Surface Facilities for Oil and Gas Handling

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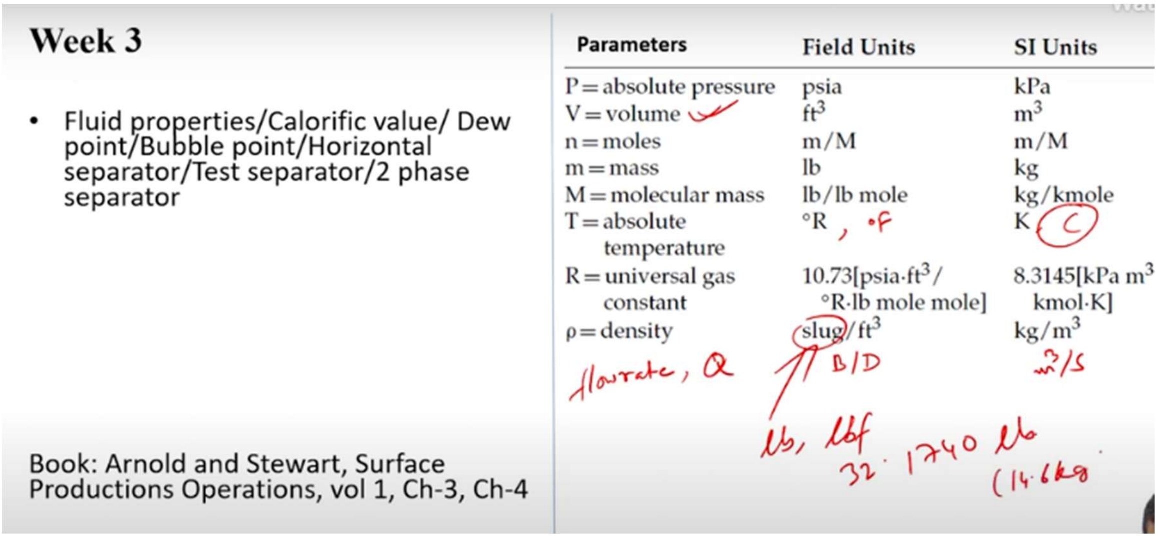
Fluid Properties And Two-Phase Separator-01

Good morning. Today I will start a new lecture topic on fluid properties, calorific value, dew point, bubble point, horizontal separator, test separator, and phase separator. So, I will discuss briefly all on this topic. Whenever we discuss about oil and gas, we talk about field unit SI unit. So, here I have given one table. So, the table says that if I have pressure.

So, pressure in the field unit will say psi, but in the SI unit say k p all right. So, k SI unit maybe you may you might be familiar if you are mechanical or chemical or other engineers, but field units they will be using like FPS units basically like cubic feet, volume, mole, m, mass, pound, temperature, and degree Rankine. Here you can see degree Rankine sometimes degree Fahrenheit is also used, but not centigrade. SI unit k and centigrade are almost similar, but they say Kelvin or universal gas constant 10.

73 you see the unit psi cubic feet degree R pound mole per mole. SI unit will be 8.315 again you see the unit rho is the density slug per cubic feet and volume flow rate flow rate. So, its volume is given here, but flow rate if I see the flow rate I can say q. So, barrel per day B per day. So, here meter cube per second you can write or liter per second? There may be many other units based on this derivation of field unit or SI unit. So, if some unit is given in a problem like in class problem we can give I can give a problem using your SI unit or field unit then you have to check in which form the answer I am asking.

If I am asking you have to answer kPa. So, if you are giving psi that means that the result will not match.



So, you will not get proper marks for that. So, every time you have to look at the unit then you have to solve the problem and you have to give results based on whatever is asked in the question. And here one thing is that slug term is there. Slug is mass slug is a mass that accelerated by 1 cubic foot per second square when a net force of 1 pound or pound force L B or L B F we say pound force is exerted out the exhaust on it on 1 slug mass is equal to 32.1740 pounds or 14.

6 kg equivalent. So, few definitions a few definitions we can discuss here you may have heard the term LPGCNG. What is LPGCNG? It is a Liquefied Petroleum Gas liquified petroleum gas and CNG compressed natural gas. Both will look like same as you

are getting from the market even burning you are getting energy for maybe you are cooking like an Indane gas cylinder will be coming to your home from Indian oil. So, that will be LPG-CNG vehicles are there they are using CNG compressed natural gas.

What is the difference between LPG-CNG and CNG? CNG is a Liquefied Natural Gas and it is obtained directly from a well bore. But LPG when you are talking about LPG is coming when you are processing crude oil in your refineries you change different temperature pressures and you will get lots of low molecular weight gas and low molecular weight liquid that will be going out from your crude oil. Those you liquefy and use for your energy purpose, for example, you are cooking. CNG will have a compressed natural gas when you are saying you have a molecular weight lower molecular weight lower.

So, methane normally 70 percent or more methane will be there than methane or ethane mixtures C2H6. But if you are saying LPG LPG is longer chain hydrocarbon like C4H10 or C5H12 I think the combination is like this CH3 CH2 CH2 CH3. So, this is 6 7 8 9 10. If I have one more then it will be 12 ok. So, this is the difference between short-term short-chain hydrocarbon CNG and long-chain hydrocarbon LPG.

And what is weight gas and dry gas? Weight This weight term is not related to water. So, weight in general common people understand this water is soaking something that is weight. But in our case in the oil and gas industry, weight means we assume that some liquid particles also there in gas or liquid are soaking something liquid that can be water that can be oil. So, dried natural gas contains more than 70 percent of methane and some ethane dry when we are talking about dry. And weight gas will contain CH_4 C_2H_6 LPG liquified petroleum gas like C_3H_8 C_4H_{10}.

So, here actually C_3H_8. Condensate also will be there condensate means it large in several carbons and will be more in a condensate mixture of hydrocarbons like

say C5H C5 to C8. This is condensate if you are going further longer chain hydrocarbon. It will be liquid actually if you go to hydrocarbon say 30 or something CCC connections then it will be waxes 13 that group will come. So, more carbon numbers are greater than the calorific value.

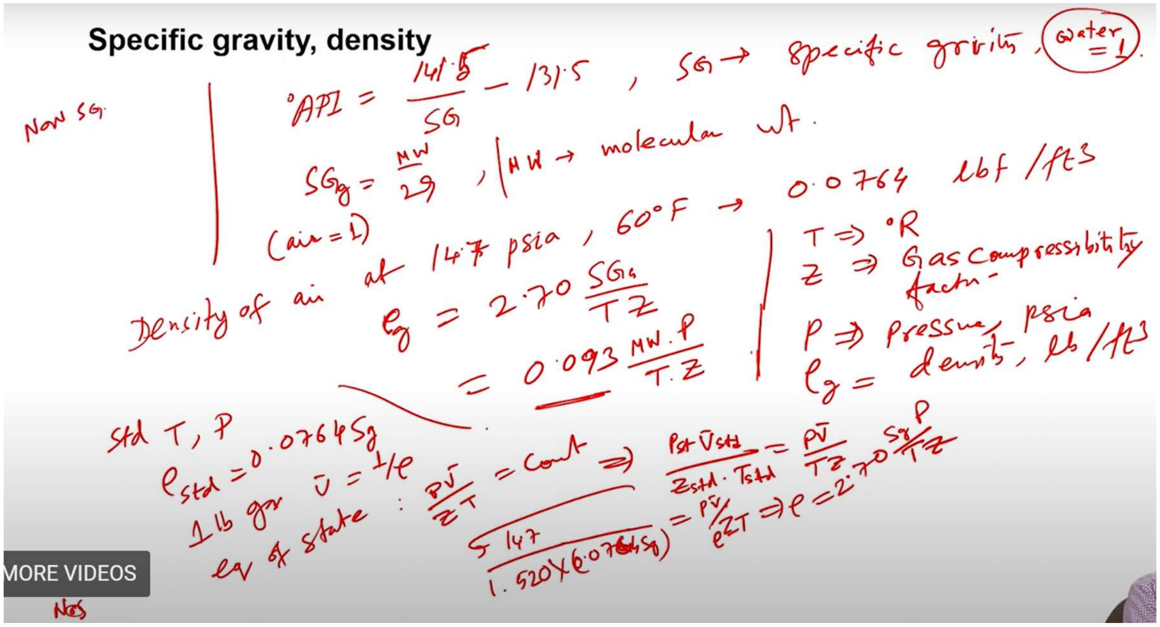
So, a larger number of carbon is there. It will have a larger calorific value, for example, CH_4 and C_2H_6. So, C_2H_6 will have more calorific value it will give more heat if you burn it. So, heat of combustion heat of combustion heat of combustion if I take CH_4 it will have 89 some data roughly I am giving 890 kJ per mole and C_2H_4 ethane. So, the heat of combustion is 1411 kJ per mole and C_2H_6.

So, here H amount increased. So, the heat amount a little bit increased by 1560 kJ mole. Here I am writing k small and J capital J name is the joule name of some scientist and k means kilo. So, kilo always will be written small k, not capital K, and mol mole or mole. So, in short form, we write mol.

So, always k you write k small like kg k small kilogram kilometer. So, k will be small if you are writing capital K. So, that people can understand, but technically that will be wrong. A few other properties of oil and gas you should remember are dew point, bubble point, cloud point, pour point, and flash point. So, the dew point is that like you have a certain amount of gas and you are reducing temperature.

Once you start reducing temperature after a certain time you will see seeing small amount of bubbles being created. So, that point is called the dew point the temperature. And during after any season when it is moving to winter. So, that time also a temperature going down in the air. So, you can see in morning time lots of small water bubbles will be deposited on your grass ok those are dew actually because the temperature went down and some amount of moisture is there in the air.

So, that moisture will be cooled down and it will be deposited somewhere. So, the temperature at which it starts creating bubbles is called the dew point. A point at which liquids first appear within a gas sample. A point, point means the temperature at which liquid first appears within a gas and this is called a dew point. So, a point means temperature.



And bubble point, bubble point means like you have liquid. Liquid can have dissolved gas low hydrocarbon low short chain hydrocarbon now you are increasing temperature. So, when you increase the temperature level after a certain temperature bubble will start creating a bubble will. So, the temperature is called the bubble point, and gas first appears when the temperature increases.

So, this is called true vapor pressure also called bubble point and dew point equivalent for a single compound mixture. So, this is also temperature I will explain again the bubble point and dew point. Pressure, and temperature you have seen in the phase diagram you have a triple point, triple point, and this is called a bubble point. The bubble point is called the dew point this is a line because you have two-phase flows and you

are changing the temperature pressure simultaneously which is why you are getting a line. So, if you fix one let us say if you fix one pressure and you change temperature then you will get only one point.

Again for another pressure, you will get another point another point another point. So, in that way now you have different points and you connect all the points you are getting one line actually for bubble point. Similarly, you are getting a dew point line also because this is a mixture of fluid when you are considering well wellbore fluid. So, it is a mixture of fluid different hydrocarbons will be there. So, because of that reason, this is liquid this is liquid zone this is gas zone this is liquid plus gas.

Because of different hydrocarbon different numbers of hydrocarbons there that long-chain or short-chain hydrocarbons are there. So, when you are changing temperature pressure, sometimes some fluid will be trying to separate from liquid or gas. So, you are getting one two-phase region, but if you are using only a single phase then you will not have a phase region you will have a liquid region, and a gas region in between the bubble point and dew point will be the same. Now, cloud point. So, the cloud point is that if you take a certain amount of transparent liquid then you reduce the temperature after a certain reduction of temperature you will find lots

of white bubbles are coming, creating a hazy mass.

So, that is creating cloud white cloud and it will be non-ad almost transparent. So, it is called cloud point. The temperature at which the solids are getting separated from the liquid that is called the cloud point. The temperature at which paraffins first become

visible paraffins first become visible that is called the bubble point. When paraffins first become visible it is called a cloud point, or pore point.

Pore point you take a certain amount of fluid there, and you start reducing temperature once you reduce

the temperature after a certain time the mass will get thicker. So, that time it will not be flowing smoothly. So, that point the temperature at which these things happen is called the pore point. The temperature at which the crude oil becomes solid and ceases

to flow. Estimation of viscosity near the pore point is highly unreliable.

So, if you are getting more points using a certain explanatory method you are getting viscosity also. So, the viscosity will be unreliable and reliable you should remember. So, when a fluid-fluid ceases to flow and paraffins separate, they separate at a temperature called cloud point ok. When fluid ceases to flow this is called a pore point, I started already beginning part anyway I will make

it available in videos. So, we have already discussed specific gravity.

So, API specific gravity you know the formula you should remember every time whenever we will be specifying oil and gas. So, especially oil will be saying specific gravity of degree API. A very low degree means it will be like

heavy crude oil and the degree will be higher like say 40 or something that will be lighter hydrocarbon will be coming. If you go to like say 10 or below 10 so, it will be heavier hydrocarbons, heavy crude. If crude oil has 10 degrees API it will be equivalent to water, the viscosity or gravity.

The degree API formula is 141.5 divided by specific gravity minus 131.5. So, S g equals specific gravity, water equals 1 relative to water. So, water-specific gravity must be 1 and you are comparing it with water-specific gravity.

So, if you know specific gravity related to water.

So, if you can put it you can get API gravity or vice versa. If you know a specific API gravity you can convert it into specific gravity.

So, the specific gravity of gas S g just put symbol g. So, M w 29, M w is molecular weight molecular weight. And we are assuming a specific gravity air related to air, air equals 1.

So, the density of air is density of air is 14.7 air at 14.7 PSIA and 60-degree

Fahrenheit is 0.0764 lbf cubic feet pound-force per cubic feet.

So, rho g rho g equals 2.70 S g g by T z ok. So, T will be the degree Rankine, and z will be the gas compressibility factor

compressibility factor. P is the pressure I am writing units also PSIA ok, rho g density of gas unit will be lb divided by cubic feet. So, this will be giving 0.093 mega not megawatt it will be molecular weight molecular weight P divided by T z, z is compressibility. So, you should remember the units if you are mistakenly taking some other unit

then things will be wrong.

So, we will try to see how to get 0.093 M w ok this one because remembering these constants will be difficult, but if you can remember the derivation procedure. So, if you can if you forget remembering this constant you can derive ok. So, standard standard temperature and pressure if I take temperature and pressure rho standard

the standard condition density will be 0.0764 specific gravity of gas. And if we take 1 pound of gas and 1 pound of gas then V equals 1 by rho.

The equation of state becomes the equation of state is PV bar z T equals constant. Now, if we take standard condition and present condition it will be like this P standard V standard z standard standard condition means 14.7 degrees 7 psi and 60 degrees Fahrenheit. And T is the standard STD of PV bar by T z ok. So, if you put all the values here like P standard condition 14.

7 and z standard condition 1 and temperature 520 degrees. The V formula is that 1 by rho 1 by rho value is that 0.0764 S g and equals PV bar z T.

So, this will give rho equals rho also will come here 1 rho term rho equals 2.

70 S g P T z. Now, S g equals I should write somewhere else the video will be coming here. So, now S g I will write here. Now, S g S g equals molecular weight divided by 29.

So, this will give rho g equals 0.

093 molecular weight P pressure divided by T z. So, you should remember these terms. If you remember for the final term also it will be fine otherwise you have to derive. And this derivation is taken from Cunard's book. So, if something goes wrong just please follow the book.