Surface Facilities for Oil and Gas Handling

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Natural Gas Processing_01

Good morning. Today I will start Natural Gas Processing. In previous lectures we have seen the oil you are producing oil and gas from wellbore. It is a mixture of oil, gas, water and sand. So, in details separation system we have seen first from wellbore we are getting fluid so it is passing through a choke, well head, then choke, then we are passing through separators, series of separators. So, initially it will be high pressure separator, then we are moving towards lower pressure separators and each stage we are getting certain amount of gas.

So, high pressure separator may be two phase initially and water, oil. So, then again when water you are separating, oil you are separating for to maintain certain amount of BSW basic sedimentation and water content in oil. So, again you are getting certain amount of gas, again oil and water. And water also will have if it is high pressure water there will be some dissolved gas.

So, the gas also you have to separate. So, every steps you are getting certain amount of gas. So, the gas whatever you are getting that cannot be sent to customer directly. So, there will be certain wellbore like gas well or condensate or oil well. In gas well gas amount of gas will be higher where oil well there will be oil amount or liquid amount will be higher than gas amount.

But whatever wellbore is there gas well condensate oil. So, there will be certain amount of gas coming out from your fluid whatever getting at the surface. The surface the fluid you got it will be passing through choke then several stage of separation. So, you got oil, oil you have seen in previous lectures that oil you have to separate for like you have to remove water, you have to remove salt content, you have to remove all other impurities

then you have to send to customer. Before customer maybe you will be putting this one in a storage tank.

Storage tank or if you have offshore facility then maybe a PSO you will be using for collecting oil then you will be sending to your refineries. Water before disposing you will be separating all oil content then maybe using offshore pile will be disposing or you have to create one another wellbore where you can inject the whatever produced water is there. So, you are injecting and this way you are disposing. Because of environmental agency regulation you cannot dispose water anywhere whatever you like. You have to follow environmental and government local government regulations.

And gas, gas every steps you are getting gas. So, gas will have different pressure let us say first step you are getting high pressure separator. So, high pressure separator means gas pressure will be higher but second step you are getting again gas. So, already the second step or second stage of separator pressure is lower. So, whatever gas you are getting pressure will be lower.

So, let us say P1, P2 again from water also or before storing in storage tank you will have certain amount of gas. So, the very low pressure will be there. So, every stage you are getting certain amount of gas. So, the gas you cannot dispose in atmosphere because it is having heating value. So, it can give you certain amount of money again it should not create a pollution hydrocarbon in atmosphere it will be a pollution.

So, all the gas whatever you are getting you have to collect and through compressor system you have to put in one single system and you have to send to your customer. So, before sending to customer you have to remove all the impurities you have in the gas then you will be sending to customer. Again when you are reducing pressure so there will be different types of hydrocarbons which will be getting separated. For example you will have CH4 you will have methane you will have C2H2 to 4, 6 ethane you will have C3H8 C4H10 not 14 is 10 C5H12 so on. So these sort of hydrocarbons mixture will be there and traces water also will be there and there will be some other components such as nitrogen you may have H2S you may have CO2 maybe traces of helium you may have traces of oxygen may be there.

So, small amount of certain compound will be there but that may not be useful for your system but that may be creating certain problem. For example water molecule very small amount is there but when temperature is going down it will create gas hydrate and it will be plugging or blocking the system. Again water is not having any heating value so if you are sending to customer your total heat usable heat will be reduced actually because water will be evaporating and it will take certain energy for latent heat portion because phase change will be occurring in water. So that heat you cannot use for useful purpose actually it will be evaporated directly. So your heating value is getting going down so that is why you have to reduce all the component.

Again many components are you will be separating but that those are maybe they will have a certain commercial value. For example H2S if you separate properly may be sulphur you can use for commercial purpose hydrogen sulfuric acid you can produce ethane propane butane those are useful for chemical industries. So although you are separating but you are not disposing anywhere rather you are using for certain application. And this lecture I have taken basically from the surface production operation book Stewart Morris and Arnold K Arnold book I have taken this is volume 2 and many websites also there you can follow for detailed study for a specific topic and few things I have taken from this naturalgas.org website and if you have taken any other content from anywhere I will be giving on this respective slide.

So whenever you are getting gas from different separator component or maybe directly from weldboard so that gas initially you may have to heat up. Why heating will be required? This you have one choke or let us say you have weldboard then well head is there after that well head it will be passing through and choke. So in choke if pressure difference is very high let us say weldboard pressure is 500 psi and you are reducing pressure to maybe 100 psi so 5 is to 1 ratio. So because of the pressure change there will be temperature change because if temperature goes below certain value then there will be frost formation in the choke system or there will be gas hydrate formation. So that is not desirable gas hydrate and or frost anything it will be blocking the whole system so you have to increase temperature so that ice or frost should not get frost or gas hydrate should not get form in that choking area.

So you have to get give some heat then after that you pass that one to high pressure

separator. High pressure separator then you can pass to low pressure separator. So you are separating two phase flow basically gas you are trying to separate and when you get certain amount of gas so you can pass through this gas to stabilization system where a condensate, condensate means little bit higher molecular weight those those hydrocarbons will get separated and from their low molecular weight let us say carbon low number of carbon CH4. You say lower molecular weight because carbon is 1, H is 4 but if you have let us say C5H10 or 10, 12. So in that case actually it is a heavier molecule.

Heavier molecule it will be settling down and you can take it separately but lighter molecule say methane also this methane part you compress again because every step your pressure is going down. So but your separating main section like say amine separator system, hydrate separator water separation system so there may be one or two columns will be there. So in that column when you are putting all different source of gas all you have to put in one system. So every time maybe you have to use one compressor system. So after a stabilization whatever pressure you get you compress it, increase pressure then again you put the main line you cool it okay then gas treating.

So in gas treating what you are doing you are dehydrating or you are reducing acid gas, acidic gas removal okay. Then after that dehydrate remove water content then again if you have some other traces nitrogen other thing again you remove then you go you send that gas to cells okay. And after stabilization if you see bottom stabilization section so here you got certain amount of oil because heavier hydrocarbon oil is there so you can get certain amount of oil also so you can send that one to cells and oil and water if mixture is there certain amount then you have to send to oil water handling section. So oil water you have to separate again oil you have to remove all the water particle from water all you have to remove all oil particle after that you dispose water and oil you use for commercial purpose or you send to your customer or refineries okay. So this is a picture of roughly how things are happening in the surface production systems or in gas facility specially okay.

And this picture I have taken from surface production operation I have stored in another book volume 2 okay. Now whenever talking about gas so few definitions you remember so one is natural gas, natural gas called fossil gas or methane gas or simply gas okay many people can say like someone will say fossil methane gas or simply so naturally basically methane gas majority portion will be methane CH4 okay. So many times they say methane gas but many people can say fossil gas also but in our case we will be using the term

natural gas okay but if you are telling someone is telling like it is fossil gas that is also fine. So natural gas I have created the short form NG so I will not write every time natural gas natural gas so I will write NG. So NG from oil wells term is associated gas okay from well bore you are getting oil if it is oil well then in that case you are saying the gas is associated gas and it can be free gas or dissolved gas.

Free gas means at inside well bore also gas will be separated from oil but certain amount of gas will be dissolved because of high pressure if you reduce the pressure again gas will be coming out from the well from the oil okay. So associated gas can be dissolved or free natural gas from gas and gas and condensed wells so this will have negligible crude oil but when whenever you are saying condensate well so large long chain hydrocarbons also will be present there okay. Hydrocarbon in my lecture I will be using HC term okay hydrocarbon HC hydrocarbon okay I will be using this HC term. Gas well produces raw NG natural gas condensate well free natural gas plus semi liquid hydrocarbon concept so long chain hydrocarbon will be there so there will be semi liquid. So if you change temperature it will be gas it will be if you reduce temperature again it will be liquid so that will it will work but a natural gas normally it will be normal at temperature pressure it will be gaseous form if you want to make it liquid for example LPG or LNG so in that case you have to increase pressure or you have to reduce temperature so in that way you can make liquid okay.

But natural gas maybe if you reduce little bit pressure then if you increase little bit pressure reduce little bit temperature it will form a liquid but reduce reducing pressure it will form again gas. Natural gas mixture of gases hydrocarbon first primarily methane plus other higher alkanes of smaller quantity trace gases usually carbon dioxide nitrogen H_2S helium water all these traces will be available. Most dangerous thing is the hydrogen sulphide and carbon dioxide hydrogen sulphide it will create acidic gas or acidic liquid if it is reacting with water okay so H_2SO_4 H_2SO_3 it will create so that will be corrosive fluid and H_2S is dangerous also for human health so you have to remove that one and water is not having any heating value and it will create hydrate or ice formation that is why you have to remove water also and nitrogen also is not having any heating value but we have to remove so that helium also it is inert gas we have to remove it okay. Sometime mercury also available so if those gases are available traces then there will be some separate separation mechanism for instance in some cases you create very low temperature cryogenic temperature cryogenic temperature means low temperature very low temperature normal air conditioning temperature will be like 25 degree and refrigerated temperature may be 3-4 degree centigrade but cryogenic temperature may be minus 100

degree centigrade okay. So, in that if you cool any gas at the temperature so nitrogen may not be creating liquid but other hydrocarbons will create liquid or solid so when nitrogen is gaseous form you separate that one you take the solid hydrocarbon or liquid hydrocarbon again you increase temperature you got nitrogen free compound or hydrocarbon.

So condense it here I have used a term this is very much flammable actually then crude oil okay because it is nearby gaseous form is crude oil and gas in between so it is very much flammable and mixture of light hydrocarbon similar to very high API so high API means light hydrocarbon if you see API if 10 degree 90 degree so those are very heavy oil okay for light oil we say like 30-40 API so this condense it will be higher range of API that means very light oil actually okay. Question for pipeline quality natural gas so just roughly some values are given so just so that you can get some idea and it is taken from kidney and parish book so methane will be about 75% okay so if you are considering natural gas so methane majority methane and some portion will be ethane also but other heavier hydrocarbon may not be there so maximum limit is there for example propane butane isobutane pentane and pentane heavier heavier means C6 C7 may be possible so it is very much traces amount may be there carbon nitrogen carbon dioxide is small very small carbon dioxide again if you are having higher amount so carbon dioxide will be creating with if any water particle is there water plus carbon carbon dioxide CO_2 plus H_2O it will create H_2CO_3 carbonic acid so carbonic acid when you are saying acid will react with metal it will create corrosion okay so Fe plus H_2CO_3 so it will be creating salt okay it will be creating salt iron salt when iron salt is created iron salt is softer than iron metal so if through pipe even iron metal pipe is there and carbon dioxide and water particles are there so carbonic water particles create acid H_2CO_3 so H_2CO_3 because this is acid it will be reacting with metal iron and it will create softer salt okay so that salt this is called corrosion so this salt is softer so pipe leakage may be possible pipe burst may be possible high pressure system is there so you have to remove carbon dioxide particle water particle then you can transport through pipe or you can use any metallic vessel also high pressure okay so H_2S 0.25 to 0.3 gram per 100 standard cubic feet total sulfur 5 to 20 gram per 100 cubic feet water vapor also 4 to 7 pound per MMACF oxygen 1% so this is this is may be possible but it depends on different different field okay let us say Indian field let us say Kambay area or Mezzanau field or Canada Canada some oil oil field they will have different composition but whenever you are sending to customer you have to maintain that regulation whatever customer gives you okay we will not accept more than this much of carbon dioxide or this much of water content so to follow that and you have to refine or you have to purify the gas accordingly and you have to send to your customer okay so whenever you are saying hydrocarbon hydrocarbon every time so let us see some chemistry okay so normally hydrocarbon this natural gas will be having alkanes alkane if you see basic chemistry so this is formula like carbon and hydrogen and this is number of

carbon atom and 2n plus 2 is hydrogen number of hydrogen atom like for example methane CH4 you can see C1H4 how it is working like n equals 1 so it is becoming C1H2 into 1 plus 2 so CH4 okay similarly if you say butene C2H2n plus 2 in that case n equals 2 so it will be like C2H6 so methane C2H2n plus 2 so this is C2H2 ethane propane C3H8 butane C4H10 similarly pentane okay pentane C5H12 okay you can go further also okay I am not going further because our natural gas does not belong to this C7 C8 C9 C10 because those will be oil zone okay and this is alkane butane C2H2n please do not write alkene alkene is different alkene carbon will have double bond for example C double C will be there so in that case so methane figure will be like this C carbon has 4 bond so all will have HHH so CH4 okay ethane if I say C2C is there and 6 carbon you have to add like this HHHHHH okay so if I say propane propane again you can see C all 4 bonds H remaining 4 carbon bonds will be HHHH okay so alkene will have C double bond C so in that case formula will be like this that molecule will be looking like this C HHHH so it will be C2H4 okay so it will be ethane so methane is not feasible right because you need 2 carbon at least and similarly propene possible so 2 bond is there so it will be alkene another term is the alkyne okay in natural gas sometime you get some alkene okay but alkyne you do not find okay but alkyne also not so common alkyne like C triple bond must be there okay for example CH triple bond CH or if I write properly chemical formulation like this HH it will be looking like this okay now whenever you reading CNG and other term so there will be one term called isobutene so butane will be having it will have one isomer what is isomer isomer isomer is same number of molecules will be there atoms will be there so but atom orientation will be little bit different okay so butane will be like carbon 4 so normal butane will have all H will be there so it will be like HHHH okay so normal butane n-butane you can say but isobutene if I write so it will like CCC I am writing 3C but there will be another C here okay and C will have HHH this will be HHHH here okay so if you count the total number again it will be C4H10 okay this is called isobutene okay once C is branched or this can be called as okay so this is isobutene okay so this is isobutene so if I say pentane pentane will have two isomer actually pentane so CCCCC and all H will be connected here okay 1 2 3 4 5 okay and in pentane CCC here I can have one C here I can have C okay so this way it will have all the H connected okay you can H all another possible combination CCCCC so C will have HHHHH and H will have here also H so total number of atom will be same but combination of CH3 will be little bit different okay so the name also changes actually although it is pentane number of carbon atom and hydrogen atom same as n-pentane or isopentane okay so they are 2 methyl butane for example this one called 2 methyl butane this one 2 methyl butane not this one and this one 2 2 methyl propane okay so anyway I am not going to details of too much chemistry so just to know the butane will have isomer so that is called isobutene so isobutene chemical formula little bit different okay so methyl methane there will be no methane or methane now ethane will have ethane or ethane also possible okay so propane is there so normal natural gas means

methane okay but if you say natural gas liquid NGL so in that case all the compounds will be there so we will see in next slides.