**Surface Facilities for Oil and Gas Handling**

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**Horizontal Separator And Sizing-01**

Good morning, last day we started filter separation, cyclo separation other part. So, from here I will continue today cyclone separate actually cyclone separate is one device where you have one conical shape or maybe parallel shaped system and fluid will be entering tangentially ok. We discussed in the last day fluid will be entering tangentially like this picture you can see top one here fluid is entering and it will be rotating when it rotating it will be rotating continuously and it will be going down ok. This rotating continuously it will be going down. Now, the high density particle high density particles will have larger radius ok. And low density particle will have lower radius why? Because when both are rotating together high density because of mass it will be trying to move further away from the centre core and lower density it will try to go, but high density fluid will have already taken the space.

So, when it is rotating high density fluid will touch the surface or the device surface and it will not give space to the low density fluid. So, what will happen low density fluid will not touch this separated surface or device surface and it will be rotating at the centre core. From centre core you put one pipe and you suck this low density fluid low density or low gravity fluid you suck from here ok. So, in that way you are separating and high density fluid you are getting here or you can see this high density fluid you are getting here ok.

So, in that way you can separate two fluid they say solid and liquid, liquid and gas even two liquids also different densities possible to separate using this mechanism. Because this there is no problem this is very much sensitive to the flow velocity and pressure. So, if you do not maintain proper flow velocity separation will not be proper. So, it is required to have a good flow velocity, flow velocity means actually you have to maintain certain pressure, pressure drop will also be pressure drop also be high. Then this separator is not having a rotating part or moving element.

So, life is longer actually if we use centrifugal separator using some mechanical means there will be life will be longer here in this case life is smaller. So, all the separating system other mechanical equipment which are static in nature the mechanical equipment no there is no relative movement that their life will be longer. If there is any relative movement between two mechanical machine parts then there will be any friction where there are some other issues because of that life will be shorter. So, the designers will try to reduce number of moving elements or relative moving element. So, that system life will be longer.

Now, we have seen horizontal, vertical and spherical separator because of this spherical separator small use we are not discussing or we are not differentiating among these three. So, just we are focusing on horizontal and vertical separator these are most commonly used in the surface or offshore production systems. So, horizontal separator if I divide like this horizontal separator is smaller ok, smaller in size less expensive, less expensive, less expensive and less liquid surge, less liquid surge, more plan area, more plan area means side area will be more ok. This is more plan area you are getting. So, larger liquid capacity, larger liquid capacity best suited for liquid liquid separation foaming crude, best suited for liquid liquid separation foaming foaming liquid ok.

So, foaming liquid means like if foam is there in if you are giving lots of surface area then foam will be broken or two particle will be colliding each other and it will be separation proper. So, in that case horizontal separator is better because you are getting more surface area. Surface area means like if this is separator and if this is gas sorry this is liquid means oil plus gas oil plus water this is gas ok. So, you are getting lots of surface area here, but if you have vertical separator your surface area is this one ok, smaller surface area ok. This area I am indicating this area is more for horizontal separator.

So, that is why foaming crude will have better performance, but if you see vertical separator in that case better in handling solids better in handling. So, solid particle will be slowly moving down and it will be settling here because it will be more calm zone and this is more turbulent zone. So, if fluid gas and liquid interface will be more turbulent zone, but if you see the bottom area. So, there will be more calm zone. So, this settlement will be better.

So, solid will be settling quicker and better way less plan area. So, this is from side it is having less plan area ok. Then horizontal separator this point is important for offshore application ok. So, because if you need very large space offshore will be very compact area actually deck area or semi submersible any other platform surface the separation area will be very small. So, in that case you need a smaller compact system.

So, in that case vertical separator may be better ok. So, relief valve and other less plan area and for this is for important this is important for offshore area offshore application ok. And relief valve and some of the control may be difficult to put relief valve, the sitry etcetera can be difficult to put, but anyway these are safety device. So, you have to put anyway. The vessel may have to be removed from the skid because it is very tall.

So, it can be toppled. So, you may have to remove from skid ok, then you can use. So, this will be better ok. So, till this time I discussed basically a vessel it is having inlet flow. I have shown you mist extractor ok, mist extractor and your control valve here and basically two phase I have shown.

So, there will be valve, dump valve this is called dump valve, dump valve and it will be controlled by level controller ok. So, it will be like this LC ok. So, level controller level controller ok, this is pressure controller ok. This is liquid, liquid means water and oil mixture, this is gas ok. So, but this is not actual case, actual case will have there will be many other items like splash guard, inlet diverter, deforming plate, vortex breaker, mist extractor, mist salamander, there will be some more items.

So, this is a basic equipment I will discuss here. So, let us say one by one splash guard. What is splash guard? Splash guard means like say ok. So, splash guard actually it will be reducing turbulence and it will be creating a laminar zone. For example, let us say we have one vertical separator ok, you have inlet diverter we already will discuss further again this inlet diverter, inlet diverter and this is inlet flow I n l e t inlet flow ok.

So, when inlet flow is coming it will create loss of turbulence ok. And it is creating let us say this space and you have water out ok. Let us say you have oil you are taking out like this, water you are taking out like this and you want more calm zone for water outlet.

So, that oil particle anything is there that can be separated or you are creating less turbulence. So, you are creating one guard here like this ok.

So, it is creating it is minimizing agitation, minimizing agitation or turbulence ok. So, that particles sand maybe will be settling quickly. So, slowly it will be settling at the bottom water particle will be creating small path and it will be moving up. So, water without heavier turbulence you are taking out ok. So, this is called splash guard inlet diverter.

Inlet diverter already I have shown here this one inlet diverter ok. This one inlet diverter I can you can see this one I am drawing here ok. So, inlet diverter actually this will be diverting when fluid is coming. So, inlet diverter when fluid is coming from in coming from the inlet pipe. So, it will be diverting flow and it will be pushing downward.

So, that high density particle will go down and low density particle will try to move up ok. And it will be going through mist extractor or gas outline ok. So, this is called inlet diverter. So, there will be different shapes of inlet diverters for example, one shape will be like this one shape inlet diverter inlet diverter ok. One shape can be like this you have separator it will be curved ok.

So, fluid will be splashing it will be going down ok. This is inlet diverter and another shape can be like L shaped. So, they are in vertical separator I have shown L shaped L shaped like it will be like this entering this inlet diverter ok. This is inlet diverter. So, it is be it will be helping to control the emulsion of foaming into the vessel by directing it down along the sidewall.

It minimizes disturbance when gas and oil or fluid liquid and gas is getting separated ok. So, some will be tangential baffle like L shaped thing some will be like smoothing smoothly it will be diverting. So, it will be curved feature will be there. So, that fluid will be liquid will be going down and gas will be going up. So, it changes the direction of flow by absorbing the momentum of the liquid and gas to separate in horizontal separator or vertical separator ok.

In many cases there will be down comer in vertical separator I will discuss later ok. In some separator there will be sand jet in mechanical equipment. So, sand jet will be like if sand is getting deposits or the bottom of the separator. So, a jet you create and remove the sand and you pushed out from push out from the from the separator system.

So, there you go sand jet system. Removable system or sand jet and drain is used to remove solids which may accumulate at the bottom of a vessel ok. Deep foaming plate ok. Now see the deep foaming plate. So, foam what is foam actually? Foam is actually gas particle covered by liquid coated by liquid ok. So, this two gas particle will not touch each other because it is coated by liquid ok.

So, it is creating like this liquid surface is gas. So, it is creating small different size of particles will be covered like this and it will be creating foam ok. When foam is created let us say this is my separator ok. Foam is foam is taking lots of space actually. So, your separation efficiency will be dropping ok.

When liquid a gas entering foam is taking lots of space gas cannot go out and separation efficiency will be down and coalescence will be reduced ok. So, merging of two particle will be difficult if foam is there and foam is created because of viscosity viscosity high this foam will be created and it is also possible that impurities are there. So, as per the other thing it will create again foam and pressure decreasing also it will create foam. So, if you can remove all this criteria then foam will be reduced. If you are unable then you have to create some de-foaming plate or mechanical arrangement.

So, you can add some chemical also, but chemical will be expensive process. So, easiest way is to create a mechanical arrangement. Mechanical arrangement different plates will like different plates say one plate, two plate, three plate you can create with angle with certain angle. So, when you are creating plates certain angle and fluid is flowing through this the particle will be colliding each other the gas particle actually when it is moving and closer to each other. So, particle will be colliding when they are colliding gas bubble will create bigger size bigger size means they will burst quickly and gas will be released liquid will go down ok.

So, this is called de-foaming plate. So, de-foaming plate will be like this if I draw like this it will be like separator and de-foaming plate will create lots of de-foaming plate when fluid liquid of gas mixture is going through this one particle will be colliding gas particle or gas bubbles will be colliding each other it will make bigger bubble again it will get burst after certain size because the surface tension will change and your gas will go to gas line and liquid will be deposited there. So, that way you are increasing your separator efficiency. Vortex breaker what is vortex breaker? Vortex breaker is there like if you have one pipe and water it is sucking let us say the water level is here and water pipe is like this water is going through this pipe. So, what happens if water level is not so high it will create lots of vortex when it is creating vortex it will suck air, air will be sucked. Similarly your surface system you have let us say water outlet line and if you water layer is here.

So, and if you are not maintaining this vortex breaking system then what will happen it will create turbulence it will create vortex ok. It is rotating and it will be creating one funnel like system and funnel center core will be sucking air in the in separator system gas will come and it will go through your liquid line maybe water or oil. So, you have to put some vortex breaker you can see the top picture I have given it is one type of vortex breaker you can put some flat plate also as a vortex breaker you can there are several types of designs available, but if you put let us say this is a liquid surface and you put some flat plate over it. So, then this if you rotating it will not suck air because it is blocking the air path or you can create some mechanism like this let us say this is your pipe this is your flow area you can create one flat plate here. So, that fluid will be sucked from here or you can create wider entry.

So, that fluid will not create vortex or if it is trying to create it will be blocked by certain flat plate or some other arrangement. So, they call vortex breaker if you are not giving what is breaker because of high wind fluid liquid or oil water is going out of the separator it will create a vortex gas will go out through the line. So, your main purpose of separation is done system will not work. Many time I said that mist extractor and mist elementary is there in almost every separator. So, what is that actually it will be like woven metallic mesh.

So, when liquid mixed gas is going through this one liquid will be touching this mesh where and it will try to create bigger particle it will fall down and only gas will be passing through this one. So, this is called mist extractor or mist eliminator or demister. So, many

terms are there a device used to collect small liquid droplets moist or hydrocarbon may be water or may be hydrocarbon coated particles they are moving trying to move out through the gas line from the gas stream before leaving the separator it will be you have to put and the particle will be growing bigger and it will be falling down. Wire mesh so, there will be many types of systems like wire mesh will be there wire mesh centrifugal device will be there, there can be vane type separator system mist eliminator system. So, vane type is like this you create vane like this and when gas and liquid mixture together flowing through this liquid will be passing through this narrow channels when it is passing through the narrow channels with low velocity.

So, liquid particle will try to join together it will try to make bigger particle when bigger particle it is making. So, it will try to set slide down and gas particle will move up. So, this is called vane type separator. So, vane type like this type of thing and it you can create some angle.

So, that when gas and liquid is going out. So, gas will be moving trying to take the upper space liquid will be taking to take lower space lower space means the liquid particle density will be more. More density means number of particle will be more and number of particle more collision rate higher collision rate higher means it will make bigger particle bigger particle means just slide down and gas will try to move up. So, in that way you are separating liquid and gas. This is called mist extract wave breaker. Wave breaker is like this like if you have offshore platform or anywhere the your separator system is shaking.

So, because of shaking you will create like wave you see this bottle water is there half filled. So, fluid will be moving like this. If small shaking is there or big shaking is there then you can things will not work, but small shaking is there still inside water you can see it is creating very large waves. If you have large waves then actually things will not work. How? Let us say I have one horizontal separator you are creating large wave and you have level controller.

So, level control will get confused it will not work or you have interface controller. So, there also the same issue will be coming if you have wave. So, you have to put wave breaker. So, what is the wave breaker? Wave breaker actually you put vertical plates. This is my separator let us assume and you put vertical plates.

So, if any wave is coming it will not reach to the another section of the separator. So, only local small wave can be there, but not a big wave like you can see this one end small movement of this bottle is creating big change in fluid liquid level in the another end. But if you have small lots of vertex breaker then this level change will not be significant. So, what is this? So, if I draw one 3D picture like this. This is your liquid level and I will put level controller like this.

And from side if I see it will be like this and you put lots of pores. So, you create resistance when fluid is trying to move up freely move one point to another point freely you are giving some baffle plate or vertical plate and you give lots of pores. So, fluid will be passing through this, but it will be passing slowly. So, it will not have so much motion inside the vessel.

So, you are creating resistance creating hole to create. So, wave may result from surge of liquid entering the vessel nothing, but perforated baffle this is perforated baffle these are called perforated perforated baffle plate that are placed perpendicular to the flow. Wave action should be eliminated then level controller will work. Level switch or wear anything is there if wave is there things will not work or it will be giving wrong signal to your sensor or it oil line will give water water line will give oil. So, that sort of many issues will be coming up.

So, you have to put wave breaker to reduce waves. Next thing is a down comer in vertical separator many cases you have inlet diverter. In many cases you will not have inlet diverter you will have down comer. How this down comer works? It will be looking like this ok, then ok, maybe wear and it will be like this water oil gas this is also gas means text tractor ok and water out water out this is oil this is called wear ok. This is called down comer this long pipe is called down comer and this is called spreader ok. So, down comer actually instead of inlet diverter people will be putting down comer just take fluid it will passing it will pass through this pipe ok, then it will go to spreader spreader is actually flat plate type thing and lots of pores will be there holes ok.

So, smoothly you are spreading liquid or gas whatever things are there in the water zone ok oil water interface nearby you are putting this spreader. So, that whatever oil and gas is coming. So, they will have water wash ok. So, to do why water wash? They say liquid

or gas liquid gas everything coming to your spreader and it is going out ok it is going out ok. Now gas particle will go up anyway, but liquid particles oil is there.

So, oil will have lots of water particle. Now what they are trying to do like if you have oil water particle in oil or oil particle in water. So, oil particle try to move up when it oil particles trying to move up. So, it will try to take some oil water also. So, what will you do you put inside water zone.

So, water and water particle it will create bigger particle. So, when you are creating bigger water particle water particle will try will not try to move up, but oil particle will try to move up ok. So, in that way you are trying to separate water and oil properly ok. So, it is location should be nearby oil and water interface ok, but inlet diverter it try to separate liquid and gas, but in this case you are trying to you are trying to separate actually oil and water gas anyway it will be separated and one chimney will be there here one chimney chimney. Chimney will be there chimney will be equalizing pressure inside this gas oil water zone and outside zone ok.

And one wear wear normally is used. So, wear like this is oil, oil will be overflowing through the wear and you are taking oil out. So, this can reduce the use of your level controller ok. So, wear reduce importance of level controller ok. So, spreader location should be interface area and you can use wear also if you are not using wear.

So, then you have to use on level controller one chimney should be there. So, that gas will be equalizing constantly and in this case your inlet diverter may not be there. Thank you.