Surface Facilities for Oil and Gas Handling

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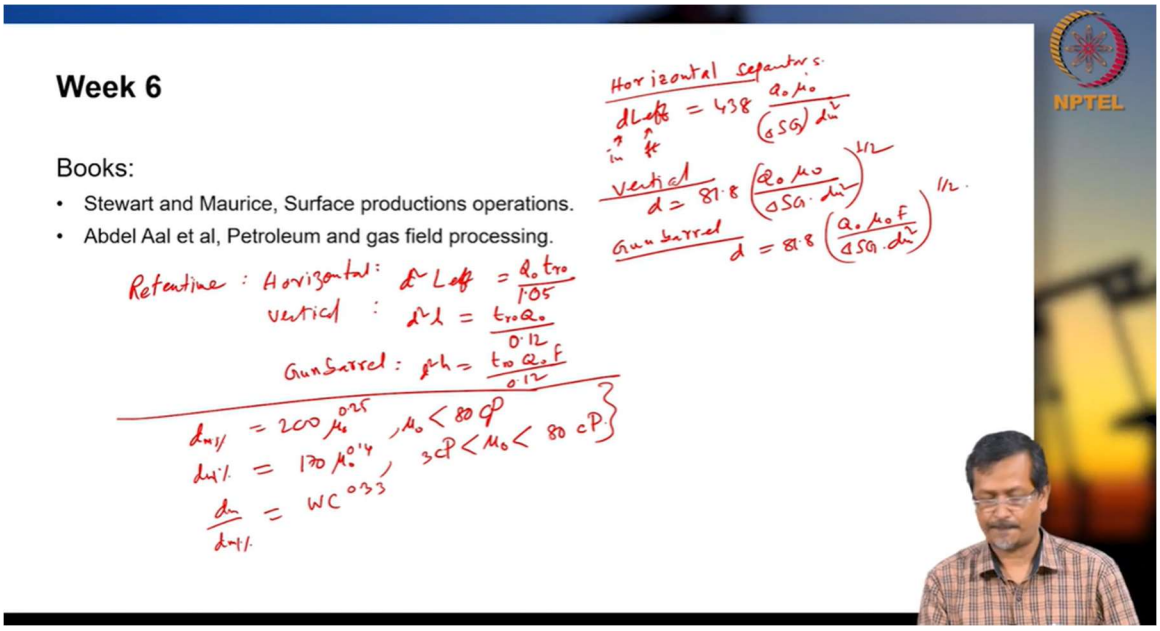
Heater Treater and Gunbarrel: Numerical Part 1

Good morning. We started already crude oil emulsion treatment from week 6, week 5, and week 6 also we are continuing. So, week 5 we have seen this gun barrel and heater teeter and electro-strip separator system. Now, in this week like 6th week we are discussing about more sizing mathematical calculation part. So, last week we saw this basic formulation. Now, today I will try to do some to solve some problems related to this sizing and heat calculation related to this heater teeter and gun barrel horizontal and vertical separators.

Let us see what things are there. So, in last week you have seen or last class you saw this formula to calculate sizing like D and L L E F effective length or diameter of the separator. So, the formula you can recap is just D L E F F for horizontal separator because we will be using this formula ok. So, just for the recapping purpose I am writing horizontal separators D L E F F because 4 3 8 q o oil flow rate mu o viscosity of oil del s g specific gravity difference and d m square particle size diameter that is will be in micron.



So, you should remember the units D in inches L E F in feet ok? This in inches, mu in C p d m in micron del s g already it is unit less and q o oil flow rate ok. So, vertical separator now vertical separator D equals 81.8 q o mu o del s g d m square ok. So, this is having power half in the previous case there is no power.

Now, gun barrel if you have the formula just a small modification will be there 81.8 q o mu o Now you are adding one term called short circuit factor ok. Last week last class you saw short circuit factor del s g d m square ok. So, the power will be again half. Now, some more formula for retention time formula for horizontal t i m e for horizontal again ok.

So, you should not mix up this horizontal particle otherwise your answer will not match actually. So, for horizontal separator the retention time formula is D square L effective equals q oil flow rate T r o 1.05 ok. Now, for vertical for vertical vessel the formula changes like this D square h equals T r o q o 1 2 ok. So, and if we if you are using gun barrel the formula will be little bit modified I already told D square h equals T r o q o 0.

12. So, T r o unit will be in minute ok and f will be coming for gun barrel because short circuit factor will be coming and q is the flow rate you already know. So, you have to

check the units also whenever you are calculating ok. One more some more formula there some more formula there for diameter 1 percent ok. For diameter for particle for 1 percent oil 1 percent water 200 viscosity power 0.25 and criteria is that mu oil viscosity should be less than 80 C p and d m 1 percent equals 170 not 1.

75 170 mu o 0.4 and this criteria is 3 C p 3 C p 2 mu o 80 C p ok. This is the criteria you have to fulfill and one more formula was there d m by d m 1 percent equals water cut power 0.33 ok. So, this formula some of the formula will be using some of the formula we may not use, but in exam purpose other purpose we can use maybe.

So, just you should remember the formula ok. So, viscosity with temperature relationship there will be chart or table. So, here this table I have drawn from the formula, formula is like this viscosity and temperature relationship mu equals 10 power x minus 1 and this is given this formula is given Arnold book Arnold and Morris book ok volume 1 ok. So, I think chapter 2 volume 1 I think chapter 2 just you can check ok y equals 10 power z x equals y into t power minus 1.163 and z value 3.

0234 minus 0.023 0.023 0.02023 g, g is equal to oil gravity ok. This is degree a p i ok.

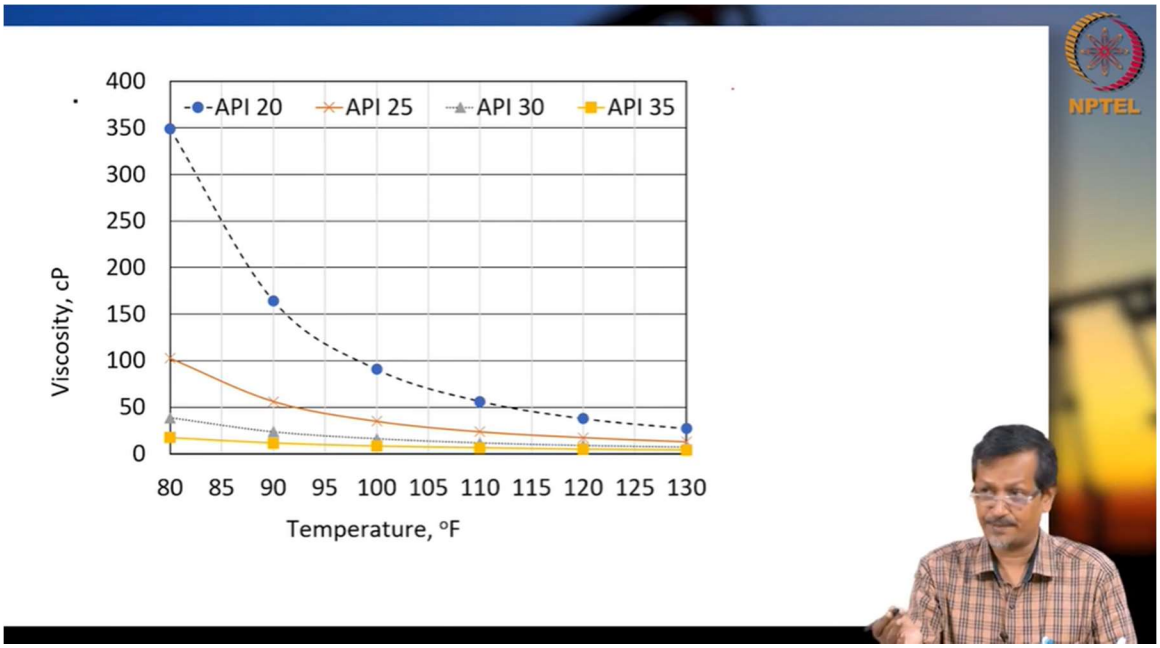
So, just solving using this these equations I have drawn this figure or this chart you can see if you are increasing temperature your viscosity is going down ok. So, you can use this chart or this figure for your next calculation if in exam maybe I can give this figure and I can ask take viscosity from the figure based on your temperature and your API gravity and API gravity for different API also I have drawn ok. So, if some let us say instead of 95 and 100 I have given 98. So, just you have to interpolate and you have to get that value for viscosity for specific oil, oil means like is heavier zone or it is lighter zone heavier zone means nearby 20 and lighter means 35 or more ok. So, normally all oil will be this range, but if it is heavier very heavy ultra heavy then API will be much lower than lower ok.

In many problems normally I give viscosity value with temperature if I am not giving maybe I will give the chart then from chart you have to calculate. I will not ask you to

remember all this small small digits for example, z equals 3.0234 it is very difficult to remember. So, maybe I will try to avoid to give this formula ok, but in, but you should remember like relationship mu equals 10 power x minus 1 simple relation you can remember big constants maybe I will give ok. For example, if I whole problem I can give the z expression other expression maybe I can omit ok.

So, that in that case you can remember like 10 power x minus 1 this is a small thing you can remember fine or maybe I will give this whole chart or this figure then I will ask take figure data viscosity data from this figure or maybe I will give a viscosity values ok. Just try to calculatsomething calculate the size and heat requirement of a horizontal horizontal ok horizontal heater heater for the settling or coalescing section the data given oil flow rate Q o given inlet BSW water content actually basically. So, 15 percent is there. So, after separation you are getting 1 percent ok, electricity separator heater heater you are getting 1 percent. Oil specific gravity is given here 0.

86. So, instead of giving 0.86 I can give API gravity also ok. So, in that case you have to convert API formula you have to use. Oil viscosityI have given for this 85 degree, 105 degree, 125 degree. Water specific gravity 1.

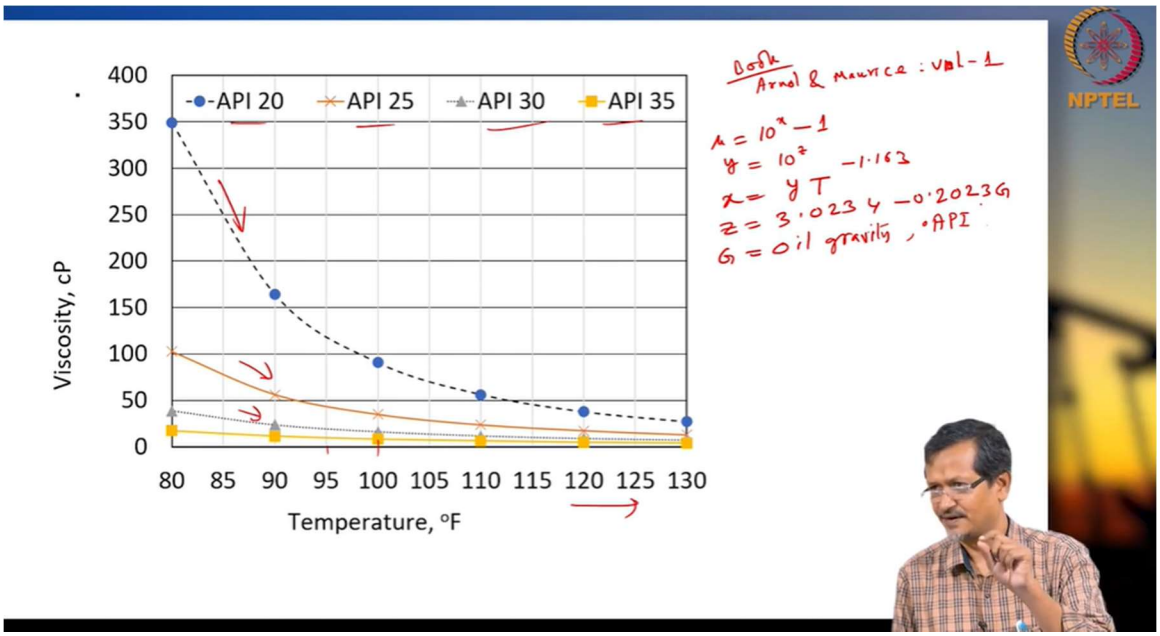


06 I have given specific heat of oil 0.5. So, many cases ifI can ask you assume specific heat. So, you should assume 0.5 ok, you should not assume more than 1 or something.

So, it will be infeasible. So, I will askselect suitable value suitable means it should be more closer related to 0.5 ok. Heaters is 1.1 or 1 that is ok within that range.

If I ask you select suitable value ok ah, if I am not giving and I am asking many time in exam I ask ok assume suitable value. So, I will see whether you are you are having that idea how much will be feasible range ok. So, within that feasible range you should guess. Inlet temperature 85 degree ok you see this 85 degree actually this is your operating temperature also ok fine ah. So, fluid inlet temperature higher, but operating temperature will be lower ok because yourinlet fluid will be having lower temperature.

So, after mixing up it will be lower temperature. So, treating temperature say 105, 125 no heating no heating means like 85 degree ok. Assume oil viscosity 105,120,85 are this10, 20 and 45 degree actually I should write respectively 85 will belower 105 will be higher lower viscosity ok I should write respectively ok. Heat loss we are assuming 10 percent ok. Now, we will try to solve the problem.



So, first we have to use this equation dm equals 200 mu power 0.25 ok because particle diameter is not given here. So, you have to find particle diameter from viscosity if I am giving particle diameter then no need to calculate this one ok. So, ah, for 125 degree

Fahrenheit ok for different temperature different diameter will be there ok because viscosity related to temperature. So, this value will be coming 200 into 10 power 10 0.

25. So, it is coming 356 micrometer or micron ok. Now, T equals 105, 105 degree Fahrenheit. So, in that case dm again a 200 into your viscosity changed to 20 again power is 25. So, this will be 423 micrometer and Twhen it is coming 85 degree the viscosity is higher ok mu is 45.

So, dm equals 245 0.25 it is giving 518 micrometer ok. You see the temperature changing. So, your particle diameter also changing because viscosity is getting changed ok. So, ignoring the effect of temperature of specific gravity. So, we are assuming specific gravity is not getting changed the small change will be there, but we are just ignoring ok.

So, for T equals 125 degree Fahrenheit what is the dleff ok. The formula you can remember 438 ok this is horizontal separator ah. So, flow rate oil mu oil del S g dm square ok. So, this will be giving 438 into 7000 already given in the problemmu o 10 then del S g 0.

2 actually. How I am getting 0.2? You just you can make minus of this one S goil minus S g water minus S g oil because it will come as 0.2 ok. So, 0.2 we have put and dm already we got thevalue356 ok. So, this is giving 1212 what will be the unit? Unit will be like inch and ft ok because d and leff multiplied.

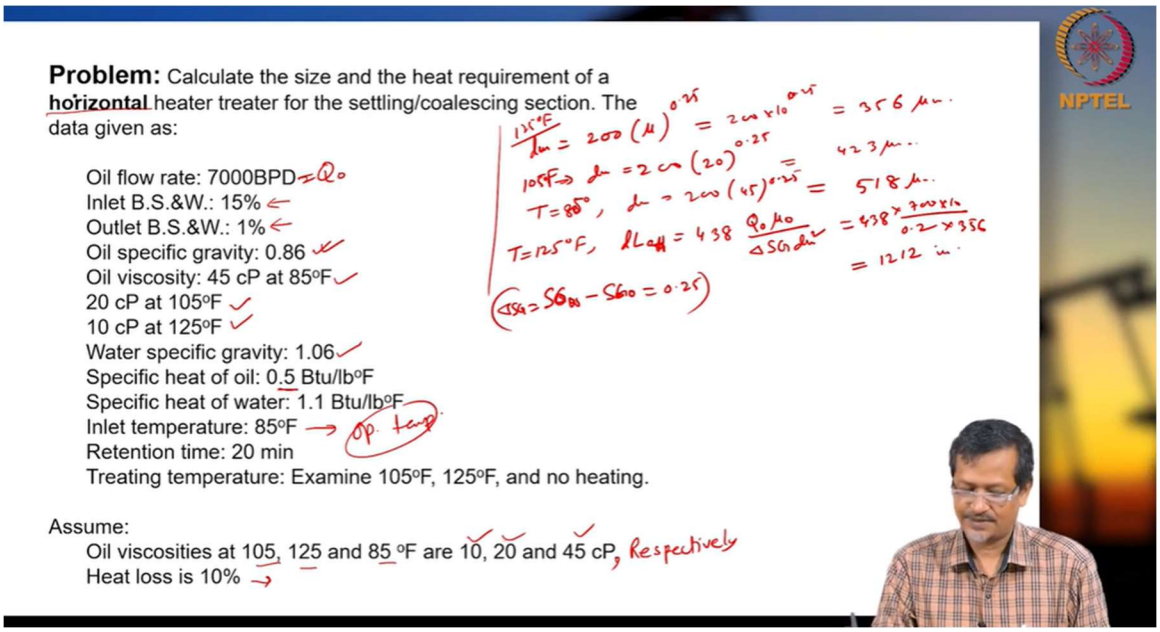
So, d unit is inch effective length unit is feet ok. Now, for 105 degreethis is for 125 degree. Now, if I calculate for 105 degree Fahrenheit. So, dleff again it will becoming different value ok. So, 438 again into flow rate you know 7000 or 7 700 or 7000 this is 7000 right 7000 BPD barrel of oil into 45 already why 45 viscosity105 viscosity should be 20 not 45 20 and del S g you are not changing with temperature.

So, 0.2 and dm value dm value you got for 105 423 ok. So, this value is coming 1714 inch feet ok inch dot feet they have written ok and if I calculate for 85 degree. So, dleff effective

length. So, this will be coming 438 into 7000 again into 45 because viscosity change viscosity will be higher 0.25 you are not changing S g dm changed actually if you see 518 it become ok.

So, this value will becoming 2571 inch feet ok. Now,you use relationship for retention time for retention time calculation you can see this d square leff formula is there ok just or the formula I have written you say d square leff. So, flow rate Q o T ro 1.05 7000 into T ro is given 20 minutes you see the question is retention time is 20 minute is given.

So, 1.05. So, this value is coming 1.3 sorry not 1.33 13333. So, many 3s are there 1 2 3 5 3s are there inch square into f d look at d square this term is there. So, it will be inch square ok. Now, we will go to the next part of this one same problem d value we will assume ok initially we will assume d value.



So, which range like say they in the book they have taken 60 72 84 96 many values they have taken ok up to 156 and they have make table like this d and leff and this one is taken from retention time retention time formula d square leff ok. Then leff calculated from for 85 degree for 105 degree then leff 125 degree ok. Now, the many values of d they have taken. So, for our simplicitywe are taking only one value now let us assume 84 ok. So, 84 corresponding leff value from that formula actually we will get leff equals 133333 5 3 should be there 1 2 3 4 5 then d square ok.

So, discover 84 if you put 84 leff value will be coming 18.9 or 19 you can say ok. Similarly for 85 formula d leff value we have 2571 ok. So, leff equals 2571 divided by d ok. So, from there if you put d value 84 2571 in divide by 84 the value will be coming 30.

6. So, some approximation error may be there. So, you can get little bitmore or less, but should be like 30 around ok. You should not be too high or too low if it is too high too low then there will be some error maybe in my calculation or maybe your calculation ok. So, 30.6 now if I go for 105 samedata we calculate leff 85 ok this one for tension time and this is for 105 125 ok 105 leff will be 1714 divided by 84 ok.

So, you are getting 20.4 then 125 you are getting 14 point125 you are getting 1212 divided by 84 because 14.4 ok this value you are getting this will be in feet actually ok . Now this value is 20.4 this is 14.4 now you can calculate other values also for example, 1 3 2 ok many other values also you can calculate, but then what is the purpose of the calculation.

So, they have given one chart actually from there. So, from retention time chart this will be length this will be diameter 0 2 5 0. So, linear scale actually um 250 means 250 100 150 200 ok 0 to 45 they have taken . So, 0 45 means 5 into 9 5 into 9 right. So, 1 2 3 4 5 6 7 8 9 ok. So, total 9 just approximate I am drawingthis is a linear scale.

So, leff in feet d in inch ok and this is a retention time calculation ok. So, retention time curve first you draw ok from d squareleff equals some value like here in this case you are having 1 3 3 3 3 3 right . So, you got this curve this is exponential curve right . Now you draw other curves also .

So, other curvesthey have drawn like this . So, 85 degree Fahrenheit some curve came like this 125 some curve will be like this maybe 105. So, they are saying so, this is the infeasible range this area is infeasible ok this is infeasible . So, any data coming above this curve this retention time curve there is feasible range ok and diameter if you are increasing diameter too much separation will not help ok. So, diameter should be like within this zone will be ok ok this can be like for example, this one can be diameter ok . So, in this book they have taken like 20 inch length 20 feet leff and has taken 84 84 inch dia ok because this if you are changing diameter too high possible, but that will not help much ok or if you are going to infeasible region this below part this part is infeasible infeasible region.

So, then it will not help ok . So, you have to get the values more than the retention time curve fine . So, this iscalculation for horizontal separator . Now, we will go for some calculation for heat calculation for for this specific design ok heat calculation 10 percent loss is there ok. We have done some calculation in previous lectures also, but for this specific purpose heat is Q formula you can remember 1 by 1 minus loss 15 Q o del T gamma oil C oil plus water percentage then gamma water and C water ok gamma means specific gravity ok gamma is specific gravity of oil ok C specific heat and W water percentage of oil or water categories how much percentage of water is there ok.

Hereyou have actually in problem 15 percent ok. So, your formula your data will be like this 1 minus 0.1 because 10 percent loss is there this is 10 percent ok into 15 oil flow rate 7000 gamma o that is given 0.86 in problem you see gamma o is given 0.86 specific heat also given 0.

5 oil total that is feasible range right plus water percentage 0.15 you can see BSW given ok. So, we are not as we are assuming basically water because 15 percent water is there and gamma oilgravity is given 1.1 ok not 1.

5 1.1 and specific heat is given sorry gamma gamma water is 1.6 gamma water is 1.06 ok into 1.1 for specific heat of water ok this is specific heat ok. So, finally, this result this will be coming 1.

1411433 British thermal unit divided by hour per hour. So, in this problem actually I miss something delta T delta T is a 105 we are assuming 105 your operating temperature and 85 your your operating temperature 85 and your inlet fluid temperature is 105 actually we are assuming this is not optimal. So, in problem if I give ok take this one as an inlet flow rate then you can take otherwise there are some procedure to find it. So, better you assume that ok this one your optimal flow rate now in a in question you know if I give for example, so in that case I will specify which temperature you have to take for this delta T ok. Otherwise many student will be taking 85 someone taking 125 then there will be different answer that be a problem. So, if you are I am creating gate like question paper then in that case multiple answer will be coming.

So, just to avoid that confusion I will be giving something concrete which will give only unique value ok that unique value will be easier to evaluate. Thank you very much.