Surface Facilities for Oil and Gas Handling

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Introduction To Separators

Good morning, I will be teaching today the factors affecting separators, different separator sections, different types of separators, and vessel internal what are the different equipment or fittings that are there inside the separators, I will just try to discuss them in this lecture. This is basically for two phases but the internal part will be in general for another separator also and the topics are covered in the book Arnold and Stuart Morris Surface Production Operation Volume 1. I think this is chapter 4. In the previous lecture, we saw two-phase separators and horizontal separators. We have drawn like this inlet is there, there will be an inlet diverter called inlet diverter right? Then there will be one layer of liquid oil plus water and this is gas and this is the mist extractor and if I have one valve control valve, this is called pressure control valve right and there will be another valve here.

This is a level control valve because if you are not maintaining level then there will be problems. So, you have to maintain the level here and in the gas line, this is liquid. So, in a gas line, you have to maintain pressure. Now, this is the simplest form of a separator.

The actual separator will have several other fittings also. For example, there will be waves because the offshore systems are there then and fluid will be creating waves. So, that wave will be creating problems. So, we should have a wave breaker, sometime we have a vortex breaker and some other fittings we will discuss later. So, this is a two-phase horizontal separator.

Now, similar way if I draw a vertical separator. So, again we will have an inlet, we will have again flow diverter and we will have a mist extractor side-by-side drawing so that you can understand the difference if it is two phases then you are creating gas and oil plus water, oil plus water and so you will have water out valve, water and oil mixture, liquid. This is

gas. In many cases, there will be some down comer. Down comer means like vertical separator I have.

So I have a vertical separator and one mechanism will be there like this. So, although fluid is entering here the fluid will be spread here only. So there will be spreader and down comer later we will discuss in details. Now, this is the simplest form of vertical separator. So, similar way you have a spherical separator.

The inlet is here and you have a flow diverter like this. You will have. So here design something unique you see gas is going out. So, I am not drawing all the valves here gas outlet valve. Fluid is entering here and diverter is this one is diverter.

This is a diverter and this is a mist extractor or demister or mist removal remover, mist extractor. Different names will be there so you should remember different names also. If someone is saying like mist remover also that is fine. So fluid will be entering like this and liquid will be falling it will create one layer. So, oil plus water or liquid.

And gas will be entering through this mist extractor and you are taking gas out. So, this is a specific design. So, you should remember that different component locations and what is the function also you should remember. We will discuss further different components then you will understand it is not so simple actually whatever you are looking at it is only simple one vessel pressure vessel is there and two layers you are creating but it will be much more complex when we discuss we will see. Now we will see the so whenever you are preparing please remember the difference between the separators where which equipment is placed where is the purpose.

Factors affecting separator. So, what are the different factors affecting it? So separation efficiency will be higher or performance will be higher if you know what are the factors controlling the separation. So, one thing is a gas and flow rate gas and liquid flow rate gas and liquid flow rate liquid means oil plus water. So, that flow rate means you have to know the minimum how much you are getting actually how much maximum you are getting, and how much average you are getting. So, your system will be working on the average side

but you should know the minimum and maximum limit also, if you do not know the maximum limit then sometimes it will be crossing that some set of variables setting variables then the whole system may not work.

So, you have to know the minimum and maximum flow rate and average also. So, what happens sometimes the minimum will be very low, and the minimum peaks will be very lower higher peaks will be very high. So average will not be like an average of minimum plus maximum average will be like it will be time-averaged. Time-averaged means that in the first minute, you will get this much flow rate the second minute you will get this much third minute you will get this much you are making time average time into flow rate then you are making average. So, that is the time average.

So that one actually will be the actual average. If you are making like the minimum plus maximum rate that may not work many times. Operation and design for different pressures and temperatures. So, P and T. So, whenever you are designing or you are buying a separator you should know the pressure and temperature rating and how to operate it.

So that also will be affecting your separator performance. Surging or slagging tendency of the feed stream. So feed stream whatever fluid you are getting so that it has surging capability or it is giving lots of surges or slagging then again your separation performance will change. Physical properties of fluids such as density and compressibility. So if you know density and compressibility then you know the separation performance.

For example, you can remember the formula of settling. Supposing it was like the, then specific gravity was also there those parameters were there. So, if you change those parameters your separation performance will change. So, you have to know density and compressibility also. Design degree separation is a 100 percent of particle greater than 10 microns you can remove then a degree is like 100 percent higher degree your separation but in some cases, you may allow a lower degree also depending on different conditions.

Presence impurities. So, impurities mean sand is one impurity, H2S is one impurity, and your paraffin, and asphaltene are impurities. So, if these things are there other than oil and gas then your separation performance will change because sand may be blocking your flow path, and paraffin will be choking all the items. Then accordingly you have to change your

temperature, you have to change your pressure, and you have to resize the whole system. So, those are changing your separation performance or you can say affecting separation performance.

Corrosion tendency. Corrosion tendency in that case actually if you have corrosive fluid this H2S or sulfur dioxide so, in that case, corrosion property will be higher. So, you have to check whether your material is selected for a separate system that is not getting corroded or eroded. So, corrosion erosion will occur together actually. So, if you can avoid that one if you know already beforehand then actually you can handle it properly. So, these factors will affect your separation.

So, the points are gas-liquid, flow rate you have to know, pressure temperature you have to know, you have to know surging or sludging possibilities, and physical properties of fluids such as density, compressibility, and viscosity of this parameter. Then you have to check the degree of separation and how many degrees you want to get from your separate system, the presence of impurity, asphaltene sand or other components are there. So, you have to check that one. So, that will affect your whole separation performance because something will be clogging your small holes let us say the mist extractor will get clogged because of paraffin or maybe sand will get deposited at the bottom or maybe the erosion rate will be higher. So, those things are also important as corrosive fluid If you have sand again corrosive fluid is there and erosion-corrosion can occur together that will hamper your whole production system.

Scrapper, two-phase separator to recover liquid carryover from the gas outlet to catch liquid by changing pressure or cooling. So, if a gas line is getting lots of liquid so in that case you can reduce the temperature so that some liquid will be getting cooled down, condensate will be created so will be getting created. So, your liquid will get separated. Gas line natural gas whenever getting it will be low short chain hydrocarbon or low molecular weight hydrocarbons and your oil high molecular weight hydrocarbon. So, if you cool down a little bit high molecular weight hydrocarbons will be getting separated quickly.

So, cooling is one option in the Scrapper system so that when you reduce the temperature your liquid particles with low higher molecular weight and low short-chain hydrocarbons

will be getting separated. Another way is that it changes pressure also you are changing pressure so that time also some get some fluid the high molecular weight fluid can get condensation. So condensation will be happening. So if you are not removing those things your gas line will get blocked the compressor will have difficulty and many other flow paths will be blocked. So, vertical scrubbers are commonly used in your oil gas systems.

So vertical scrubbers are commonly used. The major problem is blocking, blocking paths, and economic loss of economy may be right because some oil goes through the liquid line so that gas people some low molecular weight oil that has gone into your gas line. So, that may not be used by gas-purchasing people and you are also not getting money for that. So, that will be a loss of economy for that. So, using water you are removing dirt maybe, maybe water you are removing some oil also you are removing.

So, using a scrubber you can remove the unnecessary component of gas from the gas two-barrel separator. So, many times you use two barrel separators instead of a single barrel. So, two barrels are like this horizontal separator this is the vertical separator you have. So, in many cases you use two, a barrel separator will look like this. I have you can draw like this then and you have inlet here, inlet diverter is here and mist extractor gas is here and you are creating liquid layer here.

So, liquid out. So, the gravity settling section, gravity settling and this is the liquid collection section. This is liquid maybe a water and oil mixture and why are you using this two-barrel system instead of a single barrel if you are using a single barrel one barrel two barrel you are putting it separately and you need more space. But if you are using two barrels then one barrel gravity separate section you are getting gas and liquid and the bottom part you are getting calm environment. So that any emulsion and low density or emulsion particles are there like say oil in water water and oil it will be separating quickly or gas will be coming out quickly. So, you are getting a calm environment so that less turbulence will be created in the bottom cylinder or bottom barrel and your separation rate will be higher.

But these days because of the newer type of separator system single barrel these are very almost rarely used. Because of the additional cost and problem with the single vessel is reduced additional cost here I mean this one is a little bit costlier and the single barrel has improved design now so that is why people are not using this one. So this is called a double

barrel separator. What is the next filter separation? So, these are simple definitions what are the things that are there for different types of separation.

So, in filter separation if you have high gas and low liquid, liquid low, high gas flow rate and low liquid flow rate, low liquid flow rate is there in that case you can use a filter separator to remove liquid particles and another particle from gas. Either horizontal it can be or it can be vertical. So, I have taken one picture from HCP Petroleum Company you can see these are the filters. These are filters and fluid will be entering and will be filtered out filter out means solid and another particle will be caught in the filter and regularly you have to remove the filter and you have to clean it. You have to replace or you have to clean because of dirt and other things you are capturing inside the filter.

Next is the cyclone separator. So, one type of separator is the cyclone separator I think you may know cyclone hydro cyclone separator or cyclone precipitator. So many terms are there the cyclone separator is like this. I will first I will draw one common type of cyclone separator then I will explain. So, the cyclone separator will be like this, and fluid entry will be tangential.

It will be like this. If I take the top picture of this one it will look like this. Fluid is entering here. The tangential fluid entry is happening. So if I make I will try to make one separator system with this one.

Let us say this is cone type system. I hope it is visible in the camera and they are tangentially fluid entering fluid will be entering tangentially. You are giving at the center it will not work it has to give tangential entry so that when fluid is entering it will be rotating. So it will be touching tangentially it will be rotating with this inside. So this is called tangential entry. So here same thing happening it will be rotating fluid will be rotating like this.

And if you see the bottom picture here fluid is entering like this rotating and going down because gravity will be going down and because centrifugal action should be rotating. So rotating and down, down, down, down, down. So what is the benefit here in cyclone separator? The benefit is that if you have two different density fluids let us say sand and liquid. So different density high density if you can remember this mv square formula high mass it will create higher radius.

A lower mass will create a lower radius. So high-density fluid will try to take a larger radius and low-density fluid let us say sand is there and oil is there. So sand is high density so sand will try to touch this separator surface sand cycle separator surface. But oil also will try to touch but oil will not get space sand will say hey my mass is higher so I will touch this one you cannot touch because of the density difference. But both the sand will do sand will be rotating and it will be going down. Then your low-density particles will be collected at the center.

So low-density particles will be rotating at the center. Now you put on another pipe you suck it. So low-density particle will be rotating in the center and low-density particles are sucked from here. Suck low-density particles low density and high-density particles high density means maybe sand or you have an oil-water mixer also gets very high centrifugal action. So in that case also high density means water may be falling down oil low density will be moving up.

So you can create a separator also using the cyclone and you can separate oil and gas. One is that good work fluid pressure is high so use it directly if that pressure is not so high then you can use some centrifugal pump again you give high pressure and high velocity and it can be separated.