Surface Facilities for Oil and Gas Handling

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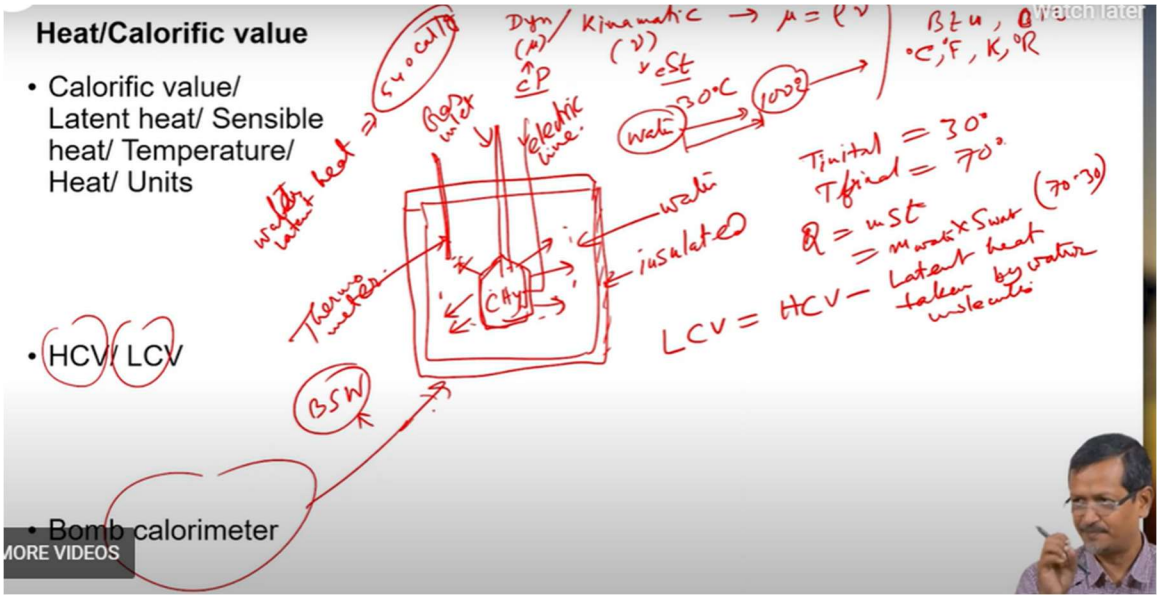
Fluid Properties And Two-Phase Separator-02

In the previous slide one more thing I forgot to tell you is that viscosity when you are talking about viscosity there will be two types of viscosity dynamic viscosity and kinematic viscosity. So, the relationship is that mu equals ah rho nu ok, dynamic viscosity mu, and kinematic viscosity nu. And unit also dynamic viscosity C p C p kinematic viscosity C s there you can see the small capital thing again. So, small c capital P ok poise someone name scientist s t stoke stoke. So, s capital C s t because C small s capital T small. So, you should remember the units, you should not you should not get confused when you are calculating something and you are you should not put wrong units also.

Now you see the heat calorific value, heat you know already ah certain heat is energy and how to measure this one you have to calculate the whole mass you have to know a specific heat capacity temperature rise based on that you can calculate heat And what is the calorific value calorific value. means how many calories you are getting if you burn certain fuel? These days people are very much concerned about food and calorific value right calories how many calories you are gaining or burning. So, in our oil and gas also we will be using the term calorific value.

So, calorific value means how much you burn a certain fuel and how much energy will be released. So, that we have to calculate. And latent I think you may know if I have water ok let us say 30 degrees centigrade. So, if start heating what will happen is 100 degrees centigrade it will reach all right then it will be steam. So, temperature when you are increasing from 30 degrees to 100 degrees centigrade.



So, this will be sensible heat. So, the thermometer if you put there in water. So, you can measure the temperature temperature increasing by 30, 40, 50, 60, 70, 80, and 90. But when it reaches a 30 sorry it will be reaching 100. So, the temperature will not rise rather it will create lots of steam, it is taking heat, but it is not showing.

So, latent means sleeping or hidden right? So, heat is hidden the water molecule takes lots of heat and it is becoming steam The water molecule means the molecular resonance and movement will be lower when it is becoming steam. So, the molecule is almost in gaseous form right? So, particle motion will be very high. So, there will be more energy in the steam particle.

So, more energy means it is taking from your heat whatever you are supplying. So, sensible heat is when you can measure the heat using a thermometer and latent heat means you cannot measure using a thermometer, but it is taking heat right. So, the unit also you should remember heat unit is joule right joule kilo joule British thermal unit BTU also uses BTU capital B small t small u many times I have seen capital Bt u also. But in some books, they are writing capital B small t small u Sometimes I have seen small b t also. So, you should not get confused I think everything is all right there may not be a standard thing.

And temperature units like degrees centigrade already you know Fahrenheit Kelvin and you have learned Rankine. These are common Kelvin normally we do not put the degree symbol correctly this is SI SI unit's standard practice is that there is no degree symbol, but

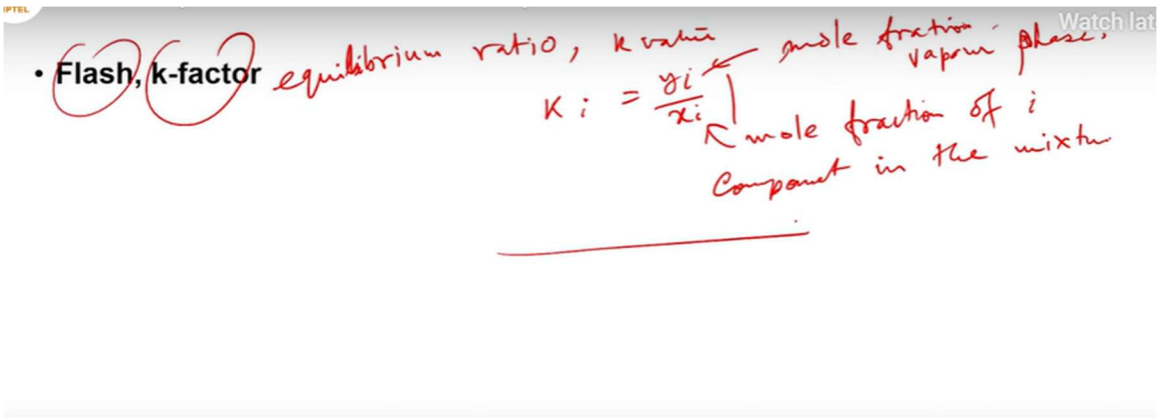
in centigrade Fahrenheit, we put the degree symbol degree Rankine R also we put the degree symbol. So, whenever you are learning you should learn the standard practice also. So, in Kelvin, you should not put a degree symbol. Now HCV LCV I already explained actually in the previous lecture a higher calorific value and a lower calorific value.

So, how to measure it how to know it? There will be a bomb calorimeter term called a bomb calorimeter like you have one vessel, closed vessel insulated, and insulated vessel like this. There will be lead and proper closer also and inside there will be in fuel burning section ok. So, fuel will be burning inside let us say you take a certain amount of methane, be for example, I am giving methane with air. Now you will have one electric coil coming here electric line this will be a gas fuel inlet.

And this will be filled with water. Now I will have one thermometer. So, how will they measure? Initially, you take a certain amount of fuel amount then you burn it. How will you burn? You create one spark using electric lines like your bike and the car will have a spark plug right. So, similar way you can create a small spark where a small amount of energy will be required fuel will be burned it will be heated up.

So, that heat will be dissipated in water. So, this water will be getting heated up let us say initial water temperature for example, let us say T initial say 30 degrees for example, actually how much they are taking it will be their scientist's job. And after burning heat dissipated in the water and it is insulated this is insulated ok. Insulated means no heat will be going in or out this vessel is insulated. So, whatever heat is generated, it will be heating water.

Now T final may be let us say 70 degrees. Now how much heat is generated? Q equals m s T right m mass how much water you have taken and T means T final mass T initial ok. How much mass of water specific heat of water then 70 minus 30. So, you got this much heat generated right? So, this much total heat you got.



So, it is the higher calorific value. Now it may have water molecule water molecule if it is there inside this fuel then fuel that water molecule gets heated up it will take latent heat. That is why I explained latent heat it will take latent heat. So, latent heat means I think 540 grams per calorie per gram I think the right latent heat is water heat. Whatever I can remember is here 540 calories per gram I think.

So, we need to cross-check. Now a certain amount of water is there that will be evaporated it will take latent heat. So, that heat actually cannot be used for your fruitful purpose. So, your actual use of heat will be lower calorific values LCV equals HCV total heat whatever you got using your calculation Q equals m s t minus latent heat taken by water water molecule fine. So, your customer like say your oil and gas surface production system engineer and customer will be specifying we do not want to water more than this much of a percentage.

If you have more than that then they will not buy you have to reduce again you have to check your separator system if there is a fault in the separator system or you have to redesign or you have to put a new separator with glycol and other units and you have to remove the water content. So, they will have BSW specification BSW basic sedimentation, and water content. If you have more than a certain amount then they will not buy ok. So, you have to ensure that your oil or gas is lower than that specified limit. So, this calorimeter is called a bomb calorimeter.

So, you are creating a small bomb blasting then that heat will increase the temperature of the water. Now measure the water temperature. It was initial it was final and this is your total volume. So, finally, how much heat you got you can calculate fine. So, flash actually

ah. So, flash is like how much amount of liquid or how much of a gas is there in a certain volume ah gives the amount of liquid phase or gaseous phase at any point in the process.

At a given temperature pressure each component of the hydrocarbon mixture will be in equilibrium. So, some amount of liquid will go into gas, gas will be coming into liquid. So, that will create one equilibrium. So, if you are changing temperature pressure then liquid equilibrium will be changing. So, that one term will come as the equilibrium factor or k factor.

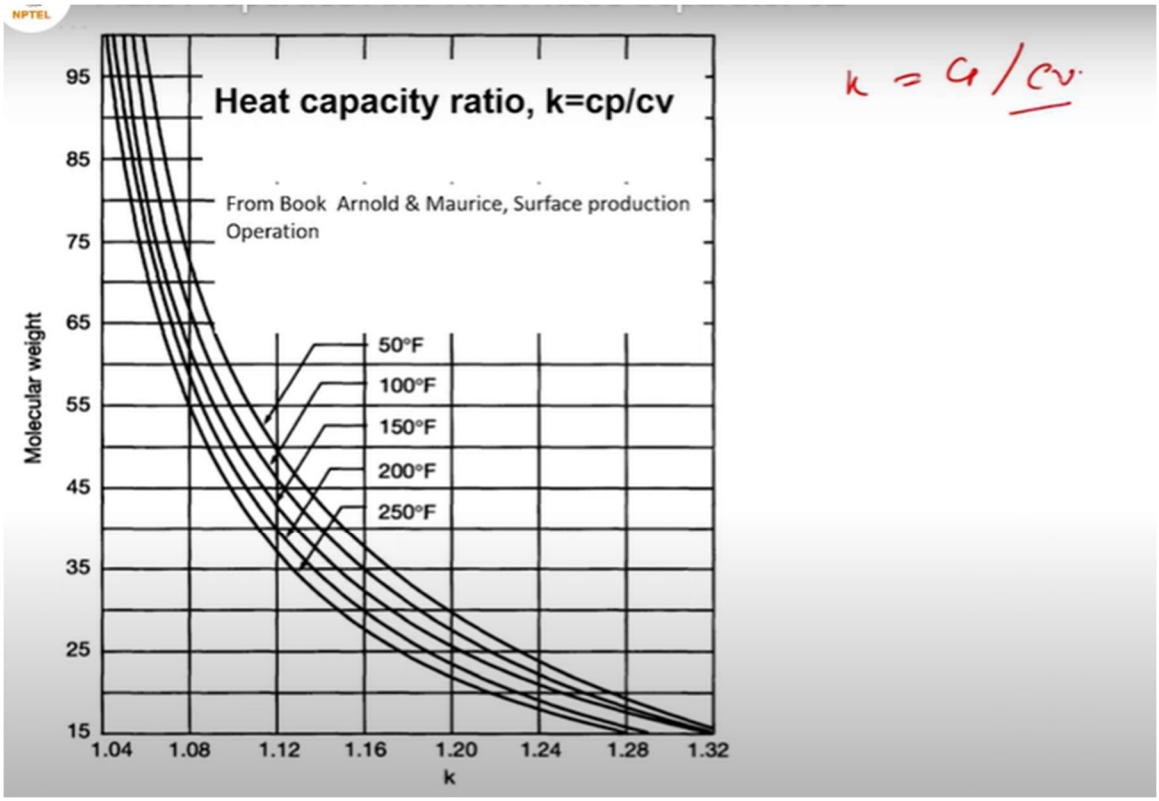
So, the mole fraction of the component in the gas phase depends not only on temperature pressure but also on partial pressure and how much pressure you have having a certain mole. So, that also will be a controlling of your equilibrium. So, the equilibrium ratio is called equilibrium ratio equilibrium k factor or k ratio sometimes they say k value k factor k value equilibrium ratio and the formula is that k I equals y I divided by x i. So, the mole fraction of component I in the liquid phase is x I mole fraction of x mole fraction of I component I component in the mixture. The composition of this one vapor phase mole fraction of vapor phase of vapor um vapor.

Her spelling is like British American American write VAPOR and I am writing VAPOR. So, if you are writing anything, but if you try to maintain uniformity that is better for example, if you are writing all in British style or all in American style that is better. If you are mixing up, you should try to avoid mixing British style or American style. So, the k factor is the defined distribution of the components between the liquid phase and gas phase. Because continuously gas will be going to liquid liquid will be going to gas.

So, the one equilibrium will be maintained, but if you are changing pressure temperature that equilibrium will change the ratio will change pressure will change. So, when you are separating you should know the equilibrium factor based on that you can guess ok this much liquid will be there in my gas. Heat capacity ratio so, all our ah oil and gas calculations use this term k. This picture I have taken from K Alan's book if you see this if your molecular weight is getting changed then your k value also changing. So, in our case normally k value will be 1.

2 to 1.3. Because we will have a different long chain of short-chain hydrocarbon if short-

chain hydrocarbon is there. So, the k value will be different for long-chain hydrocarbon there k value will be different and the number of molecular weights also ah will depend on several carbon atoms is there in the molecule.



So, normally it is like 1.2 to 1.3. So, within this range, our k value will remain ah. So, because this will be like 1920 this is around. So, this will be a housing zone. So, whenever you are calculating for ah Boyle's law, Charles law there will be one factor k. So, know the value you can take from there.

So, here normally it will be 1.4, but in natural gas, we will have 1.28, 1.3 we take those values. If something is given you can take directly that value if not given then you can sometime in the exam I can ask to guess a suitable value. When you are guessing a suitable value it should be within 1.

2 to 1.3 if it is going out of this range then we should not say this is suitable. So, whenever fluid you are getting you know from wellbore wellbore is there well head is there then choke will be there then test separator will be there. So, for test separator purposes you have to test the wellbore whereas for other compositions you have to check you have to check wellbore life also. So, the test separator can be fixed type or maybe skid mountain

or taller mountain mountain. So, a test separator is a vessel that is used to separate or measure a small amount of oil and gas small amount of oil and gas you take and measure what constituents are there in the oil or gas.

Each well is periodically tested by diverting the flow from the production separator. Production separator means continuously it is producing you are getting ah oil or gas ok, but separate test separator is that you are taking sometime monthly 2 times, 3 times, sometimes monthly 1 time and you are testing what are the composition is there whatever separator whole systems are there if composition changing then maybe whole system may not work or something will fail. So, regularly you have to check this is my composition, this is my pressure rating, these are all these things once you get then your production separator will be running smoothly. So, keeping track of oil and gas from each well evaluating reserve potential diagnoses diagnosing well problems. It is attractive to use a test separator in each well, but if you have multiple well bores then you can go through the manifold and you can use one test separator.

Many wells more convenient to pass through oil and gas from each well through the manifold and test it periodically. Frequently testing depends on the requirement whether most wells should have tested at least twice in a month. Most well we have tested twice in a month 2 times. Gas well normally once 1 time in a month. So, the test separator can be vertical, horizontal, or spherical it can be 2 phase, 3 phase.

So, different types of separators will be possible. So, equipment with different meters will be fixed on these separators, pressure gauges will be there, as potential tests, periodic tests, and marginal well tests. So, different types of tests will be conducted using your test separator. So, this is not a production separator you are taking a small amount of fluid and you are analyzing it on the spot. So, production separator is like if I differentiate between production separator.

So, the test separator can be smaller big trowel mounted will be the fixed type. If I say production separator it will have like diameter and length. The diameter will be 12 inches, 12 inches to 15 feet. And most units will have 30-inch means 2.

5 feet to 10 feet, this is a common size. So, you can guess how big it can be 10 feet our height will be 5, 6 feet right and it will be 10 feet. So, more than our height length will be 6 to 70 feet so high right? Sometimes it will be very tall also and common will be 10 to 40 feet ok. These are production separator ranges size approximately you can guess this much will be like this.

So, now we will go to the separator. So, normally like 2 2-phase separator if you see like it will be horizontal So, normally we draw like this 2 will be like. curved to the end, and the inlet is here. Inlet means it is coming from the wellhead to choke to here and there will be one inlet diverter called an inlet diverter. It will create 2 layers will liquid because 2 phases we are saying when we are saying that means, gas phase and liquid phase gas and there will be a mist extractor or mist eliminator. You see I am drawing one valve you can remember this is a control valve pressure control valve right?

So, PC pressure control you can make like this. So, gas out and you have liquid-liquid one valve will be there again control system will be there. So, this will be like level control will be there LC ok and this fluid whatever you are getting this oil out. Now, you are creating 2 layers and normally it will be 50 percent filled. So, if you are making a 50 percent filled circular cross-section. So, you are getting more area surface area interface area.

If you are increasing 60 percent liquid filled 40 percent. So, you are area is reducing if you see from the side view this is the largest area right and if you are making say more this is liquid you are making like this. So, your total length is reduced now the surface area interface area is reduced. So, an interface area is required some time. So, the gas and liquid will be separated better way because more gas will be leaving the liquid surface or gas-liquid will be falling on the surface of the liquid.

So, gas will be flowing through the inlet to divert the oil and gas mixture. So, it will come like this and gas will be moving up when it gas is moving up all liquid particles should fall. If there are small particles are there this mist extractor or mist eliminator extractor will prevent the gas prevent small tiny liquid particles from going out through the gas line. So, we will go to the vertical separator. So, the vertical separator is like this will have vertical

cylinder ok and you have to fix on the bottom also right and as this and your inlet will be like this there will be again inlet diverter mist extractor will be there and you are creating a 2 layers water is going out control valve water or I can say liquid and here also I can put gas word this is liquid this is interface area and here I should put one control system interface area ok inlet ok.

So, many times there will be one downcomer also of course, comer how does it work it will be like this one pipe will be coming and one spreader will be there liquid gas will be entering liquid plus gas ok liquid gas will be coming and it will getting spread here. When you are spreading liquid gas will separate properly and again mist the extractor gas layer you are getting you are creating some layer of liquid and you are taking liquid out. So, we will discuss later when we go for 3-phase separation animals and separation that time we will discuss further, but a vertical separator is vertically tall. You will create layers again 2 layers one gas layer one liquid layer be 3 if 3 phases are there then you will have water oil gas layer 3 layers.