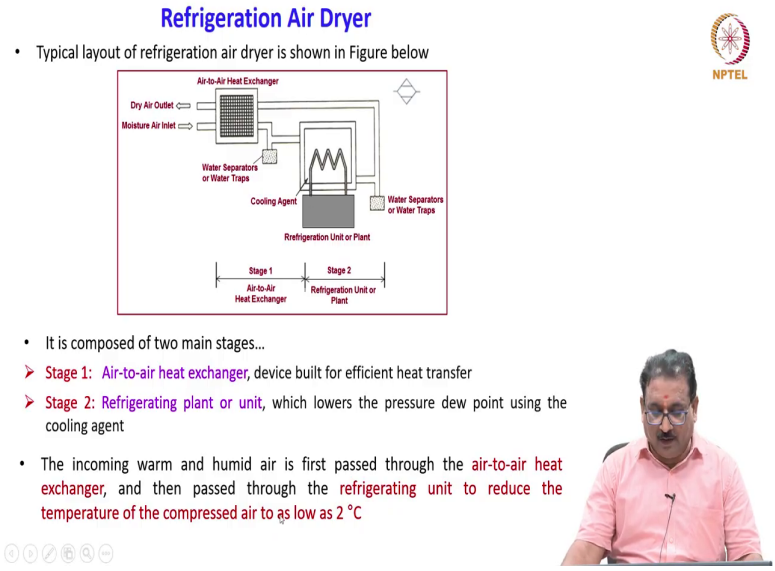

My name is Somashekhar, course faculty for this course. Refrigeration Air Dryer or Refrigerated Air Dryer, typical layout of refrigeration air dryer is shown in figure below. Here you will see, the figure shows the refrigerated air dryer which basically consists of air to air heat exchanger and one more is refrigeration unit or a plant it is also called. You will see here the moist air will enter the air to air heat exchanger.

Then it will pass on to the refrigeration unit, during each stage moisture will be removed from the compressed air. This contaminant is collected in the water separator or water traps provided at the different locations, then the dry air is taken out from here. Let us we will see now, it is composed of two stages, Stage 1 and Stage 2. In Stage 1: Air to air heat exchanger, device built for efficient heat transfer.

Stage 2: Refrigerating plant or a unit which lowers the pressure dew point using the cooling agent, you will see the cooling agent is here (Refer Time: 01:54) The incoming warm and humid air is first passed through the air to air heat exchanger and then passed through the refrigeration unit to reduce the temperature of the compressed air to as low as 2 degree centigrade.

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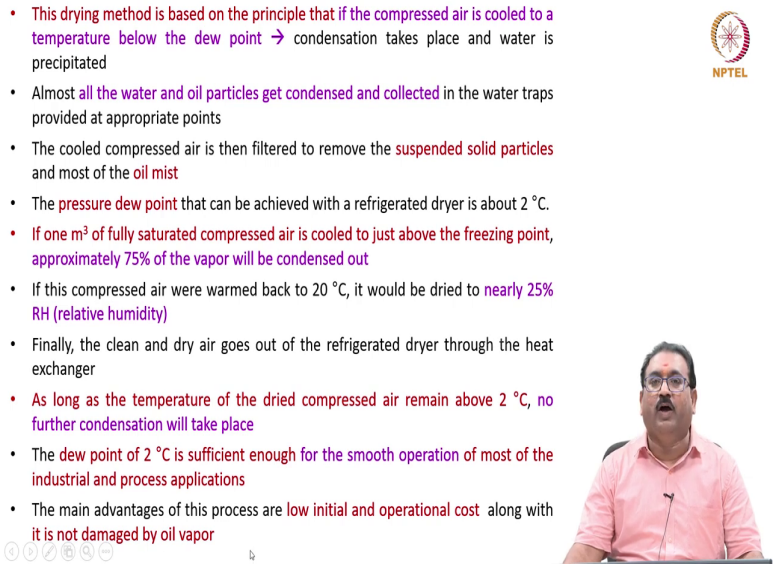

This drying method is based on the principle that, if the compressed air is cooled to a temperature below the dew point condensation takes place and water is precipitated. Almost all the water and all particles get condensed and collected in the water traps provided at appropriate points. The cooled compressed air is then filtered to remove the suspended solid particles and most of the oil mist.

The pressure dew point that can be achieved with the refrigerated air dryer is about 2 degree centigrade, as I have told you in the previous slide. If one m cube of fully saturated compressed air is cooled to just above the freezing point, approximately 75% of the vapor will be condensed out. If this compressed air were warmed back to 20 degree centigrade it would be dried to nearly 25% of RH.

Finally, the clean and dry air goes out of the refrigerator dryer through the heat exchanger. As long as the temperature of the compressed air remains above the 2 degree centigrade no further condensation takes place. The dew point of 2 degree centigrade is sufficient enough for smooth operation of most of the industrial and process applications. The main advantages of this process are low initial and operational cost along with it is not damaged by oil vapor.

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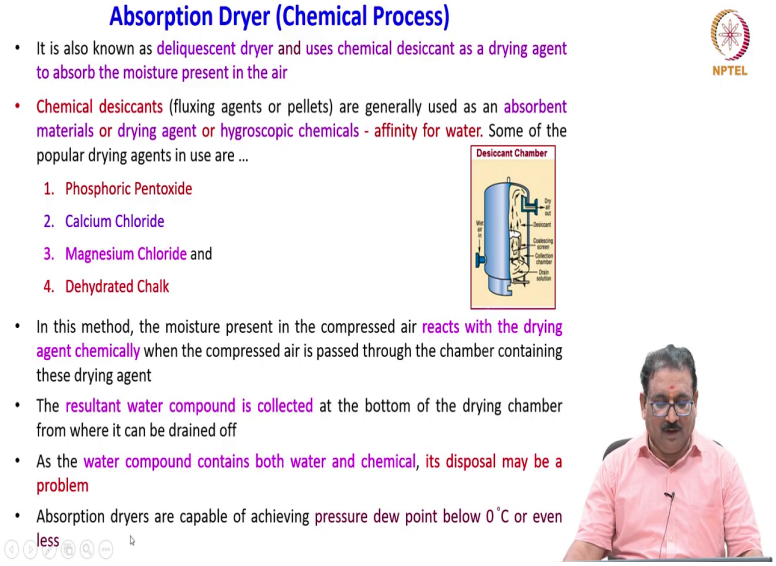

Next we will move on to the absorption dryer, which works on the chemical process. It is also known as deliquescent dryer and it uses a chemical desiccant as a drying agent to absorb the moisture present in the air. Chemical desiccants also known as a fluxing agents they are in the form of pellets are generally used as a absorbent materials or a drying agents or hygroscopic chemicals affinity for water.

Some of the popular drying agents in use are phosphoric pentoxide, calcium chloride, magnesium chloride and dehydrated chalk. In this method the moisture present in the compressed air reacts with the drying agent chemically, when the compressed air passed through the chamber containing these drying agents. You will see here one the chamber filled with the chemical desiccants.

Inlet is there and outlet is there. I will show you in the next slide also how the air is removed from the moist air. The resultant water compound is collected at the bottom of the drying chamber from here it can be drained off. As the water compound contains both water and chemical its disposal may be a problem, meaning it is not environmentally friendly.

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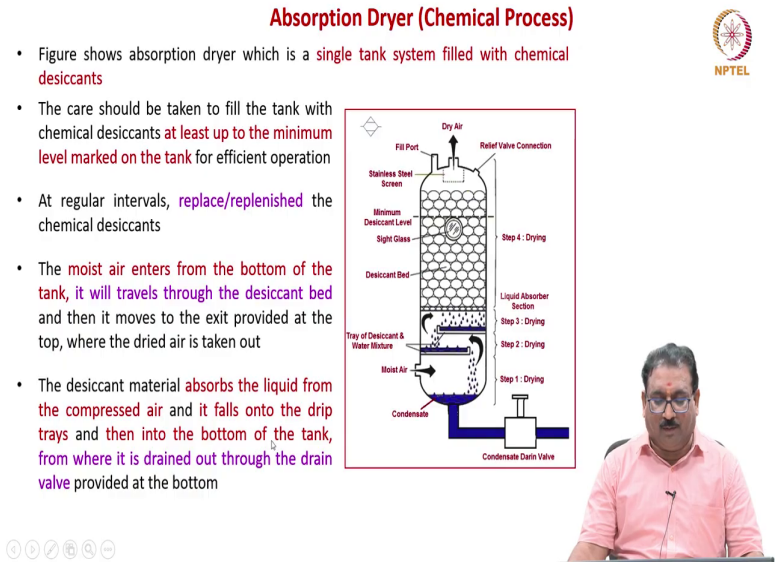

Absorption dryers are capable of achieving the pressure dew point below 0 degree centigrade or even less. Figure shows the absorption dryer which is a single tank system filled with chemical desiccants, you will see here. This is a, single tank system filled with the desiccant bed. It consists of the inlet where the moist air will enters and it pass through the here, here, here and then to the desiccant bed.

Then it will move up during the movement of the air from here to here, here to here, you know Step 1, Step 2, Step 3 and Step 4 drying takes place. Here it is a liquid absorber section here. Whatever the water and oil collected here it will drops in the tray of desiccant and water mixture and it is collected at the bottom, which is known as condensate it is taken out through the condensate drain valve.

Now, we will see here friends very important things are there here. You will see here, the in this process you have to maintain the desiccant level to the minimum level here it is marked. More is ok, if it is minimum you have to maintain the desiccant level here. This, you can view through the sight glass here and filling up this desiccant materials is through the fill port.

These are as we are seen in the ISO symbols this is for the air dryers. Let us we will see this, the care should be taken to fill the tank with a chemical desiccant at least up to the minimum level marked on the tank for efficient operation. At regular intervals, replace or replenished the chemical desiccants.

The moist air enters from the bottom of the tank, it will travels through the desiccant bed and then it moves to the exit provided at the top, where the dried air is taken out. The desiccant material absorbs the liquid from the compressed air and it falls on to the drip trays and then into the bottom of the tank. From where it is drained out through the drain valve provided at the bottom.

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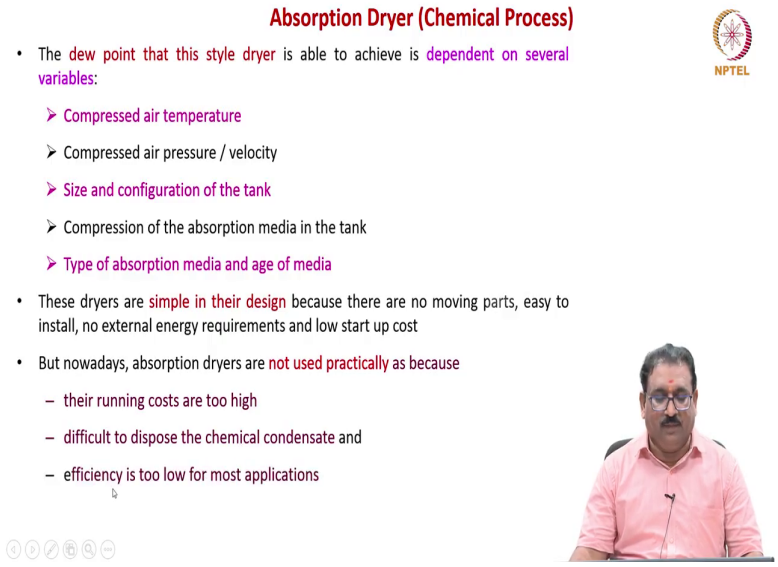

The dew point that this type of dryers able to achieve is dependent on the several parameters; compressed air temperature, compressed air pressure or velocity, size and configuration of the tank, compression of the absorption media in the tank, type of absorption media and age of media.

These dryers are simple in their design because there are no moving parts, easy to install no external energy requirements and low start up cost. But nowadays, absorption dryers are not used practically as because their running costs are too high. Difficult to dispose the chemical condensate and efficiency is too low for most of the applications.

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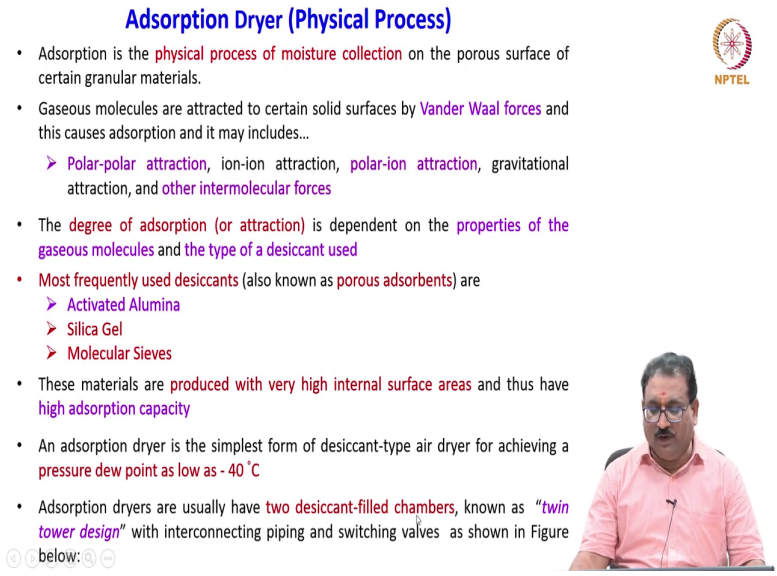

Now, we will see the adsorption dryer in which water removal through the physical process, what is this physical process we will see now. Adsorption is the physical process of moisture collection, on the porous surface of the certain granular materials.

Gaseous molecules are attracted to certain solid surfaces by Vander Waal forces and this causes adsorption and it may include; polar-polar attraction, ion-ion attraction, polar-ion attraction, gravitational attraction and other intermolecular forces.

The degree of adsorption is dependent on the principles of gaseous molecules and the type of desiccant used. Most frequently used desiccants they are also known as porous adsorbents or activated alumina, silica gel, molecular sieves. These materials are produced with a very high internal surface areas and thus have high adsorption capacity.

An adsorption dryer is the simplest form of desiccant type air dryer for achieving the pressure dew point to as low as minus 40 degree centigrade. Adsorption dryers are usually have two desiccant filled chambers known as a twin tower design with interconnecting pipes and switching valves, as shown in the figure below.

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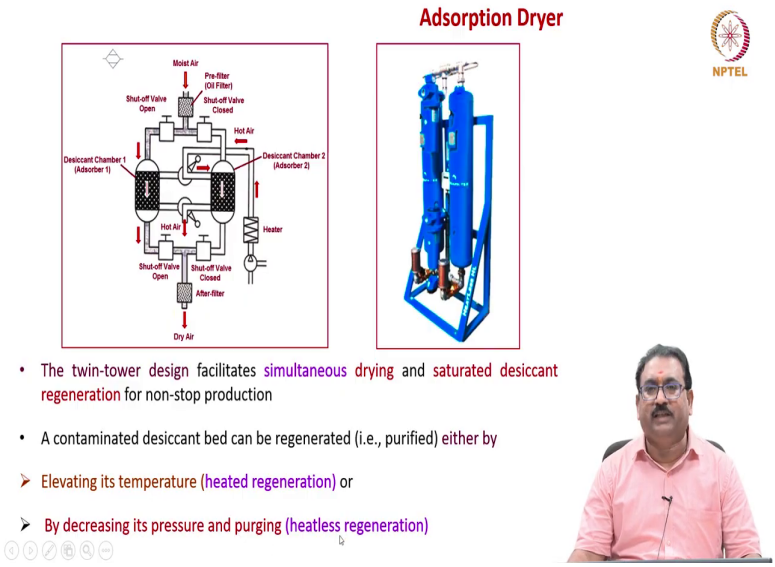

This we will see friends here; this is the adsorption dryer, this is commercially available unit. It consists of the two desiccant chamber, Chamber 1 and Chamber 2. And as usual it has a inlet moisture air enters here through the pre filter to remove the oil as well as small quantity of water. Then you will see here friends, Shut-off Valve 1 and Shut-off Valve 2 is there.

If this is open, the moisture air will enters through this desiccant chamber, which is an active to remove the air from the compressed air. And other tower is there know, this is used for regeneration. One tower is active other tower is a regeneration. Let us we will see how it is?

Then you will see as usual there are the, various filters are there to remove the moisture contents.

Let us we will see now, the twin tower design facilitates simultaneous drying and saturated desiccant regeneration for non-stop production always either this or this is used for air drying, the other is used for regenerations. A contaminated desiccant bed can be regenerated either by elevating its temperature, that is a heated generation regeneration its called. Or by decreasing its pressure and purging, it is known as heatless regenerations.

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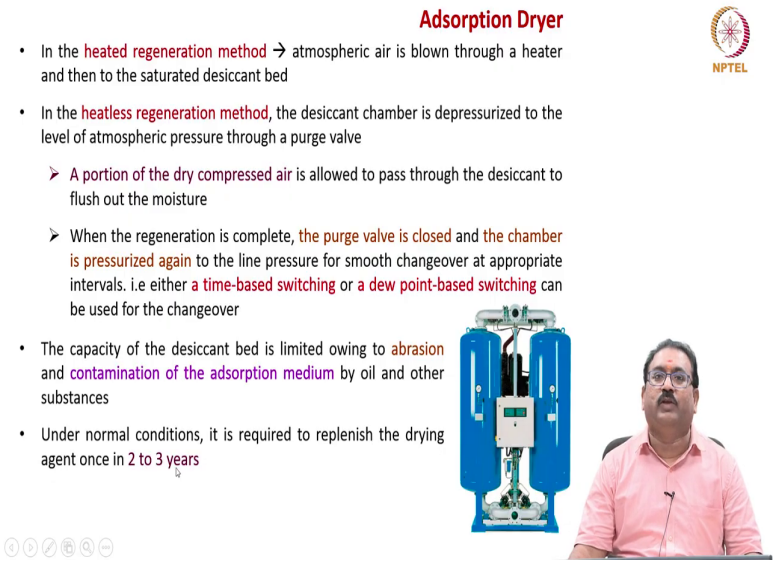

In the heated regeneration method, atmospheric air is blown through the heater and then to the saturated desiccant bed. In the heatless regeneration method, the desiccant chamber is depressurized to the level of atmospheric pressure through a purge valve. A portion of the dry compressed air is allowed to pass through the desiccant to flush out the moisture.

When the regeneration is complete the purge valve is closed and the chamber is pressurized again to the line pressure for smooth changeover at appropriate intervals. That is either a time based switching or a dew point based switching can be used for change over. The capacity of the desiccant bed is limited by owing to the abrasion and contamination of the adsorption media by oil and other substances. Under normal drying conditions, what you will do it is required to replenish the drying agent once in 2 to 3 years.

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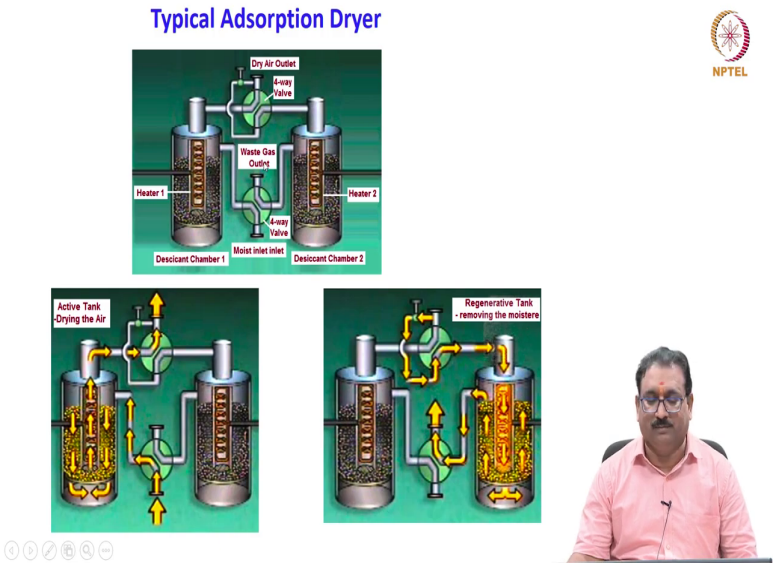

You will see here, this is schematically shown how the typical adsorption dryer works. As I have told you here this is a slightly different design it is, what I have shown here the Desiccant Chamber it is 1, Desiccant Chamber 2.

Then it has a inlet, moisture inlet and here it is you will get the dry air out and these are the four way valves for switching over. What is the switching over? For every instant, either this

will acts as a air removing chamber and this is used to regeneration. This I have shown here, you will see here in the current conditions what is this friends here the active tank is this.

Drying of the air is taking place, as you will see the moist air enters here, it will go through this and it will pass through the chamber filled with desiccant and then the clean and dry air is taken out. But, what happens to the other? Some of the times what happened that 10 to 20 percent of the air out is taken it into the second regenerative tank, for removing the moisture present in the previously present here in the this tank.

How it is? You will see here friends again please note here, here the heaters are provided in the each desiccant beds. You will see heaters; these are the Heater 1 and Heater 2. This Heater 1 and Heater 2 are on only when regeneration is taking place. Now, we will see this is the active tank for drying the compressed air and this is used for regeneration.

What is the regeneration? Removing already contaminated bed then that is why here, you will see the middle one always the waste gas outlet hot air will out. Here, this is a moist inlet and dry air here middle one is there no it is used for the waste gas outlet.

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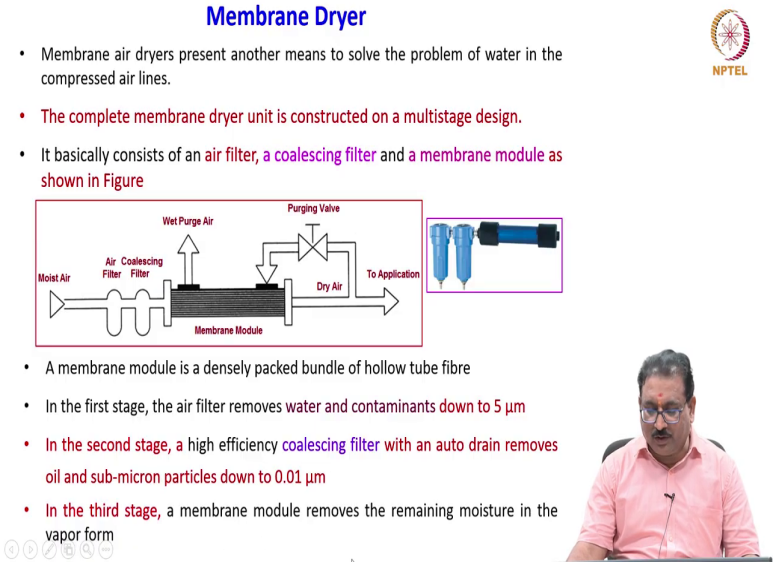

Let us we will move on to the last category membrane dryer. Membrane air dryers present another means to solve the problem of water in the compressed air lines. The complete membrane dryer unit is constructed on a multi stage design. It basically consists of an air filter, a coalescing filter and a membrane module, as shown in the figure. This is a simple schematic diagram of the membrane dryer, this is commercially available unit it is.

Here also you will see the main important things is air filter moist air will enter, here this is also air filter next one is a coalescing filter. Then it will goes to the, what is this membrane module then dry air will out. Some percentage of the dry air is taken to again to remove the water absorbed here through the purge valve. Here you will see wet purge valve air out. Let us we will see the operations, a membrane module is a densely packed bundle of hollow tube fibres.

The membrane module, it contains a densely packed bundle of hollow tubes fibre. In the first stage, the air filters removes water and contaminants down to 5 micrometer air filter. Then in the second stage, a high efficiency coalescing filter with an auto drain removes oil and sub-micron particles down to 0.01 micrometer. In the third stage, a membrane module removes the remaining moisture in the vapor form.

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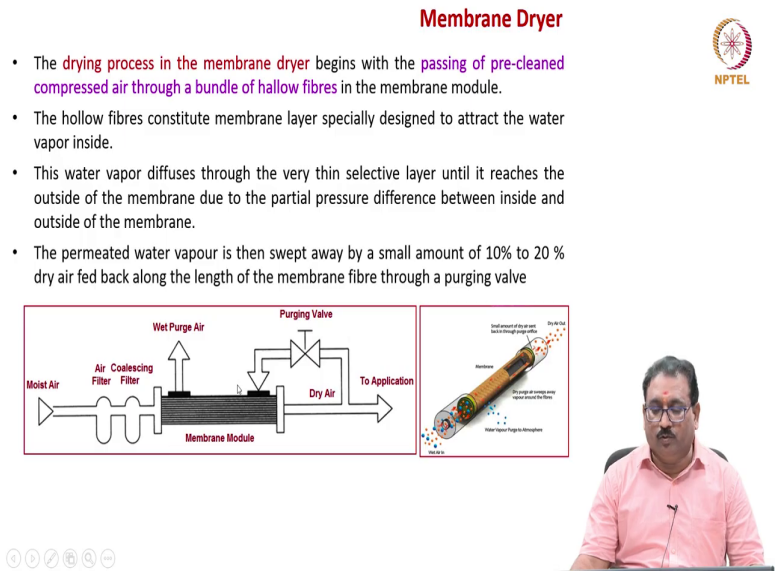

So, the drying process in the membrane dryer begins with passing of pre cleaned compressed air, through a bundle of hollow fibres in the membrane module. The hollow fibres constitute a membrane layer specially designed to attract the water vapor inside.

This water vapor diffuses through the very thin selectively layer, until it reaches the outside of the membrane due to the partial pressure difference between the inside and outside of the membrane. Permeated water vapor is then swept away by small amount, as I have told you 10

to 20 percent of dry air fed back along the length of the membrane fibre through the purging valve.

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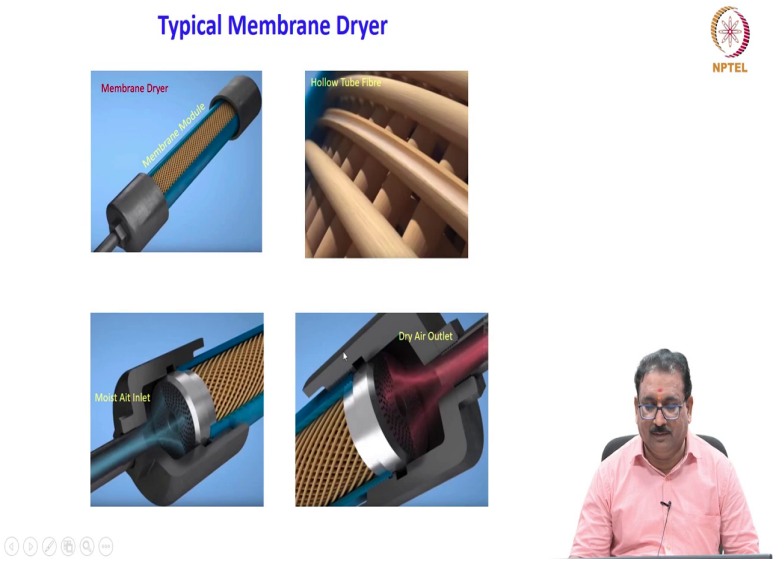

See here, I have shown the membrane dryer you will see this is a membrane module which consists of a the hollow tube pipe. You will see this how the hollow tube is there which are specially designed to attract the water molecules. As I have told you here you will see one side moisture air enters after passing through the filters. Then it will dry air will taken out from the other side.

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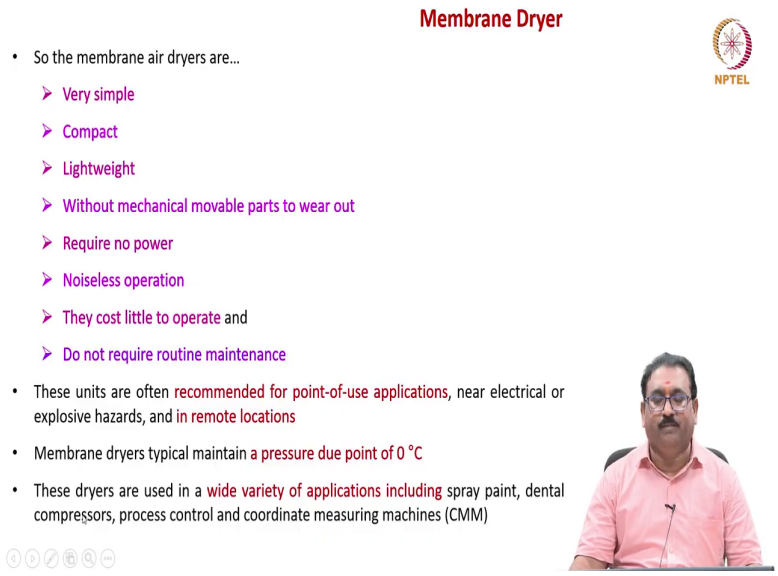

So, the membrane air dryers are; very simple, compact, lightweight, without mechanical movable parts to wear out, require no power, noiseless operation, they cost little to operate and do not require a routine maintenance. These units are often recommended for point of use applications near electrical or explosive hazards and in remote locations.

Membrane dryers typically maintain a pressure dew point of 0 degree centigrade. These dryers are used in a wide variety of applications including spray paint, dental compressors, process control and coordinate measuring machines.

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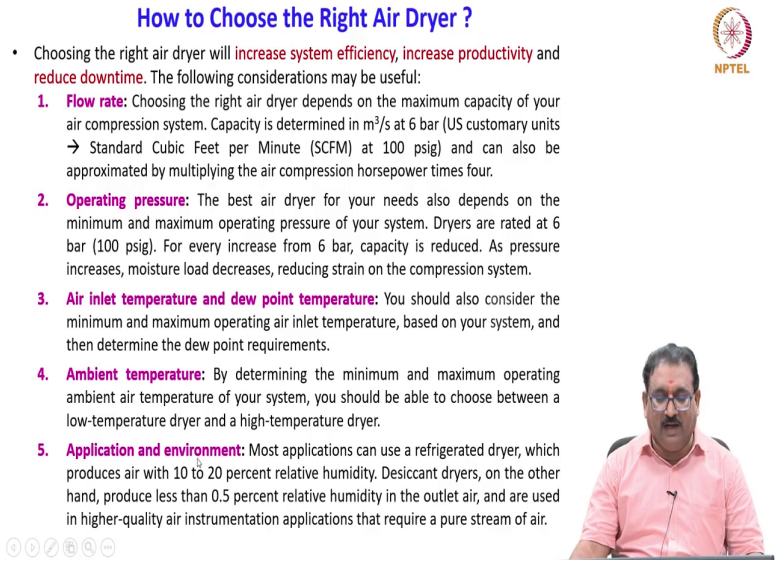

Quickly, I will tell you how to choose the right air dryer? Choosing the right air dryer will increase a system efficiency, increase productivity and reduce downtime. Already we have seen this, the following considerations may be useful while selecting the air dryer. Flow rate is one of the important parameters, choosing the right air dryer depends on the maximum capacity of your air compression system. Capacity is measured in m cube per second at 6 bar.

But in US customary units, Standard Cubic Feet per Minute briefly known as SCFM at 100 psig pounds per square inch gauge pressure and can also be approximated by multiplying the air compression horsepower times four.

Operating pressure; the best air dryer for your needs also depends on the minimum and maximum operating pressure of your system. Dryers are rated at 6 bar, for every increase from 6 bar, capacity is reduced. As pressure increases, moisture load decreases, reducing the

strain on the compression system. Third parameter is air inlet temperature and a dew point temperature. You should also consider the minimum and maximum operating air inlet temperature, based on your system and then determine the dew point requirements.

Ambient temperature next parameter, by determining the minimum and maximum operating ambient air temperature of your system, you should be able to choose between the low temperature dryer and a high temperature dryer. Then another important parameter is application where you are using these dryers and environment. Most application can use refrigerated dryer which produces air with 10 to 20 percent relative humidity.

Desiccant dryers on the other hand produces less than 0.5 percent relative humidity in the outlet air and are used in high quality air instrumentation applications, that requires a pure stream of air. These are the parameters you have to consider while selecting the right air dryer in your applications

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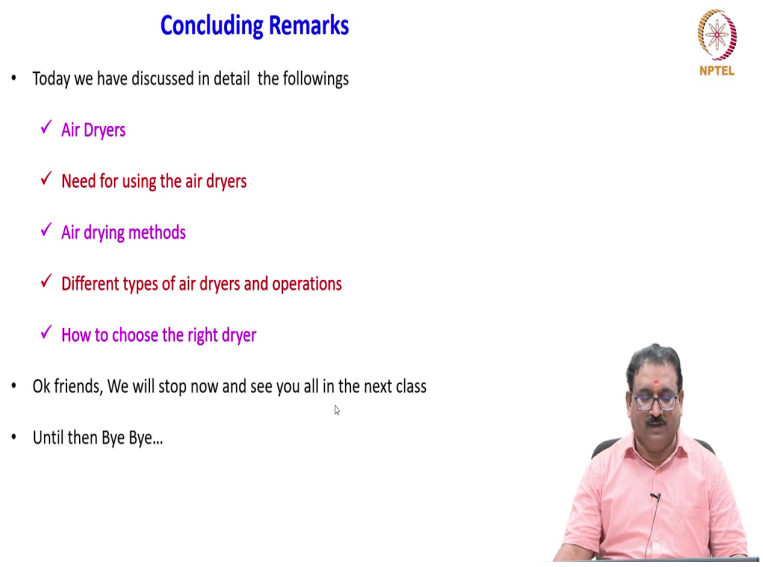

Let us we will conclude the today's lecture. Today we have discussed in detail the followings; air dryers, need for using the air dryers, air drying methods, different types of air dryers and operations, how to choose the right air dryer for your applications. Ok friends, we will stop now and see you all in the next class, until then bye bye.

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Thank you, one and all for your kind attention [FL].