Surface Facilities for Oil and Gas Handling

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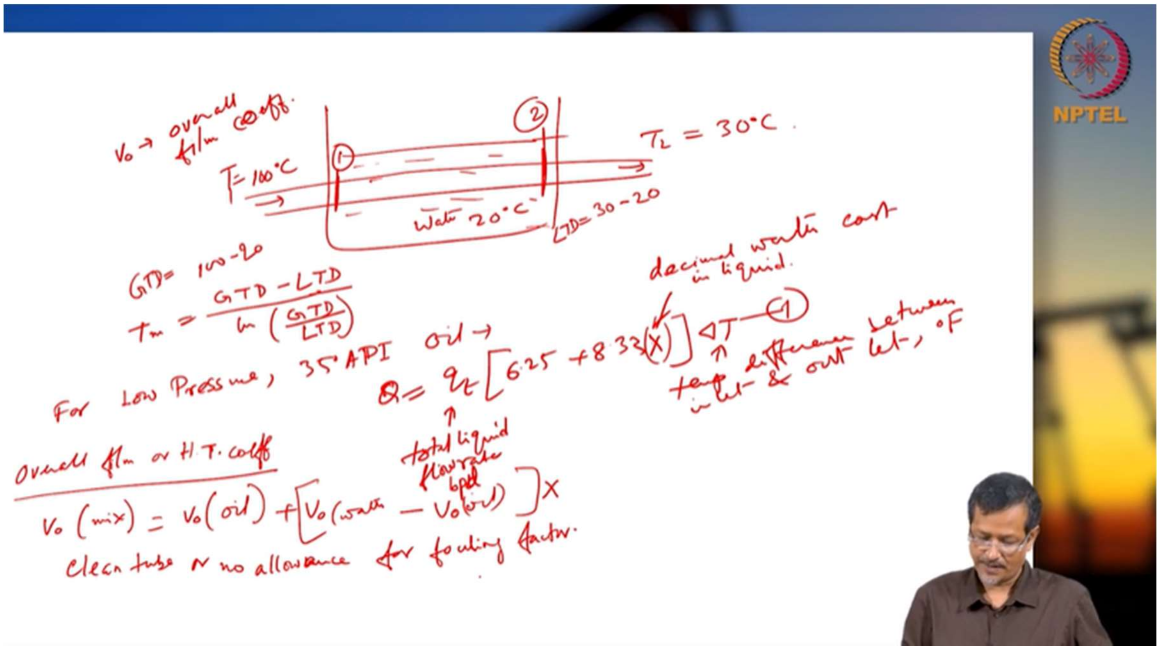
Heat Calculation-02

So, let us say I have one pipe, I have one let us say one-pot, and water is here and I have one pipe passing through this. So, say T 100 degrees centigrade and T 1, T 2 equals let us say temperature will be going down let us say 20 degrees centigrade water, T 2 maybe 30 degrees, exit fluid temperature. So, what is the temperature difference at the beginning here at this location? The temperature difference will be like 100 minus 30 yes100 minus 20. And here at point 2 temperature difference will be 30 minus 20 right? So, this will be G T D this will be L T D ok, lower temperature difference and higher temperature difference ah no here something error is there. So, because of the pipe water temperature will be going up.

So, at the inlet water temperature may be higher at the exit water temperature will be lower, or maybe if you are using one bath only. So, all the time water temperature will be maintained. So, only the piping temperature changes. So, I am assuming only the piping temperature is changing.

I am using the water temperature continuously it is 20 degrees. So, in that case, T M equals G T D minus L T D divided by the log of G T D greater temperature difference by lower temperature difference. So, what about the temperature constant we are assuming? So, normally on the surface of a separator system, will be like 180 degrees Fahrenheit they are they are assuming ok approximate thumb rule you can say. V o overall film V o overall film coefficient C o e film coefficient or heat transfer coefficient because the temperature is changing from inlet to outlet.



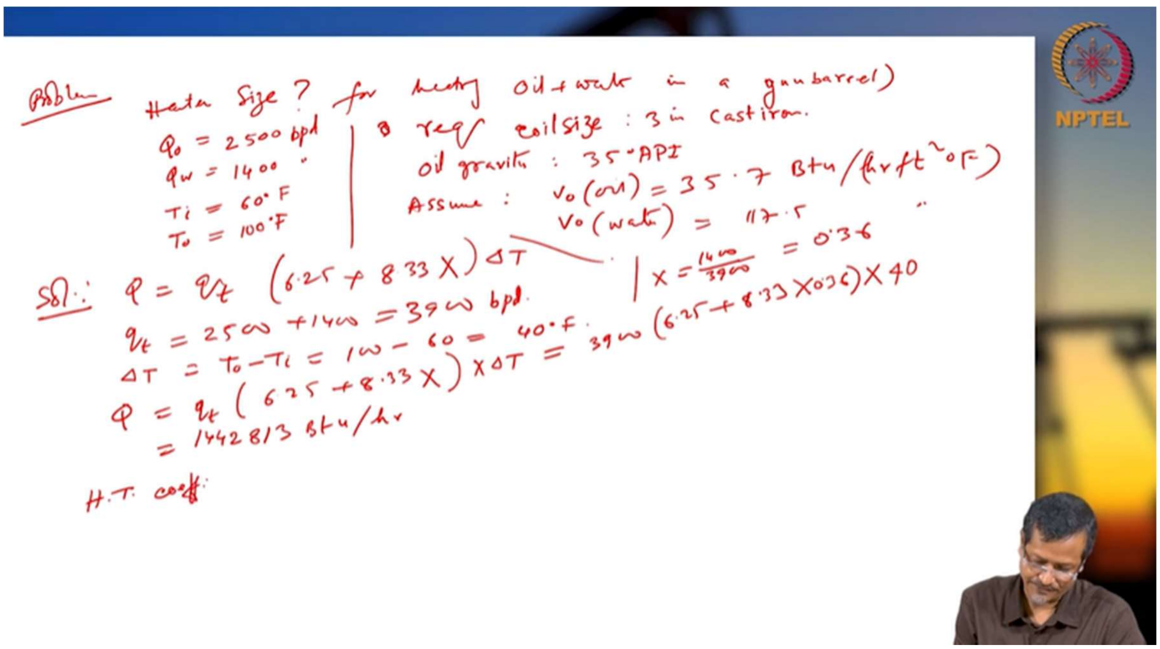
So, the h value or V value also will be changing from inlet to outlet actually, but they are saying the overall average film coefficient temperature ok. For low pressure of about 35 degrees API, they have given a formula API oil the formula is like this Q equals Q T 6.25 plus 8.33 x del T. So, Q T is a total liquid flow rate total liquid flow rate ok total liquid flow rate unit will be BPD barrel per day BPD.

X one term is used here x is decimal water D e C i M a l water decimal water constant. Now, how much fraction of water is there in the fluid? So, for that percentage, we will solve one problem. So, that time we will understand how to calculate x ok. And del T the temperature difference between inlet and outlet temperature difference between inlet and outlet.

So, a degree Fahrenheit overall film heat transfer coefficient ok. You want to go to the previous ok overall film or heat transfer coefficient overall film or h t heat transfer coefficient it will be like V o mixture V o oil plus V o water minus V o oil here and this is based on clean tube clean tube. So, there will be one x this is based on a clean tube or no allowance for falling factor or no allowance for. So, yeah these are given in the book. So, you can verify also this equation if something goes wrong.

And the falling factor I will explain this one. So, falling factor I said scaling sometime back right? So, you have one pipe when fluid is flowing through the pipe and if you have salt, salt means sodium chloride or any other salt you are drinking water you are drinking. So, PPM will be specifying the municipal authority or your biliary or other companies' PPM per se. So, how much salt is there salt content minerals are also actually there will be those will be there in the form of salt.

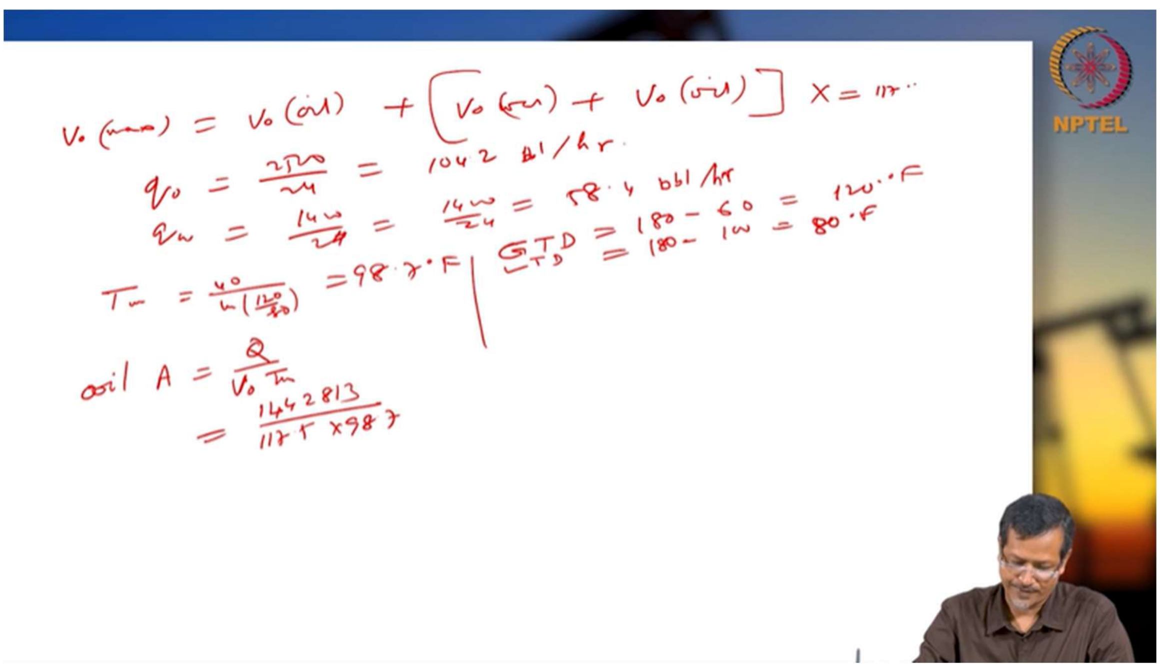
So, those salt once you are evaporating thing. So, water will evaporate, but the salt will not evaporate. So, they will be deposited at the bottom or inside the pipe. If you have contaminant that also will get deposited on the walls ok. Those will create foam or fouling ok?



So, what is the effect I already explained that normally let us say you have copper pipe. The copper pipe heat transfer rate is very high, convective heat transfer rate and con conduction heat transfer rate. Now, you have this other material salt deposition or contaminant deposition their heat transfer rate will be lower, their heat. So, like scale or fouling high h t coefficient heat transfer coefficient conduction conduction right and fouling if is there then low heat transfer coefficient low heat transfer because the heat transfer low. So, whatever heat is getting generated that will not get transferred completely.

So, your system efficiency will be reduced in the separator heater heater system I read some documents that say that because of this low heat transfer coefficient, you design something heat is not getting transferred. So, internal heat accumulation will be higher when heat is accumulated temperature will shoot up. So, that will create rupture and failure. So, you have to see whether that scaling is there. So, normally in boiler application steam engines other cases they will be giving salt-free water all the minerals and salt they will be removing they will be putting inside the boiler system.

So, there will be no deposition So, normal tap water or river water ocean water water you get. So, they will be there they will be having lots of salts. So, that same salt you cannot use for boiler application actually because of scaling issues, and boiler normally these systems whatever water you are boiling. So, that same water will be getting circulated same water getting circulated, but still, there will be some leakage or some other issues.



So, the water volume will be reduced. So, you have to give some makeup fluid all the time when you are giving makeup fluid makeup fluid should be salt. Then make a salt free and put it then things will be. If there is some scaling or fouling then you have to give when you are doing heat transfer calculation you have to give a certain allowance. So, you have let us say 100 B 2 heat transfer was there because of scaling heat transfer rate reduced.

So, then accordingly you have to give that much of allowance. So, presently in this formula, they are not using that fouling factor because the fouling or deposition on the surface heat transfer rate reduced the conduction heat transfer rate. So, that one they are not considering at this moment they are assuming this clean water you are using. So, no scaling or no fouling is needed. So, fouling or scaling will be very disastrous in boiler applications or very high pressure they are using for the steam turbine system they will be using several bars and several 100 bars of pressure.

So, in that case, very high pressure of fouling is there. So, the heat transfer rate will be lower boiler efficiency will be down again because of this heat uneven heat conduction and issues there will be overheating and other issues. So, we will try to solve one problem I have one problem I have written or not not written ok then we will write. Your slides are not going in sequence. So, write down one problem using those formulas we will try to solve.

Calculate heater size heater size heating for heating crude oil in a gun barrel for heating oil plus water in a gun barrel. So, Q oil flow rate 2500 they have assumed BPD Q water flow rate assume 1400 BPD inlet temperature 60 degrees Fahrenheit T outlet temperature 100 degrees Fahrenheit. So, required coil size. So, there will be one piping coil. So, that required coil size 3-inch iron cast iron required coil size 3 inch cast iron.

So, this will be used when we calculate final sizing. So, initially, heat transfer how much there. So, that one I have to calculate ok. Oil API oil gravity 35 degree API and assume V o assume V o oil that film coefficient for oil 35.7 V tu per hour feet square degree Fahrenheit.

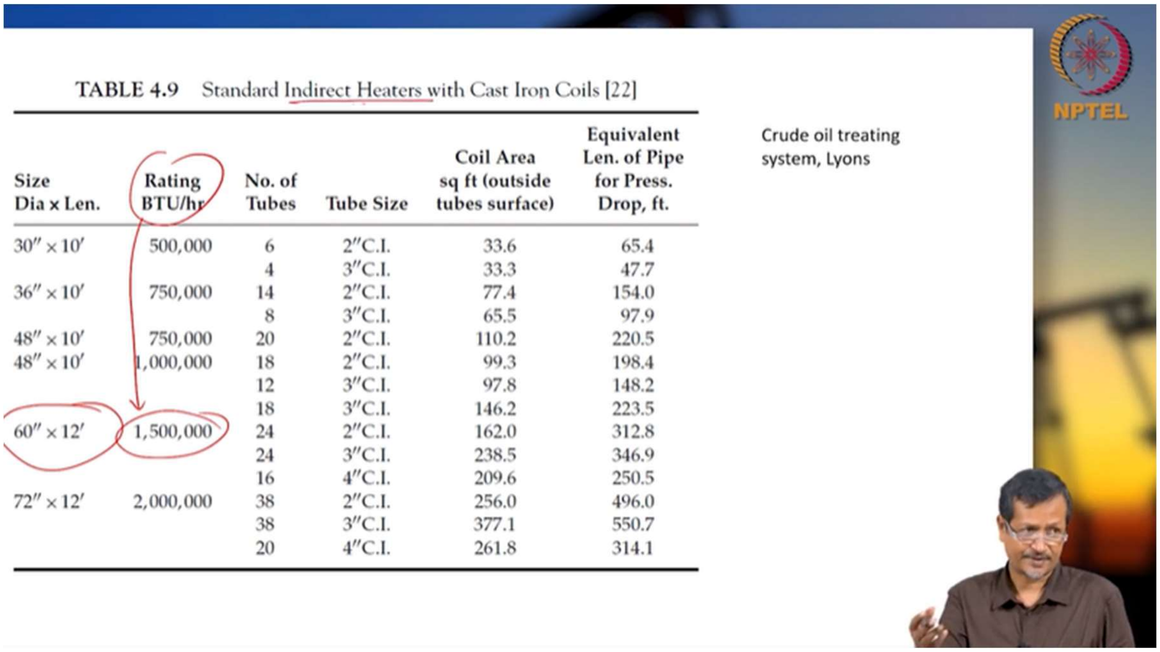


TABLE 4.9 Standard Indirect Heaters with Cast Iron Coils [22]

Size Dia x Len.	Rating BTU/hr	No. of Tubes	Tube Size	Coil Area sq ft (outside tubes surface)	Equivalent Len. of Pipe for Press. Drop, ft.
30″ × 10′	500,000	6	2″C.I.	33.6	65.4
		4	3″C.I.	33.3	47.7
36″ × 10′	750,000	14	2″C.I.	77.4	154.0
		8	3″C.I.	65.5	97.9
48″ × 10′	750,000	20	2″C.I.	110.2	220.5
48″ × 10′	1,000,000	18	2″C.I.	99.3	198.4
		12	3″C.I.	97.8	148.2
		18	3″C.I.	146.2	223.5
60″ × 12′	1,500,000	24	2″C.I.	162.0	312.8
		24	3″C.I.	238.5	346.9
		16	4″C.I.	209.6	250.5
72″ × 12′	2,000,000	38	2″C.I.	256.0	496.0
		38	3″C.I.	377.1	550.7
		20	4″C.I.	261.8	314.1

So, this one is like this V water 117.5 same unit. So, this data is given, and V o or V o oil and water they found from one table. So, instead of giving a table, I am giving direct values. So, in problem if I give a table then you have to find better I will try to give a table.

So, I will give data V o V w based on that you can calculate. The solution so, Q equals Q T you can remember the formula 35 degrees API the formula 6.25 plus 8.33 x del T. Now, the total flow rate Q T total flow rate is given 2500 plus 1400 equals 3900 barrel per day BPD ok total flow rate.

And temperature difference T sorry T o minus T I equals 100 40 degrees Fahrenheit 100 minus 60 it is 40 degrees Fahrenheit. So, Q formula you can remember Q T 6.25 plus 8.33 x into del T . So, this is giving 3900 already we have obtained the right 39 Q T 3900 6.

25 plus 8.33 x. X We are getting like this x equals 1400 divided by 3900 fraction of water. So, it is giving 0.36 360.2, and the T value we got already ah, 3440. So, this is giving 1442813 Btu per hour.

So, how much heat transfer is required we are getting per hour? So, now heat transfer coefficient equation coefficient C o E coefficient equation V o max V o max V o max equals V o oil plus V o water plus V o oil x ok. So, oil flow rate Q o equals 2500 divided by 24 equals 104.2 barrels per hour Q water equals 1424 because barrel per day.

So, you can convert it into an hour ok? So, this equals 1400 divided by 24 coming to 58.4 barrels per hour. So, now LMTD T m equals 180 minus 60 I will do GTD GTD equals 180 minus 60 why is 60 coming ok 60 inlet temperature? So, it is 120 180 means the water bath temperature they are assuming a fixed temperature of 180 degrees ok 120, and LTD180 minus 100.

So, it is coming to 80 degrees Fahrenheit. Now, T m is coming to 40 divided by log on 120 divided by 80. So, finally, it is coming to 98.7 degrees Fahrenheit. So, coil area Q by V o T m. So, 1442813 is the flow heat transfer rate divided by 117.

5 into 98.7. So, this value came actually if we put all the values it will come to 117.5. So, this is giving 124.4 feet square. Now, you have your heat transfer Q rate 1442813.

Now, you see the table I have one table I copied from one book Leon. So, this is becoming the range the rating is given. So, whatever you calculate it is near this rating. So, near this rating is the size you got this one diameter and length this will be your separated system size. So, the standard direction for the indirect heater for the cast iron coil is already given cast iron coil data, right?

So, for cast iron coil this one is your size. Thank you very much for today's lecture tomorrow we will start a new topic. Thank you.