Surface Facilities for Oil and Gas Handling

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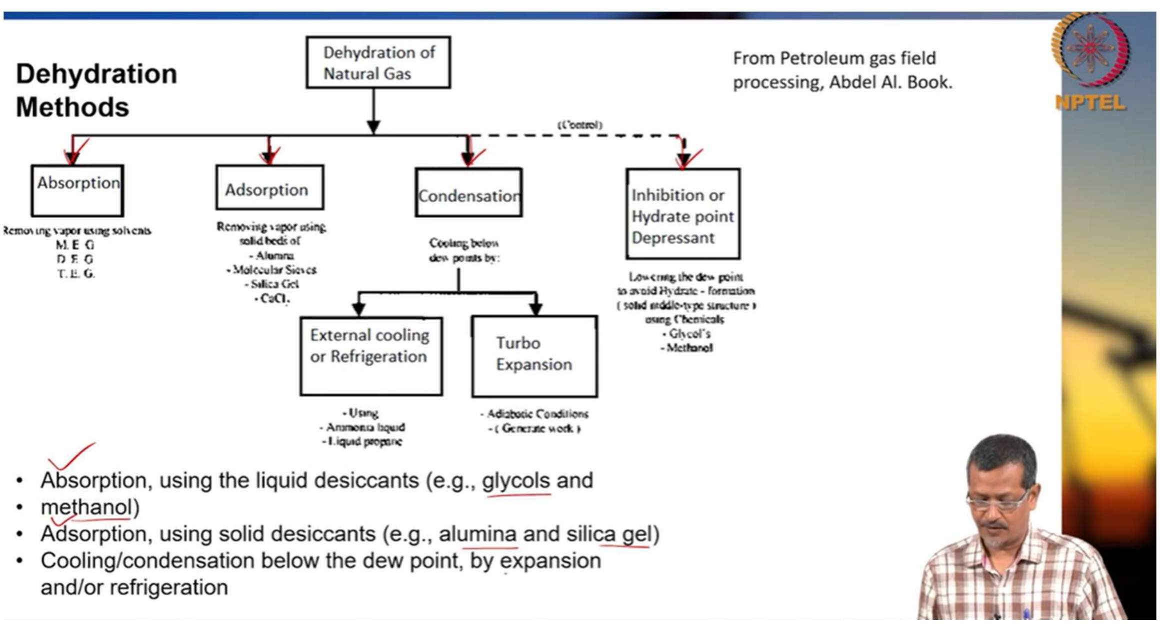
Gas Dehydration

Good morning, today I will discuss about gas dehydration. Gas, natural gas whatever you are getting from oil, bores are separated from oil, condensate finally, you got natural gas, but still it will be containing certain amount of water. So, water may be in terms of vapour of small water droplets. So, you have to remove that water droplets otherwise there will be some other issues. For example, it will be forming gas hydrate or it will be forming ice or it will be creating corrosion. So, it will be blocking path corrosion.

So, this sort of issue again it is not having any heating value. So, if it is sending to your customer, customer is burning in let us say Indian gas cylinder you are getting water content also some small amount. So, that water will be evaporating it will takes lots of heat, it will take because of phase change from liquid to gas, but that heat you cannot recover or you cannot use actually. So, that will be wastage of heat.



So, just to avoid all this wastage of heat, avoid corrosion, avoid forming gas hydrate, forming ice or plugging your flow path, you have to remove the water content otherwise sells your customer. The customer in downstream they will not buy your gas. If you are selling also there will be issue like gas hydrate formation, ice formation, corrosion and low heating value of your fuel. So, then how to isolate water from gas? So, there will be again similar sort of column, ok, absorber column or glycol contactor they say. There will be several other method also just one simplest method the glycol contactor column will be there.

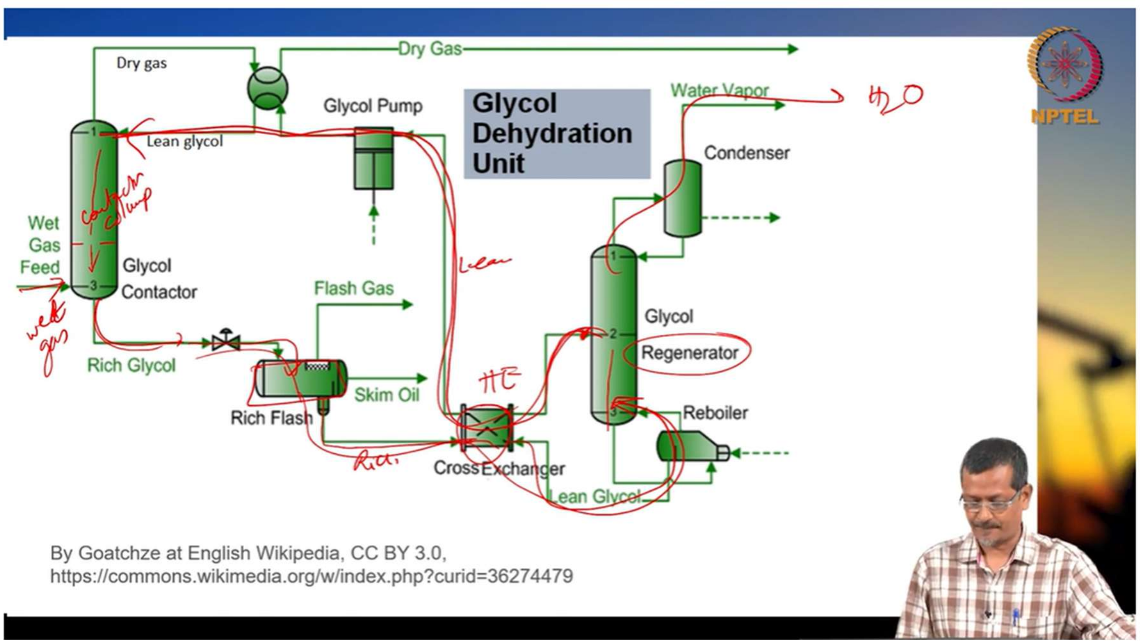
You put water plus gas or gas having some water content. So, you get dry gas and lean glycol solution you inject from here you take rich, rich or it is having lots of water content glycol, glycol, glycol solution and again you reprocess or reproduce glycol again re-inject. So, this cycle will go on and in the in between there will be reboiler system, there will be pumping system, there will be valve mechanism. So, several items are there. So, simplest way is that to explain absorbing water.

So, this is glycol contactor column then the whatever water with glycol that solution you got that is called rich glycol, rich glycol will go to reboiler section or regenerator section, ok. So, reboiler regenerator section you are producing lean glycol solution. So, lean glycol will come to your absorber section you are getting dry gas and your water will be disposed whatever water you are getting. So, whenever you are dehydrating gas using glycol. So, there will be some simple method for example, you can have absorption mechanism, you have adsorption mechanism, you have condensation mechanism you can use chemical inhibitor.

So, absorption means like you have diethylene glycol or some other type of glycol you use the glycol will be absorbing water particles and it will be you will get gas without water or water vapor or water liquid. Then there will be some adsorption process or solid desiccants are there. So, if we pass natural gas with water. So, water will be absorbed in solid and you will get water free gas. So, similarly condensation you reduce temperature at very low temperature water particle will condense it will form liquid it will be deposit on the bottom and you get gas water free you can use chemical inhibitor also, ok.

So, if you use chemical inhibitor. So, that gas hydrate formation will not be there. So, that mechanism also there, ok. And condensation you can use external cooling system or refrigeration system or cryogenic system you can use and you can reduce temperature very low you condensate or you can make small ice particle and separate, ok. Turbo expander also you can use to reduce temperature and you can separate water particle there.

So, absorption unit using liquid desiccant like glycol methanol absorption section adsorption using solid desiccant like alumina or silica gel you can use for adsorption cooling and condensation if you see below the dew point you reduce temperature. So, fluid water particle will be creating droplets most of droplet then you separate, ok. You can expand also or you can refrigerate also. Why dehydration? So, hydrates are solid formed by physical combination of water and hydrocarbons. I C compounds of about 10 percent hydrocarbon and 90 percent water grow as crystal plugs the lines of flow path it will be plugging.



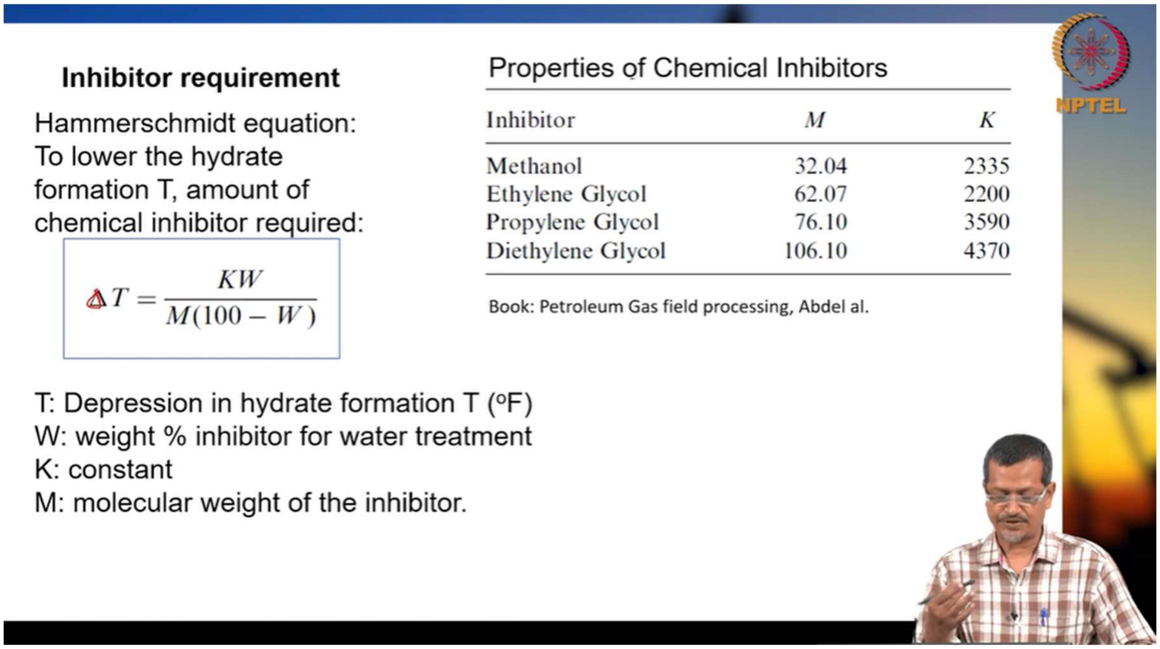
Primary condition of hydration less temperature dew point less than dew point temperature, ok with free water present low temperature and high pressure, ok. So, pressure high temperature low in that case also a high deformation will be there. Corrosion water plus hydroxy gas promote corrosion. So, if water is there then metal part can be corroded or reaction will be happening in iron. Downstream processing plus presence of water may cause side reaction forming foaming or catalyst deactivation.

So, for all these reason you have to remove water. Inhibit hydrate formation inhibit hydrate formation like hydrate forms at high pressure and low temperature and liquid must be there liquid water, ok. So, how to prevent raising the system temperature or lowering pressure? So, you reduce pressure or increase temperature hydrate will be vanished. So, down hole regulators or chokes pressure will ah installed a downstream. So, their pressure or temperature will be changing.

So, the hydrate formation will be there actually. So, you have to check whether heating will be required there. So, indirect heaters or direct heaters can be used well head and flow lines heaters ah can be heated that can be heating this natural gas it will be maintaining flowing temperature hydrate ah above the hydrate formation temperature. And some case you inject chemical to inhibit hydrate formation. So, methanol or glycol depress to depress freezing point of liquid of water you can use.

So, that hydrate will not be formed. Dehydration remove water vapour from gas liquid and water drop out depressing the dew point. So, you depress the dew point. So, that gas hydrate formation will not be there, ok. So, glycol dehydration when you are doing.

So, you will have same similar like in a mine seperated system you have seen one contactor column or absorber column will be there here also we have similar mechanism contactor absorber column you have several trays ah sometimes they call bubble column also, ok. So, glycol this is a hygroscopic made hygroscopic not hydro this is hygroscopic it is absorbing moisture, ok. So, if moisture is there you add glycol a glycol will be absorbing moisture and gas will be free from water, ok. Water vapour gets dissolved in glycol liquid, ok. Glycol dehydration cheaper water easily boiled off, ok.



Now, you got water and glycol mixture you increase temperature glycol and water will get separated because of boiling point difference water will be boiling 100 degree centigrade, but glycol be boiling at higher temperature. So, you increase temperature 100 degree centigrade water will be boiled off and you will get pure glycol. So, that glycol again you inject into your contactor column, ok. Contactor column ah and it will go to regenerator section where you will be regenerating glycol within using temperature let us say 100 to 400 degrees Fahrenheit ah centigrade centigrade temperature at lower temperature water will be boiled off high temperature you are not creating high temperature to boil glycol rather you need glycol liquid and water create steam and separate it, ok. So, this is taken from Wikimedia commons you see this one wet gas is entering, ok.

Wet gas and this is glycol contactor column contactor column, ok. So, from there rich glycol is coming here and it is going to be flash chamber again if you have any hydrocarbon anything you are separating and this fly flash flash chamber for exit gas is going to on heat exchanger, ok. From there it is going to your boiler reboiler section or regenerator section, ok. And whatever pure glycol coming it is, ok it will coming like this and pure glycol, ok some error error is wrong. So, this is pure glycol coming and it is going through this and it is going through this and lean glycol coming and entering here, ok.

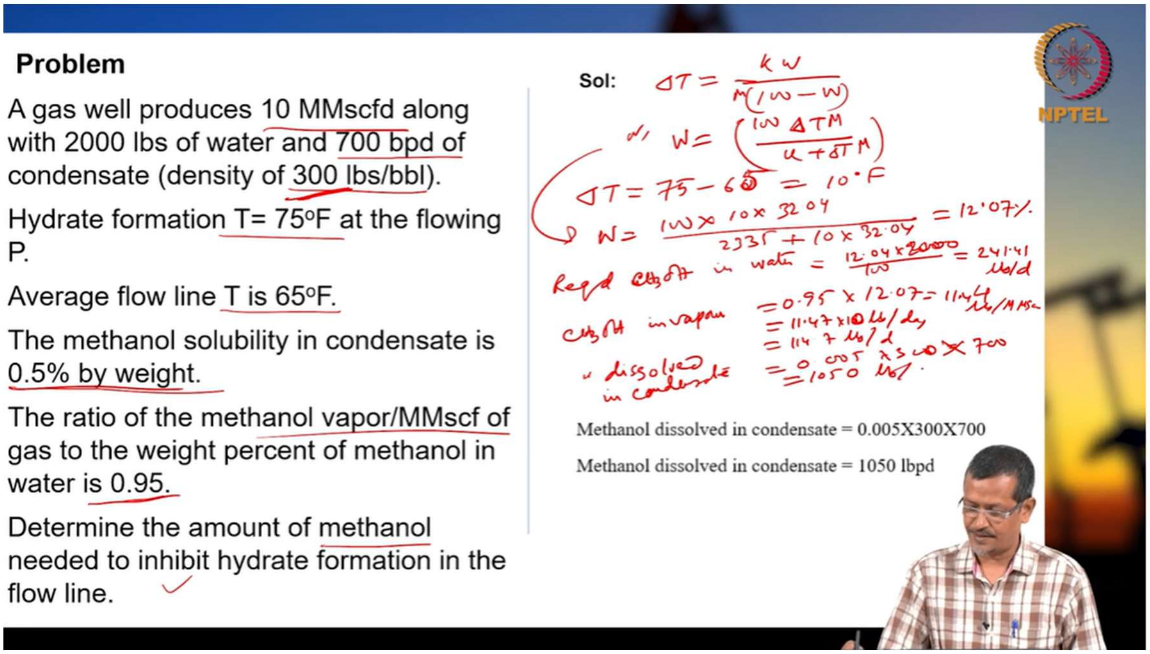
So, this is lean rich glycol and this is lean glycol, ok. So, lean glycol coming from your regenerator section heat exchanger is here from heat exchanger it is going through this glycol pump to your contactor column. Contactor column is things are getting absorbed water getting absorbed rich glycol coming flash chamber flash chamber to heat exchanger heat exchanger to your glycol separation unit, ok. And water at high temperature it will be vapor. So, you are getting water here, ok.

This cycle will continue when you are working you are separating water from gas. So, what are the different glycols ethylene glycol? Ethylene glycol is high vapor equilibrium with gas used as hydrate inhibitor and it will be absorbing moisture so, it will be hygroscopic, hygroscopic, ok. So, for natural gas transmission in line hydrate protection you use ethylene glycol so, that no hydration hydrate will be formed, ok. It will be reducing hydrate formation temperature so, that the liquid or the gas and liquid mixture it will not reach to the hydrate formation temperature, ok. So, another way ethylene glycol, diethylene glycol, triethylene glycol so, several types tetraethylene glycol.

So, several types of glycols are there you can use, ok. They have their own positive negative aspect you can read there, ok. For example, decomposition temperature or reboiler temperature will be 315 to 340 degree Fahrenheit. Water boiling temperature actually 212 degree Fahrenheit in normal temperature pressure, but you see glycol temperature boiling temperature is more actually. So, if you maintain the temperature water boiling temperature then glycol will not get evaporated or the water will get evaporated it will create a steam and you can separate, but glycol will be staying there, ok.

So, that glycol will pump to your contact column again, ok. So, diethylene glycol or tetraethylene glycol reduce vaporization because of their lower vapor pressure. Hydrate inhibitors injected in gas flow lines or gas gatherings networks installed of a high pressure free water knockout at the well head. Removing free water from the gas stream ahead of the injection point causes significant savings in the account in the amount of inhibitor is used.

So, glycols you have seen. So, what is the chemistry of that? So, methanol methanol. So, methanol also uses a inhibitor, ok. So, methanol formula is like CH_3OH it can be written as C4 bonds HHHOH, ok. Alcohol bond. The simplest aliphatic or simplest aliphatic alcohol, alcohol, ok and ethylene glycol ethylene ethylene glycol, ok.



So, ethylene glycol can be written as OH OH. So, here this straight lines this end and this end shows carbon, ok. So, this one, this one like we do like this, then this means carbon, this means carbon, this means carbon and we are not showing how many bonds and things are there, just we represent this straight lines as a like carbon bonded with carbon, ok. So, whenever you are drawing ethylene glycol you can draw like this or you can write C C C 4 OH OH, ok. Ethylene, so 2 carbons are there and OH OH H H H H H, ok and if I if I say polypropylene, polypropylene glycol, so the formula will be like this OH OH carbon here, carbon here, carbon here, no.

Ethylene glycol it will be like 3 carbon 1 2 3 by 4, yeah 1 2 3, yeah 3 carbon. So, it can be written like this C C C and I have one OH here, one OH here, remaining bonds you can make H H H H H, ok and diethylene glycol, diethylene glycol it will be like this H O O again OH, ok. Ethylene glycol, so H O CH 2 CH 2 O CH 2 CH 2 OH, ok. This is called diethylene glycol. So, O is having 2 bond, so it will not having any other hydrogen or anything, ok carbon is having 4 bonds.

So, you have to calculate 4 hydrogen or 4 some other atom is connected there or not, ok. So, diethylene glycol, diethylene glycol, ok. So, H O O then O OH, ok. So, you should try to remember how to draw this methylene, methylene glycol, propylene glycol, diethylene glycol, diethylene glycol. Inhibitor requirement, Hammers-Mitt equation to lower the hydrate formation temperature amount of chemical inhibitor required.

So, this is temperature difference how much depression is required, depression of hydrate, del T. K is constant, W is weight percent of inhibitor of water treatment, M molecular weight of the inhibitor. So, you can see the values are given for methane, M value given, K value given, ethylene glycol, poly polypylene glycol, propylene glycol, diethylene glycol. So, these values are given. So, you can use these values or in a problem sometime I give data directly, so that I will not give table, ok.

See the problem, a gas will produce MMCF gas along with 2000 pound of water and 700 barrel per day of condensate density 300 pound per barrel. Hydrate formation T 75 degree Fahrenheit at the following pressure, average flow line temperature 65 degree Fahrenheit, the methanol solubility in condensate is 0.5 percent by weight, the ratio of the methanol vapor MMCF 0.95, determine the amount of methanol needed to inhibit hydrate formation the flow line. So, basic formula if you remember, del T M, del T equals, del T equals K W divided by 100 minus W M is here, ok.

So, if I solve it for W, W equals coming 100 del T M by K plus del T M, ok. This is the formula, ok. Now, to prevent hydrate formation in the flow line, we need to lower the hydrate formation temperature to 65 degree Fahrenheit, ok. So, our case del T is coming 75 line hydrate formation temperature, but line temperature 65, ok.

So, we have to lower 10 degree Fahrenheit, ok. How to lower? Then we have to add certain chemical so that it will be the hydrate formation temperature will be going down and there will be no hydrate formation although water will be there, ok. So now, use the equation del T W equals 100 del T M 10 M, M value from table you can get or I can give, ok. So, here M value is given I think, ok. M value for d e a, this one MMCF gas density water condensate hydrate formation determine amount of methanol. So, for methanol M value you see methanol M value 32.

04 and 2335 per K 32.04 divided by K 3225, 2335 not 32, 2335 plus del T 10 into M 32.04. So, this value is coming 12.07 percent. Now required methanol, methanol or CH 3 OH required methanol in water, water equals 12.

04 percent into 2000 you see this flow rate, pounds water 2000 pounds water you have given 2000 divided by 100 because 12.04 is there. So, it is coming 241.41 pound per day.

Now methanol in vapor CH 3 OH in vapor because 0.95 it is given there you can see the ratio of methanol vapor MM SCF 0.

95, ok. So, 0.95 into 12.07 it is coming 114.1, 11.47 L B MM SCF, ok equals coming 11.47 into 10 L B per day, ok. This equals 10 MM SCF flow rate, ok.

So, it is coming 114.7 L B per day. Now methanol dissolved condensate CH 4 dissolved in condensate. So, it is coming 0.005 into 300, 300 condensate volume is given you can see 300 and 0.5 percent by weight, ok. So, it is coming now yeah 700 barrel per barrel volume also given 700 BPD, 700 barrel also given.

So, it is coming around 1050, 1050 L B per day, ok. Now total methanol total CH 3 OH methanol total amount of methanol is coming like 241.41 plus 114.7 plus 1050 equals 1406 L B per day. So, methanol dissolved in condensate dissolved in condensate equals 1050 divided by 1406 into 100 equals 75 percent, ok.

This amount of does not contribute to the treatment. So, such treatment is not good for economic reason. So, condensate initially must be separated after that only you can you should use. Thank you very much for today lecture, next day we will start new topic. Thank you.