Surface Facilities for Oil and Gas Handling

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Three Phase Separation-01

Good morning, we have started ah, Oil and Gas Separation chapters. So, two phase separator we have seen, two phase separator means this is gas, this is oil plus water. So, when we are not separating oil and water separately like we are assuming this is a liquid. So, that was two phase separator ok, this was two phase ah, two phase separator. But if we separate oil and water also then it will be creating a three phase separator. So, three phase separator means it is like this ok.

Gas I am writing only G for gas, O for oil and W for water. And I am writing like G O W because of gravity difference is there, water will have higher gravity. So, it will be the bottom layer and one more layer may be possible may be sand and other debris will be there at the bottom. So, we are not showing that one.

We are assuming there are three phases only. Three phases means one gas phase, liquid phase, liquid phase have two component oil plus water. Now, retention time. So, normally 3 to 30 minutes ok, 30 minutes retention time will be there ok. And the other terms it explain like free water.

Free water when you are separating and some water will be coming out automatically. So, there is free water actually ok. So, water fraction obtained from gravity settling is called free water ok. Beneficial to separate a free water before attempting to treat remaining oil in emulsion ok. So, oil and emulsion you are separating means that will take more time you have to use maybe heater, heater or you have to maybe use electrical systems.

So, without using that on only gravity separator is giving the water that is called free water

ok. So, coming from gravity separation, coming from gravity separation ok. Three phase separator and free water knockout. So, another term is coming free water knockout, free water knockout ok. And free water knockout what you are doing? You are removing there is small amount of gas and you are separating ok.

So, this is called free water knockout. The terms used describe pressure vessel that removes water from mixture of crude oil and water and gas amount will be lower very low amount of gas is there. So, oil and water separation ok. And you are removing basically water removing water, removing water and gas is limited, gas percentage is low ok, very low percentage of gas is there and you are removing water. So, that is called free water knockout.

Flow normally enters directly to separator from wellbore or well head or it may be coming from other separator to your to your separator systems ok. Equipment description when you are saying first let us draw one picture of horizontal or any you can draw vertical separator also. So, equipment will have one diverter right as we are discussing already inlet flow coming from well head or different type separator or high pressure separator to lower pressure. So, if you are going for high pressure to lower pressure means one stage, two stage, three stage the first stage will be higher pressure, then lower pressure, then lower pressure, then lower pressure. You can remember this stage separations technique.

So, different stages will have their own pressure, but it will be lower than the previous stages ok and more than the next stage. So, this is inlet diverter already we described diverter. If we have vertical separator then maybe there will be one down comer down comer and spreader we will explain later ok. And if you are using three phase separator. So, normally this will be coming down to water level inside water and there may be some where this.

So, you are collecting oil here and when you are collecting oil you should have one dump valve and controller right oil out and gas you will have mist extractor as you know ah this will be pressure controller right this will be level controller ok. Because gas we are not controlling level there we are controlling the pressure ok, but in liquid case we are controlling level in which level it is working ok. It should not be too low or too high. So,

that level you have to set a minimum maximum limit and there will be another layer. So, this may this is oil maybe oil plus emulsion and this is water ok.

And your fluid entry fluid will be coming here ok, it will be entering like this ok. So, slowly it will be coming down and it will be what going through water and oil will be floating over water and any gas is there it will be bubbling up and it will go through the gas gas outline or gas exhaust line gas out oil out and water I will take water you are taking through another level controller will be there ok water out. And this is actually when oil and emulsion layer level is going up. So, it will be overflowing and it will be falling here ok. So, this vertical one is called wear ok wear.

So, it is restricting flow when something is overflowing ah it will allow overflow, but it will not when it is level is lower oil level. So, it will not allow to flow water to this bucket or this area ok. So, whenever this area is filled you are getting oil out if this area always not there again you stop dump valve allow oil level out level going up again again open it going out. So, continuously you would you are doing ah this job ok. Sometime you are stopping, sometime you are opening stopping opening.

So, that work will go on ok. This is ah ah water and this one upper one is gas ok. So, this is called inlet diverter and if I draw one vertical separator. So, normally it will have one down comer. So, similar way as horizontal you just turn it down ah turn it up ah this is inlet ok and you will have again diverter then you will have one down comer down comer then one chimney will be there this is called chimney ok.

Then here there will be one mist extractor right. So, it can be like PC pressure control system gas out ok and this is called spreader in wider section and lots of holes will be there. So, it will be smoothly spreading you are creating laminar flow ok you are not creating lots of turbulence. So, slowly smoothly ah whatever fluid is coming it will be spread in water and this will be located nearby water and oil interface ok. This is water oil interface water oil interface ok and this is water and oil layer we can create one where ok.

This is oil ok. So, oil will also have again dump valve and you have one level controller level control simple you can remember LC we are used to write ah ok. So, oil out and water again we are we will create one level controller here right level control will go like this ah water oil interface ok level control will go like this just wait ok no issues ah. Then dump valve control by this and I will have one level C level controller is controlling the dump valve ok this is water out ok. The purpose of chimney chimneys to equalize the pressure inside this closed area ah oil water gas gas ok. So, if any gas is there it will be equalizing upper part and lower part and this is inlet diverter as usual inlet diverter ok.

Inlet will be diverting and slowly liquid will be entering here ok gas free gas will be going out anyway and if still there is some gas available. So, again from water and oil layer it will be bubbling up slowly it will be going out also because this gas chimney is there ok that equalizing port ok. So, you can see this is spreader this is called down comer. So, down comer will be there in vertical separator only and there will be spreader because it is long ah area ok ok. So, diverter changes ah it ensures the little gas carried out with the liquid or almost no gas diverter will be ah pushing liquid down.

So, gas it can go escaping most design contains ah down comer that directs the liquid below oil and water interface just oil water interface. So, it will be water washing. So, spreader location just below below oil water interface. So, that fluid will get ah water washed ok. If you are moving location to other part then water wash will not be there.

So, just in water area smoothly you are creating laminar flow you are giving this spread ok you are creating water wash ah. So, water wash is the coalescing water droplets. So, if there are lots of water particles are there. So, ah when it is coming in water area. So, water particle will get more water.

So, it will create bigger particle and bigger particle is there it will not move up rather it will be staying there ok. So, that way you are creating bigger particle and if you know the settlement formula V t right. So, if you have ah larger diameter. So, settlement will be quick, but in this case it is in water area. So, water particle will not move up or down the same gravity will be there when same gravity is there water particle will be staying there you are spreading inside water zone.

So, you are making bigger particles. So, it will be staying there, but lighter oil particle and gas particle it will be moving up ok. Oil pad the the the layer you are creating is oil pad actually this is oil pad oil pad or layer here also you are getting oil layer. So, this is oil pad actually how much thickness of oil and emulsion layer is there this is called oil pad ok. Oil plus emulsion layer forms a layer and wear maintains the height of oil and emulsion layer ok.

This ah you can see in both cases I have drawn wear ok. This is wear for vertical separator W E I R ok. Halogen separator also I have shown on wear. So, you can see side by side the difference of halogen separator and vertical separator that mechanical design actually. And few things are there I have shown like diverter wear, but still there are so many items we did not show gradually we will show like wave breaker will be there one vertex plate will be there.

So, that vertex will be broken ok. There will be splash breaker ok. So, some mechanical arrangement will be there. So, the splashing will not be creating rather you will be creating laminar flow smooth flow. So, that water and oil will get separated, but will not be again mixing up, but you are creating too much turbulence inside separator what will happen water oil particle again it will try to mix up. So, you try to create laminar zone or calm cool zone.

So, actually in vertical separator you are creating more cool zone ok. So, it will be good for solid separation solid particle slowly moving down it will be getting settled, but horizontal separator oil and water pad thickness is lower thickness vertical thickness ok. So, it will be more turbulence actually. So, solid separation will be little bit difficult, but vertical separator you have thick water column oil column ok. So, in that case separation will be proper especially solid separation ok.

Where maintains oil level level control maintains water level ok. So, what will ok level controller where both are maintaining water level or oil level and interface I will draw properly here oil water interface. So, that you will understand oil water interface is here ok. So, I I made thick interface area this is interface and in how vertical separate also I

will be drawing one interface area you can see I have drawn interface ok. This oil water interface area very important because if interface is moving up very high then actually where water level will cross the where.

So, oil outlet will get lots of water again if oil level is very much lower very much lower lower lower then after certain time oil outlet will get lots of gas. So, you have to maintain that properly. So, that it should not get gas or water. So, oil outlet should get only oil water outlet should get only water ok. And again the gas zone also it should not be too small like 50 percent gas we filled in 2 phase we have seen.

Now if we going smaller smaller smaller that 50 percent to 40 percent 30 percent 20 percent gas area then after certain time you will find in gas line oil is going out ok. So, you have to maintain that level properly using air and using level controller. Now mechanical level controller is there these days there are electronic level sensors also there for automatic control systems. So, but first we are focusing on mechanical level controller ok. So, you should understand things then you use electronic or any other thing that will be ok.

So, 3 phase separated types types ok. So, basically horizontal we have seen horizontal right vertical and free water knockout. This will also be vertical horizontal free water knockout. This short form they say FWKO ok. And when you are talking about horizontal again you will have basically 3 types they have defined one will be like interface level controller interface level ok.

And another is bucket and wire. So, basically horizontal separator there is some different fitting mechanism inside there in that way they are differentiating, but everyone not differentiating, but some author has differentiate like this bucket and wire and another is only wire ok. This boot type boot type ok. So, interface level controller it is like this you have horizontal separator and you have inlet diverter ok. I am not drawing properly I am just quickly I am drawing ok. And this will be longer and it will be going to water level ok inside water this wire will go.

And you will have one wire for oil ok. So, this is oil this is water water oil gas oil means oil plus emulsion ok. And this is oil out this is water this is gas ok. Now when water out we will have to put one interface level controller right and it is coming like LC like this oil also will have interface controller LC level controller we write then ah ok. So, level control will like this. So, when level is changing your dump valve will control by level controller ok.

So, gas also will have pressure control system. So, it will have like dump valve ah then pressure control ok here PC here LC. So, do not mix up ok ah. So, gas this is ah oil ok. Now bucket and wire what what is the bucket and wire type thing? So, bucket and wire type like again draw your horizontal separator you draw inlet diverter.

Now you create one bucket ok. So, bucket this leg will be longer than this leg ok. So, if you see A B C D. So, C D will be A B ok. And how it will work? It will work like this ah just wait ok. Some liquid will be coming here and your another wire will be here ah just wait ah ok.

So, water and water is fluid coming here some fluid will go up right some fluid is showing here some fluid will be going going through this it will be going it you are collecting. So, this is water ok and oil you are collecting here . So, oil so, you are creating a small bucket. So, bucket if I draw in 3 dimensional figure how it look like it will be looking like just I am trying to draw ok and you are separated like this.

So, completely you are blocking ok. So, you may have this separator ok. So, completely you are blocking half portion like say ok ah one small leg one larger leg ok my bottle like this ok you can assume. So, perpendicular like this and your fluid is entering here. So, when it is entering so, some fluid will be going through this and one hole will be here you are taking water out ah not water this is oil out ok. And inlet diverter and fluid will be coming oil this is ah this is what this is water this is water ok.

So, from diverter fluid is coming and from below the bucket water will be going and will be crossing this where and you are collecting water ok. So, this way so, your leg A B C D. So, A B and C D if you see C D will be ah longer than A B ok. Then whatever oil you are getting oil will be splashing, but it will not cross the C D that D D line ok C D E maybe D

E you should not cross if it is crossing D E then actually water where it will get oil also ok. So, actually so, your design should be like this ah this bucket bottom portion will be lower than this water oil interface lower than the water oil interface ok.

Then water will be entering below the bucket then it will cross the where, but if you are having a bucket bottom part is more than this water oil interface then oil also will go through this and it will cross the where fine. Let us say one situation ah I have where here here ah and water oil ok and this is my separator and the water layer here ok. So, water will not enter cross ok A B C D. So, in this case you see this ah water out water out is not getting water other it is getting oil you see this oil is continuous becoming like this right. So, your bucket bottom portion should be lower than ah this interface level.

So, in this situation you can see A B less than D C A B longer than D C. So, what will happen some ah let us say this case if there is any overflow and dump valve is not working then this will be overflowing and it will go there ok. So, two things you have to remember. buckets bottom portion must be upper and one leg C D will be longer than A B fine then you will get proper bucket and wear arrangement . Then ah then I should write like bottom portion of bucket bottom of ah bucket should be ah lower than the oil water interface ah interface fine ok.

Next is boot. So, boot is like this I have one separator ok and wear is here and you have inlet diverter inlet is here ah. So, liquid will be creating one layer water layer will be here and you are taking water out ok. And oil water gas ok you can see this in boot case you see one small a large portion is there in separator. What happens this will create very calm environment. So, that oil oil particle will be moving up slowly and water will be collected there from there small amount of water you can collect I can separate ok.

So, it will not take larger space on your separator system rather you are getting small chamber where you are getting your things separated fine. Next is free water knockout free water knockout can be like vertical or horizontal ok. So, you are getting more water and small amount of gas ok. So, gas portion may be smaller. So, first liquid separators section gas percentage will be lower ok and liquid percent will be higher ok.

So, this is a free water knockout small small gas small amount of gas ok. And more of a small amount of gas and you see separating water separating water separating water ok.