MARINE ENGINEERING

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Lecture14

LMTD

increasing heat transfer, so logarithmic mean temperature difference. Logarithmic mean temperature difference. When two plates are, one body is here, temperature T1, T2, And you want to calculate the heat transfer rate. So, like Q equals minus k delta T by delta x, right, dT by dx.

But what happens if temperature is varying, then what is the simple formula? So, in that case, we consider two case, one will be parallel flow case and another counter flow case. So, parallel flow means that I have one pipe inside another pipe. okay no let's say i have one pipe over another pipe okay and this direction flow and this direction flow this is parallel flow And in another case, I have inner pipe, outer pipe, inner pipe flow like this, outer pipe flow opposite.

This is counter flow. So, what happens in parallel flow if I plot it? So, this is T hot 1 T hot 2. So, let us say outer pipe is having initial higher temperature T hot 1 and lower temperature T 2 and T cold 1 through inner pipe T cold 2.

So, T hot 1. So, if both fluid are going through concentric tube and condensate flowing, so what will happen? Hot fluid will be releasing some heat and temperature will be going down. So, T hot 1 T hot 2 and what will happen cold fluid cold fluid will take certain amount of heat okay so if fluid is flowing like this then hot fluid will be releasing heat cold fluid will be accepting it we are assuming there is no heat loss okay from other other way so what the amount of heat absorbed by hot fluid will be same

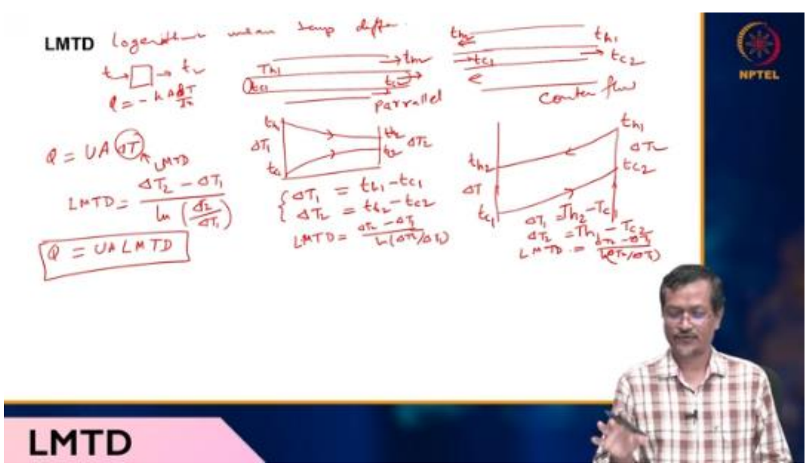
as amount of heat released by an amount of heat released by hot fluid T hot equal amount of amount of heat released by hot fluid will be absorbed by cold fluid same amount. So, in this case the formula becomes Q equals U A delta T delta T or it becomes delta T becomes

LMTD. logarithmic mean temperature difference. So, how this LMTD calculated? LMTD formula is that equals del T2 minus del T1 natural log of del T2 by del T1.

This is del T1 del T2, this difference So, del T1 equals TH1 minus TC1, del T2 equals TH2 minus TC2. This is the logarithmic temperature difference. So, now my Q equal be UA is equal to UALMTD. This is for

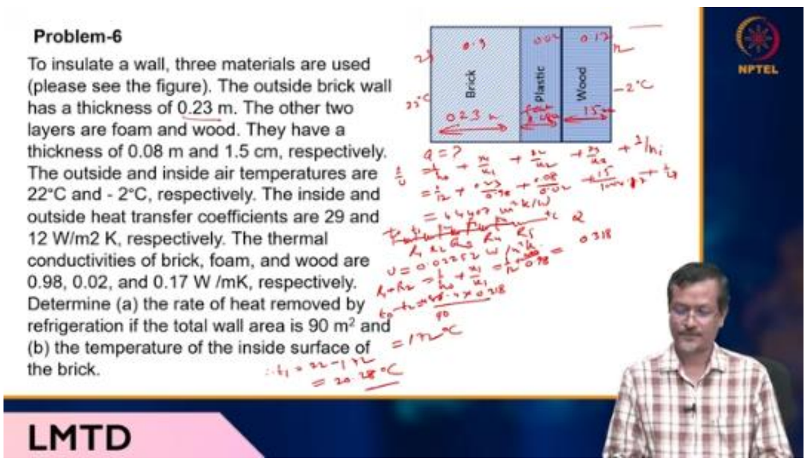
parallel flow for counter flow what will happen let us draw again the similar figure so what will happen let us say T hot entering T hot exiting T cold entering T cold exiting okay so T hot entering so this side right so hot entering and it is becoming temperature will be down okay so temperature down okay Now, T cold left side entering, T cold entering and temperature will be increasing. So, T hot entering, T hot exiting, T cold entering, T cold exiting and del T1, del T2. In this case, del T1 equals T hot 2 minus T cold 2. 1, del T2 equals T hot 1 minus T cold 2.

So, but my LMTD formula does not change, LMTD will be as it is. So, this is case LMTD logarithmic mean temperature difference equals del T2 minus del T1 logarithm del t2 by del t1 lmtd same formula del t2 minus del t1 logarithmic del t2 by del t1. okay both formulas same actually only the representation so this is a very common problem in mechanical chemical and other engineering so you should not get confused just you should remember the formula how it is getting formulated so a problem seems to insulate wall three materials are used phase see the figure the outside brick wall has a thickness 23 2 3 okay the other two layers plastic or foam okay 0.08 and 1.5 meter centimeter this is centimeter 0.02 okay meter and centimeters just please see the unit actually this mix of unit is given outside temperature inside air temperature given 22 minus 22 degrees centigrade the inside outside heat transfer coefficient 29 12 and thermal conductivity brick

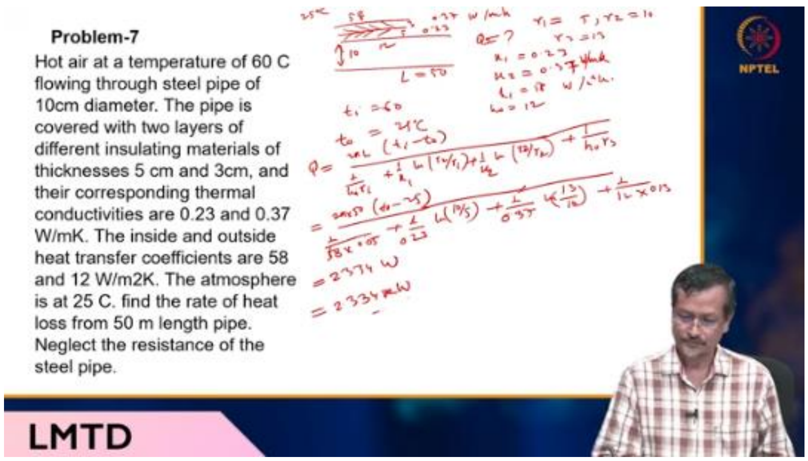


Determine rate of heat removed refrigerant Q. So, we are assuming this is inside temperature is for refrigeration purpose used may equal storage application . 0.9, 0.02, 0.17. The temperature of the inside the surface of the brick you have to calculate. So, formula is that 1 by U equals 1 by HO plus X1 by K1 plus x2 by k2 plus x3 by k3 plus 1 by h i so it is becoming 1 by 12 plus 0.23 0.98 plus 0.08 by 0.02 plus 1.5 100 into 0.17 plus 1 by 29 so this is giving 4.4 407 meter square k for water so you can see this heat transfer analogy sorry electrical analogy t o t 1 t 2 t 3 t 4 t i q heat transfer rate r 1 r 2 r 3

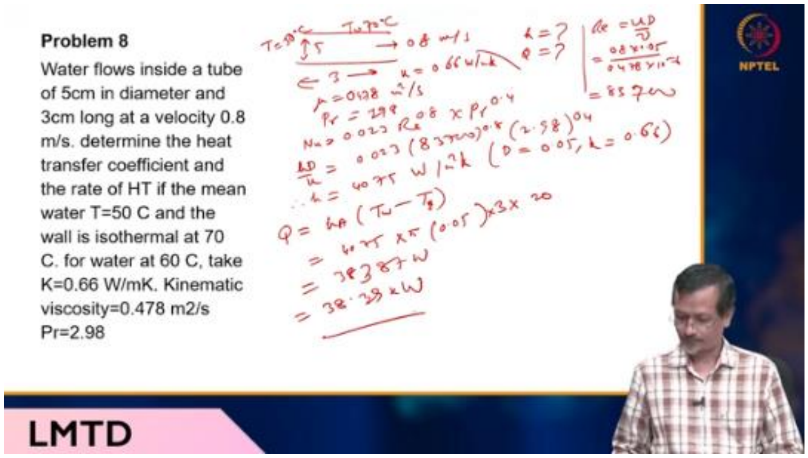
r4 r5 okay so u becomes 0.02252 watt per meter square k so r1 plus r2 1 by h o plus x 1 by k 1 1 by 12 equals 0 1 by 12 plus 0.23 divided by 0.98 equals coming 0.318 okay now t o minus t 2 equals 486 0.4 into 0.318 divided by 90 equals 1.72 uh degree centigrade so t 1 equals 22 minus 1.72 t equals 20.28 degree centigrade so hot air at temperature situation flowing through steel pipe 10 centimeter diameter okay the pipe is covered with two layers of different insulating material material of thickness 5 5 and 3 centimeter and corresponding thermal conductivity 0.23 0.37 watt per meter k the inside and outside heat transfer coefficient 58 12 12 the atmosphere is 25 degree centigrade 25 degree centigrade temperature find the rate of heat loss from 50 meter long pipe 50 meter long pipe Q we have to calculate ok neglect resistance of steel pipe so R1 equals 5 R2 equals 10 R3 equals 13



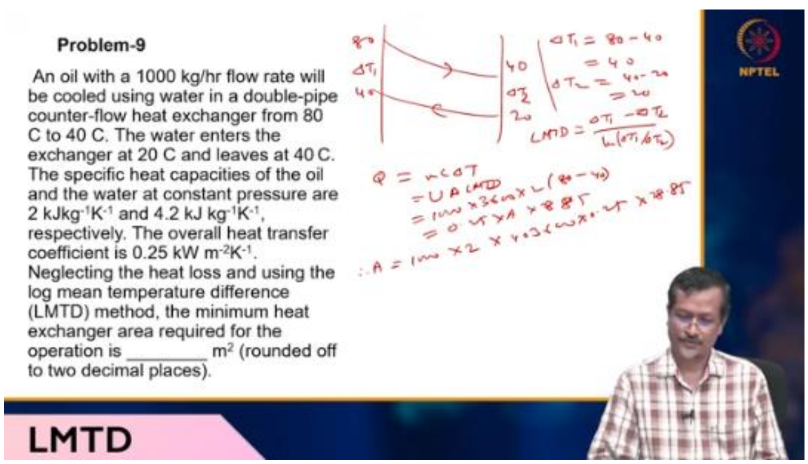
K1 equals 0.23, K2 equals 0.37 watt per meter K, HI equals 58, HO equals 12, TI is given 60, TO given 25 degree centigrade so q equals 2 pi l t i minus t o 1 by h i r i plus 1 by k 1 logarithm of r 2 by r 1 plus 1 by k 2 logarithm of r 2 by r r 3 by r 2 plus 1 by HO R3. Okay. So, this value, if I put all the values, 2 pi 50, 60 minus 25, 1 by 58 into 0.05 plus 1 by 23, logarithm of 10 by 5, plus 1 by 0.3937 log of 13 by 10 plus 1 by 12 into 0.13 so this value will be coming 2 3 3 4 watt so it is coming 2.334 kilowatt okay so water flow flows inside tube of 5 centimeter diameter 3 centimeter long and velocity is 0. meter per second there will be heat transfer coefficient heat transfer coefficient and heat transfer rate the mean water temperature 50 degree centigrade isothermal wall is 70 degree centigrade tu wall and k value 0.66 watt per meter k so no need to change units viscosity equals 0.478 meter square per second Prandtl number also given 298 okay Prandtl number non-dimensional number so Nusselt number equals 0.023 Re 0.8 into Prandtl number 0.4 use this formula so hd by k equals 0.02383700 because Re value I have to calculate Re equals ud by mu so this will be 0.8 into 0.05 divided by 0.478 into 10 to the power minus 6 so 83700 the non-dimension number so there is no dimensionality here 0.8 2.98 0.4 so this should be giving h value equals 4075 watt per meter square k where d equals 0.05 and k is 0.06



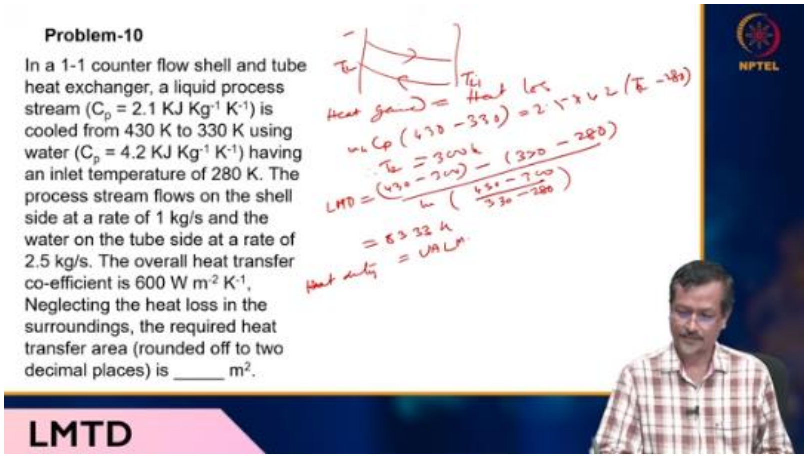
k k is 0.66 so finally q become h a t wall minus t that outside temperature fluid temperature so it is becoming 4075 into pi 0.053 into 20. so it is coming 38387 watt equals 38.39 kilowatt so in okay so this one lmtd counter for counter flow so counter flow first you draw this curve okay So, this is given 80, this is given 40, hot fluid temperature, cold fluid temperature 40, 20, 20 to 40 increasing. So, del T1 equals 80 minus 40 equals 40. Del T2 equals 40 minus 20 equals 20.



So, LMTD equals del t 1 minus del t 2 by logarithm of del t 1 equals coming okay so q equals m c del t because u a u a l m t d okay so equals one thousand into three six zero zero into two eighty minus forty equals 0.25 into a into twenty eight point two eight five therefore a equals one thousand into two into four zero three six zero zero into 0.25 into 28.85 so equals 3.08 meter square so again it is counter flow heat exchanger so counter flow exchanger means first you draw like this okay so it is given heat gain is heat loss so m h c p 430 minus 330 equals 2.5 into 4.2 t2 minus 280 okay so therefore t2 equals 300 k this is t2 uh sorry t t t1 t2 okay t cold one i can write



okay now LMTD 430 minus 300 minus 330 minus 280 by logarithm of 430 minus 300 by 330 minus 280 so it is becoming 83.33 k so heat duty equals u a l m t d so therefore 1 into 2.1 into 100 equals 600 into a into 83.33 therefore a equals 210 into 1600 into 83.33 so 4.20 meter square So, saturated stream temperature T1 equals 90 degree centigrade, Q equals UA del Tm. So, U 2 pi RL del Tm. So, 1200 given 2 pi into 0.01 into 0.4 into 90 minus 80, 50.



in 0.996 watt now enthalpy change from saturated stream to condensate del e equals 2660 minus 375 equals 2285 kg per kg okay let the rate of steam of condensate be kg per hour so q equals the rate into enthalpy change so m cross del e so therefore 1507 96 equals m into 2285 into 1000 divided by 360. okay therefore m equals 2.375 kg kg per h So, this is very simple problem I left for you. Let us see what it is. This is counter flow again.

So, 30, 50, 100, 40. So, answer I will be writing here. So, you can solve it. Equals 36.4 degree centigrade. Just you try yourself.

Again, hot fluid enters concentric pipe, heat exchanger, temperature, this one to be cooled, cold fluid enters this one, calculate LMTD counter both, you have to calculate actually. So, this one also you try, this is very simple problem, LMTD formula. I hope you can solve it thank you very much thank you very much for listening to the lecture next day we will start new topic thank you very much