Upstream LNG Technology
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Lecture - 60
Gas liquid separation in natural gas systems – II

Welcome, as we understood in our earlier lecture the importance of the Gas liquid separation in the natural gas treatment and we have looked into some of the ways to separate the gas and liquid. In this lecture, we shall be further carrying on some of the other methods of separating the gas and liquid in the natural gas systems. So, this particular lecture is on the separation of gas and liquid in natural gas systems part two.

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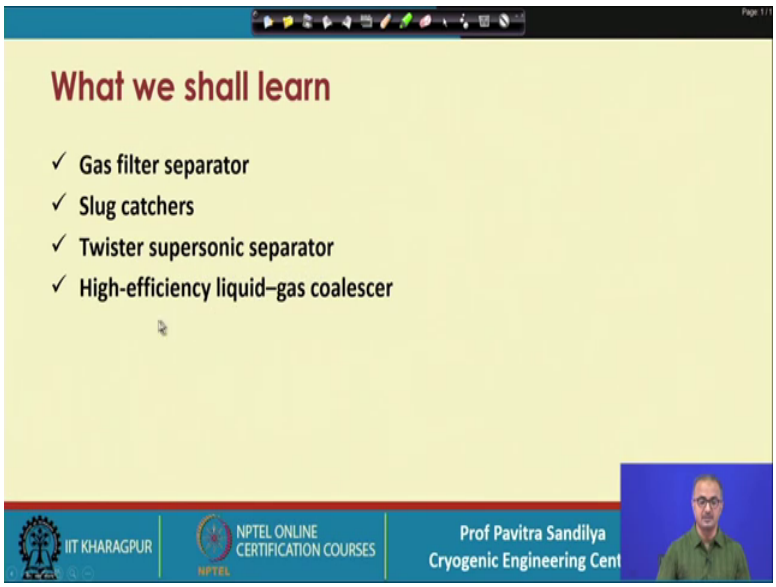

In this, what we shall be learning? We shall be learning about some other separators like gas filter, slug catchers, twister supersonic separator and high efficiency liquid gas coalesce.

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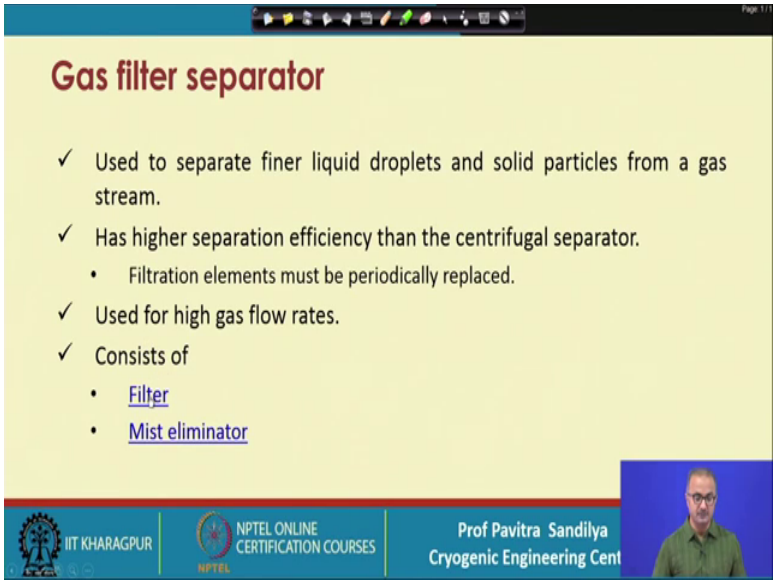

So, let us first come to the gas filter separator and it you kind this kind of separator is used to separate the finer liquid droplets and solid particles from the gas stream. And these have higher efficiency than the centrifugal separator, but only thing is this in this case we have a filter element this has to be replaced from time to time. Because the filter elements will collect all this liquid particles or the other dust particles and the pores will get clogged and once the pores get clogged no more fluid can pass through the filters so we have to replace it. So, this needs this kind of replacement and this can be used for high gas flow rates. Now, this has two parts one is filter and the mist eliminator.

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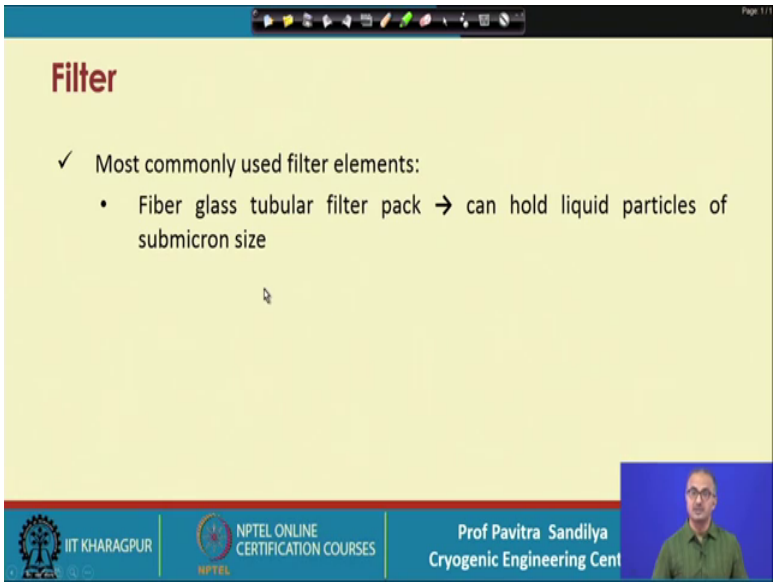

So, that is look into all of this one by one. So here we have the filters what are the filters they are some fiber glass tubular filter pack which can hold liquid particles of submicron size.

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So, very small liquid particles can be held by this filters and these are the some of the typical filters used in this for this purpose and here we can see that they have these things are even they have some kind of pores in them. And the gas can the liquid can pass through it and this will be this pores will be stopping the liquid particles or the submicron particles to pass through them, so they will not be going out into the gaseous stream.

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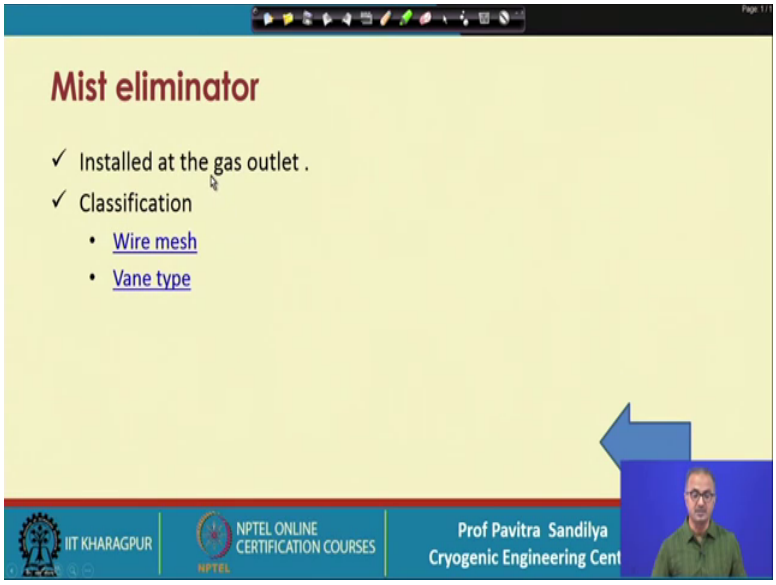

Next we have the mist eliminator and in the mist eliminator, it is generally used at the outlet of the gas, because whatever carryover of the liquid takes place inside the gas those liquids will be retained inside the separator. So, that is why we are using mist eliminator in this also we have two types.

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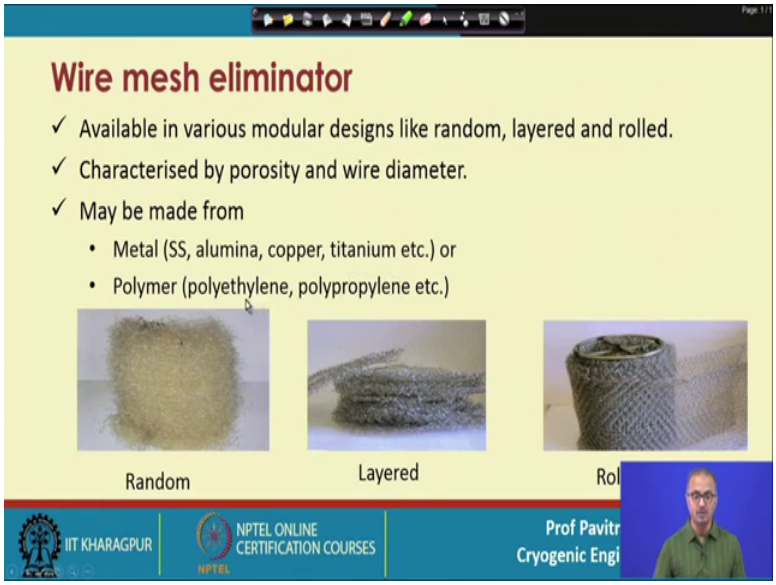

One is the wire mesh type and as the name suggests that we have different kind of wired meshes; this is random wire mesh, these are layered wire meshes like we can have some kind of plate kind of type of wire meshes and we put them layer by layer. So, we have layered wire meshes or we can have rolled thing that we make these pieces and we make a big sheet and roll it.

So, this is how we are making the rolled eliminator and these is eliminator mesh eliminator comes in modular designs like this and they are characterized by their porosity and the wire diameter. The smaller the particles to be retained we want them to be less and less porous and what is porosity is the volume of the void per unit volume of the particular system. So, as a pore as a porosity and these may be made from either poly metal or from polymer; so, some metallic things are like stainless steel, alumina, copper, titanium or like polyethylene, polypropylene etcetera.

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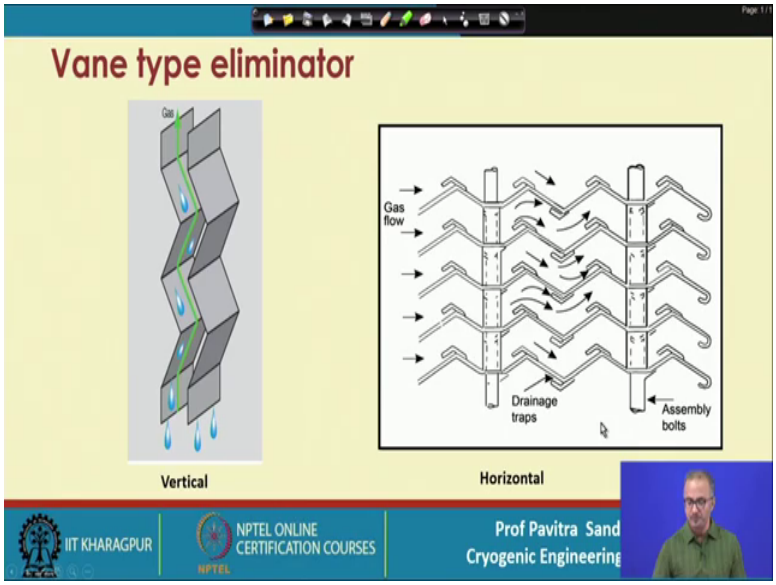

After learning about these we go to the another that type of mist eliminator. This is the vane type of mist eliminator and as you see this particular structure is a vane structure. And in this is a vertical vane and in this what we are finding that as this gas liquid mixtures flow up, because of this particular slanting of these vanes what will happens every time it tries move up it hits this particular surface and that hits it the liquid gets stuck here and comes down while the gas moves up.

So, depending on how much liquid we want to separate out we can have this length differently and also we can use mini vanes like this in parallel to take out the liquid. Or we may also have the horizontal vane in, which we find that again this structure is similar and we find that the as the gas liquid mixture flows this liquid is retained and the liquid collects here and this collects through this comes out through this drainage pipes. So, this drainage pipes are used in this we are not using drainage pipe, but here we using

drainage pipe, so in drainage pipe collects the liquid from this various vanes. So, this is how we are having the vane type eliminator.

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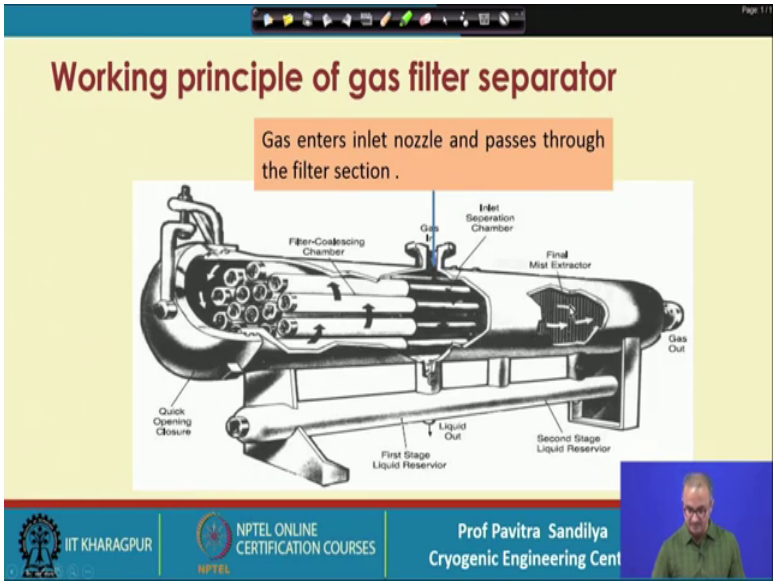

Then we go to the wire mesh eliminator, we saw this wire mesh eliminator. Then what we do that? We go to this gas filter separator here we have we can see that there is a big chamber and here is the gas inlet nozzle and it passes through the filter section. So, here we have the all the filter section here and here we have the a mist eliminator or extractor at the outlet.

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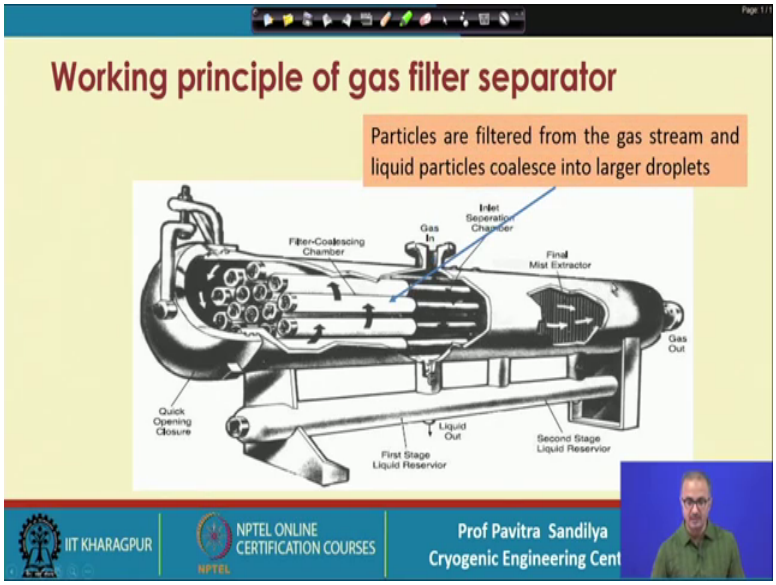

And what we find here that the particles are filtered from the gas stream when they are passing through these filters and liquid particles coalesce into larger droplets.

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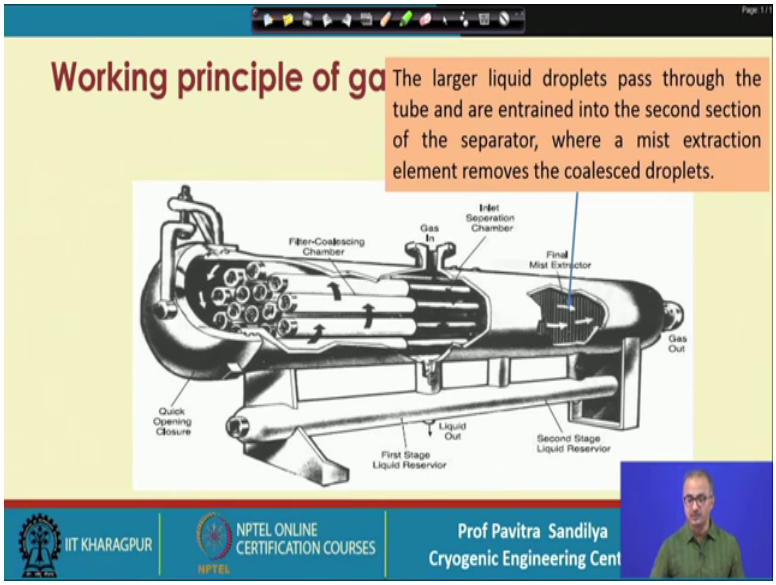

And once they coalesce into largest droplets, they can be easily drained out and whatever gas is passing through this particular outlet here we are putting the mist extractor. So, that any kind of residual liquid which is being carried over by the gas can be retained inside the separator and here we have the liquid outlet and here we have the gas outlet after liquid separation. So, this is the overall a working of the, this gas separator.

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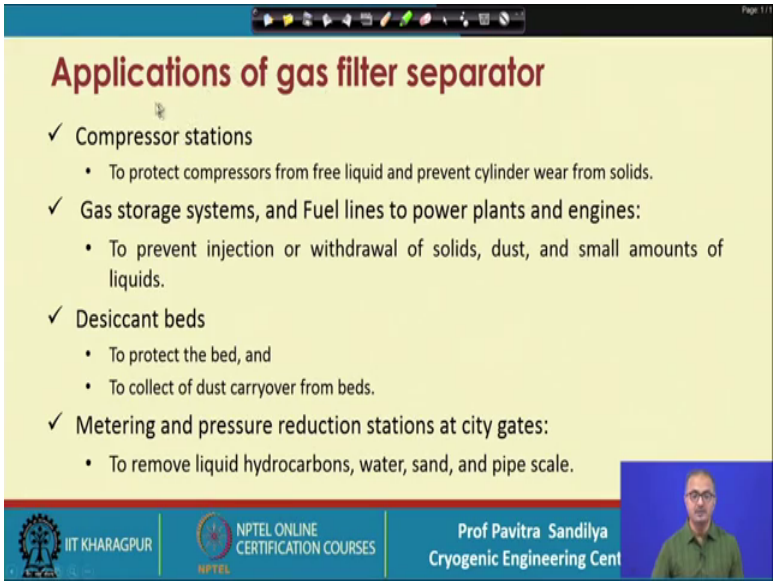

And now we find that here this applied for minions purposed like in compressor stations and why because we need to protect the compressors from free liquid and prevent cylinder wear from solids. So, we cannot allow any solids in the compressor otherwise they may corrode the, or erode the solid or the liquids are not generally allowed in the compressors.

Then we have gas storage system fuel lines to power plants and engines in this. Why we need this gas separator? Because to prevent the injection and withdrawal of solids dust and small amounts of liquids, then desiccant beds which are used desiccant means we are trying to remove the water. So, which are used for the dehydration purposes so in this to protect the bed and to collect the dust from carryover from the beds. And then we have the metering and pressure reduction stations at city gates to remove any kind of liquid hydrocarbons, water, sand particles and other kind of pipe scaling. If there is any scaling happening, then those scaled particles should not also go with the gas so we are using this kind of gas filters.

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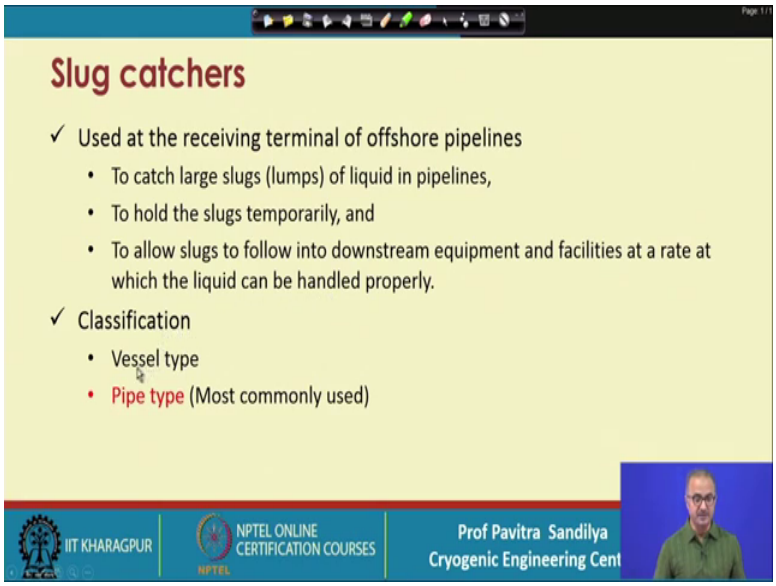

Next we come to slug catchers and these are generally used at the receiving terminal of the offshore pipeline. So, when from the sea if you are getting that gas at the offshore when that means, it (Refer Time: 08:10) among the land on the land we are using the slug catchers and what are slugs; slugs are nothing, but some big lumps of the liquid in the pipelines. So, we want to retain those catch those big lumps of liquid to hold the

slugs that means, the slug catchers; catchers will also hold after separation of the slugs. They will also hold the slugs temporary.

And then before it is drained out taken out and then to allow the slugs to follow in to downstream equipment and facilities at a rate at which the liquid can be handled properly. That means, we will keep the slug for some time and we will release it in a controlled manner because otherwise, it may so happen that in the downstream lines. If we allow all the slugs to pass through at one go, then the downstream may not be able to handle. So, that is why this kind of slug catchers are designed also to retain the slugs temporally for sometime. Again we have the classifications like vessel type and pipe type and the pipe type is the most commonly used slug catchers and here we have the diagram of slug catchers.

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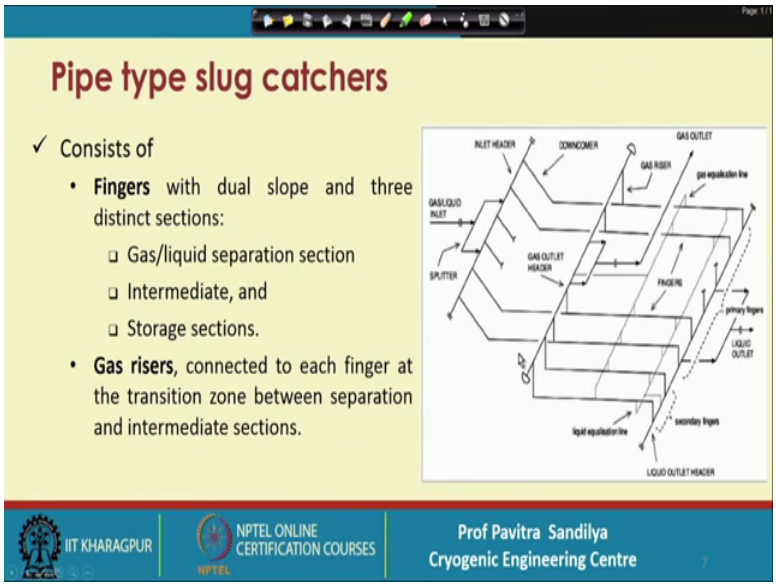

So, first we have some fingers. What are the fingers? These are the fingers we call them fingers. So, in this fingers are there and we can see that they have two slopes one is this and then there this particular slope and the gas is coming from here.

So, what happens that, these fingers have gas liquid separation section, then some intermediate section and some storage sections. And then we find that these are coming from here and then if these liquids are collected here whereas, the gas is coming up. So, liquid is going down whereas, the gas is coming up and this is going out from this

particular point. So, we have these gas risers which are connected to each finger at the transition zone between the separation and intermediate section.

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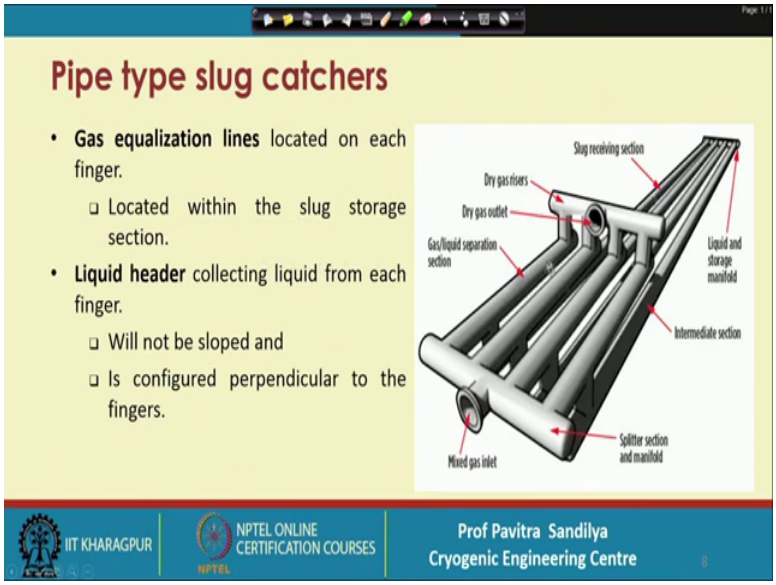

So, these are the gas risers which are there in this particular section and as I said these are the fingers. And then we have gas equalization lines which are located on each finger why because to located within the slug storage sections. So, we have the equalization line as we can see here, this equalization line they are keeping the pressures equal and then we have the liquid headers this liquid headers are collecting the liquid and from each finger and will not be sloped and is configured perpendicular to the fingers.

So, here we find the actual thing the gas mixture is coming here and this is a splitter and splitting the gas mixture into various fingers and we find the gas being lighter is coming out from the gas outlet. And these are the gas risers and we have this is a separating section and we find the liquid is coming down which cannot be seen from this figure, but on this back of this liquid is coming down and these are being collected in this header and from the header from the various header, they are going back going out of the system and gas is coming out from the system. So, this is how a typical pipe type slug catcher works.

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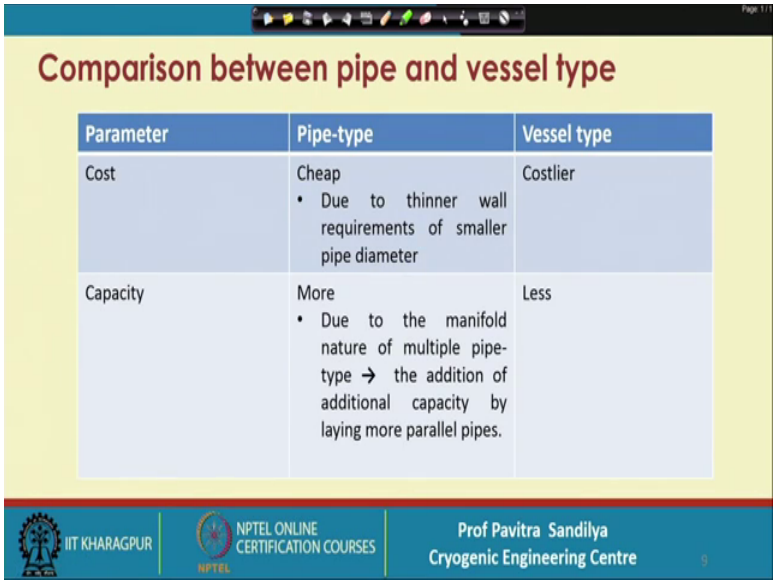

If you compare the pipe type with the vessel type, we find that these are cheaper than the vessel type and the, it can handle more gas than the vessel type that is why it is more common. And it is very easy to also enhance the capacity by adding more number of parallel pipelines that is or the finger assembling.

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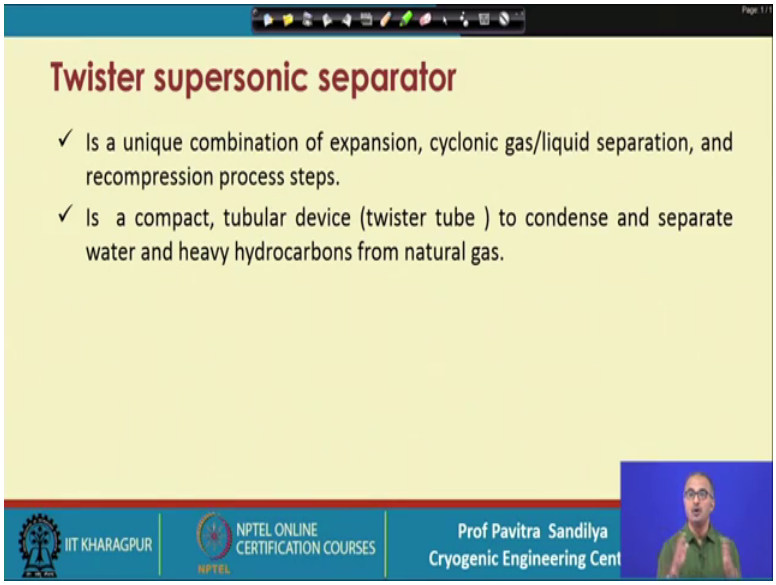

Next is twisted supersonic separator this is a latest invention and this is a very interesting thing that it is a unique combination of expansion then cyclonic gas liquid separation and recompression of a process steps. And we shall see that why we need expansion etcetera we shall see that and that is a very compact and tubular device this is that is why name the twisted tube and to condense and separate water and heavy hydrocarbons.

That means in this case what we are doing we are the originally we are getting the gas as the feed, but the gas will be containing some water vapour and some hydrocarbons and. So, we are doing in this particular thing we are not using a separate condenser to condense out the high boiling components, but only one particular this separator in which both the condensation as well as the separation are happening together. So, this is the advantage that we instead of having two separate sections we are having only one module to do both the condensation as well as the separation.

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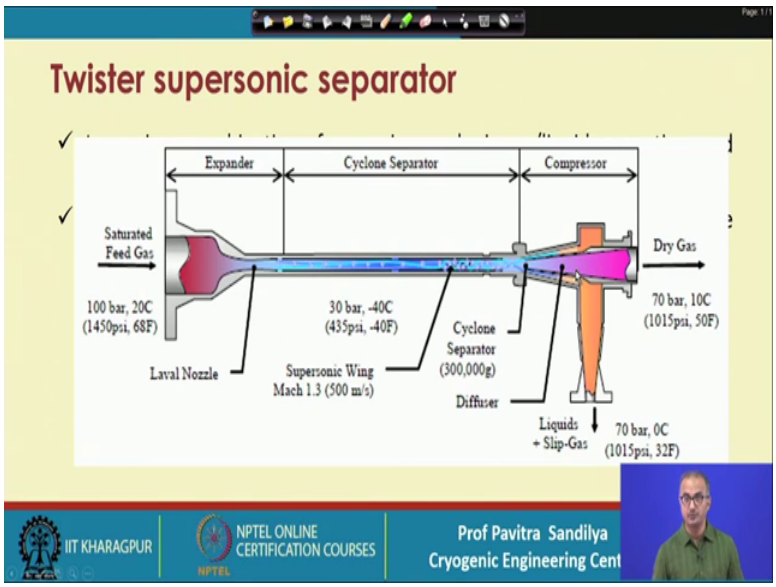

So, let us look into this thing the here we find this is a long section in which we have three sections one is expander, one is cyclone separator and another is a compressor. Now this is the feed gas coming from here it this is a typical value of the pressure and temperature here and what we find that as we have this kind of nozzle section it when it goes nozzle section it expands the nozzle section because of this expansion this kind of gas will gasses they will they cool down. And the cool down you can see that the cool down is happening to about minus 40 degree centigrade and about 30 bar. Now at this particular low temperature many of the higher boiling point hydrocarbons can get condensed and even water can get solidified that means, ice formation could be there.

And then what in this cyclone separator as we know cyclone separator means there is a big (Refer Time: 13:58) inside the inside there is a in the inside this section, because swidleing action we learnt a real that the higher density particles will be going towards

the this wall and the lower one will be staying near the axis. And when we find that again it is coming out from this section and in this again compressed and the so that we can again get back get back some of the lost pressure energy and we find that it is coming out from here. And we are regaining the pressure by this diverging section and this is a diffuser section and we are getting the pressure as about seventy bar and about the temperature rises to about ten degree centigrade and we are getting this thing.

And the liquid which is getting collected near the wall is coming out from this and it is collected from a separate port. So, in this we find that first we are cooling to separate out the hard boiling point components into solid or gases or then we are having the separation of these different density fluids and then we have the again the gas is coming out from the sections. All these things it combined in this twisted supersonic separator and supersonic because the gas reaches a high value of the it is goes to supersonic speed at this particular nozzle section. So, it is called supersonic separator.

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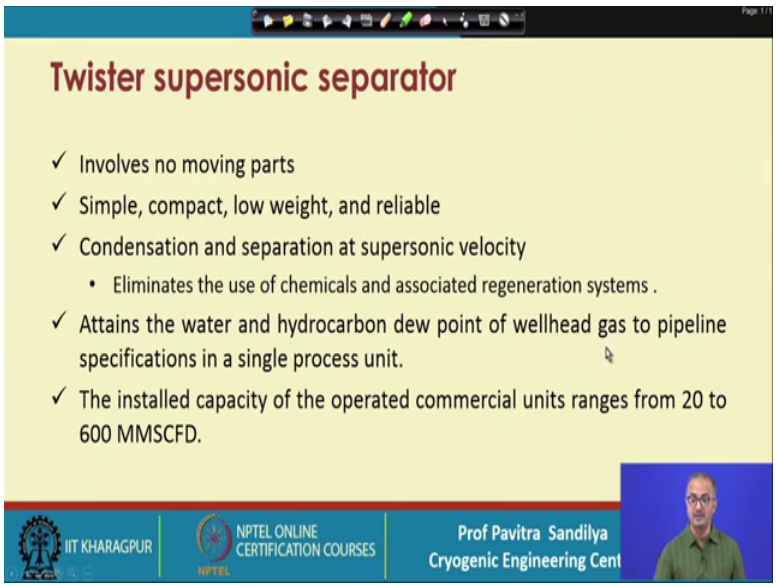

Now the advantages are that it does not involve any moving parts as we have, it is quite simple compact and low weight and quite reliable and we find that condensation separation are happening at the supersonic velocities, it eliminates the use of chemicals and associated regeneration systems. And the water and other hydrocarbons attain their dew point of the wellhead gas to pipeline specifications and the installed capacity is like this.

So, the kind the water and these things this is all that means, this can also be used to adjust the dew point of the particular gas. And because of the high pressure of the system the components do not tend to solidify they tend to stay only in the liquid phase because we know that with increase in the pressure the condensation temperature also increases. So, that is why we find that the components will stay at the most in the liquid phase and it can handle very high capacity of the gases.

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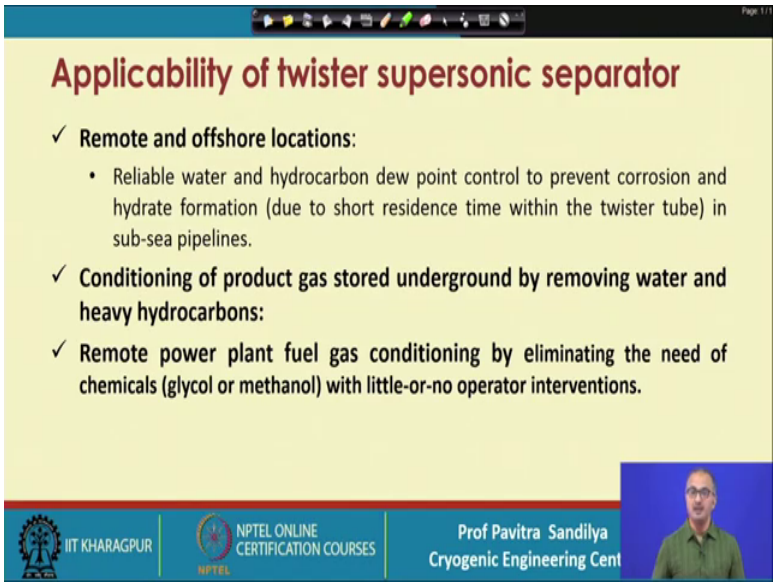

These a kind of separators are used for remote and offshore locations like reliable water, hydrocarbon dew point control to prevent corrosion and hydrate formation because there is very little time for the gas to pass through the separators. So, if there is not much of contact time between the hydrocarbons and the water then the possibility of the hydrate formation will also come down. So, that is why and that is how this kind of separator helps in prevention of the hydrate formation. And the wherever we need the conditioning of the product gas coming from by from the underground by removing the water and heavy hydrocarbons and remote power plant fuel gas conditioning by eliminating the need of the other chemicals with no or little or say operator inventions.

That means in a remote place what happens if we are using any kind of chemicals then we have to also see to it that whenever the chemical is getting exhausted we have to depress the chemicals so that may not be fusible all the times. So, if we can have some device which does not need any kind of external chemicals to remove the water. Then it

will then we would prefer to have those kind of devices and this supersonic separator is one of those devices which does not need any external agent for the separation. So, it is preferred for the remote relocated power plants.

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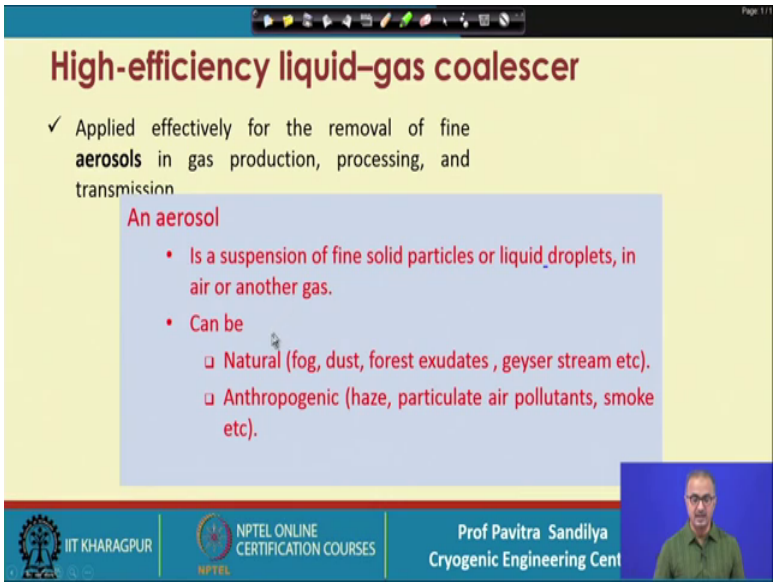

Next we come to this high efficiency liquid gas coalescer and these are effectively for removal of the aerosols in gas production processing and transmission. And what are aerosol? Aerosol is a suspension of fine solid particles or liquid particles in air or another gas and as we know that aerosols are commonly found in various in our day to day life also like in natural, natural we find this fog, dust, forests exudates, then geyser streams they are all examples of naturally occurring aerosols.

And we can also have anthropogenic that is manmade; manmade aerosol like haze then because of nowadays we are very much concerned about the air pollution. So, in that also we get this particulate particulates are getting suspended in the air ao that is also aerosol then we have the smokes they contain carbon suits so they are also examples of aerosol.

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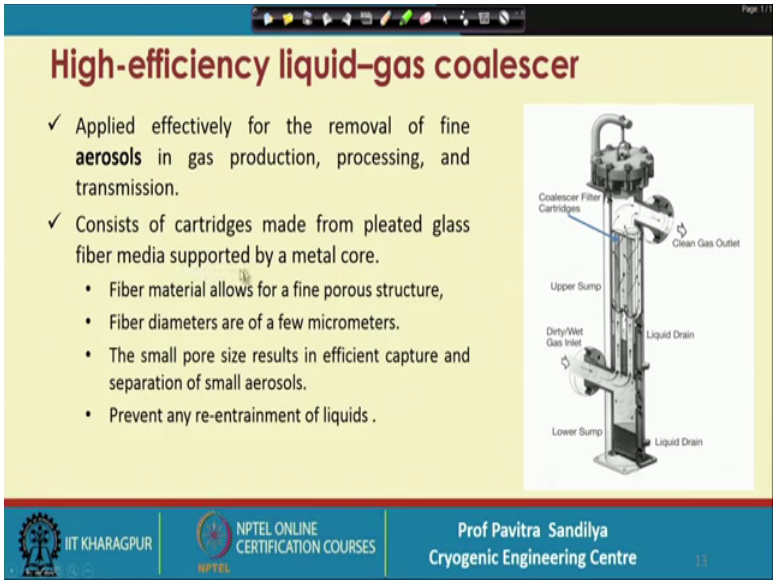

So, these kind of things can be effectively handled by this coalescers and coalesce means that agglomeration. So, what happens that these consist of cartridges made from pleated glass fiber media supported by a metal core, because this cartridges need this support metal supports because the glass fiber is very, very thin and they are not mechanically stable. So, to give the mechanical stability we use this metal cores and the fiber material allows for a fine porous structure. And the fiber diameter are of a few micrometers the small pore size results in efficient capture and separation of the small aerosol particles and prevent any kind of re entrainment of the liquids.

So, this is a typical figure of this coalescer that we find that dirty or wet gas is coming through this it is passing through this up go upward and here we have the cartridges and here we find we are getting the clean gas out. And whatever liquid is retained there they go back and through the sumps they come through and we find finally, we take out the liquid from the bottom of the coalescer. So, here also we find that we are as such not using any kind of moving components to separate out the liquid and the gas.

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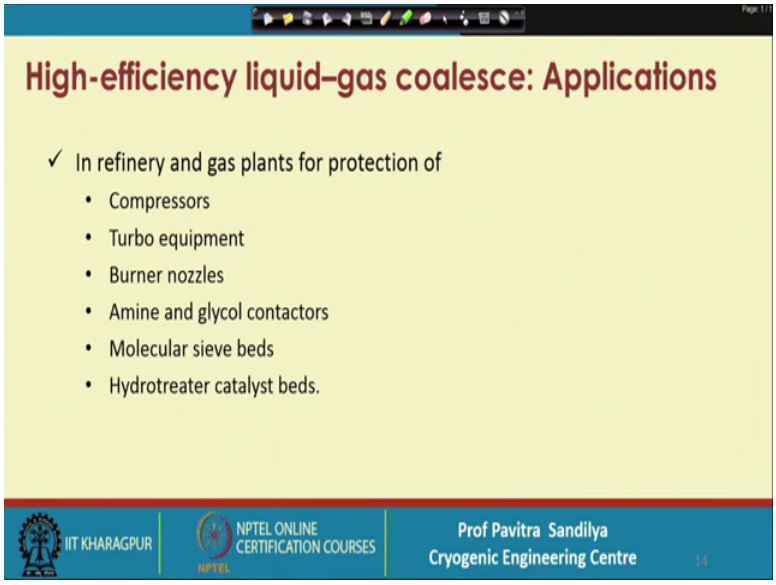

And these kinds of coalescers find use in this compressors, turbo equipment, burner nozzles, amine and glycol contactors, molecular sieve beds and hydrotreater catalyst beds. So, we are many a places we are finding that we are able to we are using this kind of separators in the natural gas processing and these are the some of the references which you can look into to have further details about this various types of gas liquid separators.

Thank you.