Surface Facilities for Oil and Gas Handling

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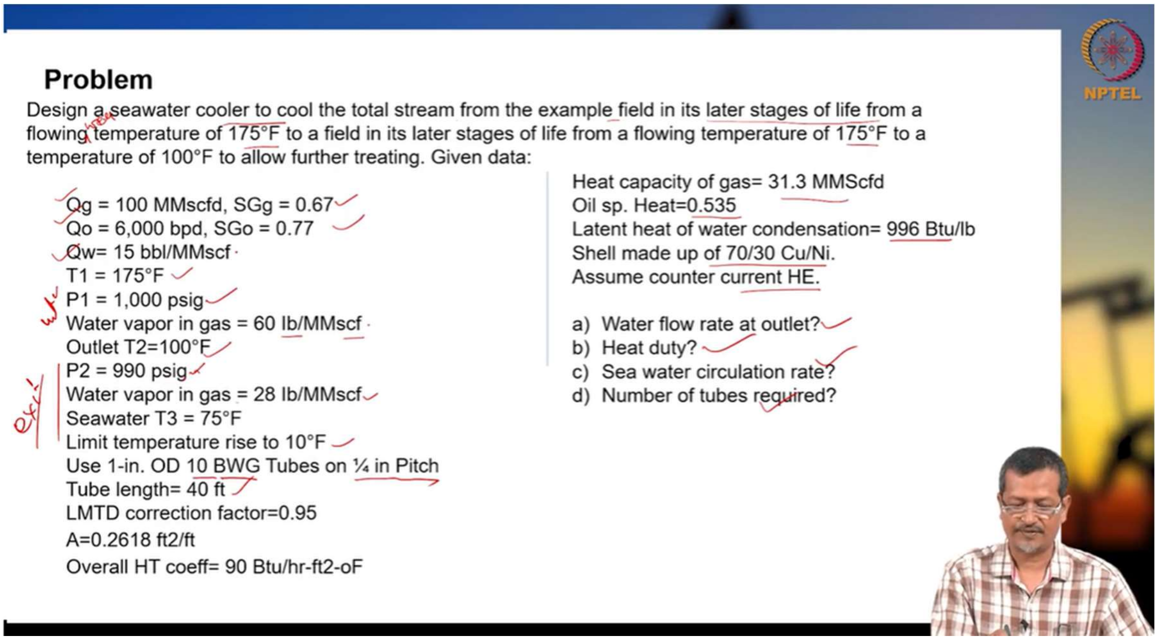
Introduction to Heat Exchanger-04

double pipe already I discussed ah. Let us so, I will not cover too many things only double pipe one pipe contact the tube fluid concentric with another pipe. So, one pipe will be inside another pipe and it should be concentric ok. So, this is called double pipe ok this is a double pipe heat exchanger. So, tubes tube is often a finned to give extra surface area. So, tube will be finned sometime fin what is the purpose of fin? Fin means extended surface extended surface like I have one surface and fluid is flowing over it.

So, what will happen one laminar layer will be created ok near wall. So, in laminar layer is created heat transfer rate will be lower. So, you create more turbulence you create more surface area because formula you can remember h a delta t. So, if you can increase a area your heat transfer rate will be increasing.

So, what you do if this is your surface. So, surface I will be creating fin. So, fin will give me more surface area because this area extended initially surface area was like this now this extra area added ok. So, surface area increased again you are creating loss of turbulence also fluid will be creating turbulence. When your turbulence is created fluid mixing will be occurring cold and hot fluid will be mixing.



When mixing up is happening more heat transfer will be occurring ok. And another thing is that surface increased again this is metal conductive surface. So, this will be this fin area surface also will be heated with same temperature ok. So, fin will be designed such a way that temperature will be almost same as main metal and cold fluid or hot fluid it will be touching the fins and surface loss of turbulence heat transfer rate will be increased. So, in double pipe or any type of heat exchanger you can use fin and you can increase heat transfer rate.

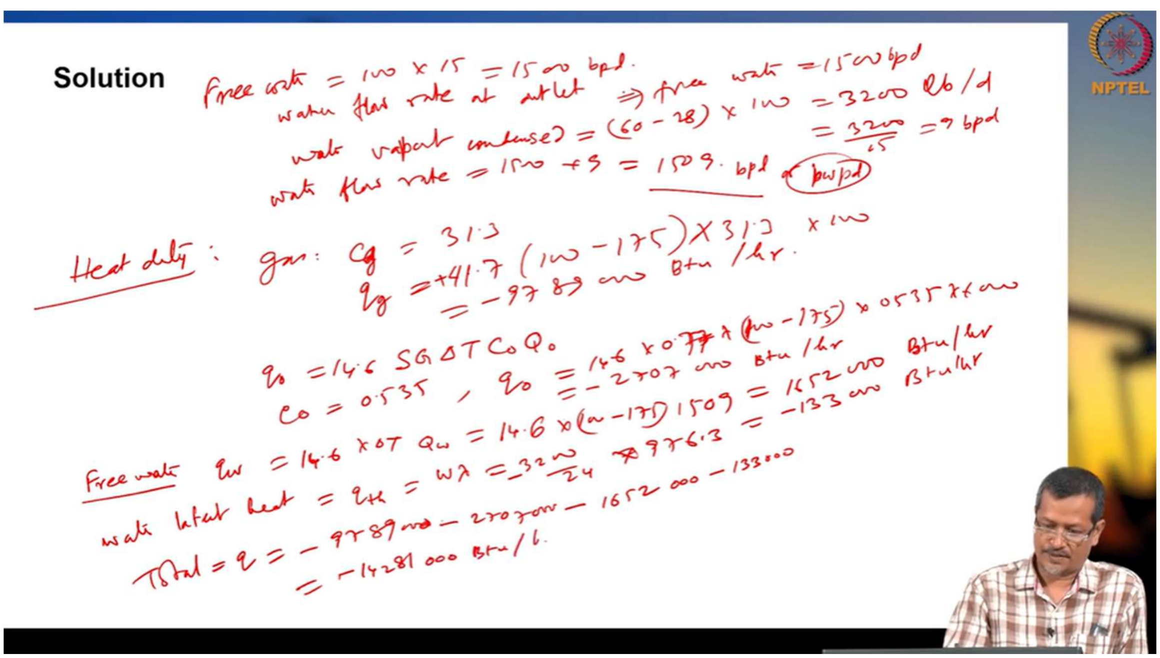
So, purpose of fin is to increase heat transfer rate using increasing area plus turbulence ok turbulence increasing plus area total area of the surface increasing because h a del t ok. Hairpin or u shaped single tube also can be used. So, u shaped ok this is hairpin type shape. So, this type of also system also can be used ok like this. So, you can draw whatever you like one entry one exit one entry one exit if ok hairpin shift.

It is cheap and readily available thermal expansion not problem for u tube because you have extended portion. So, expansion is not issue ah can be applied to most application oil and gas area ok. When surface area 1000 feet square or less ok ah we have direct fire heated and indirect ok. So, in direct fire system so, you are giving direct heat to the fluid whatever you want to heat ok. So, in that case radiation will be playing major role mainly radiation through like hot gas is coming you are having one oven right you can remember there is a rural chula right.

So, lots of fire will be coming lots of the direct radiation is heating actually radiation and some convection. Conduction is not there because hot gas is going there. So, hot gas is not touching any solid body. So, only hot gas going and radiation going that is why your pot or cooking pot will be heated up ok. So, radiation mainly and convection will be playing role direct heating system, but indirect system actually radiation will be playing lower role ok.

So, a rotary kiln open hearth furnace so, that sort of application is there where direct heating is possible. So, in that case radiation and convection basically indirect fire system steam boiler vaporizes heat exchangers melting pots. So, all this will be using some other fluid and basically convection and conduction maybe will be playing role fine. So, ok ok so, we will try to go to the problem directly ok your time almost there I am still 15 20 minutes. So, if you are ok let us try to go let us see ok.

Let us try to solve one problem based on whatever you learned heat transfer and heat exchanger. So, here one sea water cooler sea water means offshore application cooling system total stream stream from not steam stream from the water. So, for example, field in its later stage of life of a flowing well right flowing well should be right temperature 175 degree to a field in its later stage of life flowing temperature 175 degree Fahrenheit to a temperature 100 degree Fahrenheit to allow further treating given data. Data is given gas flow rate oil flow rate water flow rate is given and specific gravity gas oil is given temperature inlet temperature to the exchanger 175 pressure 1000 psig. So, psig means you have to add 14.



7 ok water vapor in gas 16 pound mmsef ok how much water vapor is there. Outlet temperature 100 degree pressure again psig given pressure outer pressure water vapor in gas 28 why 2 time given ok. So, exit this exit condition this inlet condition ok. So, 2 means exit condition limiting temperature rise 10 degree Fahrenheit. So, water temperature 10 degree will be rising we are assuming and tubing diameter 10 degree again Birmingham wire gauge is given tube of 14 inch pitch.

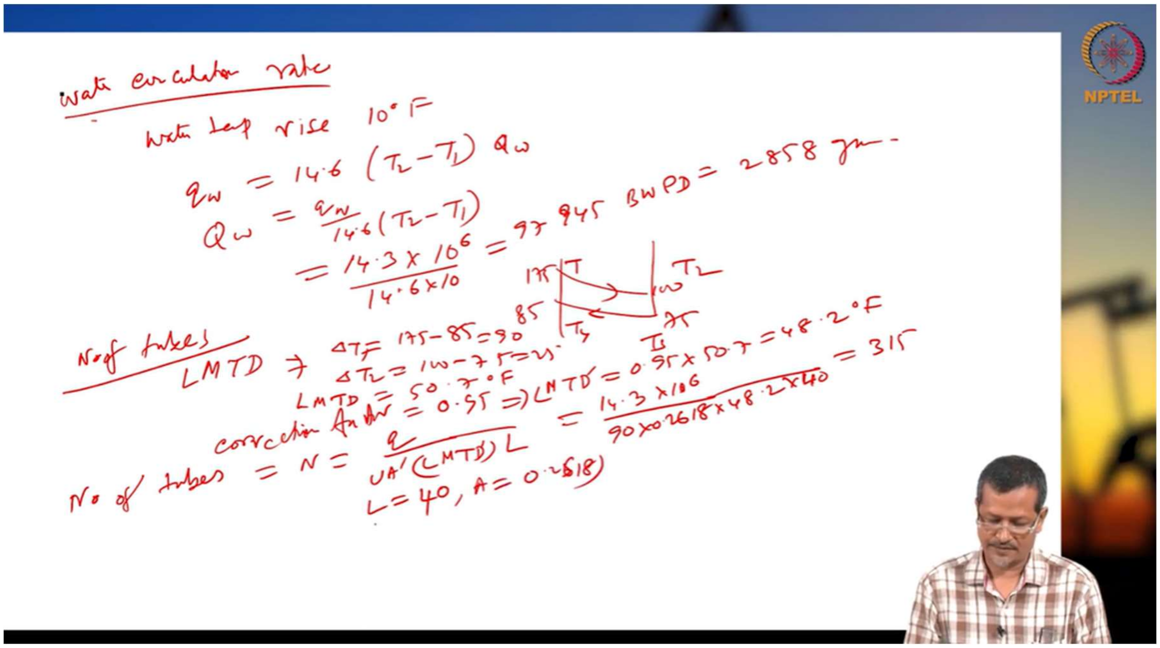
So, distance between 2 tube is 14 inch tube length 40 feet LMTD ah correction factor is given 0.95 area of tubing is given 0.2618 overall heat transfer coefficient also given heat capacity also given ah. Oil specific heat given latent heat of water foundation given shell made up of this one copper and nickel assume counter current heat exchanger. So, you can use co-current also um just for simplicity I made one.

So, in exam I can give co-current ok. So, the question is that water flow rate you have to calculate heat duty you have to calculate sea water circulation rate number of tube you have to calculate. So, here a certain amount of gas and oil flowing and oil is containing certain amount of water vapor ok. So, water be condensing. So, how much total water is going out how much total oil going out.

So, that sort of and how much heat will be required to heat to reach this certain level. So, that you have to calculate and number of tube also you have to calculate ok. So, here free water first. So, if you see this water flow rate 15 given per mmacf. So, that is free water that is free water actually.

So, free water free water is 100 mmacf into 15. So, 1500 BPD B WPD or BPD you can write ok. So, water flow rate outlet water flow rate at outlet equals free water and water vapor condensate. So, you are changing temperature. So, water vapor will be condensating condensing ok.

So, water vapor1500 BPD and water vapor condensed because temperature change 60 minus 28 16 let 28 outlet of water into 100 mmacf ok. So, it will be 3200 pound per day and you convert into BPD it will be like this 3200 divided by 150 it will be 9 BPD ok. So, water flow rate water flow rate will be 1500 plus 9 because 1509 BPD or you can write B W B WPD ok, barrel of water per day. Now, this question asks how much water will be flowing ok, free water. Now, heat duty when we are calculating heat duty how much heat required for gas water vapor water vapor to liquid then temperature change ok.



So, gas heat duty for gas. So, gas duty C g I have given the problem C g 31.3. So, Q q Q g equals 41.7 this is formula 100 minus 175 this temperature into 31.

3 this specific heat into 100 is giving minus this will be coming minus will be coming 9789000 B T u per hour ok, gas heat duty. Now, condensate heat duty condensate means how much heat will be required for condensate ok. So, Q oil equals 14.6 S g del T C o Q o C o value given 0.

535 Q o equals 14.6 into 0.77 into 0.77 into 100 minus 175 ok this is into 0.535 into 6000 given. So, it is coming minus 270707000 B T u per hour ok free water free water how much taking heat free water taking heat Q w equals 14.

6 into del T Q w equals 14.7 14.6 into 100 minus 175 1509. So, it is this is given 1652000 B T u per hour ok. So, water latent heat because phase change occurring. So, water latent heat equals Q th equals w into lambda. So, there is no water latent heat lambda.

So, if I put the values 3200 divided by 24 133 ok into 976.3. So, it is coming minus 13300 B T u per hour ok. So, total heat duty Q equals minus 978900 plus minus 270700 minus 1652 minus 133. So, it is coming minus 14281 B T u per hour ok this is heat duty.

Now, water circulation rate ok ok this problem bigger is given book actually. So, just I am giving here water circulation rate leaving ok. So, water circulation rate. So, water temperature temperature rise 10 degree ok.

So, Q water equals 14.6 T 2 minus T 1 Q w ok. So, it is giving Q w divided by 14.6 Q w equals Q w by 14.

6 T 2 minus T 1. So, this is giving 14.3 cross 10 power 6 divided by 14.6 into 10 equals 97945 B w p d equals 2858 g p m ok. So, this value is coming. So, one more part is there a heat exchanger number of tubes number of tubes.

So, LMTD you have to calculate ok. So, LMTD when you are calculating first you draw this figure. So, 175, 85, 100 75, T 1, T 2, T 3, T 4. So, del T 1 equals 175 minus 85 equals 90, del T 2 equals 100 minus 75 equals 25.

So, LMTD equals 50.7 degree Fahrenheit. So, correction factor if I use 0.95 then LMTD becomes 0.

95 into 50.7 it will be 48.2 degree Fahrenheit. So, number of tubes, tubes equals n equals u by u a dash LMTD I can see LMTD dash is better L. So, it is coming 14.

3 10 power 6 90 into 0.2618 into 48.2 into 40. So, it becomes 315 here L is 40 actually and a is 0.2618. Now, we will try to solve one gate problem it is it came in 2020 petroleum engineering. In a one counter flow shell and tube heat exchanger a liquid process steam C p given is cooled from 430 degree K to 330 K using water having an inlet temperature 280 process steam flows shell side 1 kg and tube side 2.5 kg the overall heat transfer coefficient is u also given u given 600 C p water C p water is given 4.

2 and process gas process liquid liquid C p is given 2.1 then the process steam flows steam flows 1 kg per second and water flows 2.5 kg per second. Overall heat transfer coefficient given now neglecting heat loss in surrounding required heat transfer area you have to calculate.

So, a you have to calculate actually. So, in that case what you do heat gain equals heat loss. So, m h into C p 430 minus 330 m C p delta t m C p delta t heat transfer rate. So, m C p delta t equals how much heat gain? So, 2.

5 into 4.2 T 2 minus 280 ok. So, I should draw one figure actually counter current. So, temperature 1 temperature 430, 430, 230 and another temperature is 280, 280 and this one I do not know ok. So, LMTD a T 2 having an inlet temperature 280 using water the process steam flows this one ok. So, this gives T value T 1, T 2, T 3, T 4 ok this gives T 4 equals 300 k ok. So, LMTD equals 430 minus 300 minus 330 minus 280 divide by logarithm of 430 minus 300 divide by 330 minus 280 ok.

So, this giving 83.33 k. So, heat duty equals U a LMTD. So, 1 into 2.1 into 100 equals 600 into a into 83.33 therefore, a equals 210 into 1000 divide by 600 into 83.

33. So, it is given 4.2 meter square ok this is the solution. So, another problem similar counter current heat exchanger the hot fluid enters ok. So, hot fluid enters175 degree Fahrenheit and exist 100 degree Fahrenheitand exist 100 the cold fluid enters 75 and exist 85 85 degree Fahrenheit. So, for the calculation of heat transfer rate consider the tube surface area to be a is given 0.26 feet square per feet and tube length 40 overall heat transfer coefficient also given 100.

The minimum number of tubes required a heat duty Q is given 15 into 10 plus 6 ok. Therefore, n equals Q U a LMTD ok and LMTD del T 1 equals 175 minus 85 equals del T 2 equals 100 minus 75. So, LMTD equals 175 minus 85 minus 100 minus 75 divide by logarithm of 175 minus 85 100 minus 75.

So, it is giving 50.78 78. So, so, n value is coming like1.5 into 10 plus 6 U value 100 given a value given 0.26 LMTD given 50.

78 L value given 40 40. So, this value coming 28.4. So, number of tube will be minimum number of tube like 28 to 30 n number you can give. Again another problem sealant tube heat exchanger use cooling crude oil from 400 to 360 degree crude oil flows through 3650 kg per hour water enters shell side 310 per kelvin and has a flow rate 1600 assume heat capacity crude oil and water 2.5 and ah 4.187 with the overall heat transfer coefficient U again given ah counter current heat exchanger given.

So, heat transfer area what is the heat transfer area. So, again Q equals 300 Q o equals 3650 you first you draw this curve actually ah. This counter current heat exchanger 400 T w 2 3 ah 6 0 3 1 0 ok.

ah Q w given 1600 C o given 2.5 C w given 4.187. So, LMTD equals 400 minus T w 2 minus 50 ah divided by L n minus T w 2 4 4 100 minus T w 2 50 equals 3 5 0 minus T w 2 4 100 minus T w 2 divided 5 hundred T w 2 means exit temperature of cold fluid. ah So, heat release by oil, oil h o equals 3 6 5 0 into 2.5 400 minus 3 6 0 equals 3 6 5 0 into 2.5 into 40 the water absorbs, water absorbs h w equals 1600 into 4.

187 T w 2 minus 3 1 0. Now, h w equals h o this implies 3 6 5 0 into 2.5 into 40 equals 1600 into 4.

187 T w 2 minus 3 1 0. So, T w 2 minus 3 1 0 is coming 54.487. So, T w 2 equals 3 6 4.484 k or therefore, LMTD equals minus 1 4.

484 divided by 0.7103 equals 42.35. So, it is coming ok. Now, U A L LMTD equals h o. So, therefore, 300 A into 42.35 equals 3 6 5 0 3 6 0 0 into 2.

5 into 40. So, this will be giving A equals 7.98 ok. This is the answer. Thank you very much for watching the video and you have to prepare all the problem and you have to

see textbook or get questions similar similar questions and you try to solve for preparing for exams. Thank you very much.