

Mass Transfer II
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Lecture No. # 19

So, in today's lecture we take one more example on ponchon-savarit method, and here also we will address you know the reboiler load, condenser load how many plates are require and in addition to that we will see how we can calculate the number of plate at infinite reflux ratios, and how do we calculate minimum reflux ratios. So, this is an second example of ponchon-savarit method on the distillation column based on your enthalpy energy balance. So, let see how do we address this problem here.

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Example - 2 Ponchon - Savarit Method

Methanol - water solution.

$P_T = 1 \text{ atm}$
 $T = 20^\circ \text{C}$

$F = 5000 \text{ (kg/hr)}$
 50% wt Methanol

95% Methanol x_D

1% Methanol x_W

$F = \frac{5000 \times 0.5}{32} + \frac{5000 \times 0.5}{18}$
 $= \frac{216.8}{5000 \times 0.5} = 0.36 \text{ mole fraction}$

$x_D = \frac{216.8}{95/32 + 5/18} = 0.92$

$x_W = \frac{1/32}{1/32 + 99/18} = 0.0057$

of plates = 9
 # of plates at $R \rightarrow \infty$
 $R = 2$ Reflux Ratio
 $Q_c, Q_R = ?$

So, this example two in continuation of this our discussion on ponchon-savarit method, so now we are looking at methanol-water solution, so what is given here is we have this methanol-water system feed its broad to the distillation column at certain rate 5000 kg per hour. And problem statements is this feed is 50 percent weight methanol.

So, weight fraction is given 50 percent, and then we have the top product purify 95 percent methanol, and the bottom product is 1 percent methanol. And the distillation

phase at P is 1 atmosphere, and temperature is 26 degree centigrade. So, you know in problem also says that there is a total condensation, and we have the reflux going back to the discussion column for the feed is feed heated, etcetera

But you know what we do right now based on the information the first few sentences that feed. So, much flow rate, so much is a compositions is a x D, this would be your x w, let see what we can do or we can calculate before we proceed for them. So, the question at the end of you know this lecture we should be able to answer how many plates, how do we calculate number of plates how many plates we have at infinite reflux ratios.

What is the minimum reflux ratio and what would be the condenser load and boiler load **alright**. So, before we you know go through the problem here, let see what we can calculate based on whatever information we have given to us. So, the first thing we must realize that this is 5000 kg per hour is given in the weight flow rate - mass flow rate we must convert into mole fractions molar flow rates.

So, which means F will now be 5000 into 0.5 divide by molecular weight of methanols 32 plus 5000 multiplied by 0.5, and we have 18 molecular weight of water. So, this is methanol-water system, all we are trying to say before we proceed further you know in solve in this an applying this ponchon-savarit method to answer these questions, let see now we can write in the form we need in a mole fraction bases.

So, everything is a weight fraction bases we are converting into this mole fractions. So, this is 216.8 kilo mole per hour. So, again the weight fraction is given as 50 percent we will like to convert this into mole fractions. So, Z F now again we are using this nomenclature for the feed composition, because we do not know what is the status of this feed here, if it is a liquid or it is a vapor.

So, we are using this nomenclatures Z F and Z F would be in mole fractions would be 5000 multiplied by 0.5 over 32. So, this is the moles total moles - moles of methanol over the total moles which we have got which calculate from here two point 216.8 to make it, 0.36 mole fraction of methanol.

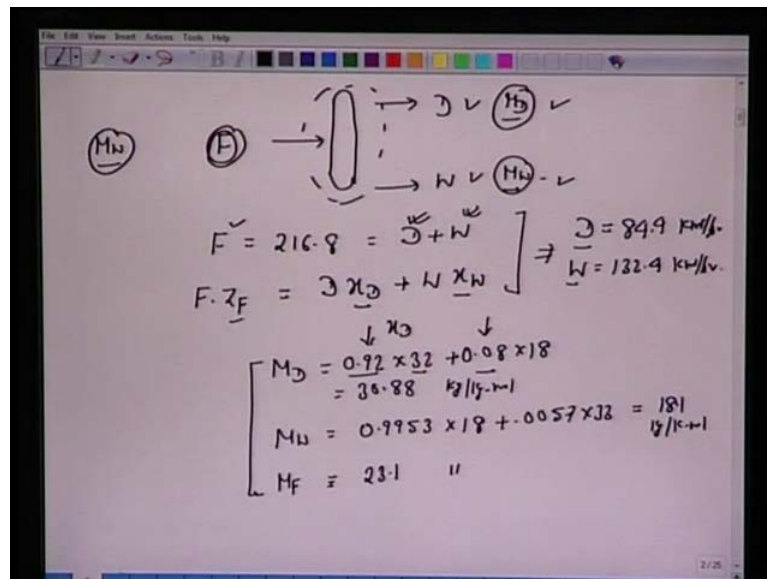
Similarly, x D is 95 percent then in mole fraction we can convert this into 95 over 32 divide by 95 over 32 plus 5 over 18 to make it 0.92 mole fractions. Similarly, x w mole fractions we have been given 1 percent. So, 1 over 32 over 1 over 32 plus 99 over 18

equal to 0.0057 mole fractions of methanol; all this is methanol more volatile component and large volatile components

So, we have not yet read we have not yet completed the statements - the problem statement completely here. So, it says 5000 kg per hour of methanol plus water system is plot into system, top product is 95 percent weight basis, the bottom product is 1 percent that is also be it basis all we have done we have applied ours previous knowledge of stoichiometry to convert all the quantities into mole fractions.

So, that is the first thing you should do as a good habit, because very often you know all enthalpy data or T x y diagram everything is given in terms of mole fraction. So, everything should be converted into kilo moles per hour instead of kg per hour, weight by weight instead of weight by weight (()) moles per moles here.

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So, let us continue with this problem here, now again we have this column feed F top product here is D, bottom product is W. So, without again going it to you know the problem statement and what are the other quantities, let see we can calculate D and W.

So, we write F as 216.8 equal to D plus W, again we can write species balance for methanol F into Z F as D x D plus W x W. So, here F is given, D is given, D and W where suppose to calculate Z F is given x D x D or x W all these quantities we have calculated two unknowns two equations to obtain the molar flow rates for the species top

product is 84.4 kilo mole per hour. Similarly, W bottom product residue is 132.4 kilo mole per hour.

So, I leave this as an exercise a very simple calculation to calculate D and W, now again very obtain you will see that we also need to know at some point of time, the average molecular weight of feed average molecular weight of the top product and they have this molecular weight of this bottom product, because you have to do lot of enthalpy calculations here.

So, before we further go let see if can get you know molecular weight of average molecular weight of your the three streams. So, if you do this you know say for example, M D average molecular weight of top product, then we have 0.92 multiply by 32 plus 0.08 into 18.

So, this would be your 30.88. Similarly, if we have molecular weight of M W which just I calculated, so this 0.92 is nothing but your x D which you have calculated mole fractions multiplied by the molecular weight, then you have water 0.08 multiplied by 18. So, this would be your kg per kg mole. So, we are calculating M D average molecular weight of your bottom product M W, this would be 0.9953 into 18 plus 0.0057 just now we calculated to 32 to make it 18.1 kg per kilo mole.

Similarly, we can calculate should be able to show that average molecular weight of the feed is M F is 23.1 unit. So far we have done very simple calculations for distillation column; therefore the feed three streams - one feed F, D and W.

have this reboiler in which part of this liquid which trickles from this bottom plate is send back to the distillation column. That means, the boiler acts as a theoretical plate and there stream and the stream leaving that bottom this boiler is saturated or it means the vapor going back to the distillation column, and the bottom product they are in equilibrium.

So, if you now the feed composition, and we now the temperature one can calculate this enthalpy, so one has to go back and recall this you know $H \times y$ diagram. So, in all this cases $H \times y$ diagrams are typically known right or one has to you know constructed from the knowledge of a specific heat or heat of solutions discussion which we had in the first few lectures, the more important here to realize that this bottom product comes out of a boiler.

So, this is the boiler in which the bottom product W goes out of this and part of this paper goes into back to the this distillation column. So, we had the last plate $N P$. So, this would be $L N P$. So, this is a bottom product from the bottom plate comes to this boiler part of this is vaporize as $G N P$ plus 1 and more important here to note that this two streams the residue W and the vapor which goes back to the distillation column they are saturated; that means, if we know this compositions W , in this case which we know here this is given as 0.0057.

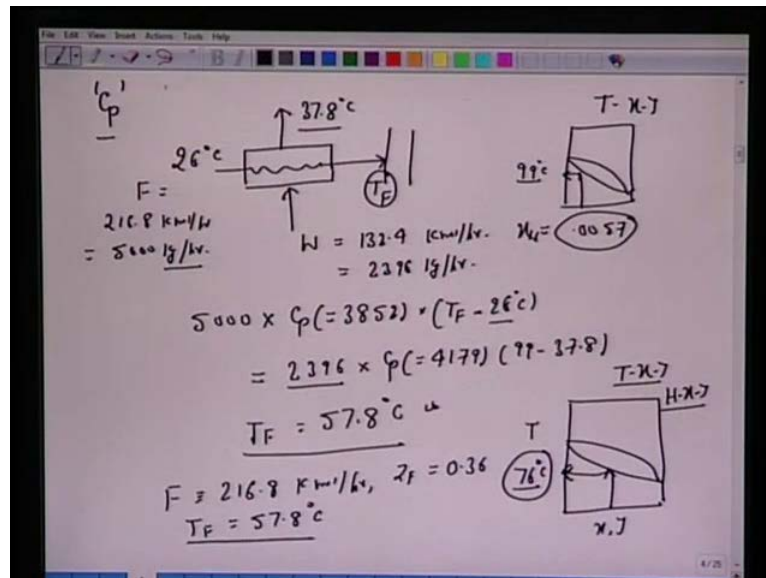
If we know this; that means, we can find out the enthalpy of this bottom product $H W$. So, knowing this feed compositions knowing this composition alone for this stream, and saying that this guy is saturated write in this conditions we know this enthalpy of this stream here $H W$. Similarly, if we look at $T \times y$ diagram this, so you have equilibrium curve $T \times y$ diagram then if you mark x here if you know 0.0057 here, then we know this temperature of stream $T W$ which goes to this heat exchangers

In other words we are saying here that knowledge of $H \times y$ diagram and $T \times y$ diagram from these two we can calculate the enthalpy of this stream, and the temperature of this stream, because we are make we are qualifying by saying that the two streams are in equilibriums. So, or it saturated

So, we have the saturated bottom product this feed on this product it can also be cooled further what can also be heated and this case is saturated once we make this is statement that this stream is saturated at this and the composition is. So, much $x W$ is 0.0057, we

can come to this H x y diagram we can calculate the enthalpy H W. So, we can read from the graph as well as we can know the temperature of this stream here T W, and this stream goes to this heat exchanger to preheat this feed here.

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In other words, now let us come back to this heat exchanger, because we have to find out temperature of this feed which goes to this distillation column. So, here we have W we just now we calculated the flow rate of this W, which was 132.4 kilo mole per hour. Since, we know the molecular weight now we calculate the molecular weight of this bottom product 132.4 multiplying this by this in a molecular weight one can also calculate the total kg or mass flow rate 2396 kg per hour.

Now, F is given to us has here problem statement we have 216.8 kilo mole per hour which correspondent to 5000 kg per hour So, we require some times this data as well 5000 kg per hour you can depends upon on the values of we obtain from this literature whether it is a per kg or per kilo mole. So, here this temperature was given to us as this feed was 26 degree centigrade, this is your T F which we want to obtain. The problem says that this residue it leaves this heat exchanger at 37.8 degree centigrade.

Now, this temperature is also known from H x y diagram, if we go back to this H x y diagram or T x y diagram we go back to this T x y diagram for methanol-water system then for 0.0057 which is the compositions of which is the composition of this stream saturated stream this number will turn out to be 99 degree centigrade.

So, now we come back to this now we start this H x y diagram. So, we have this H x y diagram and we will like to mark as many as points possible here. So, H x y and we have this H V and we have this H L H V and H L, now feed is here 0.36, and we said that this feed is cold; that means, system (()) in this enthalpy of this feed if you calculate this will fall short from here. So, if this is the saturated conditions if the feed is saturated right, then on the current feed is at say numbers is 2530 kilo joule per kilo mole

So, again this H x y diagram has to be read or interrupted in conjunction with this T x y diagram. So, our feed composition was 0.36 we realize that this temperature is smaller than saturated saturated temperature. Now top product we have calculated x T as 0.92 this is zero this is one, now the problem says that we have total condenser in the reflux is saturated liquid; that means, recall composition of the vapor which leaves the top plate the enthalpy at G 1 we have total condenser.

So, this is Q C and this top product is saturated; that means, H D corresponding to this x D all this can be located at this H x y diagram, because this is saturated reflux one can also in principle can further cool this liquid which goes as a product part of with goes as a reflects to that distillation column.

But in this case it says it is a saturated reflux which means if we know x D in this case which we know which we have calculated 0.92 this would be this should give us H D which we can mark as 3640. So, all we are trying to do is mark the coordinates as much as you know we know we can do this; for example, for this feed we need this composition 0.36 we realize that it is cold one can calculate the enthalpy to reach 25300 . So, this status of your feed here

Top product is point nine two mole fractions saturated liquids. So, we know this H D, then if you recall that this (()) would be the coordinate would be H G 1 here, because we have this latent heater we have. So, whatever vapor comes in the top plate it is condense completely to this liquid form. So, this H G 1 we can mark here the enthalpy of this stream leaving the top product or entering this condenser and this number is 38610.

So, we can mark this point we can mark this point we can mark this point we have also marked this point here, and now in the first the question is that if the reflux ratio is 1.5 times R min. So that means, one has to calculate this minimum reflux ratios if you recall from our from our previous discussions we had the extension of this line, and some

where we had this ΔD or we had this Q hypothetically stream leaving with this energy of this Q dash where in this case we do not know the reflux ratio reflux ratio is 1.5 times R_{min} .

If we know the reflux ratios then we can mark this segment based on this difference between H_{G1} and H_D , this H_D is same as H_{L0} , because enthalpy here is same as H_D . So, in this case first thing is that we have to calculate this minimum reflux ratios R_{min} .

So, let us summarize this problem here, if you go through if you read the problems statement no it will say that we have certain quality of feed. So, flow rate was given and the composition was given temperature was given, and all these quantities we were given in this weight fractions top product bottom product everything was given the weight fractions

So, first thing we did we converted all those quantities into mole fractions this, what you should also do convert all the quantities into mole fractions, because all very obtain we have all the enthalpy data and thermodynamic data in terms of your mole fractions $H_x y$ diagram etcetera. So, we converted all those we made over all material balance species balance to calculate $F_D W_x F_x T$, and x_W then the problem says that this feed is preheated with the residue before it enters the distillation column.

So, we know the feed composition we know the feed temperature now we know the composition of this bottom product and top of that it says that the bottom product is coming from your reboiler which is saturated. So, if it saturated we know the composition we can go back to $H_x y$ diagram; that means, we know it is temperature we can find enthalpy one can make an energy balance which we did to calculate the temperature of this feed which enters the distillation column.

So, now we are into distillation column we know the few molar flow rate remains the same before the heat exchanger composition will also will remain the same except which we have calculated here 0.36, we know the temperature we know the enthalpy we realize that this feed is colder it is not saturated although it is preheated. So, again one has to go back to this $T_x y$ diagram and C corresponding to 0.36 what is the temperature at (()) feed will be saturated or the bubble point temperature etcetera.

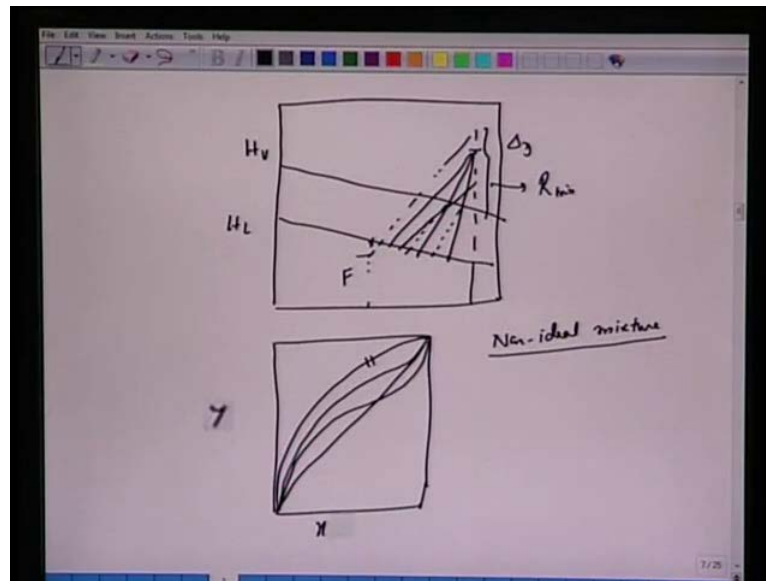
So, let us first let us try calculating or determining this minimum reflux ratios. So, we have H x y diagram again we start from H x y diagram H, we have this H V, and we have this H L. And just focus on this R minimum how do we calculate. So, this is x D which is 0.92, we know this data point we know this coordinate 38610 and we had 3640 we do not know this W D.

Now, had we known this then of course, we know first point this is y 1 we could have draw on this tie line leading from T x y diagram. So, given y 1 we could have got x 1, we would have connected this with this delta T, then get the another point here get this another equilibrium tie line. So, on then we would have proceeded like this.

So, stage one, stage two; this first operating line, this second operating line, etcetera. Now, how do we get R min we also said in our previous lecture that to get R min one has to monitor this locus of this R min as it goes up or down while changing this reflux ratio which is L 0 over D. So, when we go down right this flow rate this reflux ratio's, then is there is cross this operating line coinciding with this, this operating line. So, the definition for R min if you recall is maximum reflux ratio which gives infinite number of plates.

So, essentially at infinite number of plates we have operating line operating line coinciding with tie line. So, look at the slope of this operating line and the slope of this as we go down the slope of this line will change. So, if delta D is here and we connect with certain point here. We can see that this line is gradually becoming parallel to this and since this W D goes down and we have F which is fixed x W will also change will also move upward. So, all we have to do is to find out that tie line which coincides with this operating curve.

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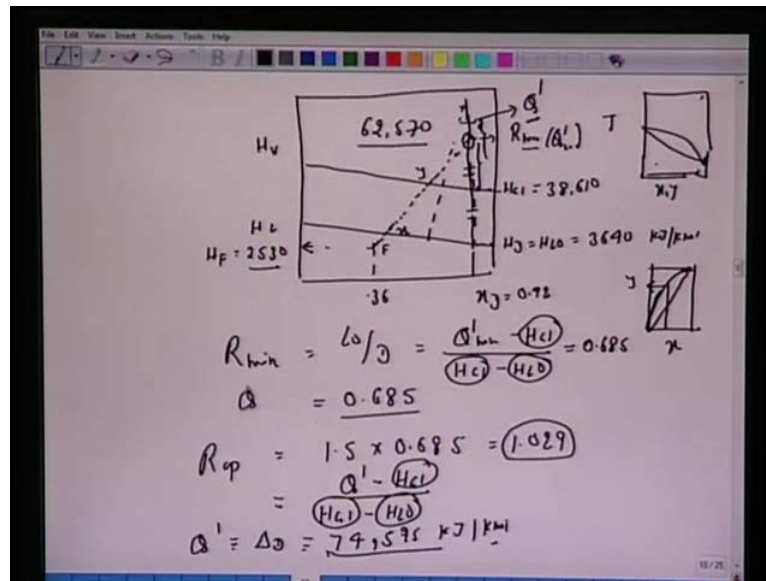


So, if you do this again on the H x y diagram, we said that there is a possibility of a certain tie line. So, this is let us draw again here, we have this some arbitrarily Δ point here and we are connecting all these points which would have been from our operating curves. Now, there is the possibility and these are here tie lines. All we have to do is to find out that tie line which corresponds which becomes parallel to this operating line, and we have to take the maximum of that tie line with thus which becomes parallel to this tie line.

Now, also now if we recall in our previous lecture, we said that we can have ideal solutions or we can have non ideal solutions very often when we have the ideal solutions and the shape of the D x y diagram is concave downward. If we have non ideal solutions what we are talking essentially of isotopic solutions isotopic mixture, in that case if you look at x y diagram, then we have different type of x y diagram.

So, if we have x y diagram it is a 45 degree line very often we have this type of equilibrium curve, but they are certain non ideal mixture in which case, we have curve like this or we can have equilibrium curve like this on these are all non ideal mixtures isotropic mixtures. In this case if we have the ideal solutions like this very often it happens that the tie line which goes through the feed, suppose this is your feed compositions, the tie line which goes through the feed composition and if you extend this, this will give you maximum or minimum.

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So, let us try to reconstruct this H x y diagram to obtain or min. So, we have this H x y diagram H V we have H L, and we have this x D point nine two we know this H L H T or H L 0 which is 3640 kilo joule per kilo mole, and we have this H G 1 enthalpy of the vapor leaving the top plate as 38610. So, these two points we know and we have this extended line we now this feed compositions here at 0.36 corresponding to which we have the enthalpy H F as 2530.

So, we said that lets find out this tie line which is going through this, so if you take this tie line and extend this will give us r. So, again it is very important that we understand that we required again T x y diagram to obtain this R. So, we have T x y diagram here we have this y versus x diagram. So, generally T x y diagram is given to us. So, we have this y x y diagram or we have this T x y diagram which is like this here

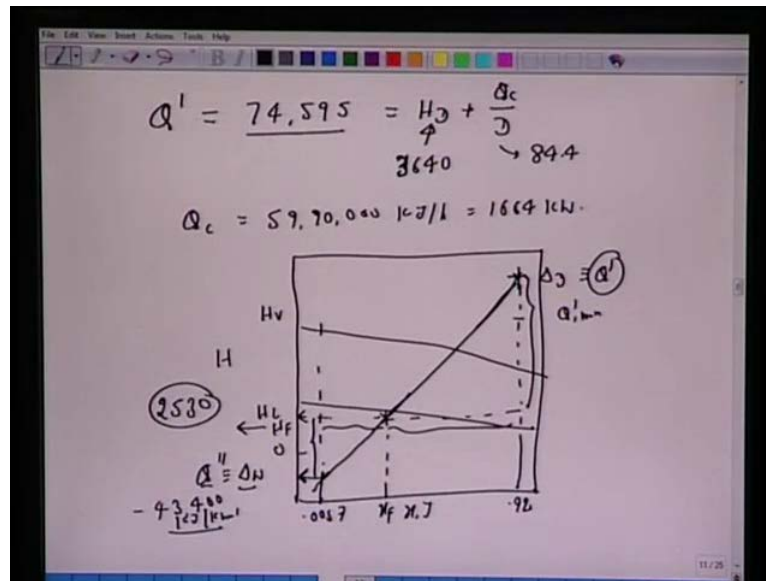
So, given x we can calculate y (()) here. So, we have to find out that combination of y and x which passes through this F from here, we get this R min now as we said earlier that in some cases is possible that some other tie line which will give might give us this R min. But in this case when the curve is concave downward like this we have shown here this tie line passes through this feed F. So, we know R min from this, we can measure - this segment this segment divided by this segment will give us R min.

So, R_{min} equals L_0 by D equal to $Q_{dash min}$, so which is $Q_{dash min}$ here minus $H_{G 1}$ over $H_{G 1}$ minus $H_{L 0}$. So, now at $G 1$ is known $H_{L 0}$ is known $H_{G 0}$ $H_{G 1}$ is known here and if you measure the segment this will turn out to be 0.685.

So, Q_{dash} ... So, from this R_{min} we can calculate and Q_{min} is we can read for the graph here which is 62,570. So, Q_{dash} everything is known one can calculate R_{min} as 0.685 then $R_{operating}$ is 1.5 times 0.685 to be equal to 1.02, and once we now 1.029. We can go back and calculate our operating Q_{prime} Q_{dash} minus $H_{G 1}$ which is same as before $H_{G 1}$ minus $H_{L 0}$; all these quantities are known to us, from this we can calculate Q_{dash} corresponding to differential point operating differential point to obtain 74,595 kilo joule per kilo mole. Somebody can also take these ratios of R_{min} and take 1.029 as you operating **operating** reflux ratios to mark this (()).

So, either we take this segment in proposal to 1.029 to mark this Q_{dash} , and we can read this or we can calculate this enthalpy of 74595 directly from scrap or we can calculate each of this will give the same result. So, the idea here is that either we calculate this Q_{dash} directly read Q_{dash} directly from the graph or we can take the segments you know that ratios of the two segments from the reflux ratios, mark it read it from the graph or we do the calculations given from you know the ratios of two same as the difference of the enthalpies. We have been Q_{dash} $H_{G 1}$ and $H_{G 1}$ $H_{L 0}$; in that case we should get the approximately the same results. Once we know this Q_{dash} or ΔD , we can calculate.

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Now, the condenser load or the heat at the condenser which is calculated as Q dash as 74595, which we have calculated or we have read from the graph, this will be equal to H D plus Q C over D H D we know over 3640 D we have 84.4 kilo mole per hour. So, by putting all this number one can calculate Q C as 5990000 kilo joule per hour or this is 1664 kilo watt. So, now let us come back to this H x y diagram again now we have calculate the boiler (()). So, that again one has to reconstruct or start from the same H x y diagram.

we have this H V H L we know this point 0.92, we have mark this Δ D now this is equivalent to Q dash, we had this Q dash min here from know which we calculate 1.5 times to obtain this feed is here.

So, this is x F and we have this V F H F , now if we extend this Δ D and P this way this will intersect this line here at 0.0057 should recognize that this line should be now Q double dash or equivalent to your Δ w . So, if you read from the graph one can obtain minus 43400 kilo joule per kilo mole. So, zero is somewhere here, we have H F 1530 (())). Now of course what we are doing trying to here is that we realize that Q dash Q prime and F they follow on the same line. So, it is a straight line. Then we can read from the graph in other words one can also make use of this enthalpy calculations. Since, we know the enthalpy here this divided by this will same as this ratio's.

So, from this also one can calculate Q dash. So, the idea is that either we read the graph correctly for Q dash or we calculate from the relation, which we have similarly here Q dash or delta w either we read from the graph by extending this line, here or knowing this enthalpy knowing the enthalpy of the different coordinates different points one can also calculate Q dash. So, it is up to you whether you read from the graph or you read from this or you calculate from the relations.

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The image shows a whiteboard with the following handwritten text:

$$Q'' \equiv \Delta H \equiv H_W - \frac{Q_B}{W}$$

$$= 6000 - \frac{Q_B}{132.4}$$

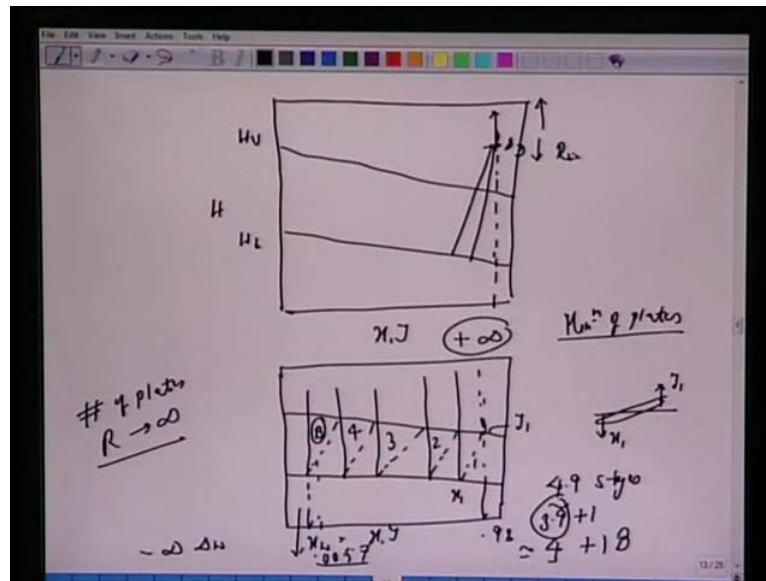
$$Q_B = 6540,000 \text{ kJ/hr}$$

$$= 1816 \text{ kW}$$

Min. # of plates $R \rightarrow \infty$
 And Total # of plates

So, once we know Q dash which is equivalent to your differential point for the bottom product or the stripping column, we can calculate boiler theta Q B over W. So, which is 6000 minus Q B over 132.4 kilo mole per hour that is the molar flow rate of W to obtain Q B as 6540000 kilo joule per hour which is 1816 kilo watt. So, we have this Q B now the class part of the today's lecture is to calculate minimum number of plates corresponding to infinite reflux ratios, and total number of plates.

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So, one again has to go back to this H x y diagram. So, we have this H V, and the H H L curve, and if we recall again from our previous discussion that the locus of the delta D points will move downward, if you are looking for R min and it goes up if you are looking for infinite reflux ratios.

So, when this locus goes up this point moves up we have all particular lines right. So, these are these are the operating lines which we need from del D del D points moves upward, then these lines will become vertically upward it will become parallel to this line in other words to calculate this minimum number of plates at maximum reflection ratios one has to start from x H x y diagram, we know the last coordinate which is point nine two given to us. So, all we do from here this is your y one first tie line first stage, we have this one. So, the top plate vapor leaving and the liquid leaving they are in equilibrium once we have x 1, all we do we draw the vertical line. So, this is operating line because this comes from plus infinity.

So, we have (()) realize that if this point goes up this delta W point will also goes down to minus infinity. So, essentially we have all these vertical lines going upward like this like this still we have reached or at least we have crossed this x W which is 0.00 bottom product was 0.0057. So, not necessarily you would able to reach this point exactly we have to do the calculation at least you reach this, but notice that the last tie line which it draw this will correspond to your boiler B. So, if you have done the graph correctly you

operating curve giving a relation between x_1 and y_1 y_2 . So, we have this y_2 this y_2 is (()) this plate is an equilibrium with the plate which leaves here. So, we have this y_1 let us mark here this is your x_1 here.

We connect this from y_2 again we have this another equilibrium. So, this stream is an equilibrium with this x_2 . So, this phase will x_2 we connect of this del point here to obtain this vapor which is y_3 .

So, we mark like this again calculate this one two three we have this y_4 you will realize that first stage second stage third stage, and then we will have corresponding to this we had another fourth stage which will connect from here you will get fourth stage, and after when you take this tie line this will cross your feed line. So, essentially after this stage four we have the feed entry. So, first stage second stage third stage fourth stage every time start start from y_1 vapor is an equilibrium with x_1 connect with this del D we have y_2 an equilibrium with x_2 connect with this del D we have y_3 , then we have this x_3 connect with this to your obtain this another point here.

So, similarly we have x_4 x_1 x_3 x_4 y_1 y_2 y_4 , and where is the last y_4 and take the tie line you can reading from this x y diagram all the time we have this y versus x diagram. So, every time we have to read this diagram to obtain this once you cross this then remember you have to connect with this bottom differential point which is corresponding to this x W we have this del x or we have this Q double dash one then we have to extend this then take another one, now this would be your four five this would be your sixth stage.

And once you cross this then every time you have to connect with this again take this we have the seventh stage, you can connect with this we have this eighth stage connect with this realize that after this eighth stage the ninth stage will exceed this 0.0057. So, it means we required total number of stage eight plus one, this one is the last stage which is boiler.

So, if you recall our discussion we have the last weight here eight starting here with one and the last reboiler x is a theoretical stage, because the product in the vapor and the liquid we are in equilibrium, so the last stage nine drawn here (()) this boiler. So, we have essentially eight plus one status here.

So, in this lecture we have taken this example based on Panchon-Severin methods, where we have addressed how to calculate minimum number of reflux. How do we calculate total **total** number of plates corresponding to 1.5 times R_{min} or we have minimum number of plates corresponding to infinite reflux ratios.

So, essentially start with $H-x-y$ and mark all your enthalpy points $x-y$ coordinates, and then do this staging. Try to identify that every stage vapor and liquid leaving in the two products they are in equilibrium based on this we can also do some other calculations like ratios of the molar flow rates of L_1/G_1 , L_2/G_2 , etcetera every time you have to realize that we are (()) this differential equations the difference between the liquid energy. And the vapor leaving reaching that plate is a constant given by this top enthalpy.

Similarly we can do the for the bottom stripping sections, whatever liquid leaves and whatever the vapor reaches that plate the difference is also same as your bottom product enthalpy or the species. So, once we mark ΔD and ΔW then our calculation becomes simpler we can do the calculation for condenser load for the heating load how many plates are required for the two extreme cases of minimum reflux and the maximum reflux or infinite reflux.

So, when we have the minimum reflux will we look for that tie line it passes through this heat combination we said that typically it happens that most of the ideal solutions, where they have $x-y$ diagram concave downward, but in some cases when we have isotopes. Then we have to be extra careful we have to find that this possible that some tie line can give maximum number of maximum reflux, which is larger than corresponding to the tie line which passes through this heat compression for that happens only in case of non isotope or isotropy mixture are the non ideal extreme.

And once we have an armine we can calculate operating or which is typically one point five times the minimum flux ratios, similarly if we are ask to calculate the minimum number of plates corresponding to infinite reflux ratios in that case the points goes upward both ΔD and ΔW goes downward, we have all the operating lines vertically in that case or we have suppose to do the starting with y_1 calculate x_1 draw a vertical line get, y_2 draw this x_2 draw the vertical line, and find out how many minimum number of plates are required for this maximum reflux ratios. So, that is the

example of panchon-severit method we have again two examples we are encourage to solve as many as problems from both tray ball as well as (()) book you know a separation procedure. And next time we will meet or in the next lecture we will take of anew topic on distillation column by, but by different methods called Mccabe thiele method, thank you.