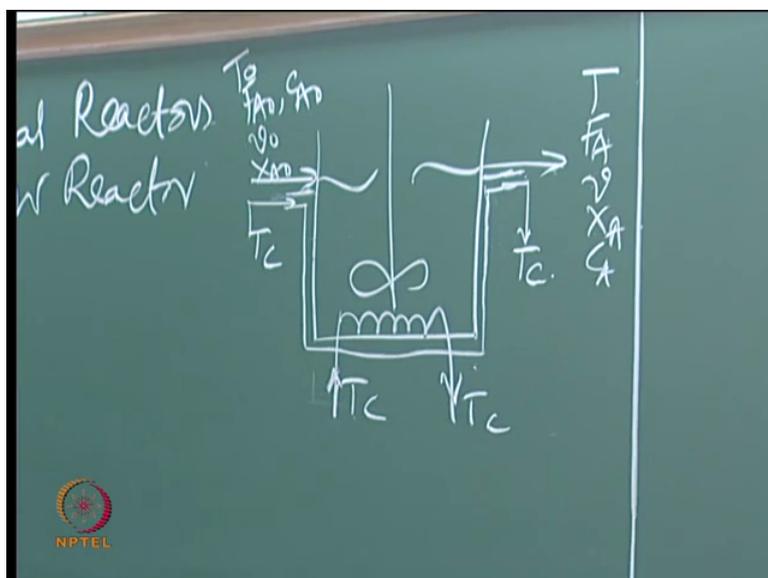
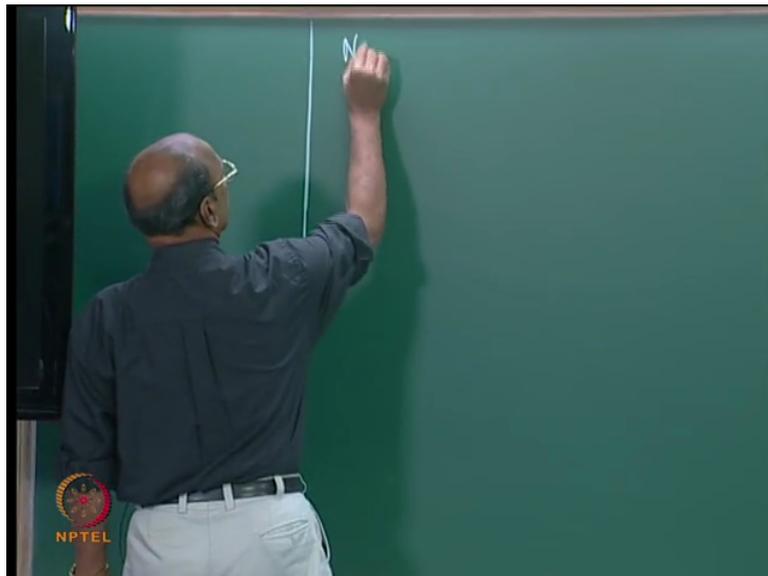


Chemical Reaction Engineering 1 (Homogeneous Reactors)
Prof. K. Krishnaiah
Department of Chemical Engineering
Indian Institute of Technology Madras
Lecture No 47
Non-isothermal Mixed Flow Reactors

Yeah we will discuss about mixed flow reactor, non isothermal.

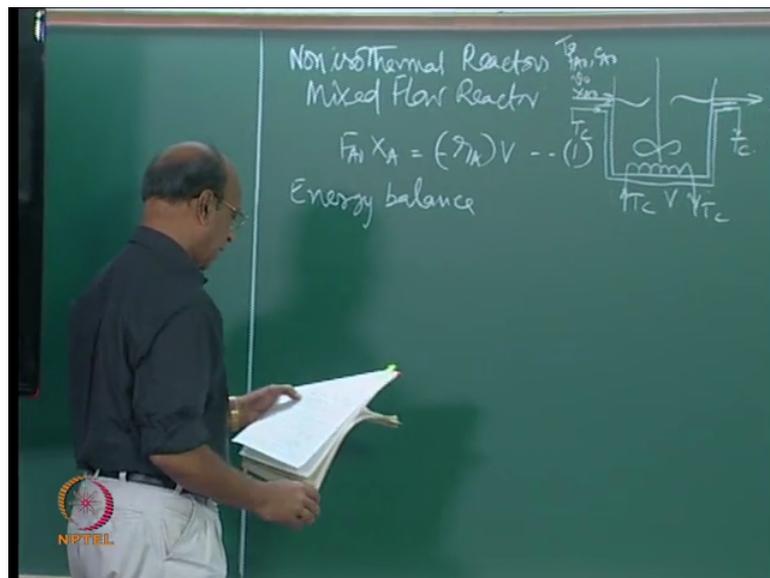
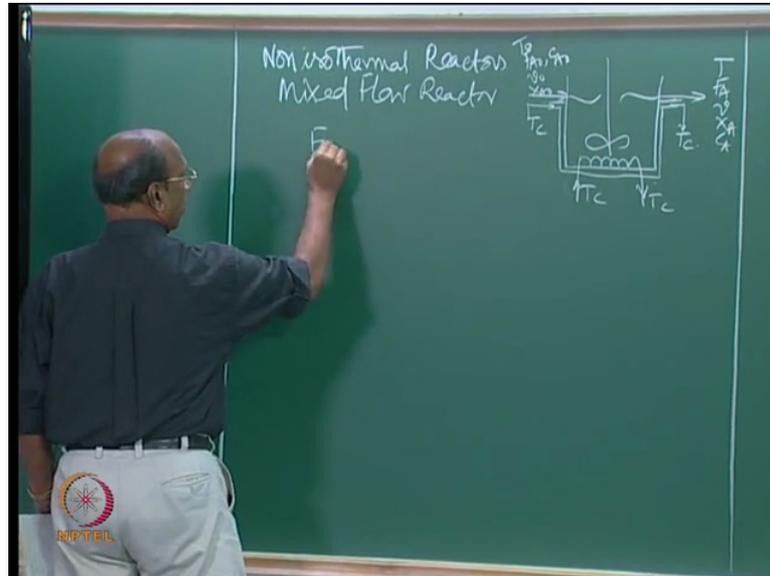
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Non isothermal reactors mixed flow reactor. So as usual we have to draw the picture here. This is entering leaving then we have here almost to the top. Okay this is TC in, TC out, this is FA nought V nought, XA nought imparted T nought. So this side I have T, FA, V, XA, CA here I may have CA nought, okay. All that and if it is if the heat transfer area is not sufficient

then we also may have internal cooling coils. Okay or both also sometimes you have to use and as usual you have to write here material balance and energy balance. Material balance already you know.

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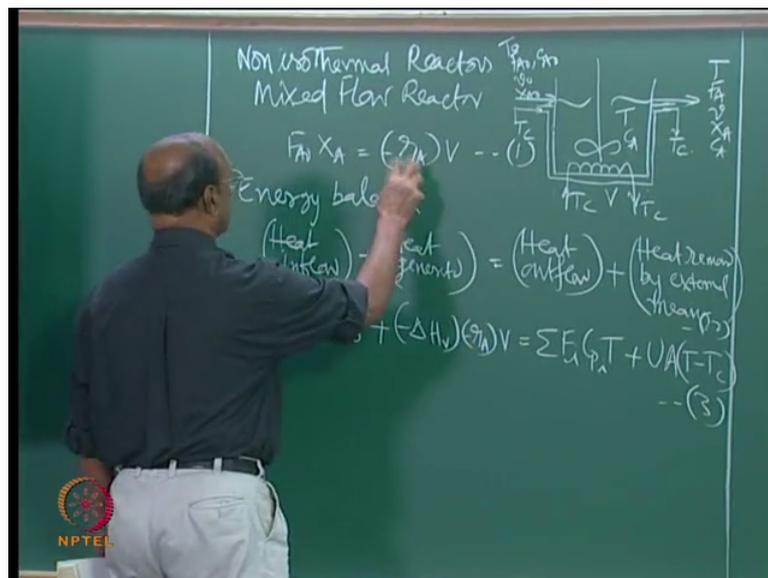
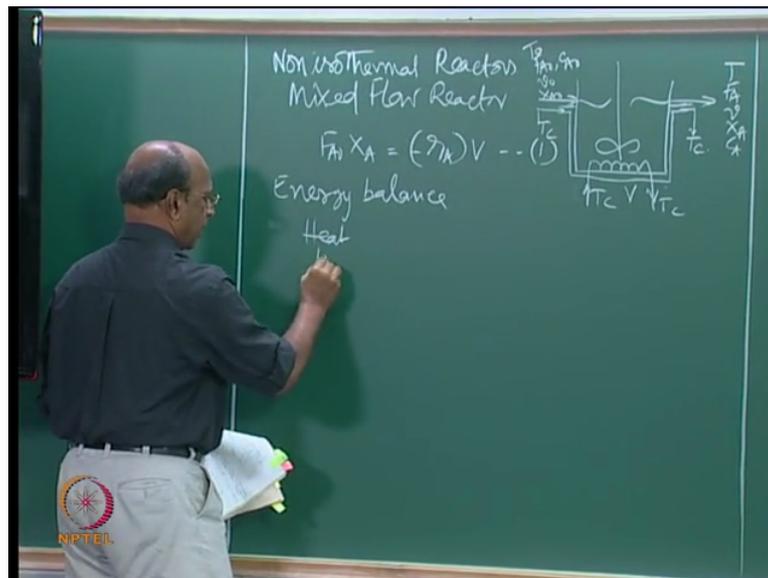


This is $F_A X_A$ equal to. Chaturai any idea? $F_A X_A$ equal to.

Student: Minus r_A

Prof: Minus r_A into V . Excellent very good, minus r_A into V . V is the total V here I have total V okay. Yeah and of course t_{ou} is volume volumetric fluid that is already you know this is equation number 1 then energy balance for energy balance for the entire, this is only for one species A and energy balance for the entire fluid.

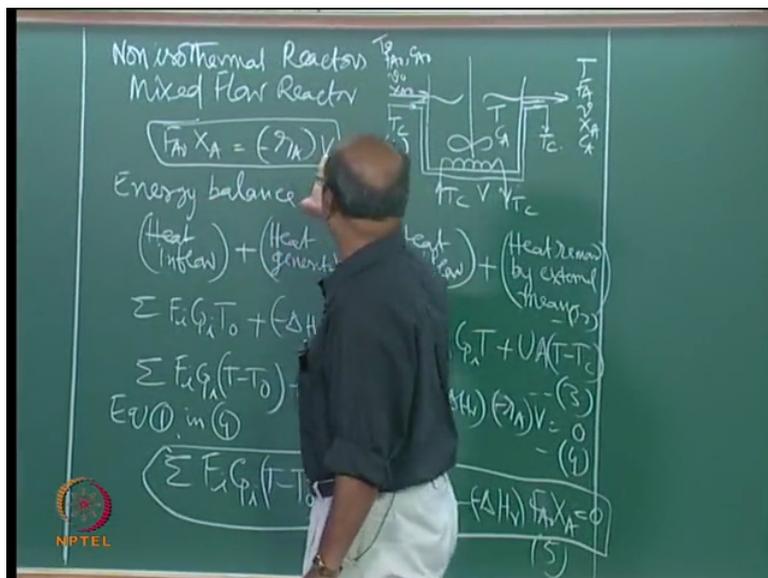
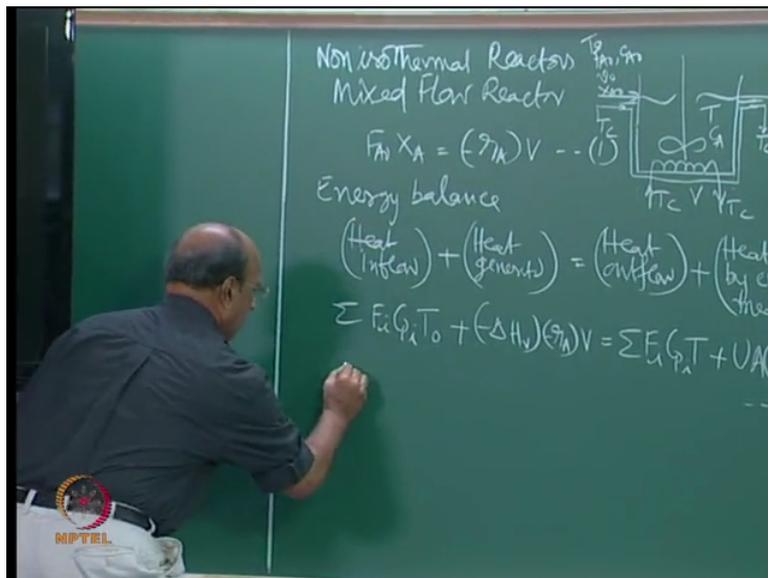
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So heat in flow plus heat generated equal to heat outflow plus heat removed by external means. Yeah so this will be sigma of $F_i C_{p,i} T_c$ nought yeah plus heat generated is minus delta H_r minus r_A into V the other one is again sigma of $F_i C_{p,i} T$ plus $UA(T - T_c)$ yeah. So because it is a mixed flow reactor inside also you have T and then C_A and X_A okay C_A is enough.

Those also inside same okay so that is why $T - T_c$ is this one so this is equation, this is equation 2 this equation 3, good so as usual we have to write this one this minus r_A into V , I have to convert into F_{A0} nought X_A . Because we need the relationship between X_A and temperature so that is the reason why we have to substitute there. Yeah

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So let me write this one as $F \sum C_{p,i} T - T_0 + UA(T - T_c) - (-\Delta H_r) F_A X_A = 0$. Now substituting this is 4 that is 4, substituting equation 1 in 4 will give us $\sum C_{p,i} T - T_0 + UA(T - T_c) - (-\Delta H_r) F_A X_A = 0$ so this is equation 5.

So this is our working equation along with this idea is to find out the volume okay, so now there is no trial and error required and how do you use this two equations? How do you use those two equations?

Student: (0)(6:24)

Prof: Harsha? Tell me how do you? Because by this time you should have learnt the game right? The rules of the game, yeah.

Student: (6:39)

Prof: It is always the problem except Harsha everyone will answer yeah. Harsha is a unique species only one, yeah tell me.

Student: choose X.

Prof: Choose X (6:52) choose X, choose X okay he has chosen point 8 so after ward what you do?

Student: (7:02)

Prof: yeah choose X why you are not thinking? yeah get.

Student: is to guess delta T.

Prof: Yes, where is delta T here?

Student: There is no (7:21)

Prof: T minus A you have to guess?

Student: (7:25)

Prof: okay if yeah I have chosen XA equal to point 8 then what will happen?

Student: (7:37)

Prof: Yeah can you directly calculate T from there.

Student: Yes

Prof: Yes, there is no trial and error involved in this. Why Anupriya?

Student: There are 2 variable which (7:52)

Prof: 2 variables X and T and 2 equations okay the beauty with mixing assumption is that the Time of course if it is batch it is time and if it is mixed flow sorry plug flow the length dimension disappeared because perfect mixing throughout the system only 2 variable so directly you know, we are now trying to calculate volume so that means X you should know.

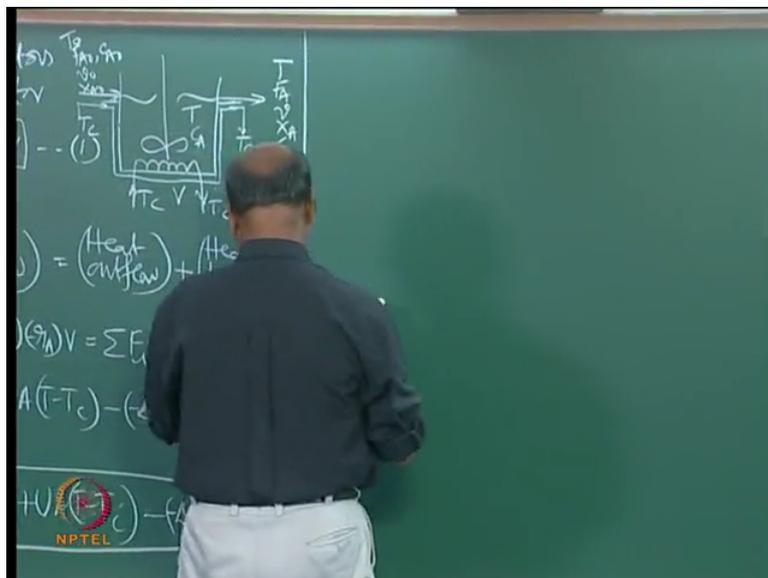
That's what I think Harsha guess is right. So X you know then FA nought I know delta HR I have delta HR I know, UA I know, TC I should know.

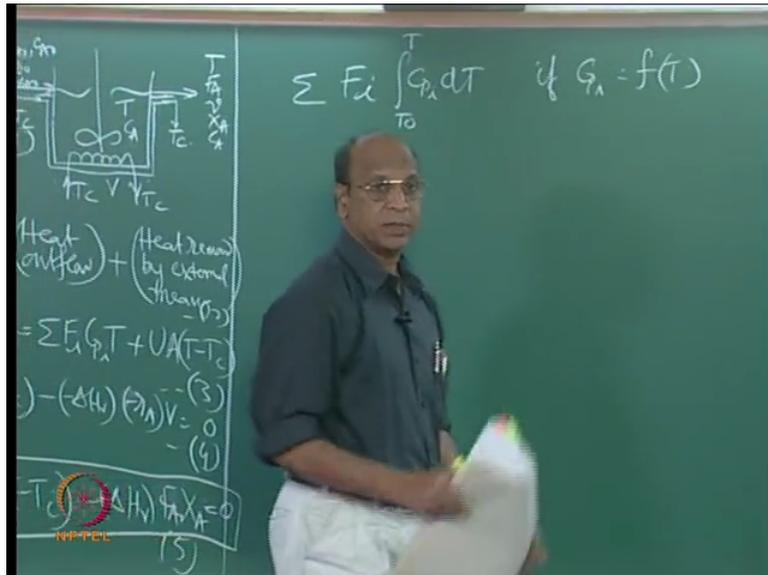
Cooling system then this CPI Sigma I mean Fi I can calculate depending on what kind of reactor reaction I have may be A plus B going to R plus S or A plus B going to R only or A plus B going to R plus S okay can be constant density or can be variable density all kinds of thing okay. Yeah so that is why this is easiest one to find out T from this equation 5 directly for a known XA all other things we should be known then what is the next step?

Student: (8:58)

Prof: yeah so that means I know X, I know T now I will go to this minus RA minus RA contains X and T right? Minus RA equal to K0 if it is first order, okay all that, then I know FA nought XA I know and volume you can calculate, straight forward, absolutely no problem, okay good. So now only I can tell you a little bit of more complication here. Now this equate this term, this term can also be written if there is a change of a CPI with temperature, then I have to put an integral sign here. So that means what would normally write is.

(Refer Slide Time: 9:39)





Sigma of $F_i C_{Pi} \Delta T$. Okay if there is a C_{Pi} is a function of temperature. And you know now C_{Pi} is a because you know in this one it is very easy because it is an algebraic equation. Is not a differential equation, so there is no delta Z or delta X and all that so that's why I thought I will mention here so how complicated it is now which I can just, algebraically only conceptually you don't have to learn anything I told you long time back.

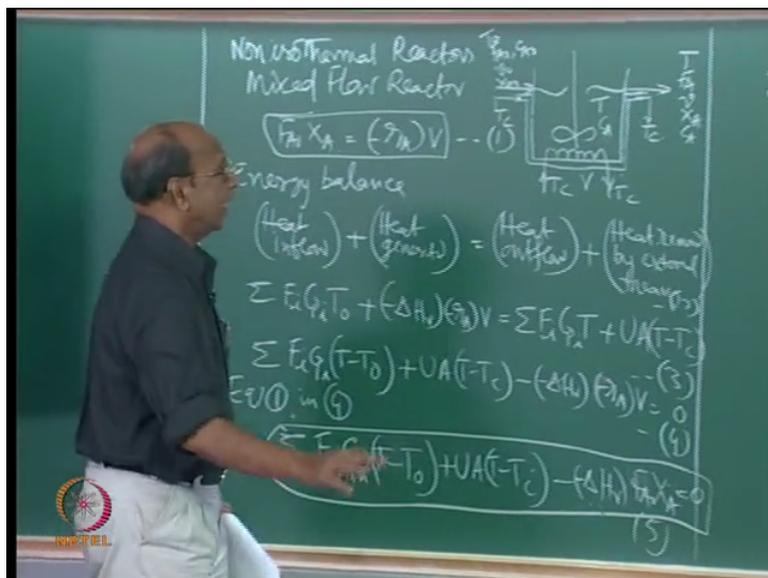
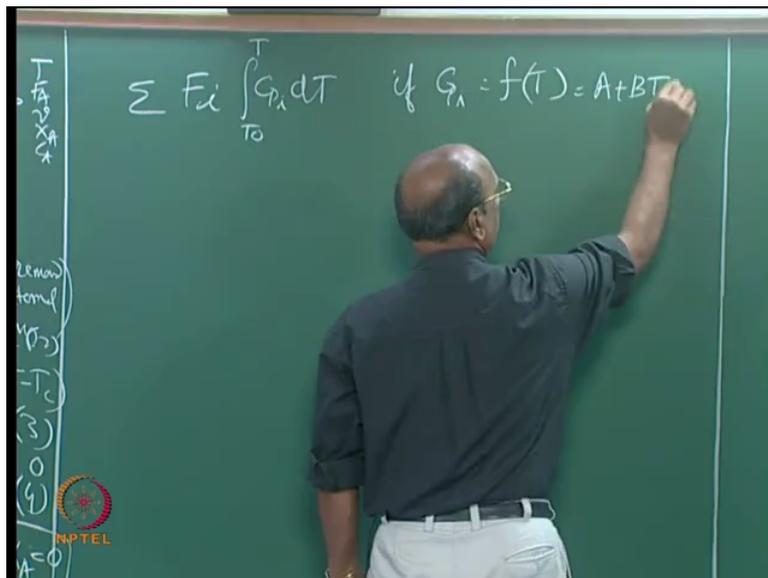
You are not learning anything, you conceptually it is only mathematically written, mathematical written, mathematical details if you relax assumption okay, so that is why and what is the functionality here for C_{Pi} .

Student: () (10:37)

Prof: A

Student: () (10:43)

(Refer Slide Time: 10:45)



Prof: okay so now of course, for each compound, depending on I know you can go to thermodynamic tables and then find out that what is A value, B value and then C value? Now that has to be substituted here. Right? Then you will get TQ correct no? Abdul then correct or?

Student: (())(11:12)

Prof: yeah integrate then what you will get?

Student: T cube

Prof: How you solve T cubic equation because, you have to get the relationship between X and T you can not directly use X and T cube, right? Then you will have 3 roots. Which root?

Right is the correct root. So all that will be more and more complications as per as mathematics is concern, right?

Because if I tell this one for plug flow and batch reactor, it will be not easy to understand but here it is very easy because this straight algebraic equation now you can write this and top of it is not only, yeah of course here we have taken $T - T_0$ then you have T^3 there and yeah here I have T all this I have to take into account and then find out what is X and corresponding T then only you can go here.

And then substitute in minus RA the T and the XA and then you can calculate volume. So that is what is mathematical complications but there are not threatening, its only you know the time and patience you should require for solving this kind of problem, okay so that is why one has to be careful and also on the top of it I have here F_i is nothing but $\sum F_A$ is sorry $F_i = \sum F_A$ equal to $F_A + F_B + F_R + F_S$ if I have $A + B$ going to $R + S$ it is not simple stichometry like 1,1,1,1, I may have 2 A plus 3B going to R plus another 2 S.

So correspondingly now you have to find out what is F_A nought? This is where you make mistakes. If you don't want to make mistakes then normally definitely you don't want to make mistakes right? Because you are worried about marks only, right? So that is why if you don't want to make mistake you have to do all the assignments. I think only except only 2 (()) (13:13) here in the class room only are doing the assignments. Okay you Jio life only 2 I don't know I think.

Student: (())(13:25)

Prof: It must be correct, because this is unique you know.

Student: (())(13:31)

Prof: for given XA , XA is given otherwise volume can not be found, you know that volume you have XA is given, so how do you unique, unique means this is only unique equation. Thats all this one algebraic equation and you can not make anything any mistake there and there is no quadratic equation where you will get two numbers that is why I am telling if you go to this then you will get cubic equation.

So it will be unique only because here I have T and here I have T right and only those 2 are not, I mean not 2 these only T is not nought all other things are known to me including XA because XA is given to you point 8 are some values.

Student: () (14:12) other reactor,

Prof: there also XA will be given but there is another one.

Student: We are guessing. We () (14:21)

Prof: No we aren't guessing, you tell me the reason I told you many times whether it is. You tell me why are you guessing there?

Student: () (14:36)

Prof: Not algorithm. Come to physics first. Algorithm you can go later. What was the problem there? I had two equations but three unknown. There by and what are the unknowns?

Student: () (14:50)

Prof: Now again same thing, except there by everyone will answer. Right now Gopi, that's why you know many times they ask? You tell me what is the fastest travelling thing in the world?

Student: Brain

Prof: Not even light, light suppose to be the fastest okay. You are faster than light. Okay, now you can go to any galaxy, galaxy number G 1250 I don't know what it is. But that's why they give that galaxy numbers, that galaxy number may be you know may be hundred light years away. You know what is light year?

Student: () (15:31)

Prof: yeah what is light year? Harsha?

Student: distance, measure distance,

Prof: Distance I think that is the light travel per second how much and then you calculate all this okay. But that means even light to travel it may take 10 years but you will be there in 10 seconds. Not even I see where it is much much fast one second so this is the problem.

This is the problem with you because I think mentally sitting physically sitting here mentally you can be anywhere okay even now you may be thinking that something else even though I am talking all this, exactly so that is why even though I repeated many things many times that

how this has become only two, two variable problem and the earlier one 3 variable problem, define.

Student: () (16:24)

Prof: yeah I see, see you see KK always right. Yeah okay you must be thinking something what is happening in Calcutta okay there everything is going on tramps or moving properly I think assume that is most interested things for us okay anyway even if you don't think things will go there.

Student: no sir I am just thinking that length of this equation your XA value is given you are finding out T and from that equation you are finding XA value is given you are finding out B.

Prof: X and T values are both known for me.

Student: XA values

Prof: see what is the basic thing in a non isothermal thing? You should know the relationship between X and T and then that X and T you should use in the desire expression. The desire expression is number 1, equation number 1 so but you know you have to get that X and T relationship, okay otherwise you can not do that. In a mixed flow reactor that is straight forward because in this equation there is only X and T nothing else.

But there is another thing in this equation in this equation means it is energy balance equation. In this equation there is another thing in the other two reactors in one batch reactor it is time that is involved, which I don't know and in plug flow reactor it is, distance which again I don't know.

These two we don't know so that is the reason why we have to guess and check that whether your guess is right and then that is how you try to solve that problem whereas here that is not require. Right. And I also mention sometime that in mixed flow by the assumption of perfect mixing the distance is dissolved, okay distance doesn't play role, why?

Because anywhere in this reactor I have the same concentration and same temperature whereas in plug flow along the length I have temperature changing concentration changing and length is there. Right so that is why you have one more variable that is why you have one more variable Z. That Z I don't know, where Z I don't know, X I don't know, T I don't know

even though X is given the remaining 2 definitely you don't know under you have two equations and that X corresponding to that X what is Z and what is T we don't know.

Unless we know all that you can not finally find out what is the total volume or length if it is cross sectional area is given okay, good so that is the one and another nice thing you know yeah here you have to remember that it can go to very very complicated. And here I can give this kind of problems in the examination okay to pin you because here, somehow we know the idea of taking mathematic courses are only to use here.

It is not just to get the degree here just to get the courses just to come for completion and then some grade. Right this M1, M2, M3, M4, M5, M6 how many how many M's you had?

Student: 6

Prof: yeah till 6, 6 mathematical courses you must be PHD in mathematics by this time. Okay but we don't know how to write the limits. Okay earlier problem we have seen, right so that is why all that information is given only for using here. That we have forgotten, Savita. Okay how many M's you had?

Student: (0)(19:36)

Prof: 3? Okay 3 M's that is I think she belongs to biotechnology. Biotechnology.

Student: (0)(19:45)

Prof: 3 mathematics yeah, in fact this is another bad thing in our society always we think that you know when you are in this school, if you are not good in mathematics okay let them go to biology or medicine. Okay and if you are good enough in mathematics then okay let him become engineer as if there is nothing else there in the world. In fact in biology you have the maximum mathematics.

We don't know I think you know there are beautiful mathematics how to calculate the number of spots, that will come for a cheta no cheta you know cheta? Which runs very fast, okay cheta okay how do you pronounce it. Chitha (0)(20:27) how do you know it is only TA not THA okay.

Yeah I think Britishers also called chata not cheta because only in Indian language we have TA okay that is why TA TA like that you know. So that is the reason you know what you have

there okay so, you know the tremendous amount of mathematics and you heard of person called Roger pen rows, Gopi.

Student: (0)(21:01)

Prof: Encyclopaedia basilica.

Student: (0)(21:01)

Prof: Roger federar uses only his hands and legs you know to win. But this guy uses only his brain nothing else.

Student: He is a (0)(21:18) from Oxford.

Prof: yeah but what is e he? Mathematician?

Student: (0)(21:24)

Prof: yeah he is also won, you know he is a friend of Stephen hawking you know. Both are them together proposed a theory about you know the universe how it started and all that. Okay both of them are due for noble price. Roger pen rows is also. Okay these two are really great, but you know no one is able to prove that experimentally that there theories are correct thats why they are not able to get.

Like hiks (0)(21:50), hiks is waiting for noble prize, okay, Hiks, he told some particle should be there now it is others you know experimentlist to find out and say that the particle was there so far experimentlist you wont get the noble prize but he gets the noble prize. Who hiks gets the noble prize. Okay so that is the beauty of using your brain. So that is why which one is given more value?

See experiments means again you have to do with your hands, legs and all kind of things, right. But idea first idea, of course if the experiment is fantastically design they will also get. Okay both of them may get together whoever design that experiment, right so thats why this all this people are waiting Roger pen rows also.

He has a beautiful quotation that he says that I don't remember the exact quotation he says that nature is embedded with mathematics if you remove physics and look at that you will see only mathematics. In an I think the words are very nicely if physics is evaporated then you

will only see mathematics that's what I have been also telling you all the time that means first learn physics and then it is only mathematics that is left.

Even telling this also that is what this is the simplest mathematics we are talking about okay. This is not real mathematics there are many many complicated mathematics that is why the nature it is tremendous amount of mathematics that is involved in CRE also beyond certain point that physics if you cross physics and then try to solve, physics is what like you know defining what is mixing defining what is plug flow.

And defining simple concept like what is recycle? All that if you learn thoroughly and then it is only left with you only mathematics. Okay so that's why that quotation is really fantastic quotation when I read first time I was so happy to see that quotation because nature is completely embedded with mathematics that's why you know wrongly we tell that if you don't know mathematics go to biology.

Biology and zoology is nothing but nature correct? Yeah in fact nature is only engineering its not nature, because whatever nature has done you are creating those things, nature has not done your flight, flight design so that's what we have design. They have not design train, okay nature. So that's why we are doing train, car, cycle all that. And we need mathematics I mean the engineer for this and we need god for that.

Okay so that is why I appreciate zoology, and biology, biotechnology and all that now a days I don't know all noble (24:40) most of them are getting whether it is physics or maths or chemistry all of them are getting noble prizes for which subject?

Student: (24:49)

Prof: only for biotechnology. Its not biotechnology it means something connected with you know biology and all that now it is physics and chemistry there is not much difference everyone is working on biological problems. That's why there was article now do you want to have this 6 noble 6 or 7 were though you know. I think 6 how many Gopi?

Student: 6

Prof: not definitely not, 5-6 I think yeah, (25:15) also have to add.

Student: Economics, literature, physics

Prof: yeah economics, these things if you add then I think 6 are there. So out of the six prizes now do we have to go to same prizes are do you have to change the names of the prizes. That is what recently you know recent this is the season you know October is the season for noblarates right? Yeah most of them wont sleep also because anytime they may be woken up and then call okay you got noble prize.

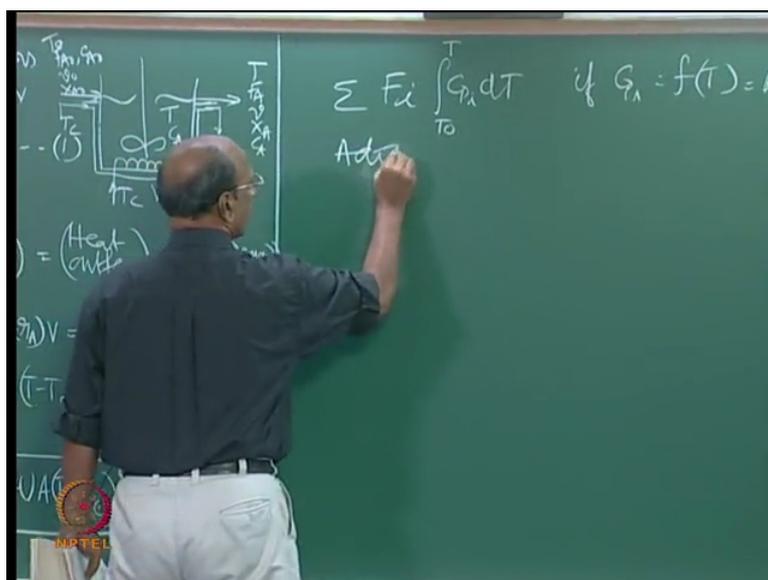
Because the timings are different you know from Sweden and other places so that is why. Flight yeah so what is I was telling?

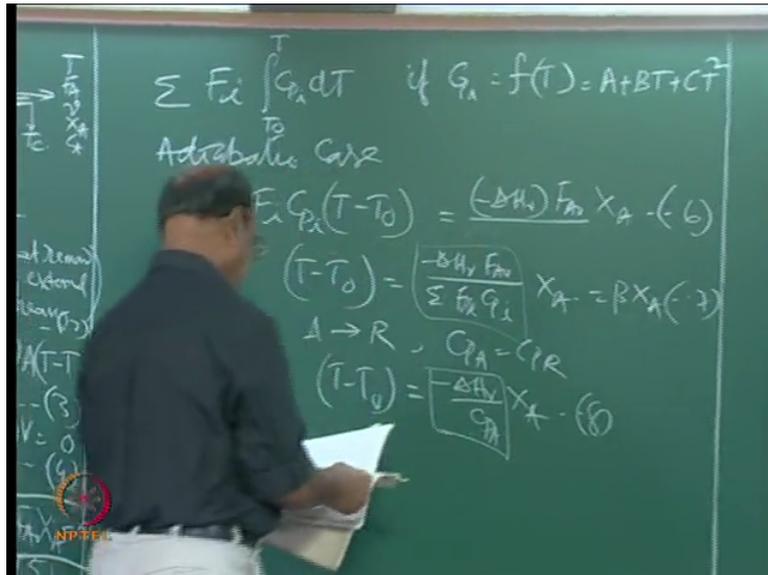
Student: (())(25:53)

Prof: About biology yeah so that is why probably only for biology they may have noble physics and chemistry, traditional chemistry traditional physics gone. Okay so that is why mathematics, mathematics, mathematics is very important next time don't laugh when I say vectors and tensors okay good. So this is the one and now this is very simple problem. You know mixed flow is very simple problem, always he is a nice guy.

Nice guy when you call nice, when is not giving any problem, okay this will never give us any problem. Okay now, this fellow also gives a problem now, right the problem is if you look at equation 5. There are 2 terms now okay just before going to that yeah adiabatic case that is usual so equation 5 for adiabatic case how it will be, yeah so this UA will be 0 for adiabatic case then we will have sigma for adiabatic case.

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Adiabatic case sigma of Fi Cpi T minus T nought equal to delta HR FA nought XA by yeah. This is something wrong? Yeah

Student: sir (0)(27:27)

Prof: sorry sorry yeah so that is the one in our format when you want to write this T minus T nought equal to minus delta HR FA nought underated by sigma of Fi Cpi into XA which is nothing but beta yeah thank you. Which is nothing but beta XA, right? So this is much easier to solve because yeah now. (0)(28:01) what is the procedure for adiabatic system.

Adiabatic case also I have to find out what is the volume of the reactor. Yeah Rahul is it unique or trial and error?

Student: Unique

Prof: unique because simply T minus T nought equal to beta XA of course beta we are taking independent of temperature. So straight away I know what is XA because I am finding out volume, the other one also one can do, you can also find out I mean volume should have been given, then you can also find out what is XA? Okay that procedure I will not discuss I think you will have just leave it for your imagination.

It is just reverse problem. Okay so now this is also X I know T directly you can calculate then I can go to this equation this equation contains. Minus RA as a functional temperature and conversion okay. XA then I can calculate what is volume? Right good so thats all that is very simple one and again this become there is a special case if I have A going to R and also CPA equal to CPR yeah so what is the equation for adiabatic line?

That's called adiabatic line, minus delta HR by CPA see CP whether it is CPA yeah CPA into XA is there definitely yeah okay CPA or CP are both are same. So that is the equation so this is what is better for us. Because if you want to look at old literature, new literature also they have but most of those people will use only minus delta HR by CPA as RCP as beta value because it is easy to discuss and mathematically not complicated okay.

So this is equation number 6 6 this is 7 this is 8. Okay good so the next one, next one is yeah now you have to look at this equation and then C there are 2 terms here okay you look here, if I ask you to find out what is the amount of heat that is removed and what is the amount of heat that is generated, we are not writing the balance separately we are not writing what is entering what is leaving, what is reacting of generation all that so now.

Those 2 terms definitely there is a co ordination between amount of heat generated amount of heat removed. So now what is the equation for the amount of heat generated what is the amount of I mean what is the equation for amount of heat removed.

Student: heat generated is (ΔH_R) (31:08)

Prof: Heat generated I think you don't have any problem.

Student: (ΔH_R) (31:12)

Prof: minus delta HR,

Student: RA

Prof: yeah RA into V which can also be written as $-\Delta H_R$ into XA okay. Yeah that's actually we will write minus RA into V minus this one, this one. Now then what heat removed?

Student: UA (ΔH_R) (31:32)

Prof: this one is heat removed,

Student: no, no that one (ΔH_R) (31:36)

Prof: this one?

Student: UA T minus that one place heat associated with the outer stream.

Prof: yeah so what is this?

Student: Sigma FI CK T nought

Prof: yeah what is that? Is it heat removed or heat generated.

Student: heat removed

Prof: yeah heat removed by what mechanism?

Student: (())(31:52)

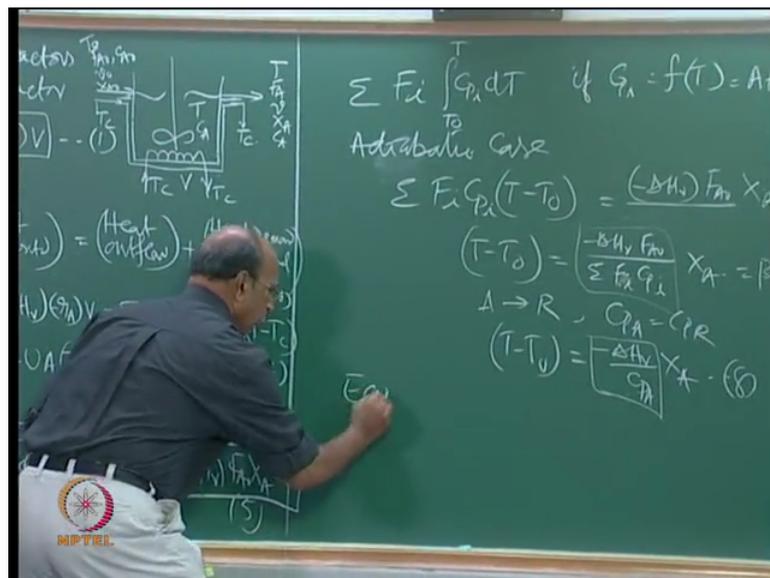
Prof: product only but what, what is the mechanism? There is a flow

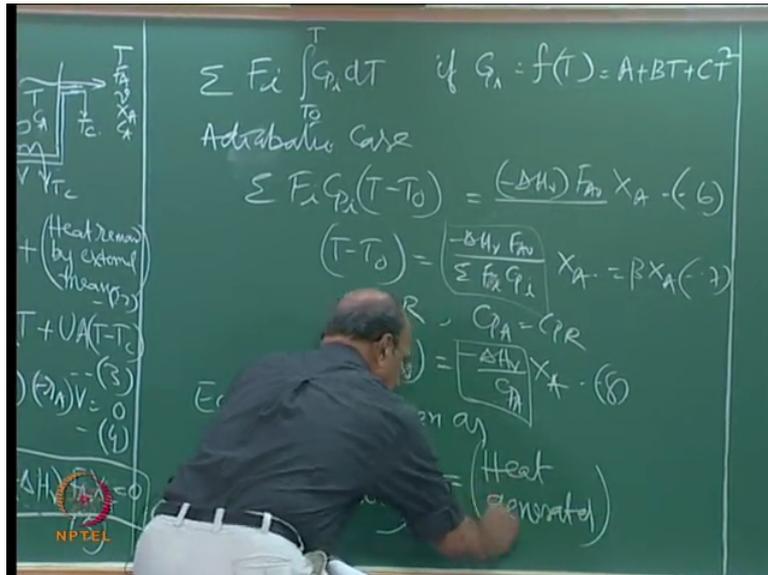
Student: convection

Prof: By convection, because flow is there some amount of heat is entering with the feet and some amount is going out that is also taking some heat that total is this. Right? Yeah the total amount of heat that is carried by the stream and this is one by external means, heat exchanger so that is the total amount of heat removed and this will be the total amount of heat generated.

The solution when you asking it is actually the cross between these 2 is the one which we are talking about. That means for a persistence to be stable we should have that heat generation is also equal to heat removed. Otherwise you know it is not stable, it is not steady state. Right there is something different so that is why, what we write here is this equation 5.

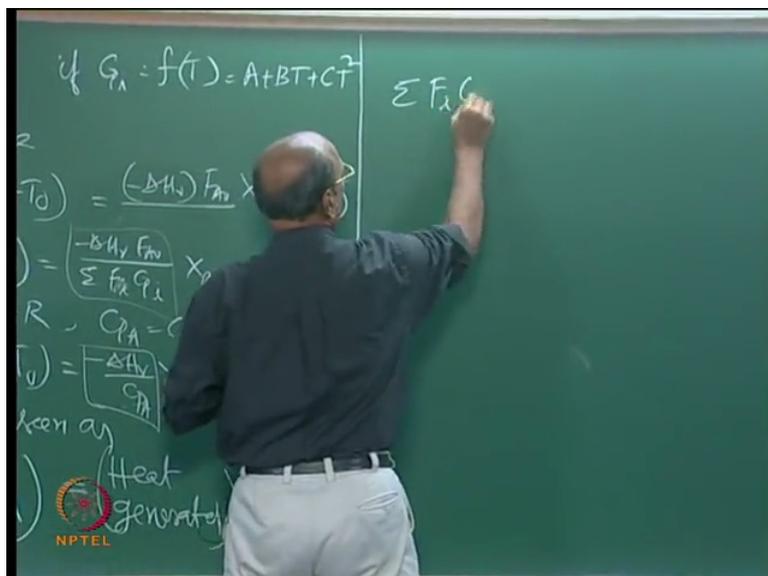
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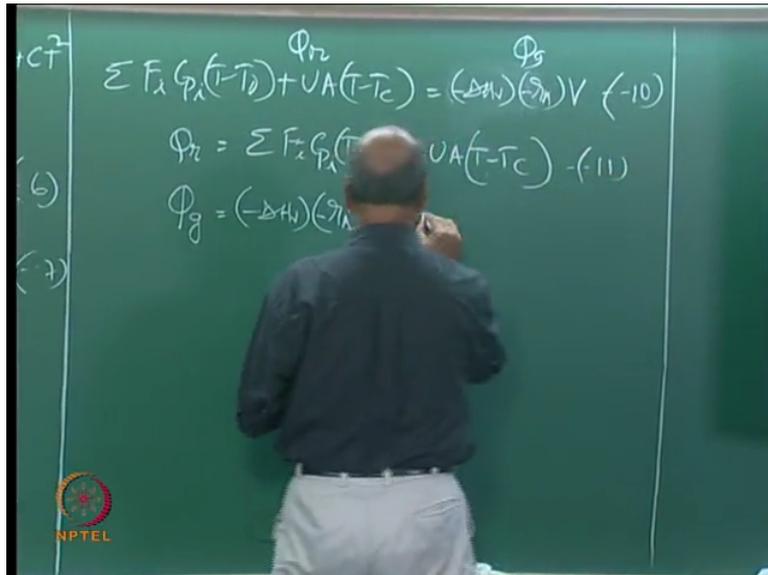




Can be seen as heat removed must be equal to heat generated, correct? This is 0 or simply take this entire thing out okay this entire thing out so then that will be heat generated and not equation 5, equation 4 sorry, equation 5 also same but here you will have more $(\Delta H_r) F_{m_0} X_A$ minus $R A$ into V and ΔH_r that is the heat generated okay so now.

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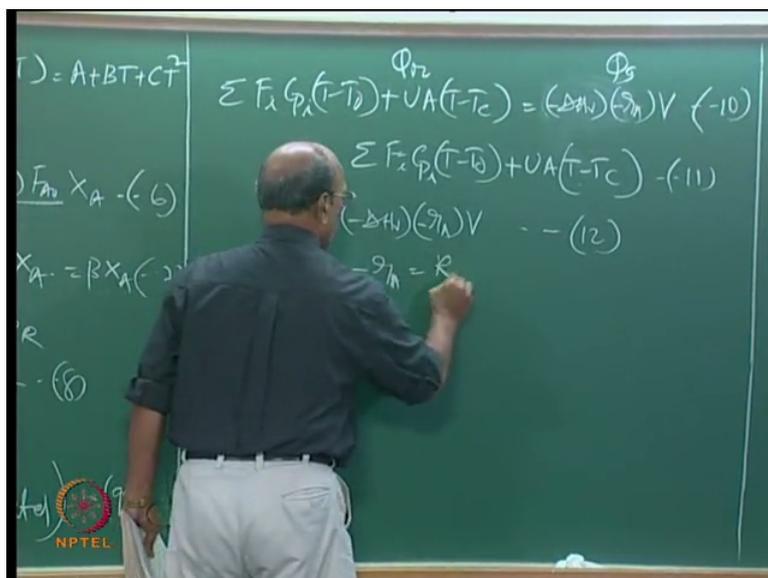


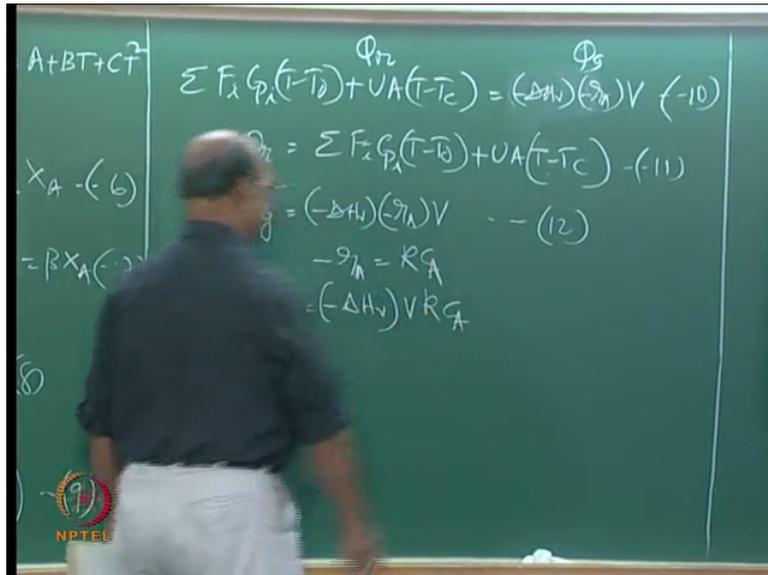
Yeah these 2 equations we have to write as $\sum F_i C_{p_i} (T - T_{D}) + UA(T - T_C) = -\Delta H_R \eta_m V$. Yeah okay so now this I can write as Q_R heat removed, this is Q_R this is Q_G . You see and Q_G is $-\Delta H_R \eta_m V$. Okay so equations number if I write this is 9, this is 10, okay yeah okay this may be 11, this is 12. Right? So now equation 12 also this one is it a function of temperature?

Student: yes.

Prof: Minus RA is the function of temperature, so now if I want to plot for example how heat is generated with temperature. I have to convert that into an equation in terms of temperature. So now let us do that. How we can do is?

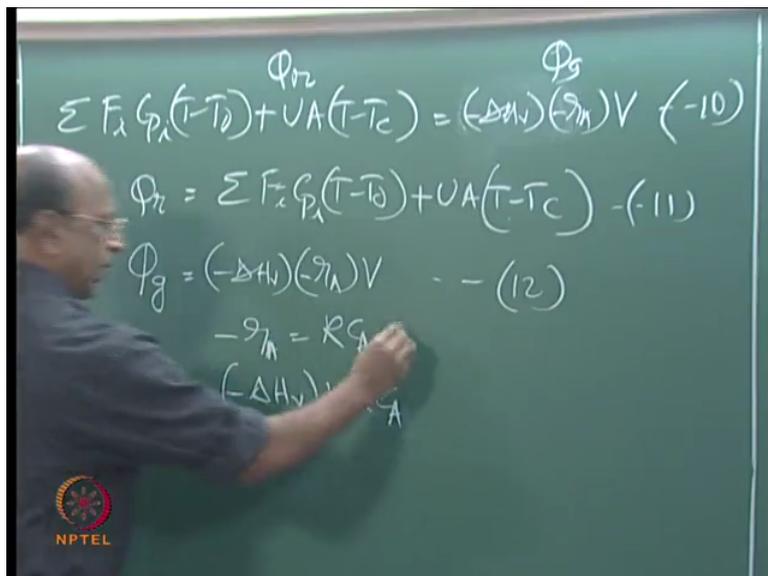
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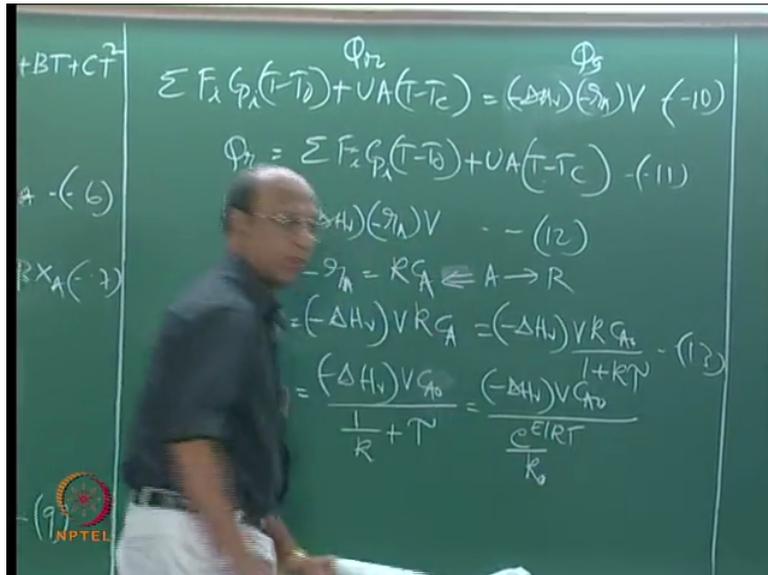




Let us assume that I have minus RA equal to K into CA first order reaction, that is going on we are talking about MFR right? Okay so this equation I will have and substituting this in QG will have minus delta HR V minus RA equal to K into CA yeah.

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This is okay I have simple thing like this A what this what is given here. Okay for the reverse this is what is given here. This minus RA okay good. So now this equation CA can we write in terms of again tau and all that what is CA by CA nought for first order reaction if I have mixed flow. Because that CA I want to eliminate because everything I want to write in terms of only temperature. So that CA I have to eliminate.

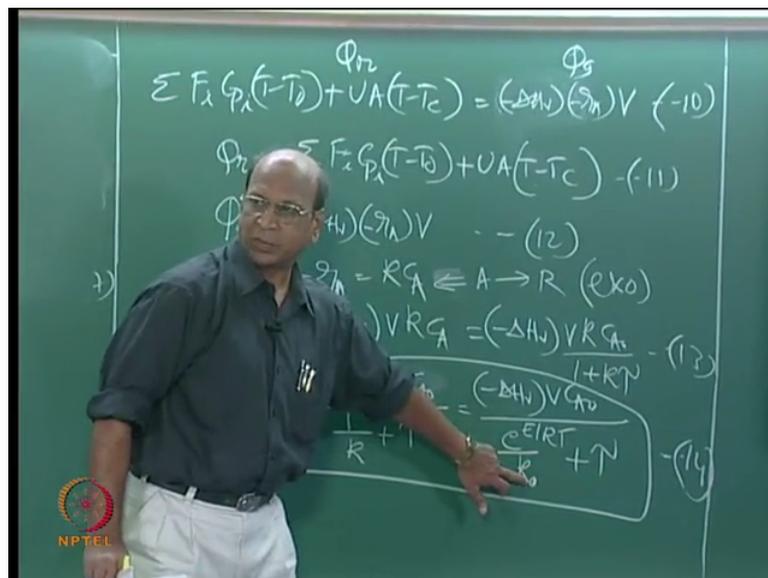
Student: one by one

Prof: yeah CA by CA nought equal to 1 by 1 plus Ktau, so if I write this one here this is nothing but minus delta HR V K CA nought by 1 plus k tau. Now is it a function of temperature. It is the only function of temperature so this equation is 13, so this can be written as QG equal to minus delta HR V CA nought so this if I CA nought everything is there, okay so K if I divide this will be 1 by K plus tau correct?

Okay yeah, so now this can be written as minus delta HR V CA nought by this one is K nought into E power minus I will take to top that E by RT by K nought correct plus tau. Okay

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$$\begin{aligned}
 Q_r &= \sum F_i C_{p,i} (T - T_0) + UA(T - T_c) \quad \text{--- (11)} \\
 Q_g &= (-\Delta H_r) (-r_A) V \quad \text{--- (12)} \\
 -r_A &= K C_A \rightleftharpoons A \rightarrow R \\
 Q_g &= (-\Delta H_r) V K C_A = \frac{(-\Delta H_r) V K C_{A0}}{1 + K T} \quad \text{--- (13)} \\
 Q_g &= \frac{(-\Delta H_r) V C_{A0}}{\frac{1}{R} + T} = \frac{(-\Delta H_r) V C_{A0}}{\frac{e^{E/RT}}{R_0} + T} \quad \text{--- (14)}
 \end{aligned}$$



So now this equation which is equation number 14, right? This equation, equation number 14 is

1 in terms of temperature, now equation 11, I know that QR equation 11 is heat removed. This is heat generated. This is also in terms of temperature. So I will plot QR and QG yeah and Y axis and versus temperature. So first if I plot QG how does that look like? If I plot only QG for that particular reaction depends also on reaction what kinds of reaction you have. For that kind of irreversible first order reaction, come on quickly. Anyone has been exposure to this?

Student: () (39:06)

Prof: So now I have to plot first QG versus T.

Student: decreasing curve

Prof: decreasing?

Student: increasing curve

Prof: Increasing curve and Rahul says S shaped curve.

Student: () (39:33)

Prof: Delta A is fixed, it will not depend exactly on delta A. () (39:41) is exothermic reaction we are taking. Right exothermic reaction, write I think delta HR is exothermic reaction okay here I will write minus RA EXO. Again please write exothermic reaction that's correct I think as () (39:59) it depends on delta HR sign. Okay so this is exothermic reaction that is positive yeah so what shape. Rahul where did you say that it is S shaped?

Student: mathematical methods are () (40:13)

Prof: because he told if you could have told 0 you could have also put 0 what is your interpretation. Yeah it is S shaped curve the reason is that you have this exponential term. You have this exponential term so that and also initially you know that temperature is less so the heat generated will be less and then we have the right combination of concentration.

And maybe concentration is high initially temperature is less but total heat generated is less so then with some conversion heat generated will be more temperature increases, concentration decreases little bit but effect of temperature increase is more. You know the rate will be much more now so then it starts raising.

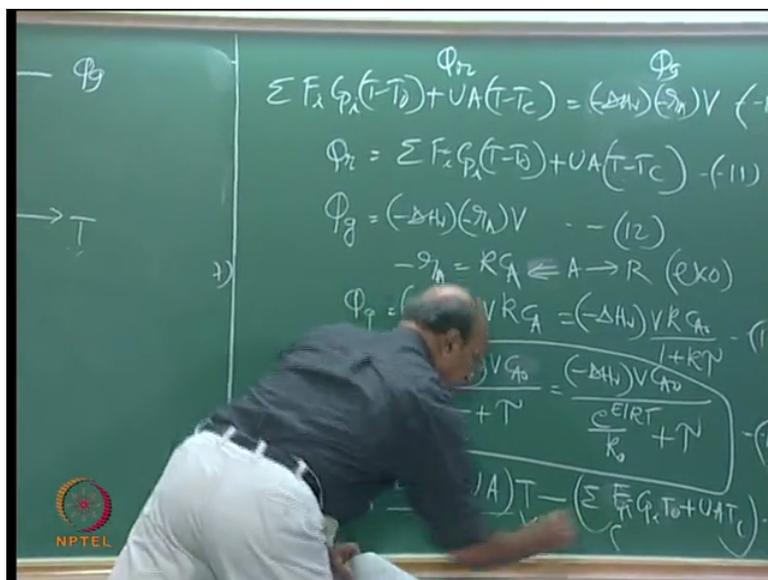
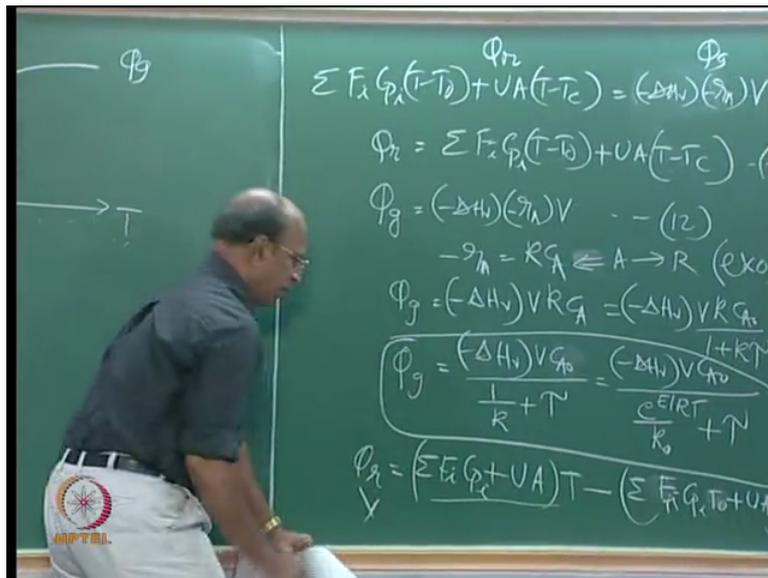
And it is steeply goes with the correct combination of X and concentration and temperature steeply increases and afterwards it also flattens because you know initially slow right, most of the natural curve are like that. Even including micro organisms how they growth also it is similar to that. Most of there are many many natural processes where you have initial starting because micro organism when you want to grow you have to give it food.

And then you have to put some micro organism where they have to first get accumulated, accumulativize to the yeah conditions. Then it is slow then after sometime it peaks up so they will be comfortable and then onwards they start consuming more and more food and that will

T ought also is there. Plus I have UA no, okay UA TC I will put bracket here. Correct? Rashmi, Correct?

Okay so this is equation number 15. So unless we imagine in our normal Y equal to MX plus C we can not draw the lines. Correct? I don't know who is taught I would like to find out who first told that straight line equation is Y equal to MX plus C.

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This is also this Y, okay all this is M this X and this is C so when I plot that depending on T ought where it will goes? Because that is a T ought which is starting here then you may have a condition.

