Upstream LNG Technology
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Lecture – 03
Sources and Process Overview of Natural Gas

Welcome back. Today after learning some basics about natural gas, we shall now see that what are the various type of sources and the distribution of natural gas the world over, at the what places, they are available. And then we shall see the overview of the processing of the natural gas; the details of which will be taken up in separate lectures later on.

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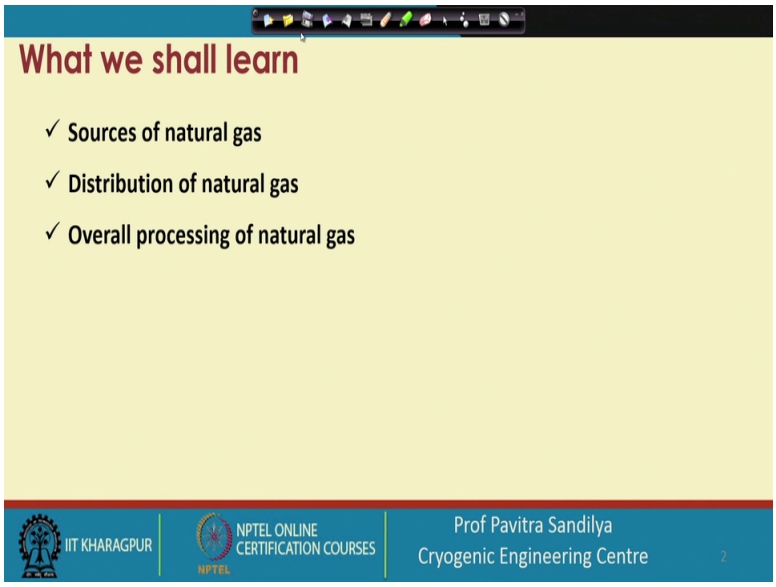

So, today what we shall learn are the various sources of natural gas, the distribution of natural gas, the overall processing of natural gas.

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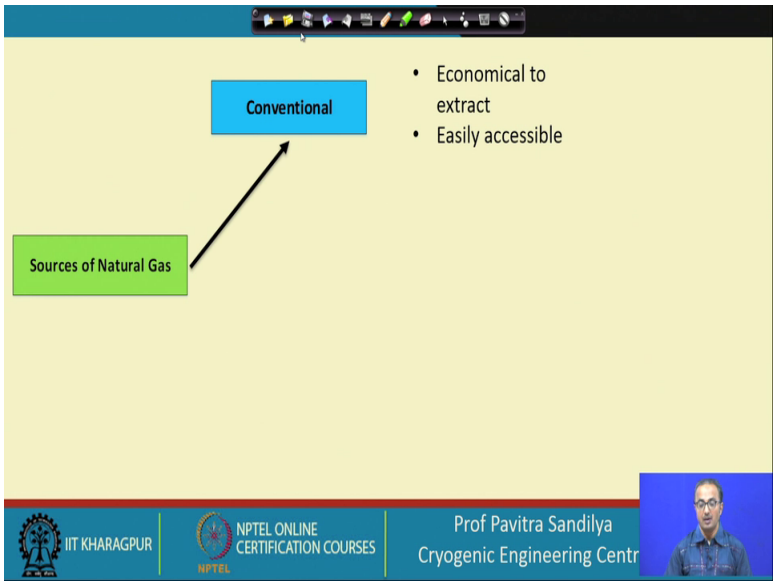

So, let us first see the various types of sources of natural gas. Now, here in this case, we have 2 types of sources. One is the conventional sources and what we mean by conventional we mean that from these sources the natural gas can be extracted economically and commercially and these sources are accessible to us easily comparatively easily.

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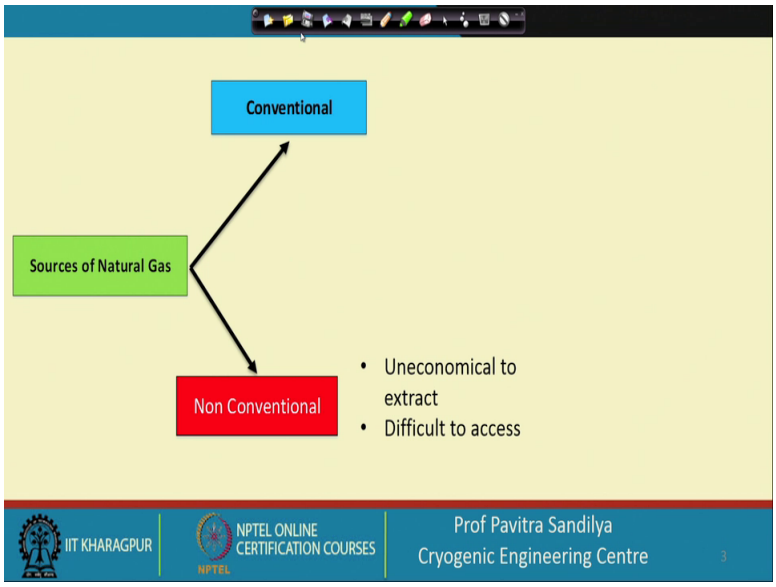

So, under these sources we have. So, if you and then we have non conventional sources by which we mean that these kind of sources are being developed because so far, the

production of natural gas through these sources is not yet commercial and these types of sources are very difficult to access.

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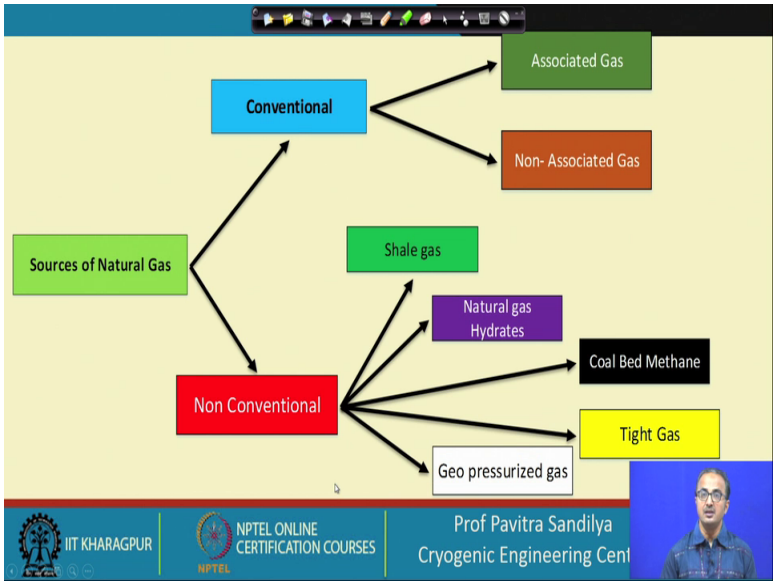

In the conventional sources, we have again two types. One is associated gas and another is the non associated gas.

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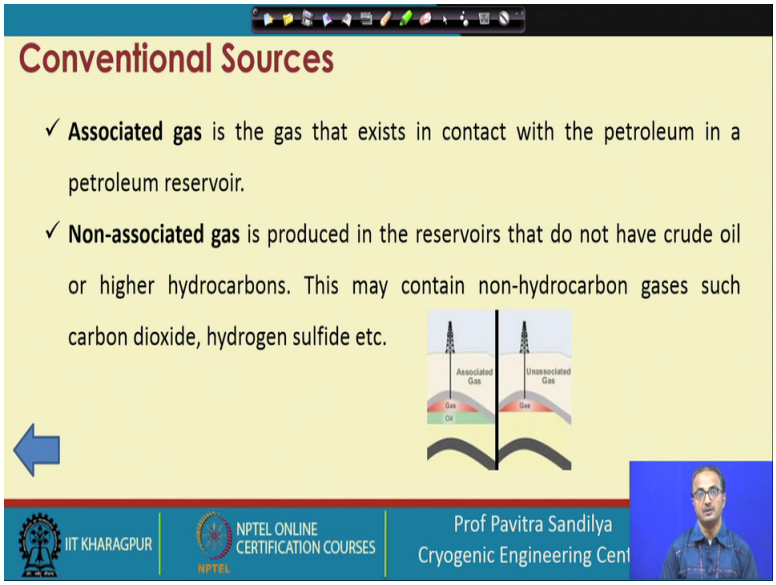

Now, let us see, what we mean by these when we talk of associated gas, we mean that those gases which are in contact with the petroleum in a petroleum reservoir and by non

associated gas we mean that the natural gas is staying alone without any associated petroleum.

Now, these non associated gas may contain some non hydrocarbon gases like carbon dioxide H 2 S, etcetera and in this particular figure, we have shown that how the associated and non associated gas existing in the associated gas, we find that the gas is lying on top of the oil, whereas, in the unassociated gas we have only the gas present. Then we come to the non conventional the sources of natural gas, here first we have the shale gas.

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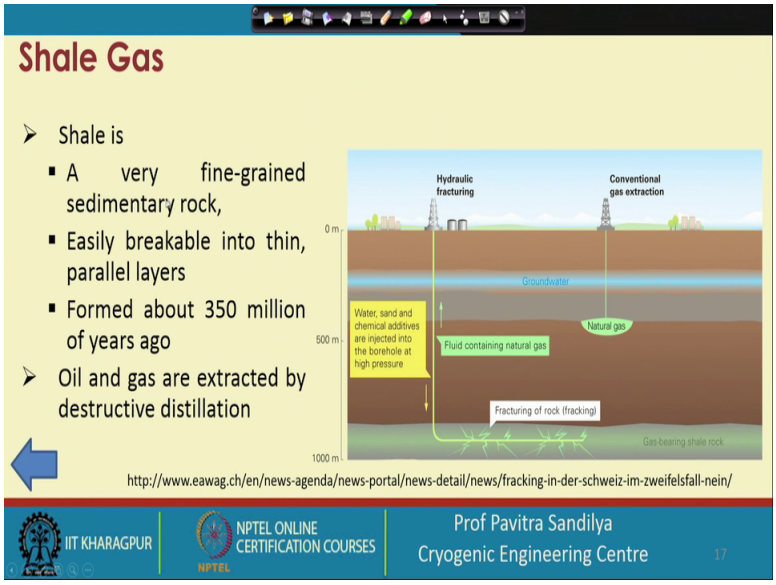

The shale gas is being developed by many companies; what we mean by shale is the shale is a fine grained sedimentary rock and as we see in this particular figure that these rocks are existing quite below the land. And this, then they are easily breakable; that means, their chi friable brittle and they can break into thin parallel layers and they have been formed over a very long time, a few million years, you have to taken place to get this shale gas formed shale is formed.

And here we see that the shale gas is under is taken for destructive distillation to get the oil and gas what we mean by distillation is that with destructive means that we are destroying the particular shale normal and this destruction is brought about by applying high pressure load high temperature and here, we find that we add some kind of water

sand and other additives are injected at high pressure into the bore holes to cause fracture or what we call the fracking of the shales.

And by distillation will mean that when various components are getting formed, these components have different sizes and accordingly, they have different boiling points and distillation separation means we separate all these components based on their boiling points. So, that is why it is called destructive distillation and we can see these shales are existing quite below the sea it is about 100 meter.

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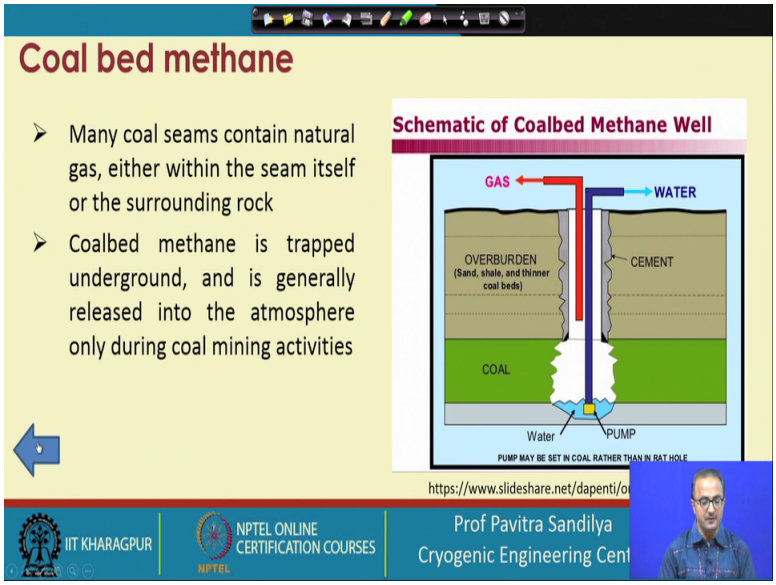

Next, we have the shale gas we have the natural gas hydrates and let us see; what are these sources?

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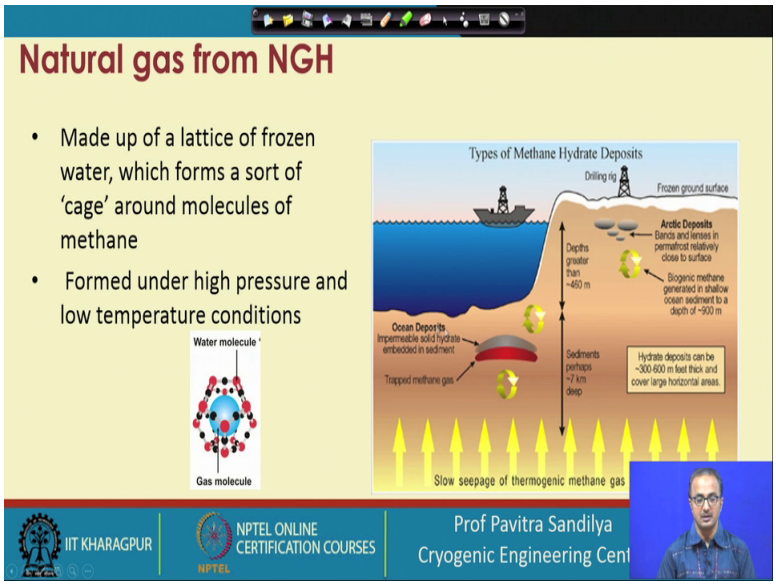

Now, natural gas; hydrate it, how? First let us understand; what are hydrates. Hydrates are some compounds which are formed as shown in this figure by a cage of water molecules which are formed due to hydrogen bonding between the motor molecules and in this cage, some gas molecule is trapped and the water molecules are called the host molecules while the trapped gas is called the guest molecule.

Now, these guest molecule is trapped within the cage by weak forces like Van der Waals forces and this gas hydrate can be formed by many gases like carbon dioxide, nitrogen, methane, ethan, etcetera and this is generally found when the gases are in contact with water and it is some kind like a face change of these mixture. So, this is simply a physical existence and the gas hydrates generally look like a water ice, you cannot differentiate between the hydrates and the ice and for the formation of these hydrates high pressure and low temperature are needed.

So, natural gas hydrate means that the hydrates formed by primarily methane in that we might be having some amount of ethane hydrate some amount of propane hydrate and because they need high pressure and low temperature such kind of conditions are available generally at 2 types of places in the world. First, in this case, we find that this at the permafrost region; permafrost means perma means earth and frost means ice. So, these kind of regions are found in the antarctic or arctic another region is in this, we showing that in this permafrost region, we get low temperature, but not very high

pressure on the other hand, beneath the sea, we find there also we might be finding the gas hydrates, but in this case, the driving force is high pressure and not so low temperature and these things are formed at about a kilometer or more under the sea.

Now, again we have to understand that these gases, these hydrates are formed within a fixed zone inside the subsea sediment because it is not that the whole sediment is full of hydrates because if we go deeper and deeper into the sediments, we are reaching towards the center of the earth where the temperature again starts increasing. So, there again the conditions will not be favorable for the formation of the hydrates. So, these hydrates are formed within some particular zone inside the subsea sediments.

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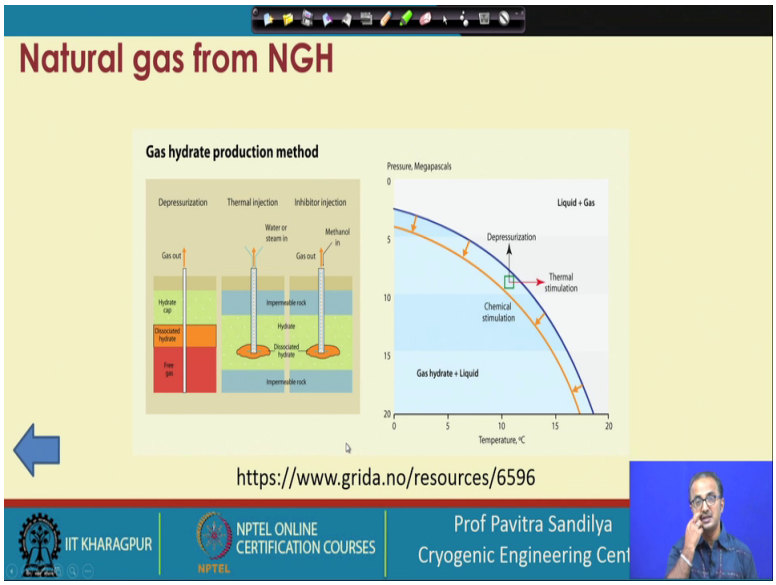

Next, we see that to get this natural gas, from the gas hydrates generally so far, there is no commercial technology, but many technologies are being developed and under these technologies, the there are broadly 3 categories. First is depressurization this means that we are reducing the pressure inside the sediment and we reduce the pressure this gas hydrates will dissociate into water and the gas and then the gas is taken out.

The second one is thermal injection or in this what happens, we somehow heat the gas hydrate sediments and by heating; that means, by increasing the temperature, we are again to again trying to dissociate the hydrates into the gas and water and thirdly, we have some inhibitor injection; what it means that we are using some type of chemicals which act in may act in 2 ways. One is that they may reduce the rate of formation of the

hydrate and second way is this; they will shift the thermodynamic equilibrium line so that the gas gasoline the gas can dissociate easily. This thing is shown in this particular figure, we find that there is a first, we see that this blue curve, we see this blue curve is determining the actual phase diagram; phase diagram, this is on the y axis we have the pressure and in on the x axis, we have the temperature.

So, in this phase diagram, this blue curve is showing that below this blue curve, we have the preserves of the gas hydrates, whereas, above the blue curve we do not have any gas hydrate. So, suppose we start with this particular point, here we have the gas hydrate when I say depressurization, I mean at a constant temperature almost constant temperature, I am going towards the pressure reduction please mind it that here the pressure is shown increasing from top to bottom unlike the way we the way we put the original at the bottom. So, as I go up the pressure is decreasing. So, by decreasing pressure, I can go into the gas and water region.

Similarly, from this point at a given pressure if I start heating it, again, I will get into gas and hydrate on the other hand when I am using some chemical inhibitor, what is happening this particular equilibrium line curve itself is shifted below the original one. Now, when this string shifted; that means, this inhibitor is playing it altering the equilibrium behavior of the hydrate. So, that this curve is shifted below and this region goes above this region this curve and then the hydrate starts dissociating. Now the practice is this that we may also combine these methods to get the natural gas and these various methods are still being research upon. Now, next in this line we have the coal bed methane.

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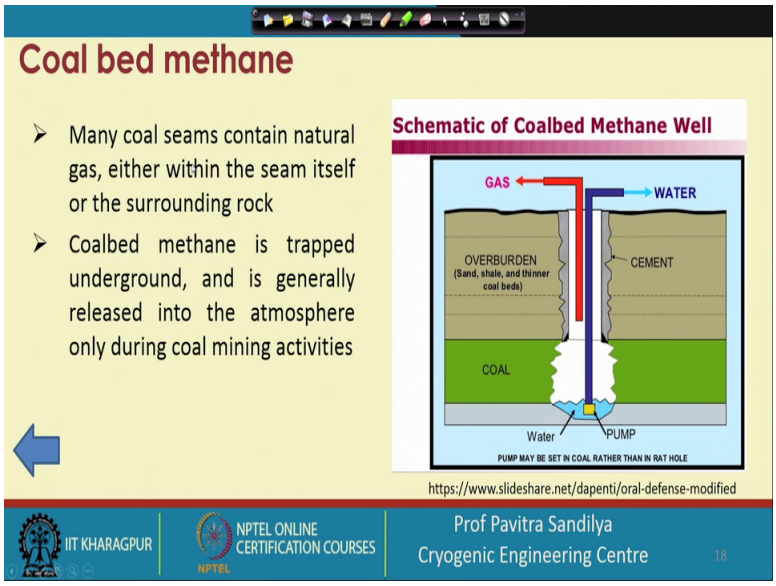

In the coal bed methane; what it means that we have some bed of coals in the mines and we know that over a period of time these coal seams may contain natural gas and these coal seams are hotter than what we do, then we get this in this particular figure, we see that we put the water and then by some reaction the coal which is basically carbon gets into a methane. So, and then the methane gas is taken out from the coal seam and the coal bed methane is trapped underground and is released during the coal mining activities

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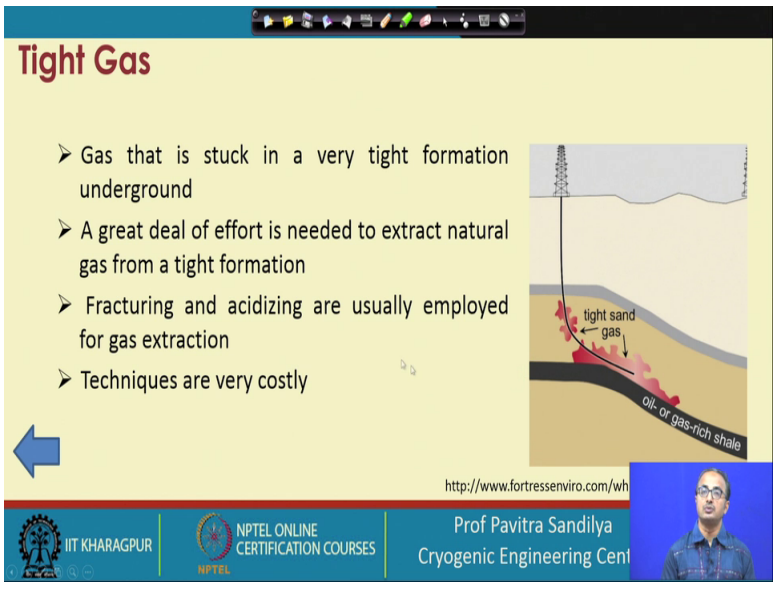

Thirdly next we have the tight gas, the word itself means the gases are held very very tightly under the sediment because they are held very tightly; so, it is difficult to extract these gases from the tight gas reserves. So, these reserves are generally put under some fracturing or we use some kind of chemicals like acids to get them gas hydrate, but the associated cost is quite high compared to the other unconventional sources.

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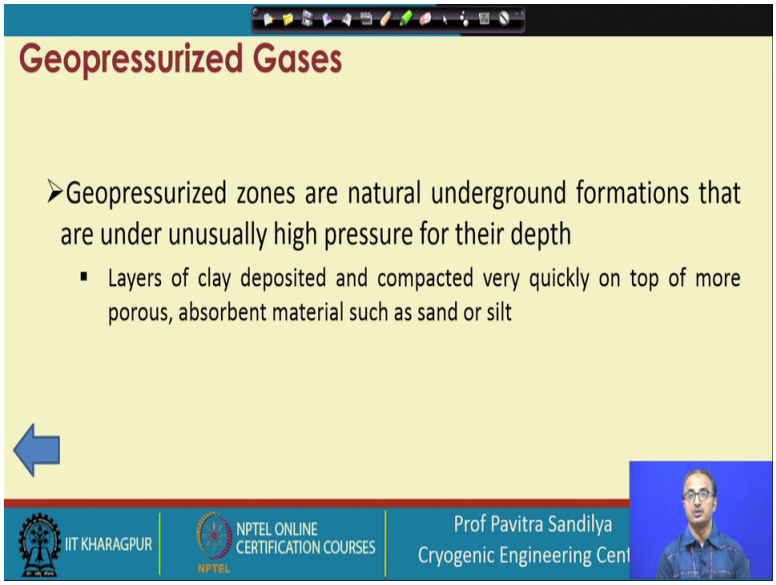

And lastly we have geo pressurized gas. This geo pressurized gas are supposed to have a substantial amount of natural gas geo pressurized gas and the natural gas hydrate both are estimated to have a very high quantity of natural gas. But still it is not possible for us to it has not been possible for us to get a commercial production of natural gas from sources and geo pressurized at the word means that under geological condition the gas is existing under pressure this high pressure and the high pressure is obtained at a deep level inside the earth.

So, in that high pressure, we find that layers of clay get deposited and they get compacted over a period of time and then the gas is trapped within the pores of these deposited clays.

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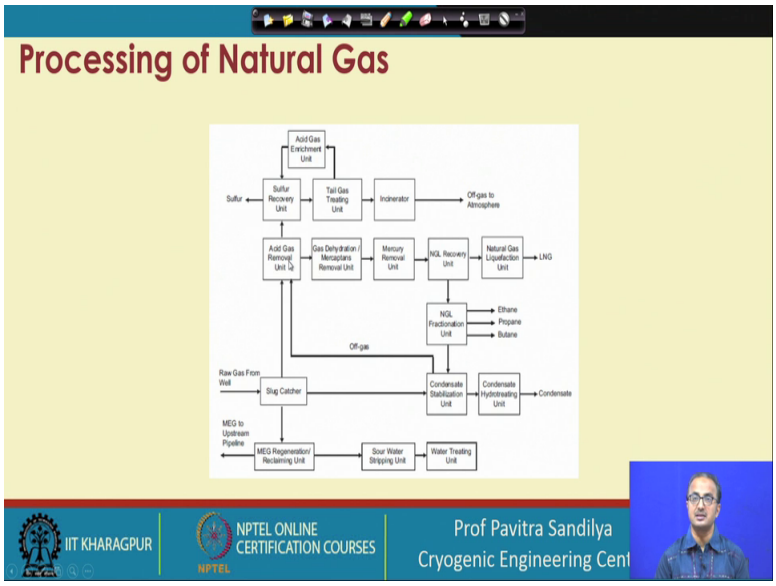

Now, with this; we see the various sources of natural gas, then we see the overall view of the processing of the natural gas because the raw gas which is coming to us that have to be processed to get rid of many impurities, before it can be consumed. So, in this particular figure we show the overview of the various types of processing first we see the raw natural gas is coming from here and then we are taking out various types of slurries and other slugs from this thing and there many things.

We do may carry out many processes like we stabilize the condensate we remove the acid gases like carbon dioxide, H 2 S, then we may remove sulfur depending on the amount of sulfur content of the natural gas, then there may be mercury in that; then there are other treatments are done to get rid of the various impurities and ultimately, we take it for the production of the LNG through liquefaction of the natural gas.

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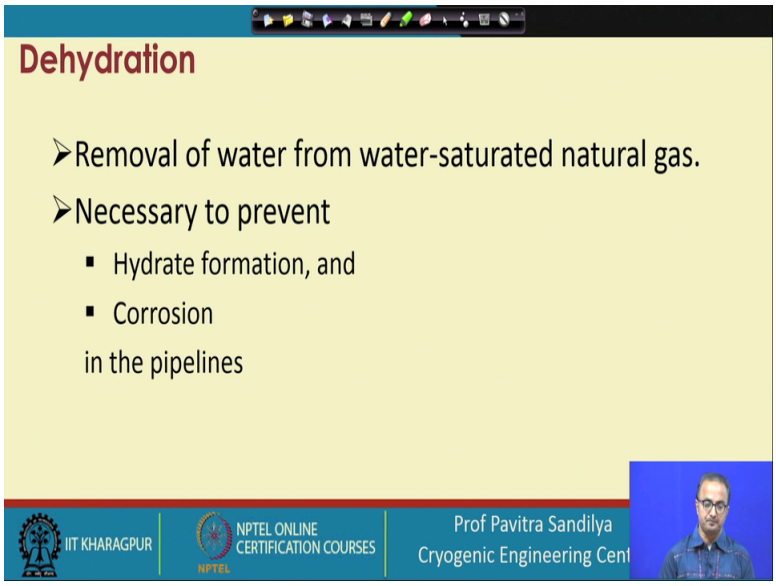

Now, we shall just quickly have a overview of the important processes in converting the raw natural gas into LNG. First, we come to dehydration means that removal of water and we know that the natural gas generally contains lots of water as it comes out from the sea and this water needs to be removed for that matter any impurities need to be removed so that we can get high calorific value of the natural gas.

And water has other concerns also because if there is a good amount of water it will so happen that it can form hydrates and these hydrates may clog the pipelines. So, we need to prevent the formation of the hydrate and also in presence of water the acid gases form some weak acids which will lead to the corrosion of the pipeline and other equipment. So, that is why it is important for us to remove water and bring it down to in to an acceptable level.

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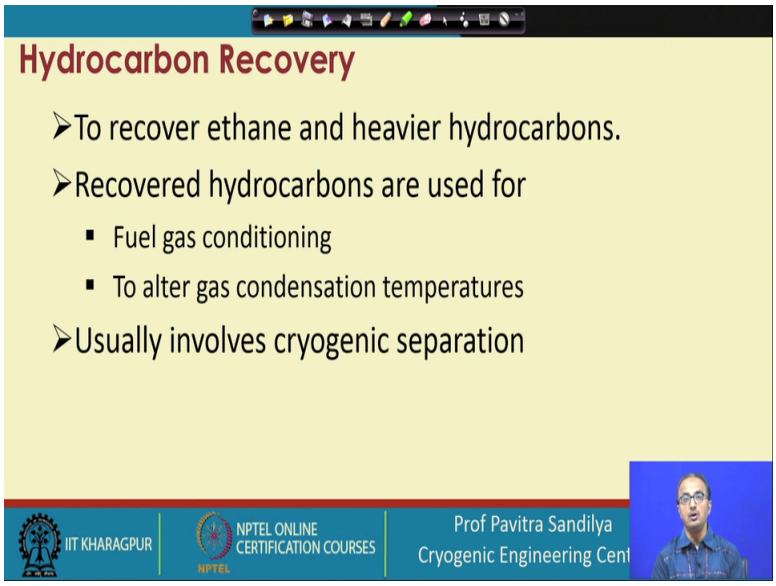

Next comes a hydrocarbon recovery in the hydrocarbon recovery our aim is to remove the higher hydrocarbons like ethane, propane, etcetera because they are also useful, they may not be having that much fuel value, but they are also useful for other purposes. So, we need to recover these hydrocarbons like ethane and heavier hydrocarbons and we do some kind of conditioning and by do and we also altered the condensation temperature, as we learned earlier that the composition of a gas determines the temperature at which it can condense at a given pressure.

So, this bubble point, dew point, etcetera are there which tell us that whether a gas will be condensing or not; so, this temperature also depends on the composition of the natural gas. So, we have to remove these hydrocarbons. So, that we can adjust the condensation temperature of the natural gas and generally this kind of recovery process involves the cryogenic separation.

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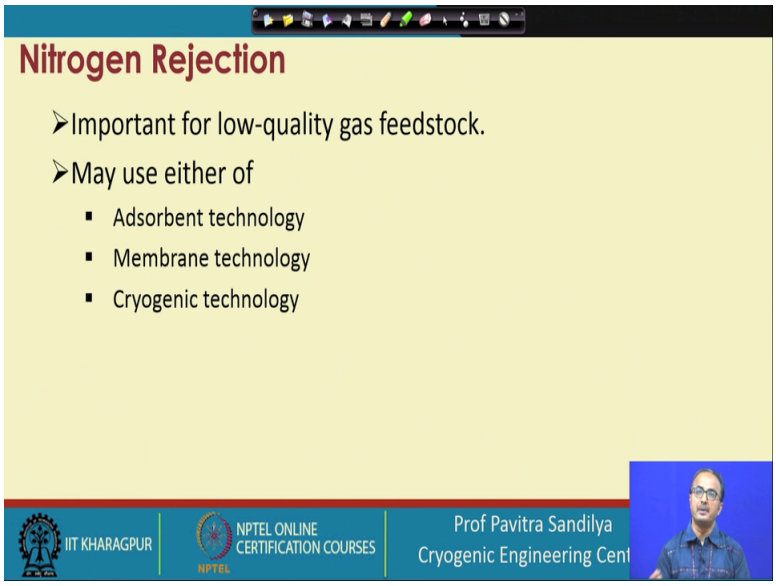

Next is nitrogen removal. Nitrogen is also very important and very significant amount of the natural gas is having nitrogen and so, nitrogen is an innovate gas as such as does not react with other components. But it reduces the calorific value and that is why it is important to remove the nitrogen and there are various technologies to remove the nitrogen. Some of them are like adsorption by which we mean that we use some kind of solids to remove the gas adsorption.

Then we have membrane these membranes are some semi permeable barrier which allow only some components to pass through them and some of them are retained over the membrane is you can say that membrane has something like the kind of sieves we use at our home to get tea or to separate out the coarser particles from the wheat flour. So, those that kind of thing, you can say membranes; they are semi permeable barriers and thirdly, we have cryogenic technology which apply very low temperature to remove the nitrogen and nitrogen is one of the cryogenic gases.

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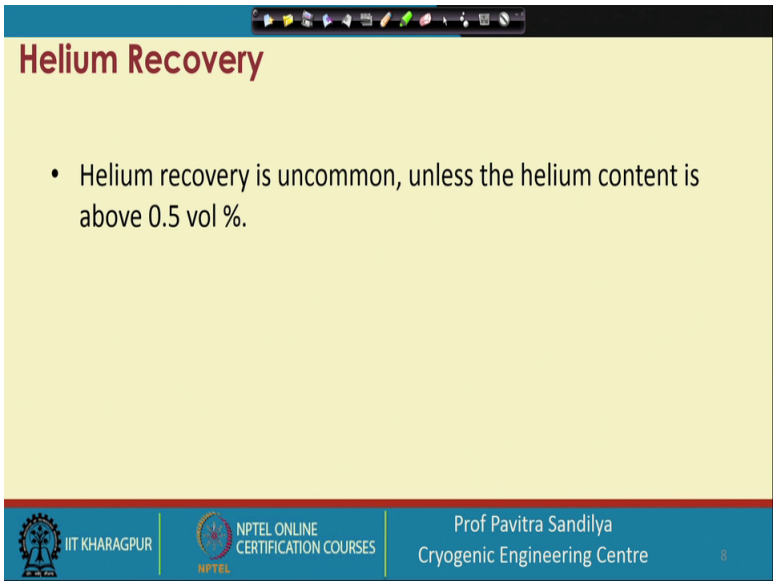

Then we have helium recovery helium if perhaps, you know is a very important gas and the whole super conductivity is dependent on helium and one of the very common applications of helium is MRI which is nowadays a very common way to analyze various types of medical problems. So, for this, we need helium and the helium is obtained from the natural gas.

So, this even though helium is presented at a very small amount, but natural gas is only source of helium. So, helium needs to be removed provided that it has some this much of volume percent; it is present in the very very low amount. So, we need to remove helium if the amount is good enough.

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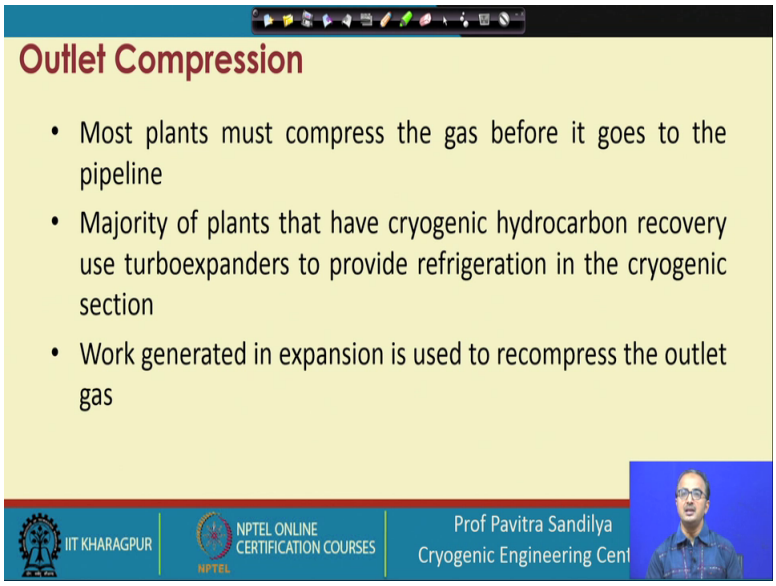

And then we need outlet compression this is that the gas which is produced need to be compressed when before it goes to the pipeline, to make it flow, generally, the natural gas which is obtained from the reservoir comes at a very high pressure. So, there we do not need to compress it much the natural pressure itself can make it drive make it flow through the pipelines, but on the outlet side after undergoing many processing the pressure comes down.

So, we need to again recompress the outlet gas to make it flow through the various pipelines and to as we know that the compression needs work and this work may be obtained from some other turbo expanders which are there inside the plant itself. So, that; that means, we are trying to recover the work produced by at some place by the turbo expanders in the plant and use it for the compression.

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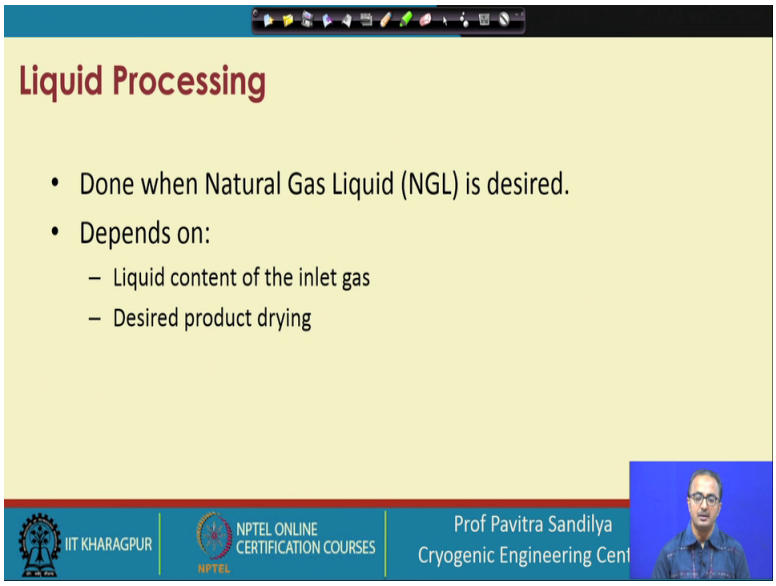

Next, we have liquid processing this liquid processing means that we are getting the natural gas liquid this is not LNG. LNG is basically the methane and methane and some other higher compounds, but NGL means some higher hydrocarbons other than methane they are also coming and there are also can be used at feedstocks for making other chemicals. So, they are also recovered as NGL and it depends on the liquid content of the inlet gas and the desired product drying.

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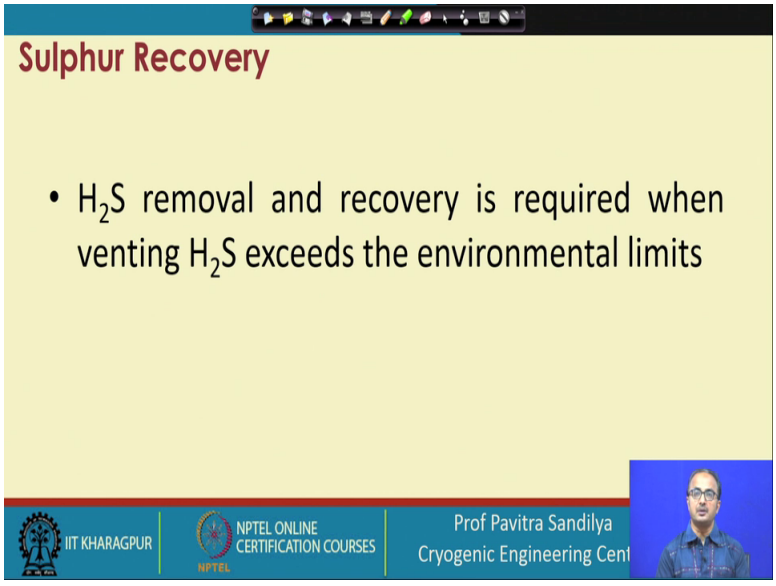

Next comes sulphur recovery as we know; sulphur is not very good for the environment because it can cause environmental pollution. So, generally what happens that depending on the sulphur content of the natural gas, we may or may not have a recovery system if the sulphur content is low then in that case we did not need to recover the sulphur. But in case, it goes above the stipulated limit, then we need to recover it and we recovered it in various ways that we shall learned in our subsequent lectures.

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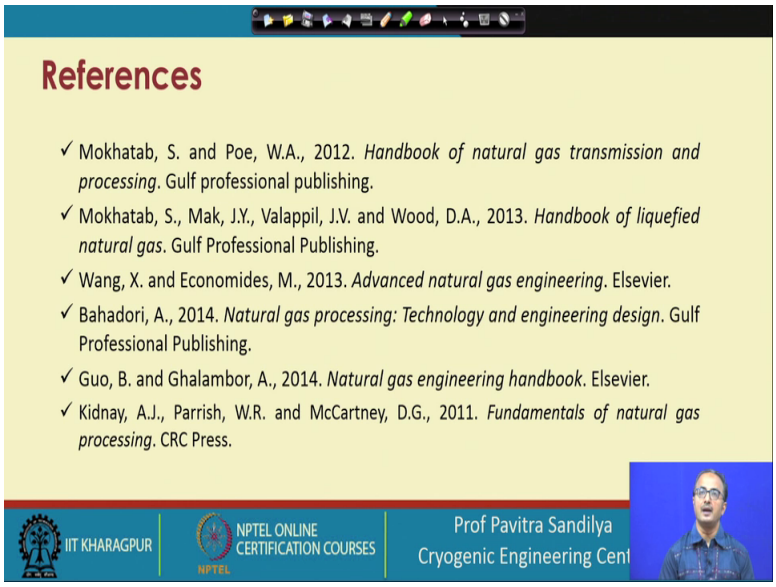

So, with this we come to the end of the overview of the various types of processing that are done to make the natural gas suitable for consumption and how here we have; I have state some of the very good references which you might refer to understand and learn more about all the topics covered in this lecture.

Thank you.