Conduction and Convection Heat Transfer
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Lecture 64

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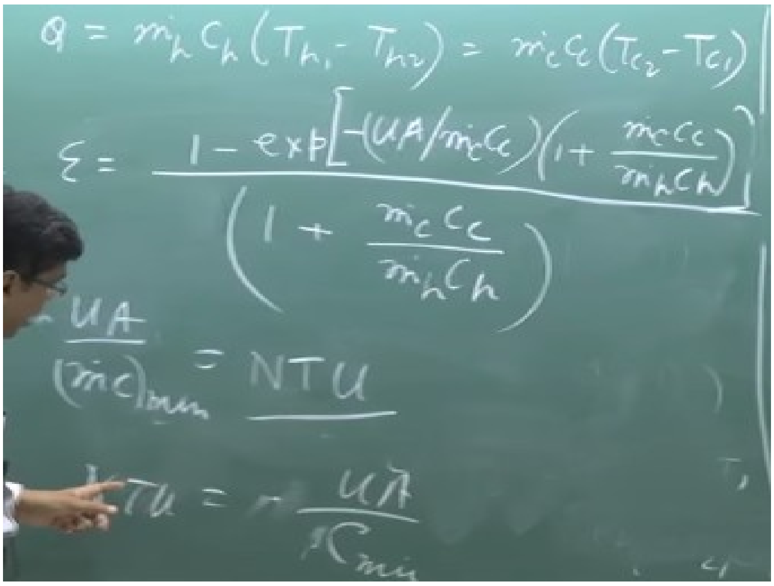

In terms of this quantity. Clear? Now here m dot c C c is the minimum heat capacity. Now this term minus u A/ m dot c minimum is known as number of transfer unit NTU which is a dimensionless term overall heat transfer coefficient, surface area of the heat exchanger divided by m dot into c minimum. Now if you can ask me the question you should ask this question to me. Without gossiping or chatting with your friend at the back sir, if the hot fluid is the minimum fluid what could you have done?

Now if the hot fluid is the minimum fluid first I tell you this expression will be same just m dot c and m dot h will be interchange with each other so that in a generic formula I can write in terms m dot c minimum and m dot c, generic formula. So, this will interchange if m dot h c h is the minimum then it will be m dot h c h NTU is minus u A/ m dot c minimum. This will be NTU and this will be one plus m dot C minimum/ m dot c.

Similarly, it will be one plus m dot c minimum/ m dot c but how to do it just interchanged. Here I was start again I started with cold fluid as a minimum fluid hot fluid as the minimum fluid I will m dot h c h. This is not all I will first take secondly, I will not T h to that is the second catch here T h 2 will not be substituted from this equation T c 2 will be substituted and in that case T c 1 will not we added subtracted T h 1 will be added and subtracted.

This is having a rhythm; Good boys can understand this thing better. Immediately by intuition here, we will take m dot h c h as common then it will be one plus m plus m dot h c h/ m dot c C c. Here T h 2 will remain as it is T c 2 will be replaced in terms of other temperatures from here T h 2 T h 1 and T c 1 and after that I will add and subtract T h 1 and in that case, I will use the definition of Epsilon as T h 1 minus T h 2 divided by T h 1 minus T c 1.

Because the definition of Epsilon is the change of temperature for the minimum fluid and the change of temperature maximum change of temperature available in heat exchange. Now if you write in a very generic fashion, a generic expression is like this if I make a very shortcut compact form by defining a parameter –now if I define it like this m dot c as the capital C

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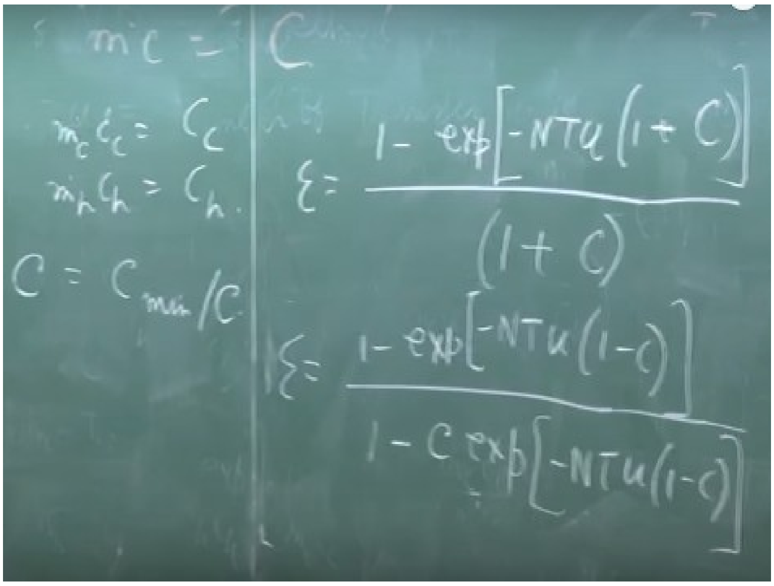

That means the capacity rate or simply the capacity and m dot c m dot c C c is the C c and m dot h c h is equal to C h and if I define C as the ratio of C min/ c which may be either this by this that means this by this or this by this depending upon the case. In that case the expression will be very simple it looks like simple expression remain same 1- exponential minus NTU where NTU is minus uA. Sorry, not minus, sorry.

NTU is a scale quantity dimensionless m dot C minimum that means C minimum with this nomenclature where NTU, is NTU into 1 plus capital C and therefore here it is 1 plus capital

C this is the expression. Where capital C is the ration of the total capacity that means m dot c specifically ratio, ratio of the total capacity. What is the ratio minimum to the other one? That means C min by C so this is the expression and this expression is for parallel flow.

Counter flow expression will be again a tricky and that I leave to you to do the counter flow expression in both the cases that is left and an exercise and the expression will be Epsilon is equal to one minus exponential function of minus NTU into here it will be 1 minus C and here it will be 1 minus C into again exponential minus NTU into one minus C. Now, you see that in condensation and boiling I told one of the fluids will be parallel in case of condensation the hot fluid is a parallel line.

In case of boiling the cold fluid is parallel line and parallel line means temperature does not change and I told qualitatively that counter flow and the parallel flow remains same but now mathematically you see that for a condensation and boiling problem this one of the fluid specific heat tends to infinity. The fluid which is boiling, and the fluid which is condensing C infinity. I showed you earlier in the figure which means that C is equal to C min/ C that means

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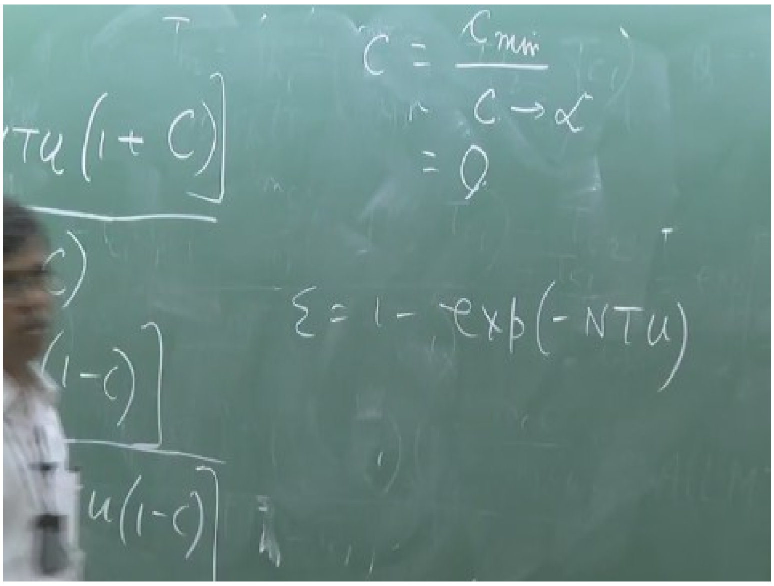

This higher C tends to infinity because which tends to infinity that will always be higher no question of calculation. That means an intelligent boy will tell that for boiling condensation the ratio which you denote as C will be always zero and if you put C zero in both the expression will yield the same value Epsilon is one minus exponential minus NTU this is the argument. If you put C zero because the ration is always zero.

Because the higher heat capacity rate whatever we got the product of m dot C is tending to infinity. Which is not a matter of hot fluid or cold fluid, which one is higher and which one is lower. But here one thing is very much open that if I do not know the temperatures explicitly then what we can do when we know the NTU because area you know overall heat transfer coefficient we know and the mass flow rate and specific heat.

We know, we can straight away find out the effectiveness and when the effectiveness is known, I can find out the temperature. So therefor this is a case where the rating will be done explicitly no iterations rating means the size is given we have to find out the heat transfer that means all four temperatures are not know explicitly. So, we can find out the Epsilon.

And whenever we find out the Epsilon. T h 1 and T c 1 all right I will work then from the definition of Epsilon I can find out the temperature difference of the minimum fluid that means heat load will come in the temperature difference of the other fluid will also come. So therefore, where rating heat load and cooling load is not done but size is given NTU Epsilon method is an explicit method to find out effectiveness, very quickly temperatures are found.

But where the temperatures are given sizing is to be made LMTD is useful because from here knowing Epsilon NTU as a function of Epsilon will be little difficult you understand this may require tedious calculations or iterations.