Surface Facilities for Oil and Gas Handling

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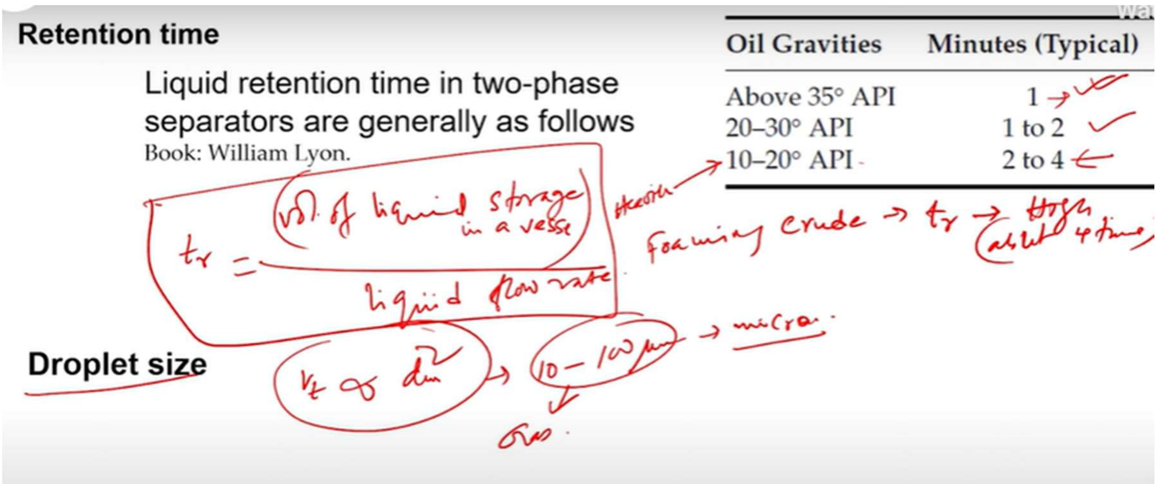
Horizontal Separator And Sizing-02

So, when you are running your system there will be certain problem because of foam creation, if paraffin may create problem, sand may create problem and there will be two term blow by and carry over I will explain. So, what is foamy crude? So, foamy crude is this, if we have paraffin aspartame sort of impurities and if you have maybe viscosity higher. So, in that case a foam will be created, this say you have separator and liquid what liquid and gas interface is this one and foam means like small small gas bubble coated by liquid ok. Let us say this is gas out ok. So, if I have lots of foam or bubbles not joining together because of certain chemical and other reason. So, this is taking certain space right.

So, actual separation space got reduced ok. So, because of foam, foam reduces separation space separation space ok. Large volume to weight ratio large large volume to weight ratio ok. So, volume is higher than weight ok.

So, it will create a froth over it and that will what is the problem? Problem is that if level control is there, level control will be working because of certain it does level control on balls or buoyancy floating device will be there. The floating device will be working if fluid viscosity fluid gravity and this gravity is properly matched. It is not matched properly because you created foam. So, actually your gravity of foam is different than the actual liquid, then your level control of the ball will be floating how much? So, it will be creating wrong signal ok. So, when it is getting wrong signal.



So, liquid out valve can be opened before required time or after required time ok. Uncontrolled foam bank impossible to remove separated gas or degassed oil from the vessel without in training some of the foamy material in either liquid or gas line ok. So, this gas line can get some foamy material some bubble particle or liquid line also can get some foamy material. So, both cases it is a problem. So, you have to remove foam, then you can get your liquid out or gas out ok.

So, in some cases you can use foam depressant or chemical and in some cases you can use that mechanical arrangement de foaming plates. Paraffin, paraffin actually at certain temperature it will be solid ok. If you increase temperature it will be in liquid form, but reduce temperature it will be hessi mass it will create cloud or small small particles that will be blocking everything ok. So, coalescing plate mesh everything gets plugged because of paraffin coalescing plate. Coalescing plate means particle will be growing together mixing together making diameter larger.

So, this coalescing plate ok or mesh or is deforming plate or anything it will get plugged. If known that the paraffin is a problem centrifugal mist separator can be used or you can at high rotational speed you can separate the solid also or paraffin also or you can increase the temperature of the system. So, that paraffin will not form solid. So, create liquid and you move from separator to another place where you can separate paraffin separately ok, your handle separately, but you cannot take a in say paraffin in every separator. So, increase temperature remove one by one then maybe in certain stage you can remove the paraffin that will be ok.

Sand again sand also one biggest problem from beginning I am discussing the sand particles will be heating the metal surface when it is heating metal surface it will be eroding actually. When small sand particle heating metal surface one particle and the particle two particle three one million particle two million particle heating. So, metal particle surface will be erased gradually ok. When metal surface is getting erased and if you have corrosive fluid. So, erosion and corrosion will be occurring.

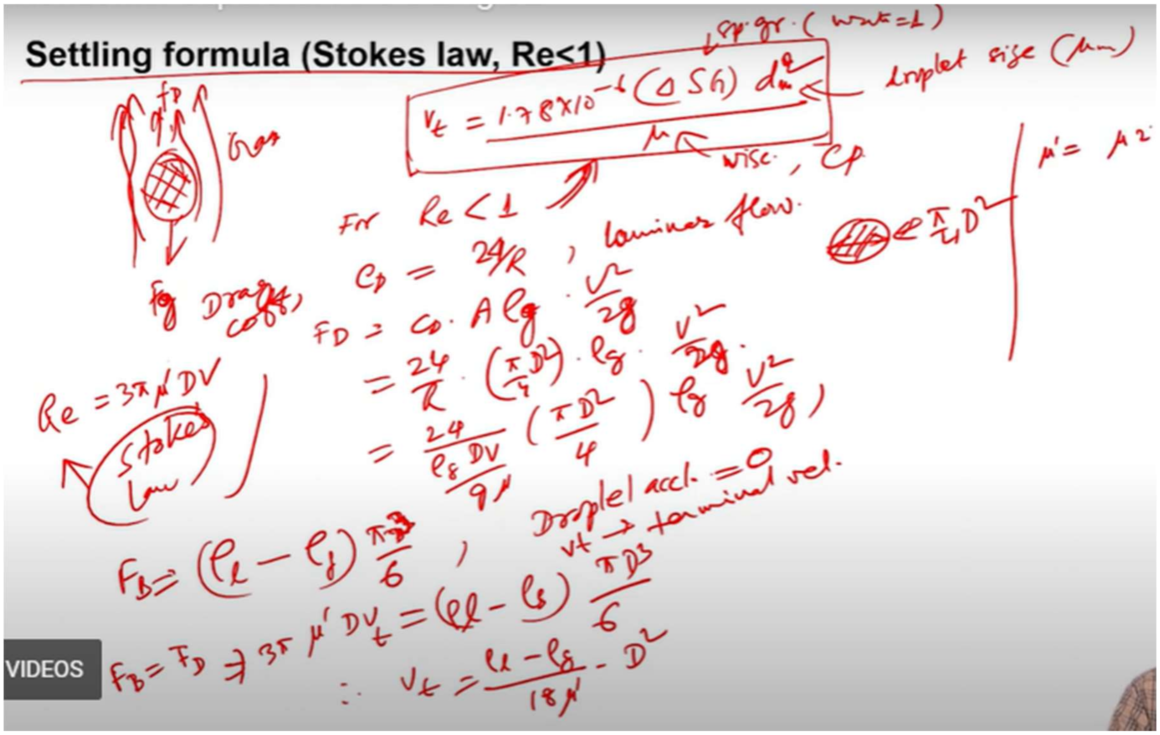
So, erosion and corrosion corrosion needs some fresh metal surface and corrosive gas it will be reacting it will be creating salt. So, salt this iron plus H_2SO_4 iron sulphate that is softer material and sand is there. So, sand will be removing those iron sulphate when sand remove iron sulphate again fresh metal surface came up again the acidic gas will be reacting on the metal surface create salt sand will be removing that one. So, continuously this erosion and corrosion will be occurring. So, your metal surface will be eroded.

Another issue is that it will be getting deposited in your valves, chokes, separators. So, that will be a problem and again handling sand on the surface if you have larger amount of sand. So, you have to remove all the hydrocarbon particle then you can dispose. So, it is having multiple negative impact on your surface separation system or oil gas production systems. So, you have to handle that one properly ok.

So, it will be creating plugging it will be accumulating inside material pipes, tubes, valves and one thing is that special hard trim can be done. So, that erosion rate can be reduced to minimize sand effect on valves. Accumulation of sand can be eliminated by the use of sand jet and drain. So, sand jet you can create and forcefully remove the sand particle from the separator systems blow by. So, blow by actually free gas escapes with liquid line ok, can be indication of low liquid level.

So, let us say you have one separator system and your oil liquid output out is there liquid line ok and your liquid level is here. Because of certain reason your liquid level gunned down this level and it reached to exit end. So, what will happen? So, this will get certain amount of gas. So, you have to avoid that one ok. This is stopped by level safety low sensor ok.

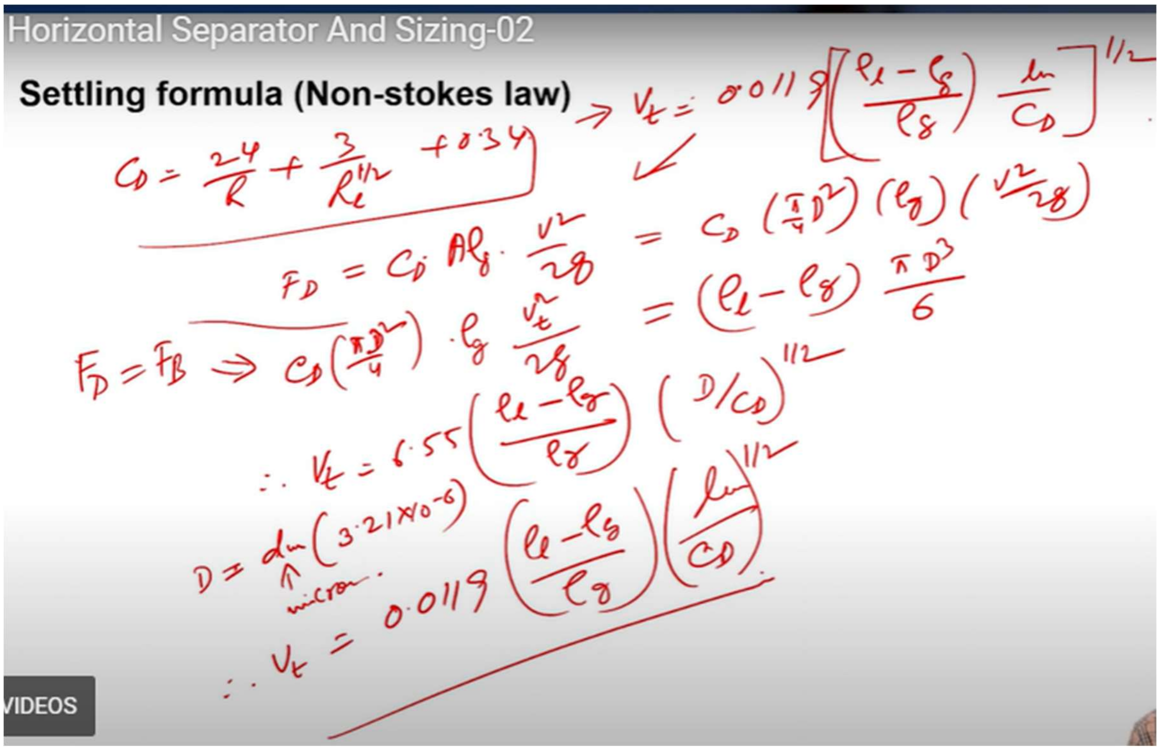
Some sensor must be there. So, if level is going below certain limit then you must stop liquid output ok. Your valve should be closing the flow path. So, that liquid level again it will be going up then you can remove the liquid from the separator ok. When liquid level drops 10 to 50 percent 10 to 15 percent 10 to 15 percent below certain limit then you have to stop dump valve again allow to build up liquid level further then open liquid level liquid output valve or dump valve then things will work like this ok.



So, the carry over. Carry over occurs when free liquid escapes with a gas phase ok. Free liquid free liquid escapes from the gas phase and can indicate a high liquid level. So, this can indicate a high liquid level ok. Damages vessel internals, foam, improper design, plug liquid, outlet liquid outlet or flow rate that exceeds the vessel design rate. So, that will create liquid carry over through the gas line ok.

Before we discuss further for separator designing we should know about settling. Settling means a particle falling down ok and gas is moving up. Gas is moving up and let us say liquid particle falling down ok. So, because of liquid particle is falling down and gas moving up there will be drag will be acting on it ok. And liquid particle falling down there will be buoyant force or net force downward it will be working.

So, if we know the terminal velocity based on the terminal velocity we can calculate further your separator sizing let us say seem to same length or diameter we can get from it. So, retention time good morning we will discuss today two phase separator. Two phase separator and that basically topics will be like particle settlement, droplet size, retention time, re-entanglement, gas capacity based calculation, liquid capacity based calculation for vertical separator for horizontal separator. So, it will be more mathematical previous lectures where they are based on more theoretical part, but we will go towards more derivation and mathematics. Let us say first assume horizontal separator, horizontal separator like this and we will be assuming 50 percent liquid ok, 50 percent liquid.



You can assume different type also, but 50 percent assume liquid we are assuming because we are getting more surface area if we have 50 percent field ok. If this is side view of the separator 50 percent means you are getting more this the let us say this is D ok. And if you are feeling 60 percent, 70 percent or 30 percent, 20 percent so, in that case your interface area gas and liquid will be lower ok. But in your separator system actually you need more surface area that is why we try to maintain 50 percent liquid field, but separator can be different you can design separator for different liquid percentage also ok. And this is for calculation for two phase separator only.

So, liquid say retention time in two phase separator generally as follows like if we have more than 35 degree API American Petrol Institute gravity, then typically 1 unit retention time can be ok, 20 to 30 degree 1 to 2, 10 to 20 degree 2 to 4. You see the viscosity actually heavier oil is this one ok. So, heavier oil means particle settlement rate will be lower ok, because heavier oil means density viscosity will be different because of viscosity and density other part different. So, particle will not settle quickly ok, liquid will not move up or oil will not go down. So, that way it will take more time to settle.

So, you are giving more time like 2 to 4 minutes above 35 degree API very light oil. So, in that case you are giving very low retention time. So, that is 1 minute. The retention time formula normally T R will be volume of liquid, volume of liquid storage in a vessel, storage in a vessel divided by liquid flow rate, liquid flow rate ok. So, this is the formula for retention time ok.

For most application T R will be 3 second to 3 minute, foaming crude will increase T R or retention time to 4 times. So, if you have foaming liquid. So, in that case retention time you have to increase because foam will not allow to separate gas and liquid quickly ok. So, for foaming, foaming instead of crude T R retention time will be high about 4 times. If you do not have foam let us say 3 minute to 3 minute or 2 minute, 4 minute you can give, but foam is there that means, you have to increase.

Although you may be using de foaming plate, but still you need higher retention time. So, that liquid and gas will be separating properly. Drop plate size. So, drop plate size is also very important because you can remember the V T formula ok.

D M is your droplet size. So, a larger droplet size will be separating quickly ok. In our case normally we will be using 10 to 100 micrometer or micron ok, 100 micron the size we will consider for our calculations. Separator removes about 10 to 100 micron size, gas capacity calculation removes 100 micron and gas scrubber removes about 500 micron ok. So, gas capacity. So, gas capacity in our calculation will take like 100 to 200 within that range of our calculations.

So, I will discuss later what is gas capacity calculation ok. Settling formula, we have seen one settling formula V T equals 1.78 into 10 power minus 6 del S g specific gravity difference and d M square divided by viscosity ok. You have to remove this formula because many time I will ask what is the relationship between viscosity and V T or V T and d M or V T and S g ok. Many time I say if I change S g what will be the value of V T ok.

It will be increasing decreasing how it is related. So, if you are not remembering the constant part still you have to remember the other part del S g d M and mu relationship with V T ok. So, del S g is specific gravity, the specific gravity it is related to 1 water, water equals 1 d M droplet size in micrometer or micron ok. mu is the viscosity C p ok. Now, you draw this picture gravity and you are getting drag force because when gas is moving up gas is moving up gas will be trying to move the particle up because it will be dragging.

So, that is why drag force will be upward and gas F g the force due to gravity F g we are writing. So, for low Reynolds number Stokes law if we are assuming for. So, you have to remember this one for R e less than 1 actually this formula for R e less than 1 ok. So, if we drive this formula it will be like this C d equals 24 by R e again it will be coming from Stokes law ok. Flow around the particle we are assuming laminar flow there is no turbulence is created very small smaller flow velocity is there.

So, this is laminar flow ok this criteria you should remember. So, drag force F d equals C d drag coefficient drag drag coefficient C d into A rho g V square by 2 g A means area of this is particle. So, this area will be pi by 4 d square this area particle area. So, if I put C d equals 24 by R 24 by R into A, A means pi by 4 d square rho g V square by 2 g, g means gravitational acceleration due to gravitation ok. So, this one if we simplify 24 by R e, R e formula is that R e equals 3 pi mu dash 3 pi mu dash d V this is Stokes law ok.

So, you should remember this formula is used here. So, rho g d V g mu dash pi d square by 4 rho g V square by 2 g and buoyancy force because of gas is moving up and it is giving buoyancy force. So, buoyancy force will be rho liquid minus rho gas ok, the density difference pi d cube by 6 particle volume ok. Droplet acceleration let us assume the droplet acceleration equals 0 and terminal velocity is V T ok. So, finally, you are getting 3 pi mu dash d V equals rho L minus rho g pi d cube by 6.

So, d V actually d V T F B equals F D implies ok. So, finally, you are getting V T equals rho L minus rho g by 18 mu dash d square ok. Once you convert all the units, units like mu dash equals mu 2.0881 d equals d m 3.281 10 power minus 6 this is micron ok, this is d is feet rho L equals 62.

4 S g rho g equals 62.4 S g ok. S g is specific gravity related to water already given up ok. So, if we put all these values here. So, finally, you will get the equation V T equals 1.78 10 power minus 6 S g d m square by mu ok.

So, you should remember this formula ok. So, this for Stokes law R e less than 1, but in practice this equation does not valid in oil and gas system. So, we have to modify this equation. So, what is the modified form ok? So, in practice the Stokes law does not hold. So, in this case modification is like this C D value will be 24 by R e plus 3 by R e power half plus 0.

34 ok C D value is changed ok. Now, terminal velocity also be changed got changed V T equals 0.119 rho L minus rho g rho g d m by C D. So, how to get this one because remembering sometime this equation will be difficult because there will be some constant and those constant sometime very much confusing because of this field unit. Now, how to derive it F D drag force equals C D A rho g V square by 2 g ok.

You have learnt this one. So, C D pi by 4 d square particle diameter rho g V square by 2 g ok, particle velocity. Now, F D equals F B buoyant force. So, it will give C D pi d square by 4 rho g rho g V T square terminal velocity because when F D equals F B. So, I am putting terminal velocity 2 g equals C D pi d square equals rho L minus rho g pi d cube by 6 previous lecture slide we have seen pi d cube by 6 the volume ok.

So, therefore, V T becomes 6.55 rho L minus rho g rho g d by C D power half ok. Now, if I put D equals d m converting unit 3.21 into 10 power minus 6 d in micron then V T becomes 0.0119 rho L minus rho g divided by rho g d m by C D ok. So, this formula you should remember normally this formula be using not the previous one previous one just basic to give idea how particle settlement formula will be working if R e less than 1, but in this case R e look more than 1. So, we have to use this formula.