Surface Facilities for Oil and Gas Handling

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Produced Water Treatment-01

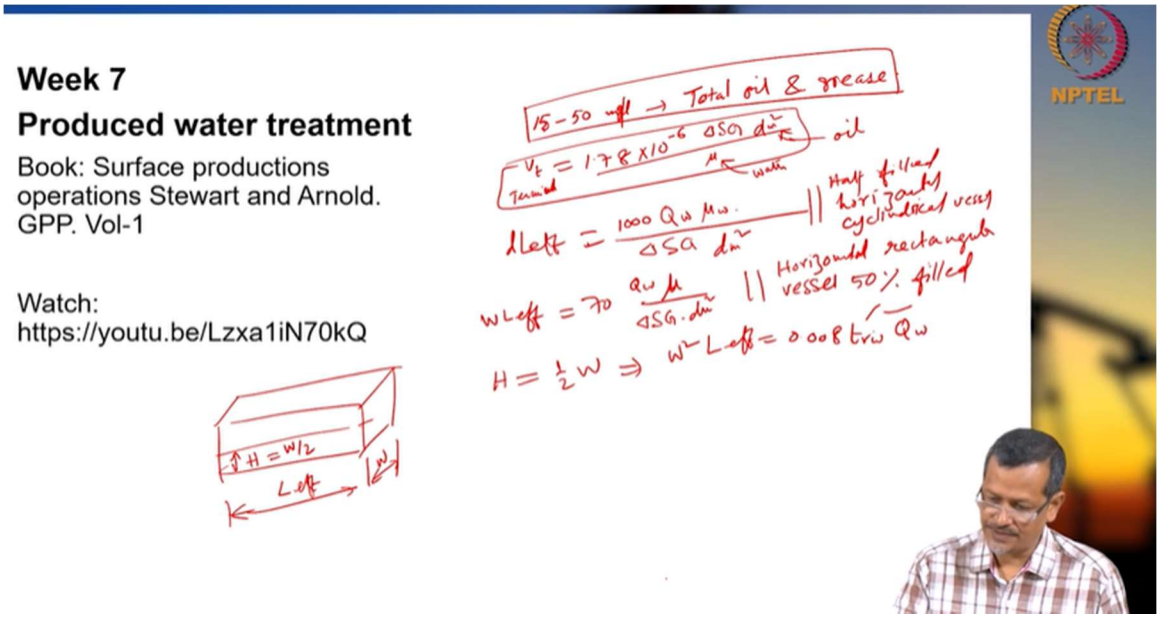
We have started producing water treatment systems for the procedure for the refined equipment used in the produce for treating water which means removing hydrocarbon and sand from the water before disposal. Water you cannot dispose of anywhere, because it will contain hydrocarbon. So hydrocarbon is dangerous for this living organism and you cannot put this water on the surface at the presume. So if you put them there then trees will die or this living organism will die. So that will be contaminated on the surface. So you have to dispose after separating the oil content or sand if you are there then you have to separate the sand also and sand you can take it separately.

Now what are the different possibilities? That the gravity-based separation is there. Another is that you can use centrifugal forces or you can use some multivariate filter to separate. But if you have a small particle of oil droplet which low-cost system you have to make with a less maintenance system then that will be better. So already we have seen 5 to 15 to 50 milligrams per liter if oil content is there then it may be allowed to be disposed of by your regulatory agency.

But if it is more than that then you have to remove oil content or hydrocarbon content. So this is called total oil and grease content. So you have to remove and you have to make maintain this amount 50 to a maximum of 50 milligrams per liter. And that means this depends on different countries or different zone regulations. So if you are using here separating oil or treating oil if you are treating water and removing hydrocarbon from water in the US certain regulation will be there, India certain regulation will be there, Europe certain regulations will be there.

So you have to follow the local regulation and you have to maintain that oil content. If you are not maintaining then there will be legal and other issues. So when we are going for separation so normally follow the equation Vt equals 1.78 into 10 to the power minus 6 del SG dm square divided by m. This is the settlement equation.

We are using this equation in many places in oil-water separations. When fluid flow is laminar and not much when it is laminar flow we know this is terminal velocity. This is the dm particle diameter. If you are using water oil droplet separation oil droplet separation so will be oil diag, oil droplet diameter. This is the case when is phase is water so it will be water viscosity.



What if you are using the opposite let us say the water particle from the oil you are separating The water particle is dm diameter will be water and the viscosity of the oil will be used. So you have seen vertical and horizontal schemas that can be used for oil separation from water and you have seen the formula in the last lecture dL eFL equals 1000 Q water mu divided by del SG into effective length into d 1000 kilo meter per del SG and dm square. This one we have seen for horizontal cylindrical vessel half filled horizontal cylindrical vessel. For horizontal rectangle cross section we have seen the formula WL eFL equals 70 Q WL mu divided by del SG dm square. So this is for the horizontal rectangle.

So we have seen the formula WL eFL equals 70 Q WL mu divided by del SG dm square. What we have one assumption is that if we have H equals half W or by rectangle cross section. This is W and this is H half-filled. Now for the horizontal separator which is a rectangle cross-section, we assume this effective length is there and half filled is H will be 50 percent of the weight. So in that case we got the formula W square effective length equals 0.

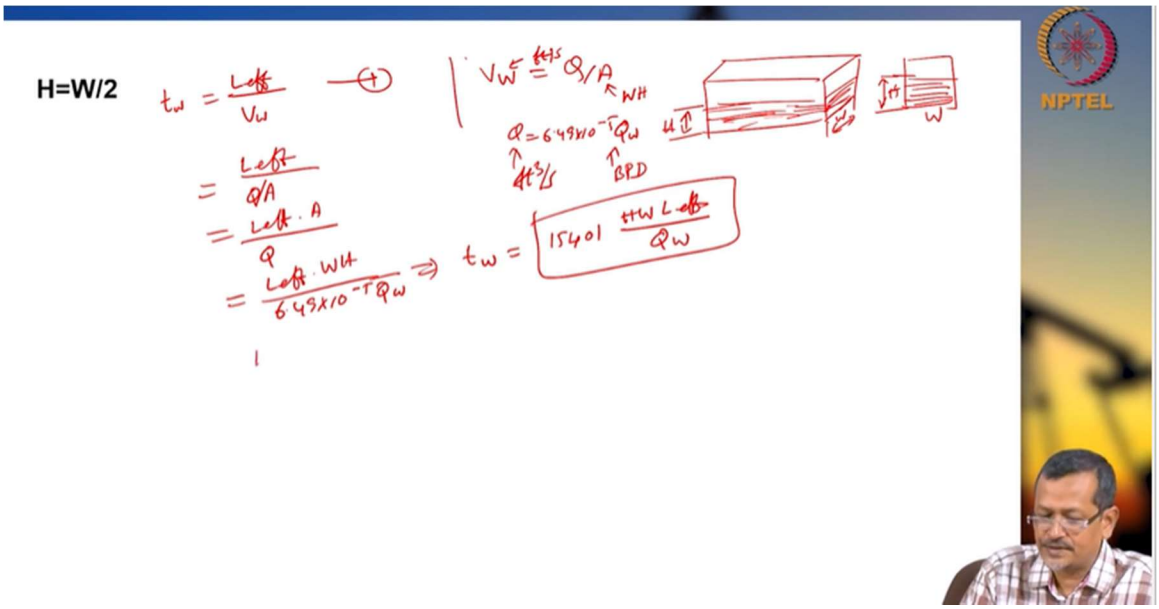
008 TRW Q water retention time. So this formula we can derive this formula. How to derive? So to derive this one we have to assume T water retention time which is the effective length divided by the velocity of water. Let us assume this equation one and assume VW equals flow rate divided by 80. So what is the area? The area should be like if I make my circle cross-section area like this side mu like this.

It is 50 percent filled so I can write it 50 percent. This portion is filled. So H is here H and this is W. So this is W this is H. So area is W by H.

So A becomes W by H and flow rate flow rate for prime mu Q equals 6.9 10 to the power minus 1 Q W in V PT Q is Q by P per second. So VW by 3 P per second. So now I can put VW by 2 and area P by 2 VW by 2 is Q by A Q by A. So A E F F and A divided into Q.

So it becomes A E F F and A we got the H divided Q Q 6.49 into 10 to the power minus 5 Q T So finally we simplify it to become T W equals 15 401 H W L 50 and Q. Now H is limited H equals W by 2. So if we put here this equation it will come like this W square is equal to 0.

008 T R W into Q. So vertical centigrade formula will be like this. So T square equals 6 6 9 1 F sub shut factor Q water this is mu del SG dm square. So to derive this formula we have to assume that V oil and V water do the same thing. So V oil, actually V oil particle will be slowly moving up. So oil particles will be slowly moving up.



So the formula is 1.78 into 10 to the power minus 6 del SG dm square by V W Q by A. What is A? A will be this diameter D so pi by 4 diameter square and we are counting degrees140. So then V W becomes 6.49 10 to the power minus 5 W W divided by pi by 4 D square divided by 140. If we solve it this will be giving D square equals 6 6 9 1 F into mu del SG dm square.

So F we are introducing just for short factor consideration. So height of the water column is free we determine from the retention time equation H becomes 0.7 T R W U W divided by T square. So from retention time calculation, this comes like this T water retention time H divided by V W by H this is H. So H distance will be covered, and if V W velocity so total time will be T W.

So V W equals Q by A equals Q divided by pi by 4 D square by 144 as you have seen it is a sectional area. Now T W equals T R W into 60 plus we are calculating in terms of minutes. So H becomes 0.7 T R W U W is equal to T square for vertical, cylindrical. Plate velocity parallel plate interceptor.

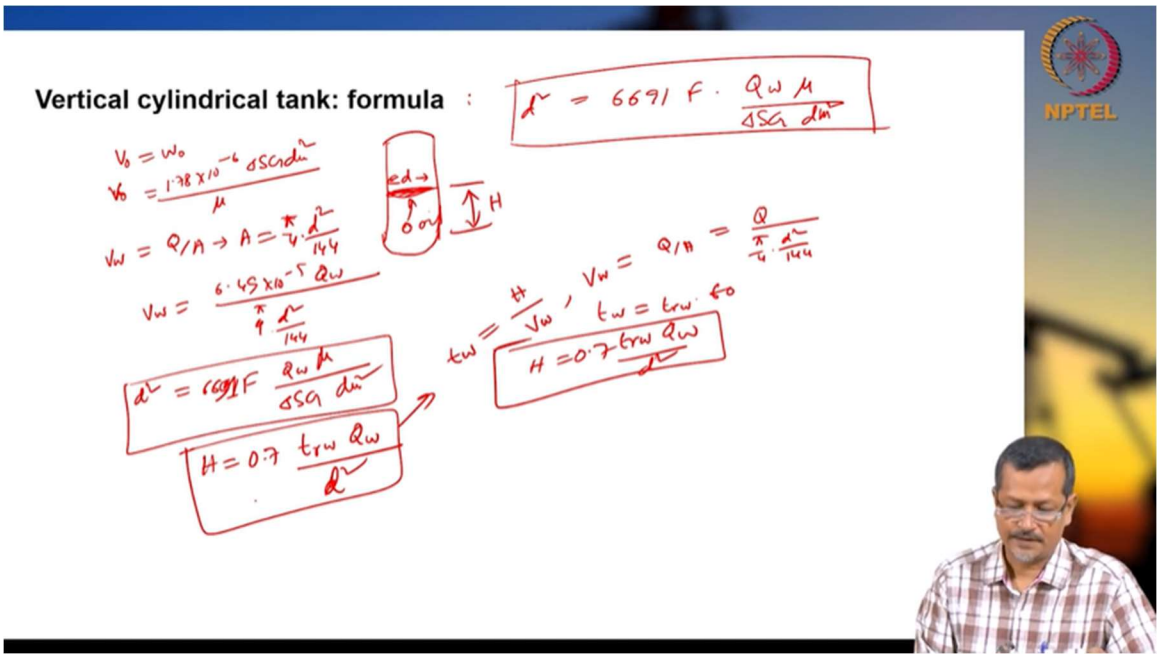
So if you have any separator let us say horizontal or vertical and if you give enough time then slowly oil particles will be moving up and evaporating. There will be a layer of oil and it takes a minute and water it takes a minute. But that takes too much time. So just to elevate the ratio time created people design plate velocity. Plate velocity is like two plates you will be taking one plate here and another plate.

So while fluid is passing oil and water mixture small amount of oil is passing through this one slowly. So what does happen oil particles try to move up and water particles try to move down. So it will create two layers. Let us say if I create two layers it is very much slanted and oil is moving from here to the oil and water mixture. So oil particles try to float and it will try to pass the upper surface.

And because it is stretching the upper surface slowly it will try to move up also it is slanted. It will be almost 45 degrees. So one layer two layers multiple layers as I have created is called a flat plate itself. So a flat plate means one plate two plates and it will be almost 45 45-degree angle and laminar fluid will not create turbulence. The turbulent fluid we are creating means fluid will be mixing up again.

So you get very low velocity slowly the water is moving down and oil particles because of this low velocity and low-density low gravity will be trying to move up. When it is moving up it will be touching when it is touching many particles will be touching. So when touching particle size will be growing up so when they are growing up their velocity will be larger so it is moving up and water slowly two layers are there so the bottom layer is water touching. So there is a plate well itself. So internal plate includes gravity separation this is due to gravity.

We are creating different mechanisms but this is happening due to gravity. So there are several types of other PPI parallel plate interceptors, CPI parallel plate interceptors we will discuss later. After 30 microns separation of oil droplets is possible using a parallel plate separator. So now how does it work? Let us say water you are giving from here water plus oil small droplets small percentage. So water will be trying to follow this path and oil droplets say this is my oil droplet what will it do? It will try to move vertically up.



So vertically up it will try to move vertically up. When it is touching the upper surface the lower surface of the upper plate so will move in this direction. Okay, oil will be going up and water will be going up. The distance between two plates is a perpendicular distance. This is an oil droplet and a large droplet rises.

So large droplets form. Okay and separates separates from water and oil sheet velocity. Oil velocity is direction is water velocity. Water is going this way while touching the upper surface of the tank. Okay if sand is there sand will be accumulated at the bottom.

This high density. And you see this is making an angle theta. Theta normally it will be 45 degrees but if you have a larger amount of sand sand will be blocking this too late. Okay, sand will be getting formulated it will be deposed to the bottom layer. Slowly it will be developing this thickness and it will be blocking the part. So what they do they will be trying to increase the inclination.

So it will make 60 degrees around inclination. So normal best will be a 45-degree inclination. Okay, so normally 45 degrees inclined. Okay but if you have more sand then you give a 60-degree inclination. Okay so now one thing is that you have a flatbed interceptor.

This is called a flatbed interceptor. The term they use flatbed interceptor. Now they develop corrugated. Corrugated plate means like you have seen this roofing. Roof right household roofing areas.

So it will be corrugated. Okay, it will be shaped like this. So like one two three different many sheets, I put corrugated one corrugated three corrugated okay and you put slant. Okay, you make corrugation like this and you make slant like this. Okay, so what happens when you are making a slant and the figure will be like this?

So now my fluid is flowing from bottom to top. What will happen? Low-density fluid will be touching this area. You see this figure I am drawing. Okay, low density means oil. Okay and if you have sand the lowest-most position sand will be collected.

Okay, this side here oil is getting collected. Okay, this sand will be collected and slowly water will be going down. So water will be in between the spaces. It will not take oil space or sand space slowly it will be moving down. But oil will be collected at the top crest part slowly it will be moving up. Okay, when it is collecting at the top crest part one particle to particle many particles will be from near coming together almost nearby.

So when they are coming together they will be trying to fuse. When they are fusing they will be making bigger particles. The bigger particle is dm particle diameter is larger. So you can see the vt formula vt proportional to dm square.

Okay so VT or terminal velocity will be increasing. So in that case particle will be moving at a faster rate separation will be proper. Okay, so they have written like CPI is the parallel plates are corrugated like roofing material. The axis of the corrugation parallel to the direction of the weight pack is inclined at 45 degrees and the bulk water is forced downward. So water will be forced downward but with laminar velocity do not get turbulent velocity. So this is the simplest picture you have seen of how this plate flat plate or corrugated plate works.

Now we will see the CPI corrugated plate interceptor and how it works. So this is a cross-flow interceptor. So fluid will be flowing in one horizontal direction but particle velocity will be in a different direction.

Okay, so this is cross-flow. This is a corrugated plate. So sand particles are here and oil particles are here. Okay so you collect sand oil separately and how this cpi is working? It is several different versions of it.

So one version I am drawing here. This is the inlet. Inlet oil with a larger percentage of water with a larger percentage of oil. So when it is entering it will be going from zone here and it will be developing through here falling here. And this is your plate interceptor corrugated. cpi. So because from the side you are seeing that's why this parallel side you are seeing but it will be like this.

Now this mixture coming through this and you are getting very laminar flow. So water will be exiting from here and oil will try to move up. Okay so when inlet oil is mixed, what is entering and there will be debris collection. Slowly fluid is entering and so solid particles will be developing here.

Okay, so solid particles will be developing here. And water will be moving up and water will be falling here. Water will be passing through these small narrow channels. Then it will be moving and again debris will be collected here. So debris will be collected here.

Water will be moving up, moving up, moving up. Here we create water wear, water wear, and adjustable wear. Okay, so what happens this water will be falling here. This water will be taken out. You are taking the water out of this system.

This will be taking low-oil water or plain water. Now how are you collecting oil? So oil will be there. Oil will be kept there. Oil will layer this oil.

Oil will be overpouring. This is not where. From there, you are taking oil out. Spikes now I am trying this.

Oil out. So this oil wear. This is the adjustable wear. Then oil out. So whenever, in the exam I give, okay draw one CPI and show flow direction. How these things are working. So there will be different versions.

Any version you draw and you show how the CPI is working. So I will write it down. Okay, what if I give it an objective question or a gate-like question? There maybe I will give the picture or I will keep something missing and I will ask okay I will define that area. Okay from this picture then you have to practice.

I will be putting in some wrong information. I will ask you I will define which is wrong. Or the figure because when you are writing gate gate-like exam. In that case, I don't have the option to ask you to draw a figure and explain. In that case, I have to give you a figure and ask you to identify it.

If you do not practice actually, in exams you will get confused. So you should practice also how this system mechanical system works. How things should get separated. You have to read the details also from the picture.