Plantwide Control of Chemical Process
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Lecture - 16
Control of Heat Integrated Columns

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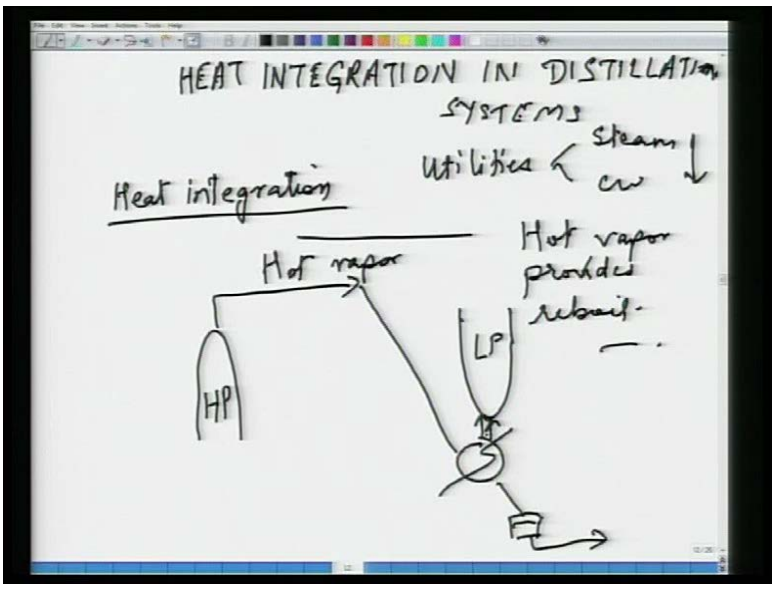

So, good morning to all of you, welcome to this next lecture, today we are going to look in at control of heat integrated distillation columns, heat integration in distillation systems. First of all what do you mean by heat integration? Well specifically heat integration in general means, you got a hot stream some place in the plant, you got a cold stream some place in the plant, the hot stream needs to be cold, and the hot stream and the cold needs to be heated up in the temperature differences are such that you brought together, well you bring the hot process stream and cold process stream in contact not in contact in a you know energy contact in heat exchanger. And so hot process stream cools up, and cold process stream heats up and this is called heat integration, because now you are not having to use steam, which is expensive to heat the cold steam and you are not having to use cooling water to cool the hot steam, cooling water or some other cool it, so here utility consumption goes down, when we talk of distillation columns.

So, when you do heat integration utilities consumption of utilities mainly steam, and cooling water this goes down. So, you are steam consumption per kg product produce because of heat integration can reduce significantly. So, thus the idea behind the heat

integration, why do you want heat integration, because you want to consume less and less energy because energy is expensive, it also you know sorry economic reasons basically. When we come to the distillation columns, what do you mean by heat integration?

In heat integration the distillation is the way, it is a complaintist, you will have a hot vapor steam, I think you got a column, you got the hot vapor coming up the top, and if this vapor is hot enough this can be used in the Reboiler some columns to create boiler right, and whatever as condensed is collected in a drum and then you take out reflex it back over, whatever you want to do with it. So, basically what we are saying is the hot vapor is condensed is used to provide Reboil, hot vapor provides Reboil all right.

Now, one of the ways of making sure that the most common way of making sure, that the vapor is hot enough is to ensure, that the column from which the hot vapor coming is operated at a high pressure, and this is at a low pressure. So, that you see the higher the pressure the higher the boiling temperature therefore, the vapor will be hot enough and there will be sufficient driving force in this Reboiler, so that Reboil can be provided to its column, it is already drawn there anyway.

So, typically heat integrated distillation system will have high pressure columns, low pressure columns, and vapor from the high pressure columns will be used to provide Reboil in the low pressure column, and there are several common configurations that are prevalent that you will come across, and I just list go through them.

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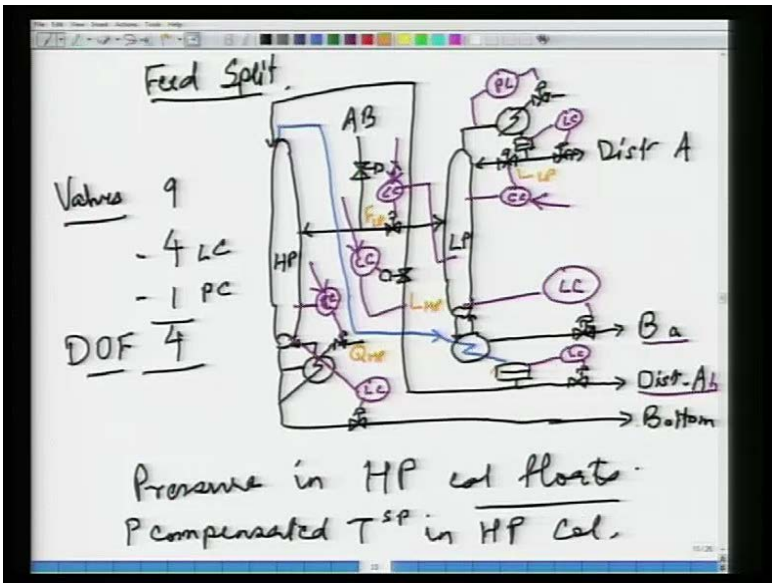

So, one of the most common once is you know feeds plate. You split the feed, let say I split it into two half s not necessarily, aware I split it into two parts one part goes to the low pressure column LP, the other part and let us say the feed is essentially a binary mixture may be mixture, then the other part goes to a high pressure column. The high pressure column as its own reboiler, so you got a reboiler and this reboiler is providing a reboil here, then off course you got the bottoms, it is coming out. The low pressure column as it is condenser I has got a small reflex drum, it A B mixture that is going in, the hot vapor from this high pressure column, and let me draw the this heat integration scheme in blue. So, it is clear that how we are let see, so this is got low pressure column also, has a reboiler.

So, liquid come down here, there is some reboil going here, and the stream that is the hot stream, that is used to reboil the liquid I the low pressure column is this hot vapor, so this hot vapor, the hot vapor is used here, it condenses and once it is condensed is collected in a small drum, and part of it is withdrawn is distillate, this is also distillate and part of it is refluxed back in to the column. So, you can see that this reboiler this you know this unit here, is a reboiler for the low pressure column, and it acts as a condenser for the high pressure column.

Now, if we start looking at degrees of freedom, let see you got a valve here, you got a valve here, you got a valve here, you got a valve here, how much steam is you putting in

is in your hands, how much bottom is drawing of is in your hands, how much is taken out is it distillate from this reflux drum is in you are hands, how much is being refluxed back is also in your hands, that feed is what it is, so let see there are two valves, so on.

This t, there are three streams of which any two will have valves, the third will be dependent on what, so let say I just draw those two valves in this way there is a reason am drawing it like this, so is there a valve on this blue line, while we can think about this way whatever is Reboiled, we generate that is because of stream in the Reboiler of the high pressure column, that Reboil has to condensed, so that no point providing the valve here, because that will create unnecessary pressure drop.

So, I am not showing the valve on this vapor draw line all right, hot vapor from the top of the high pressure column does not have a valve, to avoid unnecessary pressure drop all right. So, now look at degrees of freedom total number of valves 1, 2, 3, 4, 5, 6, 7 and 8, 8 because the feet is not counted, total number of valves is seven, not counting the total feet in to the system, how levels do I have to control one level here, one level here, and one level here. So, 1, 2, 3, 4 has to control 4 levels, how many pressures do I have to control, well I have to control these pressure.

So, one pressure that leaves essentially degrees of freedom is two, how many things in my feed to while, I thought that degrees of freedom should come out to be 3. 1, 2 let say 1, 2, 3, 4, 5, 6, 7, 8 and 9 of which the feed is not included, this guy here is the 8, now I make sense. So, total number of valves is 8 4 levels need to be control one pressure needs to be control, that leads 3 things that the operator can adjust in order to get for the kind of separation, that you want what are those 3 things degrees of freedom is 3, what are those 3 things well operator can for example, in most conventional system you operator can set, which use a different color may be may be the L, may be this q, and may be essentially the split here, how much of the total feed is fed in to the first column in the into the LP column, even though the total flow is fixed remainder go into the HP column to the high pressure column, so the split. So, maybe I do know what I should call like this, well let say this flow to LP column.

So, the operator can get the kind of separation that he wants, but just in reflux in to the LP column by just, in the Reboil into the HP column, and by adjusting the split of the

feed into the LP and HP columns, what percentage of the feed goes in to the LP column, what percentage goes in to the HP column.

So, degrees of freedom is 3 and I just explained to you how it should done, now then just like just draw a control system for this system situation I have gone to remove this. So, I have a their remove this fine, well simple things first pressure control, level control, how do I control the bottoms level, well this have a level control is shown, there would be in the level control here, so this would be level control I am thinking on the fly, and it is good to think on the fly, because let sort of clarify many things, this would be level control.

My question is how do I how do I control this level? That is the question let see by the by the distillate will be pure A, this would be A, this would also be A and so I have taken out I have taken out, whatever is condensed are the vapor split it in to the distillate and reflex in to the HP column, what about the bottom from this column there is no stream showing back.

Let see. So, there as to be a stream here and that stream valve, I will just show it here this is the bottom stream from this guy, and it is this bottom stream, that is used to control this level. So, in my accounting there are actually 9 valves, 9 independent valves, but then these one extra there will be to control, oh just a sec 1, 2, 3, 4 level is that only 4 well degrees of freedom, well think is three does not matter, we just keep at it.

So, will vary about degrees of freedom later, so well control goes this way this level controller goes this way. So, I got my level controller in place, how do I said the reflex in this column valve to hold a composition constant or to hold the purity of or to hold the amount of impurity is the distillate that is be constant.

So I can control either a temperature or a composition and I will just say composition, but see C does not mean composition, you calculating also control at a temperature. So, this is at the temperature TC, how do I just split well, notice that the amount of Reboil that I get, in this LP column is not in my hands, the Reboiler s what it is there is vapor that is coming, which is the blue stream hot vapor as much heat, as it loses in the surface area provided in this Reboiler, well as much heat as it loses, that is the amount of reboiler that fixes the amount of reboiler that you get. So, that reboil is not in you are hands, what is in you are then is how much you are putting in to the LP column.

So, I would like to put only as much such that the amount of an impurity, that is coming down the bottoms in this stream. So, this essentially B with some amount of a, if this amount of a is starts to go up; that means, my bottoms id getting impure; that means, I do not have enough Reboil here, to split it in the Reboil is not there, so that a is leaking down the bottom of this column. So, therefore, what should do is since the Reboil is not in my hands, what I should do is reduce the amount of feed that putting it.

So, what I would say is will do this, if the amount of a impurity in this stream right here goes up, then I should reduce the amount of fresh feed, that I am putting in to the LP column. By the way note, that pressure in the HP column floats, what do I mean by that what I mean is here, if whatever reason because probably for the bottoms of the LP column became cooler.

So, therefore, since more heat got transferred in this Reboiler over here therefore, the condensation rate increased, because the condensation rate increased amount of vapors, that we producing is the same the pressure of this column for example, goes down the little bit similarly, whatever the reason, if the amount of condensation in this Reboiler goes down, well then the pressure here goes up in the HP column.

So, the pressure in the high pressure column will actually float depending on what is going on Reboiler in the acting as a condenser, and a Reboiler in the condense for the HP column, and the Reboiler for the LP column for the for the low pressure column.

Now, revisit the issue of how do I said this well this is said, so that you have the impurity in the distillate here, if the impurity here which is small B if this goes up, but you need to increase the reflex. So, this is essentially composition control, you may also use temperature controller.

Since, the pressure is controlled in the LP column, CC can be replaced with TC no issues, if only HP column you replace for example, this is to be a TC or this should be actually CC because I am just say if you want to say, I want to use a temperature controller here, well notice that the pressure in the high pressure column float, since the pressure is floating then you will have to use pressure compensated, temperature set point in hp column.

What was the problem, we were looking at degrees of freedom, so , if I look at the degrees of freedom well operator can set, this set point level and pressure controller, and do not make a difference we can set 1, 2, 4 and 4, these are the 4 set points that the operator can play with, so that the degrees of freedoms situation, actually 4 has to if I look at look at the accounting 4 levels need to be control 9, 4 and 1, so that is ok.

So, that actually 9 minus 5 the degrees of freedom is actually 4, and if I look at what is my degrees are freedom are what those degrees are freedom are essentially the reflex in to the LP column is this guy, how do I say this if I want to look at the degrees of freedom, well how much is the reflex is putting back in to the column, how much reflex am putting into the HP column this is also. So, reflex in the low pressure column, reflex in the high pressure column, the feeds splits, the feed is going into the low pressure column 1, 2, 3 and finally, the steam going into the high pressure column.

So, essentially these are the 4 things that the operator can adjust I order to ensure that all the product streams, which is distillate from LP column, distillate from HP column, bottoms from LP column, bottoms from HP column all these streams have impurity levels, that are acceptable, all right. I think I have done this feeds split business reasonably there is also, may be will do the next configuration well 13 14, that is fine, all right.

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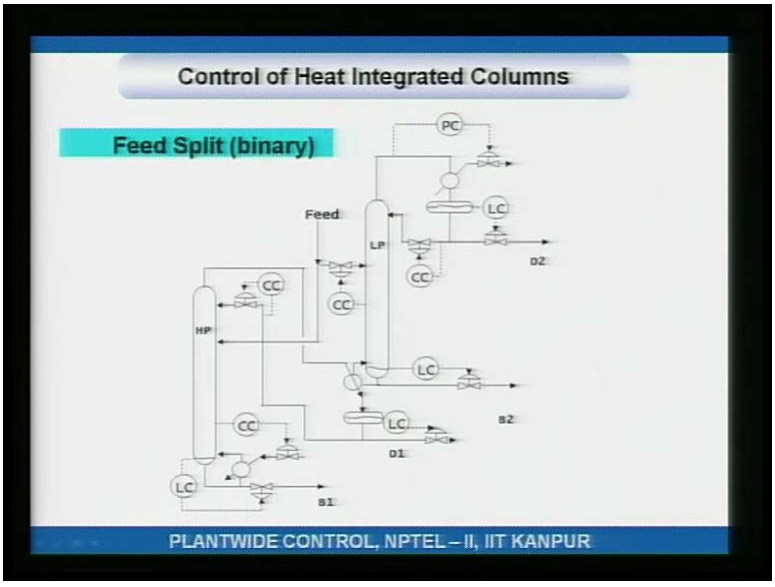

So, here is the feeds splits binary distillation column, that I just explained to you, and you would have appreciate is the same thing is the D 1, 2, 3 and is the fourth one, where is the fourth one there is a fourth one, these 4 set points is what the operator adjust to get the kind of split, that you want.

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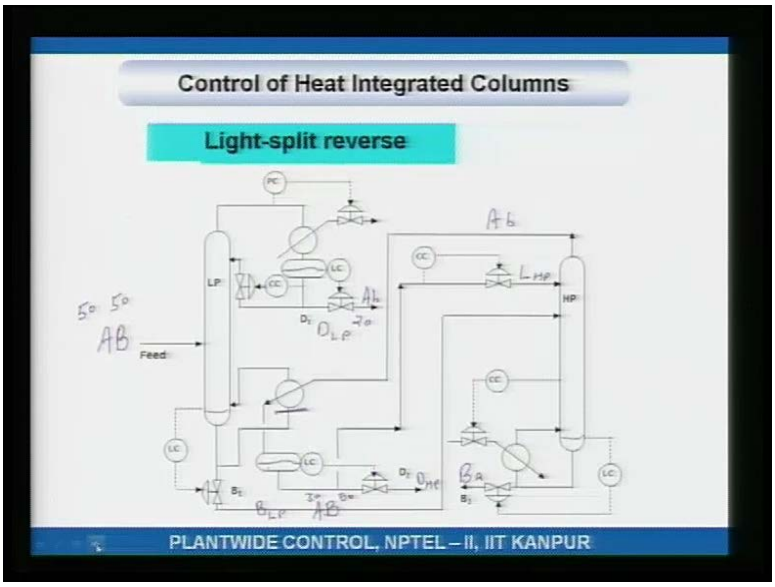

If I go next, let us look at this one, and then I may be explain it on the note pad, again I am having another A B mixture, that is coming in. So, there is another A B binary mixture, that is coming in it goes in to a low pressure column, and the split here, is such that part of the a goes up, so this is a with A little bit of b, but not all of the A.

Let us say this is 50, 50 if this is 50 kilo moles per hour of A, 50 kilo moles per hour of B the distillate is let us say about 20 kilo moles per hour of A with some amount of B negligible amount of b. So, then the bottom is another A B mixture, this is the bottoms from which column this column, this is another A B mixture, which is sent to high pressure column, and now this would be 20 has would be taken up, this is actually only 30 kilo moles of A per hour and 50 kilo moles.

So, the stream to the HP column has small amount of small relatively lesser amount of A, you got a Reboiler here, you take out the B down the bottoms, which some amount of a impurity the top from the hot vapor from this HP column is essentially all of the A with some amount of B impurity, it is condensed in this Reboiler right here, this is where the

vapor is condensed collected in a reflex drum part of it is taken out to distillate, and the other part is sent back to the to the HP column as reflux right.

So, this is L HP this is distillate from HP, this is distillate from LP column, and this is where is the bottom here this is the bottoms from low pressure column. So, let just take a look at it again and how do I want to take look at it.

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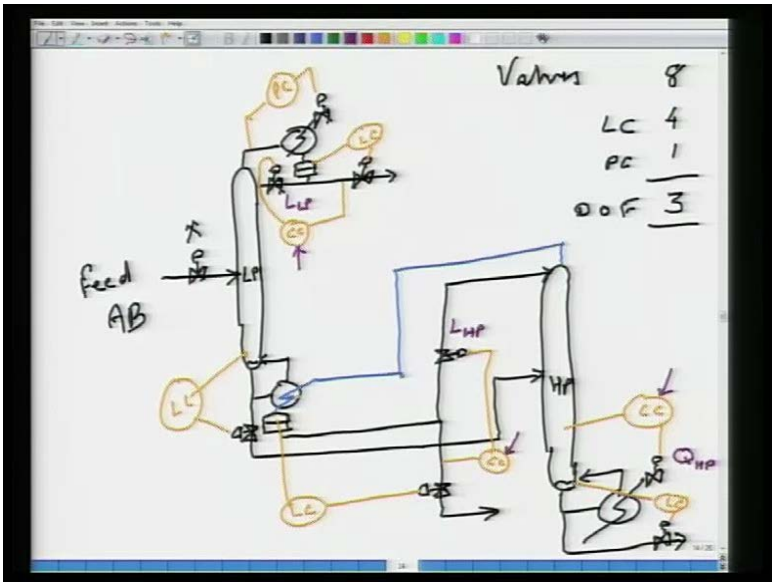

So, what I have here is I got low pressure distillation column, which takes in my binary feet. The low pressure column has got a condenser, as before part of it is refluxed, part of it is taken out to distillate the bottoms from this columns, which is this guy is sent to a I just say high pressure column, the high pressure column as got a Reboiler of it is own that uses stream to get, whatever Reboil you want and off course, part of is drawn is bottom, feed is an A B mixture, the this is a high pressure column, the hot vapor from the column and this is where energy integration will happen, heat integration happens this is hot vapor, this is sent this is condensed here, and this hot vapor provides heat to create Reboil in the low pressure column.

So, the blue stream condenses, and that gives you the black stream going has reboil in to the low pressure column, the condensate is collected in a reflux drum in a drum part of it part of it, sent as reflux and the other part is withdrawn as let see distillate, so this is reflux and this is let see distillate.

If I start drawing independent valves, I hope I do not measure the degrees of freedom this time, well in if you miss upon the feed control structure, it will predict here, how many things are there in the hands of the operator to get the kind of separation, that is desired is the valve here, what about the valve here, it is a liquid stream, so there will be a valve here, and what would this valve is used for probably level control.

Let see if drawn all the valves I think. So, if I count the number of valves 1, 2 excluding the feed valves 1, 2, and 3 excluding this guy, because the feed is something coming from upstream 1, 2, 3, 4, 5, 6, 7 and 8. So, this number of valves is 8, how many levels do I need to control 1, 2, 3 and 4, 4 level controllers, 1 pressure controller, what is the degrees of the freedom, well I think it turns out to be 3.

Let just see if this time is correct, what are those degrees of freedom the amount of reflux, that I am putting in to the low pressure column, the amount of Reboil that I am putting in to the high pressure column, as well as the amount of reflux that I am putting into the what kind of column, that I am putting into the high pressure column.

So, these are only three things that are there in my hands to get the kind of separation that I want all right. So, let us draw the control structure, and I think we will use what I will continue to use this may be I will use orange, whatever this time so; obviously, this is pressure control, this would be level control, this would be level control, again this would be level control again, this level probably will get controlled using the distillate the drawn that I am drawing out of here, now what is left with me is what is use to get the kind of separation that desire.

So, this guy would be a temperature controller, well the pressure again, the pressure in the high pressure column will float because depending on the how much condensation occurs in this guy, depending on the how much condensation occurs in this Reboiler the pressure in the high pressure column will float.

So, I would say this is CC, if you want to make it a the TC, you will have to use pressure compensated temperature set points, what is the impurity level in the distillate right here, that is what put set this guy, and what is the impurity level here or trying to set a tray temperature is what would set this guy.

So, the operator is adjusting, this set point this set point, this set point through the this set point or through these controller the reflux in the 2 columns, and the Reboil in the HP column get adjusted to get the kind of separation, that would like degrees of freedom here is correctly turns out to be 3.

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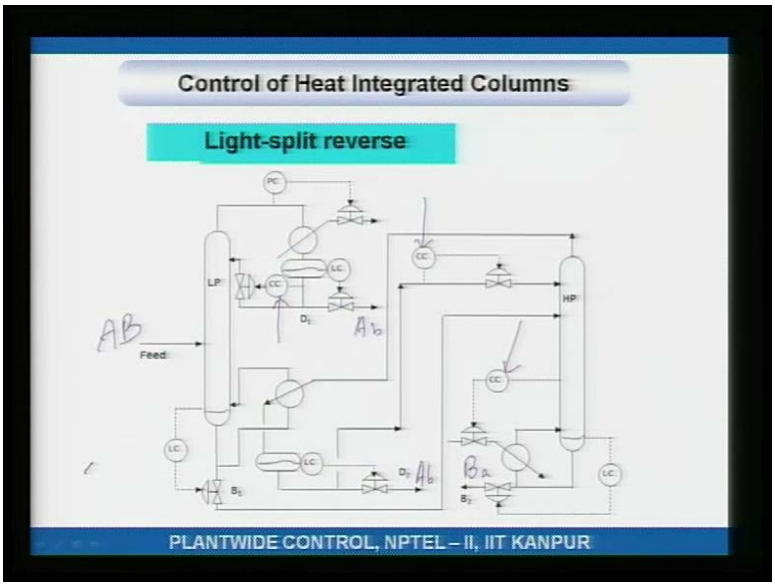

Over here, and again notice that again notice that there are three compositions, that are being set 1, 2, 3 and I check, well if this is another A B mixture like I describe to earlier this is A with a little bit of b, A again with the little bit of b, and this is B with the little bit of a, why was the degrees of freedom 3 here and 4 in the previous case.

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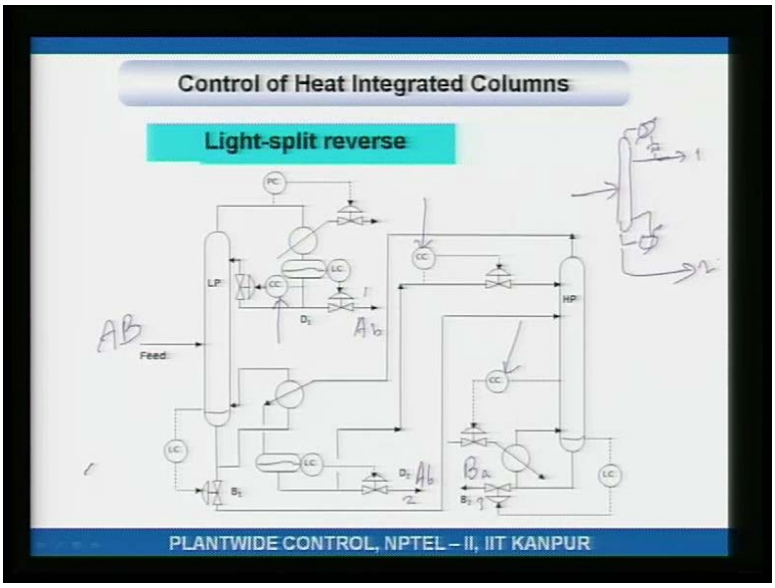

So, if I go the previous slide, notice that there are 4 product stream 1, 2, 3, 4 degrees of freedom is 4, how many product stream do I have here 1 2 and 3 degrees of freedom is 3, if I have a simple distillation column I think time is running out, but what the hell we list, how many product stream do I have on this distillation column 1 2, what is the degrees of freedom on the simple distillation column 2, very straight forward way of speaking out degrees of freedom.

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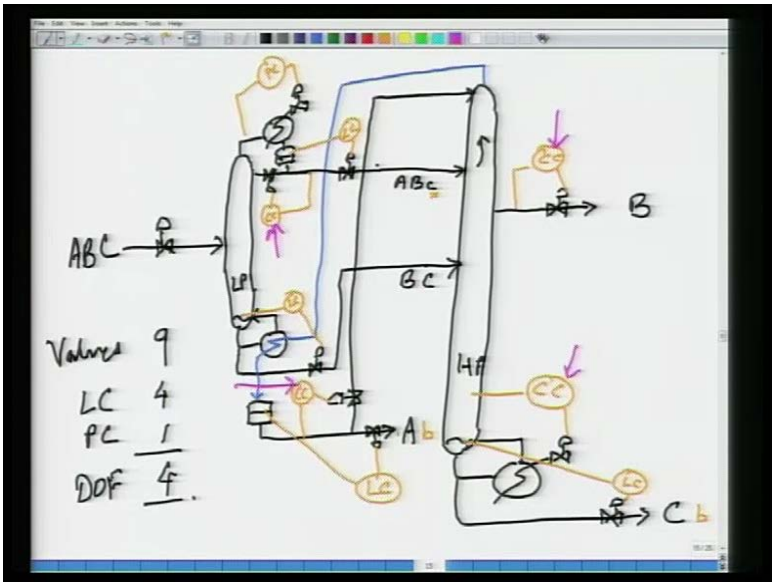

Now, will look a ternary mixture, we just to be separated in to its pure components A B and C, so that let say you got ternary mixture coming in here, that say A B C, well one of the most common sequence in probably is called the pethyak sequence, and I think what am drawing is the pethyak sequence, I may be a wrong in terms of the nomenclature may not be the pethyak sequence, but there is some name associated with this sequence, and what we do here is you have a pre fractionators, what the pre fractionators does is splits A B C into some of the A B going up to the top well. So, it splits into A B, B C, so the light key and the heavy key is B.

So, the pre fractionators is at low pressure, and some amount of reboil gets created here, then there is a main column section, which is split it all, and this is got a reboiler of the zone, and I think this is also got a condenser of (( )) not from will see, I got the PPT right there, part of it is refluxed, part of it is taken out this is.

So, all right the bottoms from this stream is actually, B C with the little bit of A, I just say this bottom is sent to the main column, there is no condenser here, what to do here is you take the hot vapor this is high pressure column, the main column is at high pressure you take the hot vapor bring it here, and here it condenses, and after condensation it goes to a reflux drum.

So, that is condenser. So, this is reboiler this unit here act as reboiler for the low pressure column, and the condenser for the high pressure column and part of it is drawn as product part of it is refluxed back, suppose this guy will act to have a condenser up and this condenser want be too large and off course, the stream coming in here is essentially A B, so this is B C; this is also sent to this column, and it sent above this guy as because its lighter then this guy.

So, the lighter the feed stream that this further up into the column is should be sent, and you can that this is A B and this is B C, somewhere in the middle if I go down composition will be purer and purer in B, if I go up composition will be purer and purer in B very little C, so some where there is a side draw which is essentially pure B, and that is about it. So, you got the reflux you got the vapor this is heat integrated I think pethyak sequence.

Let count the valves, feed off course I do not controller it because the feed is something that is set from a stream process 1, 2, 3, 4, 5, 6, 7, 8 and 9 where the hell of course, I do,

so if I look at my product streams there are three product streams, this is pure B like I explained, this is pure C with the little bit of B, and this is pure A, and A little bit of B that is if I go up here, if I go in this direction the tray composition will get richer and richer in A, and so the vapor is nearly purchases A, which is condensed and drawn is part and part of it is of course, refluxed back all right.

So, to be it appears if I look at the number of valves excluding the feed there are 9 valves 1, 2, 3, 4, 6, 7, 8 and 9 notice, again that I do not want to take unnecessary pressure drop there is no valve drawn on this blue line, that will create unnecessary pressure drop let not call this is heat integration ternary sequence I do not think this is pethyak, will talk about the pethyak little later.

So, we were doing the degrees of freedom, so number of valves is 9 how many levels do I need to control 1, 2, 3, 4 4 level controls. So, degrees of freedom should be 9 minus 5 4 right, so degrees of freedom is 4.

Let just see what are those 4 things that can be adjusted to get the separation that you want, and well off course this reflux is that is something that can be adjusted in L LP all right, L HP is something that can be adjusted Q HP, something adjusted and something that can also be adjusted with this side draw streams.

So, I can have just called it side draw from the high pressure column. So, it appears to me these are the 4 things that can be adjusted to get the kind of purities, that you want and let draw the control structure, and it will become obvious what am talking about. So, if I start drawing my level and pressure controller, so well PC here is in this way level control the most obvious thing is do is this, the level control here again the most obvious thing is do is this, level control of this reflux drum where, the most obvious things is to do is control the things using this valves, level control here, the most obvious thing is do this now I have put in my 4 level control, and pressure control.

Now, let see well the amount of C impurity that going up to the top here, if this too much C that is going at the top here, I increase the reflux I cannot do too much, here because the Reboil is what it is, the primary impurity in this guy is B I hold it constant by adjusting, if too much B is leaving in this stream I increase the reflux to the HP columns, if too much B is leaving down the bottoms I increase the stream, composition control or temperature control off course.

If I use the TC then because the pressure of the high pressure column floats I will have to use pressure compensated temperature set point, I hold the purity of B constant by adjusting the amount that is being drawn of if the purity is going down I reduce the draw of the purity of B here is going up I increase the draw of right.

So, what are my degrees of freedom well here goes 1, 2, 3 and 4 4 composition are being maintained by adjusting those 4 degrees of freedom, which we had discussed reflux into the LP columns, reflux into the HP column, reboiler duty in the hp columns, and side draw from the HP column right these three things get adjusted to get the kind of impurities in the reflux, and or product streams all right.

So, this is what we have here the LP column, the HP column and I will just go through the degrees of freedom well 1, 2, 3 and of course 4. So, this is A of course it is a A B C feed, and this is whatever is this A B, this is B C, this is pure B, this is pure C or nearly pure C and this is pure A.

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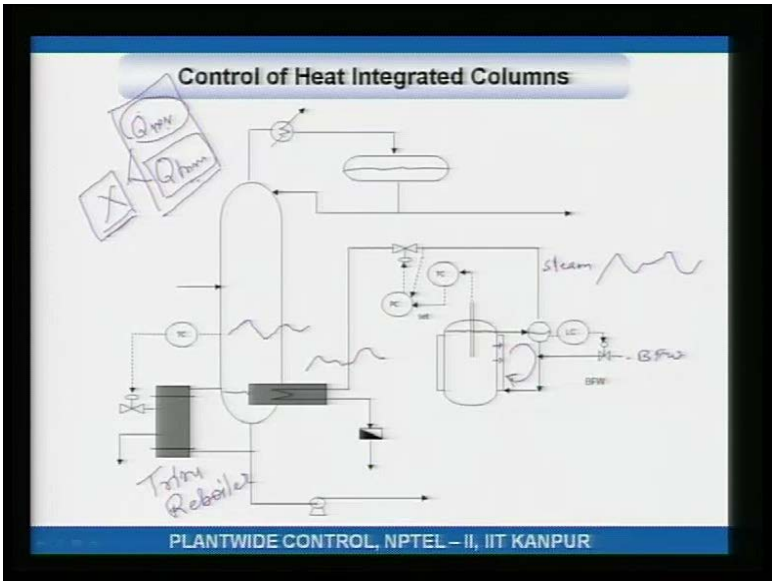

Sometimes what happens is you got a highly exothermic reaction going on, and you know that reaction heat is being removed to generate steam; I will just explain what is going on here. So, here is my reactor highly exothermic reaction going on here, and what I have is I have let say water, it is water circulating in the jacket, and the circulation rate is very high, so water circulating in the jacket, and the circulation rate is very high and because this circulation rate is very high there is hardly raise in temperature in the jacket.

So, as for as the reactor is concerned it is seeing a jacket at constant temperature because heat get transferred across the valves the liquid you know the water, that goes here it flashes and generates steam, this is the steam that gets generated. So, this is off course boiler feed water, now because the steam is getting generated, the level of the water here will go down that s made up, but putting in more boiler feed water which is here.

Now, this steam is being used to get some Reboil in this distillation column, you got 5 minutes off course, this Reboil is not enough to get the kind of split that I want. So, let us say if the amount of Rebolier duty, that I want is x let us say the steam from the reactor is giving me may be 70 percent or 60 percent of the total reboiler duty that I want, the remainder thirty forty percent is coming from this trim rebolier, this is called a trim Reboiler, now notice depending on what is going on in the reactor this stream fluorite will fluctuate. So, this steam fluorite is going all over the place is fluctuating because this is fluctuating the heat that is transferred from the steam from the reactor will vary and therefore, and will boil up here will vary.

Now let us say what am doing is am controlling a tray temperature by adjusting Reboiler duty of the of the trim Rebolier, how does it work the steam rate from the reactor fluctuates, so this is going all over the place, because of this the temperature starts to go up or down as the temperature is going up or down the steam rate in the trim Rebolier goes down or up. So, that the temperature is broad back to the set point.

So, what it essentially means is because the steam is varying the steam from the reactor is varying that creates variability in the temperature, the temperature must deviate before the trim Reboiler can reduce or increase or adjust the Reboiler duty to get that deviating temperature back to it set point.

How do we overcome this problem as a very metric, you see what we are doing here is we are controlling the trim duty. So, if the total duty is x and this x is split into whatever is coming from reactor, and whatever is coming from the trim I am adjusting the Q trim now because Q reactor is varying all over the place, Q trim the temperature controller tries to vary it all over the place, but the point is the heat duty requirement is x instead of trying to vary this in response to this, how about if I control x itself, that is the total amount of steam not Q trim, but Q trim plus Q reactor, that is what is done in this next scheme that is shown here.

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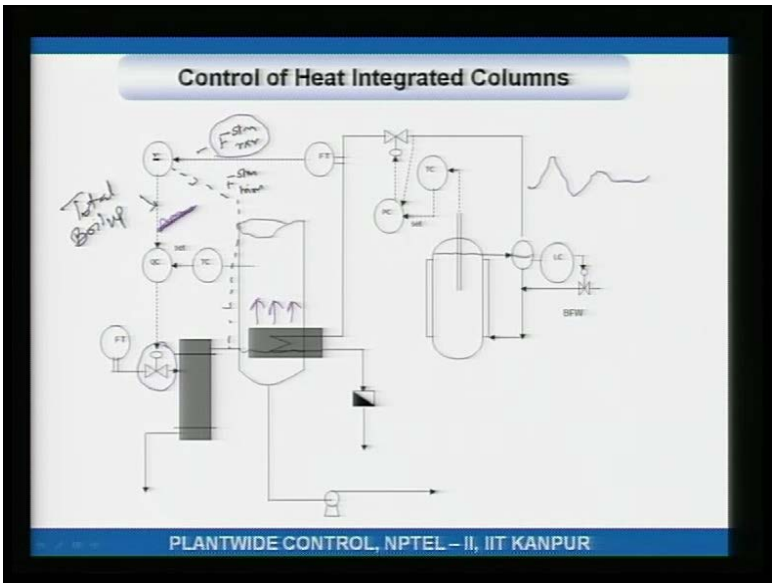

So, what I have is a flow transmitter. So, there is a some in there is a mistake here, so this is the flow of the steam from reactor. So, this is flow of the steam from reactor. So, this is flow of the steam from trim cooler or trim Reboiler, which also called as another oxlip Reboiler, this trim Reboiler these two streams are these two flows are some, so that is the this plus, this you know this guy plus this guy this signal is total steam or total boil up because total boil up is nothing but the total steam divided by the theta vaporization.

So, this total boil up is the signal that goes to this total boil up controller or total Q controller, and the temperature controller is essentially adjusting the set point of the total Q, instead adjusting the set point of the trim Q, the temperature controller is now adjusting the set point of the total Q, how does it work well if this guy is this steam rate goes all over the place, let say it is going all over the place, this signal goes all over the place right, this signal goes all over the place, now because this guy goes all over the place this Q controller, what it does is it takes in actually it takes the same signal, this Q controller sees what is the amount of steam, this Q controller what it does is it says that the total amount of Q is varying therefore, it immediately changes the valve position of the trim Reboiler. So, that the amount of steam here, so that this total stays constant.

So, now what happens in this case is because this guy is changing because this because this is changing the Q controller, the total Q controller adjusts is, so that the sum, which is this guy remains constant.

So, there is a variability in the steam being generated in the reaction section, because by adjusting the amount of steam in the trim cooler I can quickly bring the total steam generated back to set point, as for as the temperature controller is seen, as for as this distillation column is seen the total of amount of boil up, remains relativity constant.

Now, since the boil up is constant noting happens to this temperature, earlier variability in the steam rate from the reactor from the reaction section was causing the boil up to vary,, because the boil up to vary the temperature varies in order to bring the temperature back I adjust it with the trim duty, now here what is happening is the boiler from the reactor is varying, the steam from the reactor is varying; however, as the steam from the reactor for example, goes up the Q controller, total Q controller reduces the duty or the amount of steam to the trim cooler or to the trim Rebolier therefore, the boil up from the trim Reboiler goes down.

So, if steam from reactor is going up Q C will act to reduce steam from the trim Rebolier and therefore, what does it does is that is the total boil up remains relatively constant, it want be exactly constant, but it remains relatively constant, because it is relatively constant it does not change a lot therefore, this temperature does not change all right.

So, in this way this scheme in this control scheme, fluctuations in the steam generated from the reactions does not cause fluctuations in the tray temperature, I want say does not cause it causes very little fluctuations in the tray temperature.

So, this is a better scheme then what we would doing here, in this case because this guy is varying the boil up will vary because the boil up will vary the temperature varies because the temperature vary, then I bring the trim duty down. In this case because I am trying to hold the total boil up constant the variability in the total boil up gone down is the boil up is the steam from the reactor is increasing steam into the trim rebolier is decreased and therefore, variability in the boil up is much reduced, because where variability in the boil up is much reduced temperature is relatively constant. So, in this scheme the product purity is controlled or the split will be controlled better more tightly, that is it for today.