Upstream LNG Technology
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Lecture – 54
Sulfur recovery in natural gas systems- II

Welcome. Today we shall be learning some more processes which are used for the recovery of the sulfur. This is in continuation with the previous lecture on the sulfur recovery.

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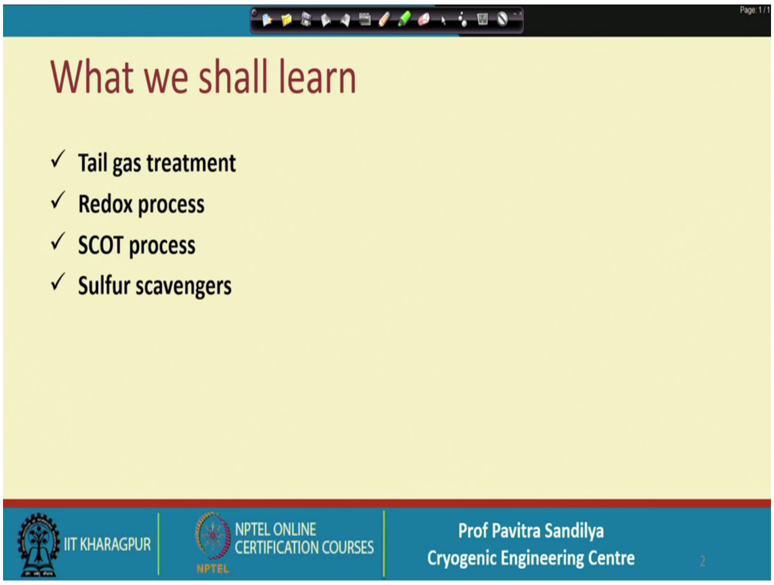

In this particular lecture, we shall be learning about these four processes for the sulfur recovery.

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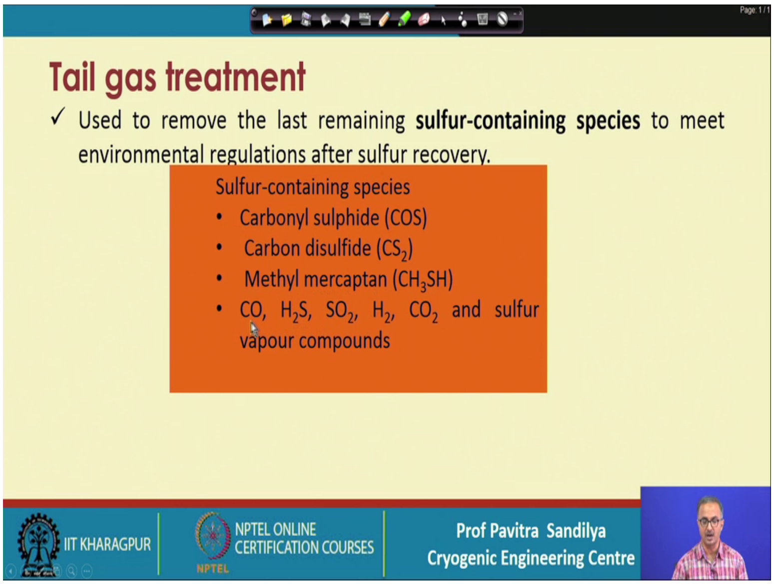

First we come to the tail gas treatment, this is used to remove the last remaining sulfur containing species to meet the environmental regulations after sulfur recovery and these species are these carbonyl sulfide carbon disulfide methyl, mercaptan and carbon monoxide, H 2 S, etcetera. So, all these are the species feature also recovered during the tail gas treatment and this uses an amine system for the sulfur recovery.

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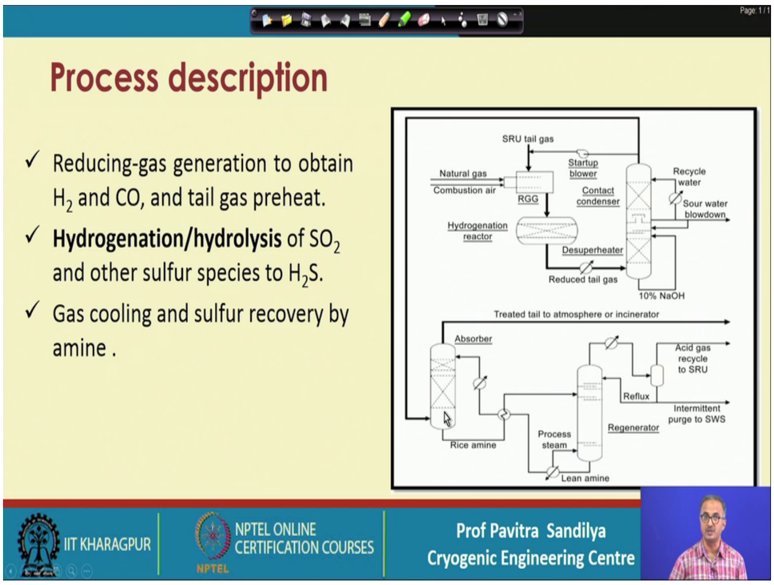

This is the process description here. So, these constitute basically 3 steps. First step is the reducing gas generation to obtain H 2 and CO and the tail gas preheat. So, this hydrogen and carbon monoxide are the reducing gas with the generated here.

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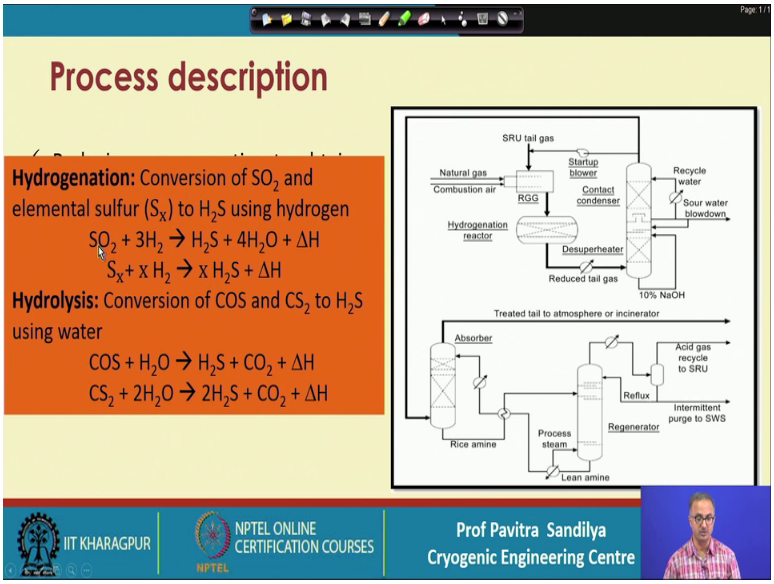

And in this; what is done that we heat the tail gas to about 290 to 340 degree centigrade by a reducing gas generator which is shown over here. So, this natural gas this is coming and their combustion air is also inputted, this is the reducing gas generated. So, after this we carry out the hydrogenation and hydrolysis of the sulfur dioxide and other sulfur species to obtain H 2 S.

So, here we show this hydrogenation is being done and in these the reactions are like this, hydrogenation we call when sulfur dioxide and sulfur elemental sulfur are converted to H 2 S using hydrogen that is why then hydrogenation. So, these are the two equation by which the sulfur dioxide is convert to S x to H 2 S and elemental sulfur is converted to the H 2 S and this delta is represents the heat of the reaction and then we have hydrolysis in which this CO is that is the carbonyl sulfide and carbon disulfide are converted to H2S using water using this particular reaction with some heat of reaction.

So, this is the second step. After this the gas is cooled and sulfur is recovered by amine in this particular thing in this particular column and in this column we find that maybe; they are using some kind of alkali that is NaOH and in this particular, we also go for a second stage of removal of this sulfur. So, these are 2 ways, we are removing this H 2 S to H2 because H 2 S is acidic, we are using some alkali amine or the NaOH to get to recover it.

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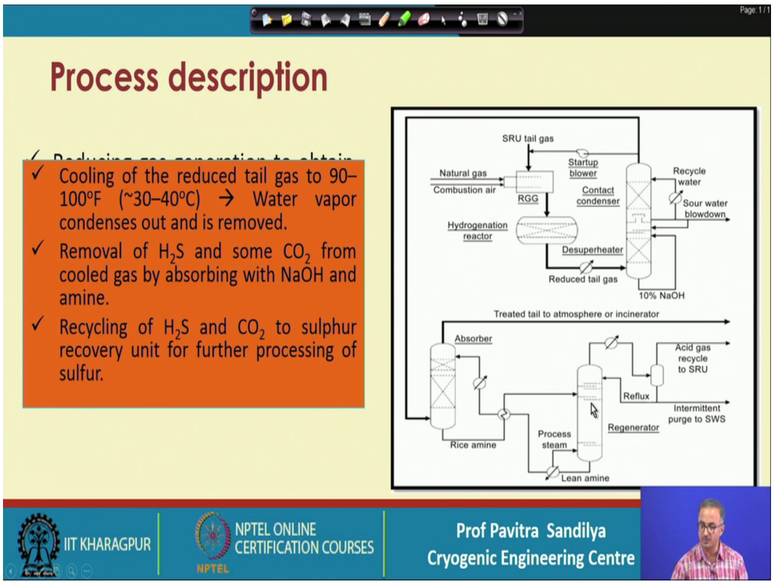

And then what we find that in this particular equipment tower, we are may getting back the amine. So, we are cooling the reduced tail gas to about 30 to 40 degree centigrade and when we reduce the tail gas temperature, we find that water vapor condenses out and is removed and removal of H 2 S and some CO 2 from the cooled gas by absorbing with NaOH and amine and then recycling the H 2 S and CO 2 to sulfur recovery unit for further processing of the sulfur.

So, here we are this treated gas is taken to atmosphere incinerator and here we are getting this acid gas recycle and this is going to the sulfur recovery unit. So, this is the overall process description for the tail gas treatment.

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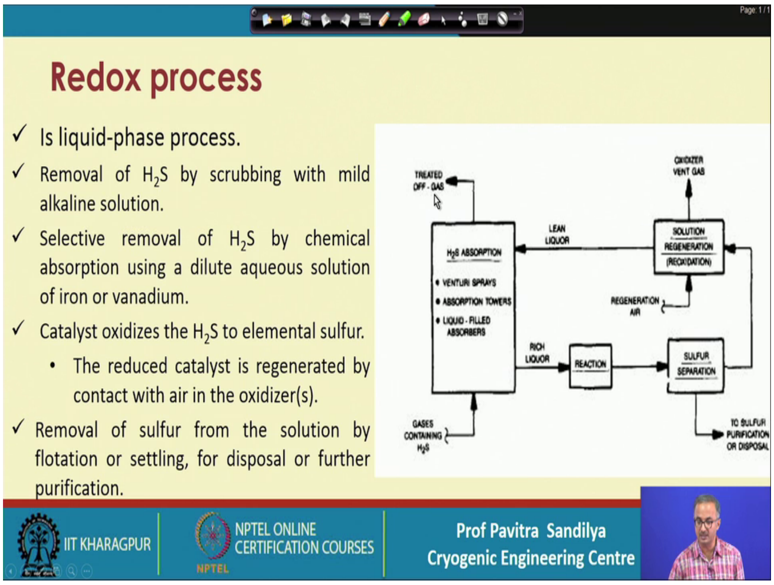

Now, we come to the Redox process, some name redox means reduction and oxidation. So, both reduction or oxidation as carried out in this particular process the it will liquid phase process and what we do that; first, we remove the H2S by scrubbing with some mild alkali solution in this thing. And, this venturi sprays are used for this kind of removal scrubbing, these that is this spraying the liquid in the from the tower that is for we are using venturies, venturi sprays. And, then this is absorbing absorption going on in this and then this H 2 S is removed selectively by some chemical absorption using a dilute aqueous solution of iron or vanadium.

So, one of these in this here reacting this H 2 S with the iron or vanadium aqueous solution and then we find that we are going for the sulfur recovery and the catalyst oxidizes the H 2 S to elemental sulfur the reduced catalyst is regenerated by contacting with the air in the oxidizer. So, we find that first it is reduced and then this oxidized and the removal of the sulfur from the solution by floating of settling. So, ultimate we find that we are able to remove the sulfur by converting the H 2 S to elemental sulfur and here, we are recycling the rich liquor after regeneration in this particular thing by heating with the here.

So, that is how we are carrying out this redox process. So, here we find that the H 2 S containing gas comes after remove of H 2 S, this is the treated of gas which is now meeting the environmental regulation quality.

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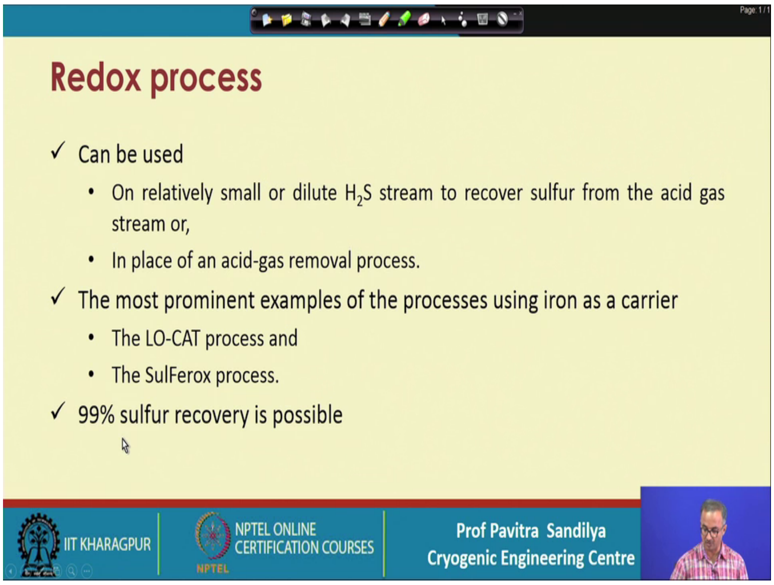

This redox process can be used for small or dilute H 2 S stream to recover sulfur from the acid gases. In this case, we are recovering sulfur directly and this can be used in place of acid gas removal process, if the H2S concentration is less. And, these are the two variants of this redox process LO-CAT and sulferox, we shall not be covering these 2 processes here and it is possible to recover about 99 percent of the sulfur from the tail gas.

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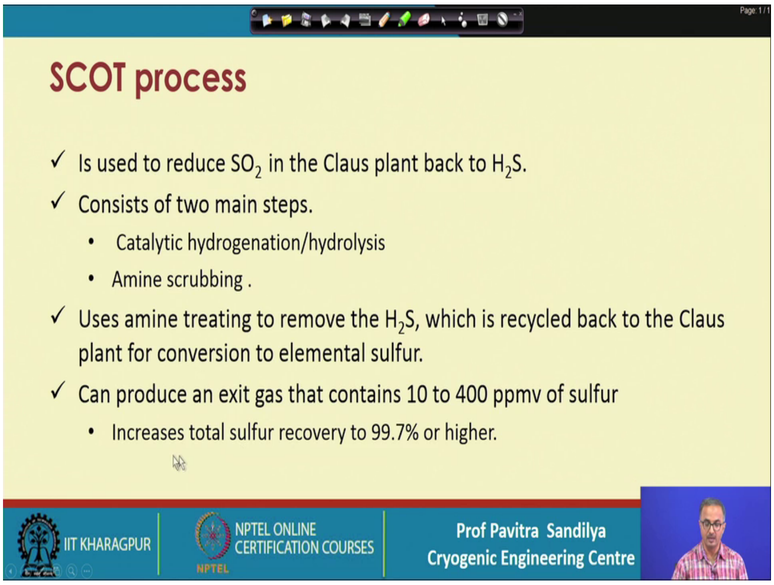

Next, we come to the scot process it is used to reduce the sulfur dioxide in the Claus plant back to the H 2 S; as we learnt earlier about this Claus process. And, here it consists of two steps one is the catalytic hydrogenation or hydrolysis and another is the scrubbing with amine. And, the amine treating is used to remove the H 2 S which is recycled back to the Claus conversion to the elemental sulfur. And it can produce an gas exit that contains very low amount of sulfur in the range of 10 to 400 ppmv and it increases the sulfur recover up to 99.7 percent; that is SCOT is SCOT process is a very effective process.

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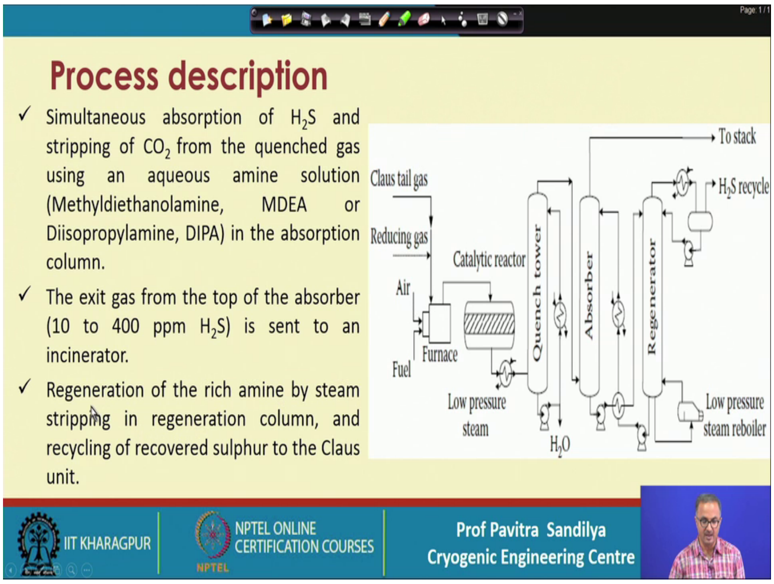

And here is the process description it also entails many steps. First is that the heat the feed of gas is the Claus tail gas, it is coming we are putting in the mixing with the reducing gas here. This mixing gas consists of the hydrogen or mixture of hydrogen and carbon monoxide and these are all mixed with this Claus tail gas and also, we are putting the air and these are taken to a furnace. And they are heated up to about 300 degree 302 degree centigrade and then it is catalytically reduced to get the H 2 S from SO 2, CS 2 and COS.

So, the Claus catalytic reactor here we are able to get the H 2 S and water from this components. And, then what happens that the cooling of the gas is done using a waste heat exchanger through so, that in the heat, this heat exchanger we are putting water and whatever heat is generated during the reaction is used to convert this water into the low pressure steam. And, this low pressure steam can be used for the regeneration purpose and the gas is further cooled to about 38 degree centigrade in a quench tower.

So, gas is goes in the quench tower. So, it is further cooled before it is same to the absorber because, it is cooled because the absorption is favored at low temperature. So, the gas has to be cooled and this cooling is achieved by recycling with water in the quench tower. And, after this what we find after this in this tend to absorber, in the absorber we are using some kind of a amine to take out this carbon dioxide and the H 2 S. And, exit gas or top of the absorber contains about 10 to 400 ppmv of H 2 S that is this exit gas is about 10 to 400 ppmv of the H2S and which is sent and the generation of the rich amine by the steam stripping in the regeneration column.

So, in this regeneration column, we are whatever rich amine is coming that is taken here and from this we are getting the lean amine which is fed back to the absorber. So, this absorber regenerator are taken in pair to do this particular process and for the regeneration as I said that low pressure steam is taken and this low pressure may be obtained after from this particular steam which is obtain after the catalytic reactor Claus reactor.

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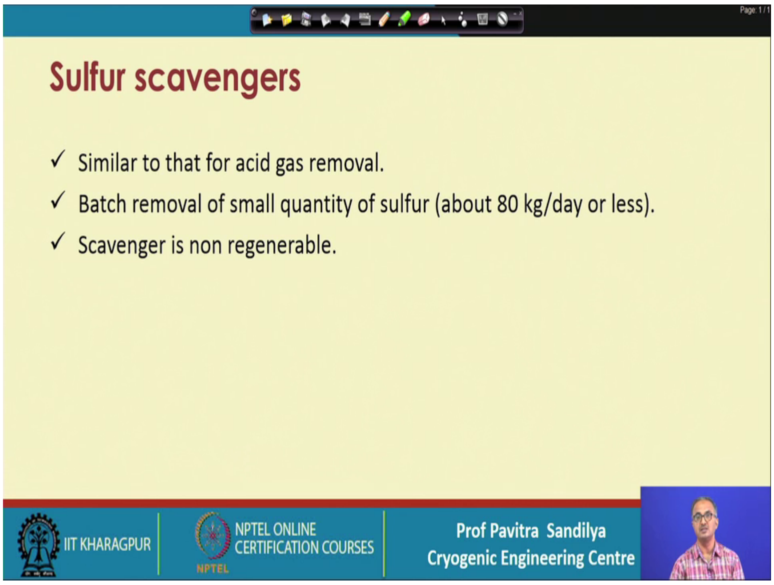

So, this is how we carry out the overall process and lastly, we come to the scavengers this scavengers are similar to the once which we learnt in a another separate lecture on the acid gas removal. In that particular lecture, I have given a detail of the scavenger operation and how to split the scavengers. So, I am not into any of the details of the scavenging operation. Here simply, I am putting the salient features that it is used for the acid gas removal too means and it is removal of the small quantity of sulfur about 80 kg per day or less. And, this scavengers because they are reacting chemically with the H 2 S so, they cannot be recovered. So, that is only once through and that is why they are confined whenever we have small amount of H 2 S.

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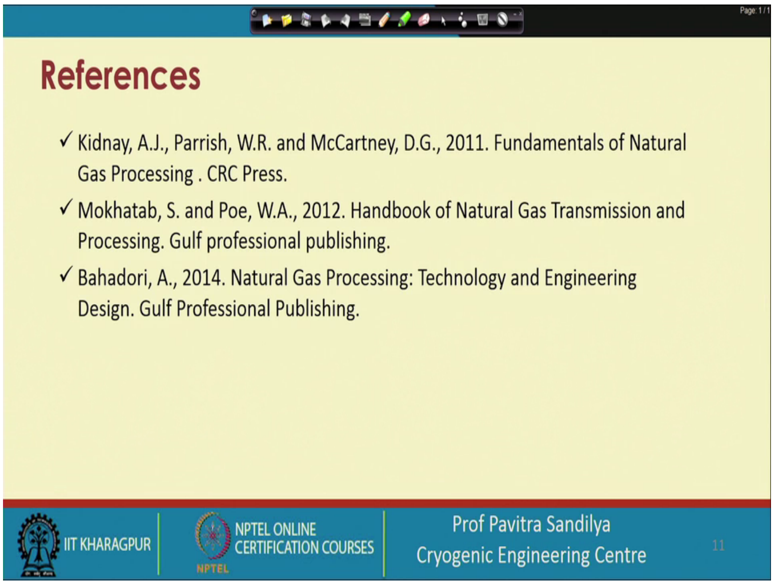

So, these are the references which may be consulted for more detail.

Thank you.