Plant Wide Control of Chemical Process
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Lecture - 24
Degrees of freedom (contd)

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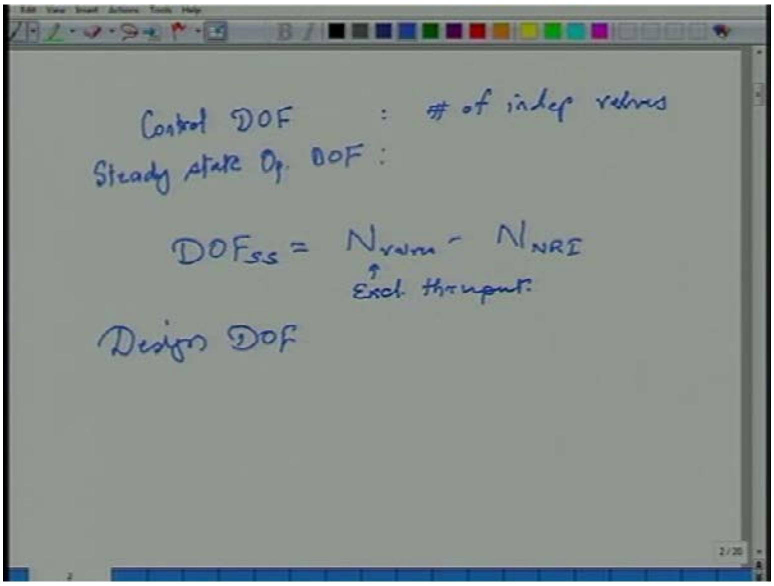

Alright, welcome to the next lecture, last time we were looking at degrees of freedom of a process, and there was what we called control degrees of freedom, then there was what we call study state operating degrees of freedom, operating degrees of freedom at any, what is control degrees of freedom?

Give me a simple answer, control degrees of freedom, number of independent valves control degrees of freedom. What control degrees of freedom? Number of independent valves, what is study state operating degree of freedom? That is the answer is giving, that the number of independent things set points that can be adjusted to change the study state. In any process and what is the formula, that we derive DOF study state is equal to number of independent valves, which is controls degrees of freedom minus number of non reactive inventories; this is what we are seen last time.

Now, I am going to introduce degrees of freedom, which is called design degrees of freedom. What is design degree of freedom? And by the way this number of valves excluding through put, that is the most common scenario because, through put is set either by the management or by an upstream process excluding through put basically, fill to the process yah.

Now, I come to the next one design degrees of freedom, what is design degrees of freedom, what you mean by design, no that is not design, when you designing a process the process is a not at there, you have to decide how big the reactor should be you have to decide, how many traces in the column should be, see when you operating process, the reactor is already there, it has be as it is no more the column is already there, it has to trace and it has whatever diameter it has right, these things are already construct it, you are not set to free any more there already set for an existing process.

So, for an existing process you have operating study state operating degrees of freedom. When you designing a process, the process is not ate there it is in your hands, how big the reactor should be and how many traces in the column it would be it is in your hand what should the recycle rate will be etcetera etcetera etcetera. So, how many things can be adjusted to design the process is design the degrees of freedom, and instead of talking about, it let me take just an example.

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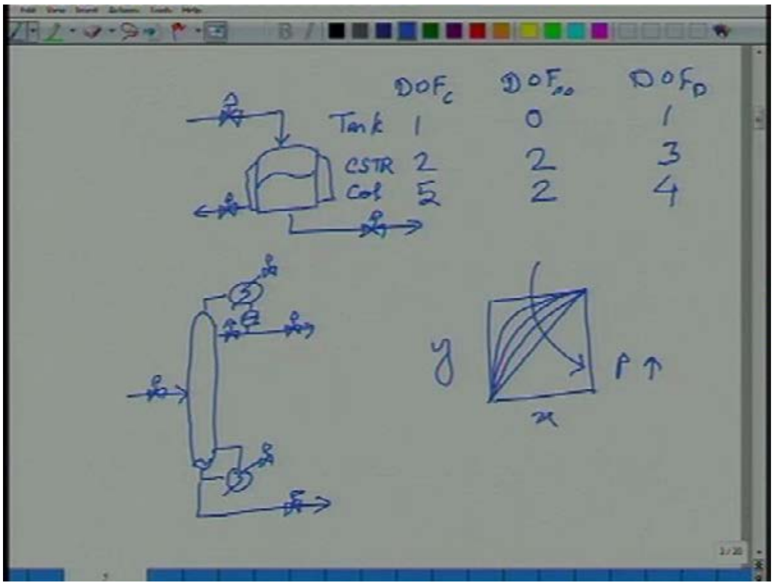

So, we will be start the same way, let say we got a tank, let say adjust the tank, how many design degree how many study state degrees of freedom does it has excluding have through put 0. So, DOF study state, DOF control degrees of freedom design, and how many control degrees of freedom does it have excluding to through put no 1 and that 1 1 level control inventory control right.

Study state degrees of freedom is 0 excluding through put excluding through put, how many design degrees of freedom does it have, and what is it what is that design degrees of freedom, when you design a tank, what is it that the designer can be vary can be change, well how big is it, basically the volume right, and typically the aspect ratio l by t will be 2 east to 1, that standard construction whatever.

So, how many design degrees of freedom length and diameter I just call it as volume. So, it is actually how big is the tank basically, it degrees of freedom is 1.

Now let us change it to CSTR. So, now I got an exothermic reaction it is going on, heat that being remove excluding through put how many degrees of freedom, so this was the tank, simple tank, now we are doing it CSTR excluding the through put, how many control degrees of freedom 1, 2. How many study state operating degrees of freedom, excluding the through put is the inventory non reactive, it is reactive, it should not be discounted, so how many study state operating degrees of freedom? 2. What are those degrees of freedom the adventure operating tank, and the temperature right?

How many design degrees of freedom, when the unit is not designed, how does the reactor how does the reactor, reactor reacting temperature reacting operating level yah yes or no. So, I hope it is becoming clear to you if you can set you can fix number of independent valves, degrees of freedom flows automatically yah, that is the good question, we generally do not count the jack design, because you see to remove heat you need a certain amount of delta t.

So, once you set the reactor operating temperature t j is for example, t reactor minus may be 30 degree Celsius, this not a really degrees of freedom did you see what I am saying.

So, basically in a cool rector suppose to remove, whatever heat is been released in the reaction yah, how much heat is been released is set by the conversion, how you remove that heat yah, you need a mechanism to remove that heat, it could be a jacket, it could be a cooling coil, it could be a external heat exchanger, it could be a boiling reactor with vapor re condensed recycle the heat removal mechanism, whatever it may be you essentially removing you want to heat that been generating the reactor, which is fixed right it is not really degrees of freedom, does it answer the question alright.

So, well what the hell we are doing, now let us take the destination column, since we are we are proceeding in this line of hot let say the column, and let this column be a very simple column distillate bottoms, if you start putting in valves, these are the independent valves flow by the re boiler by the gravity, and you do not want to pinch the vapor because that creates unnecessary pressure drop therefore, there are no valves this your distillation column yah, excluding through put, what is the control degrees of freedom. So, let say a simple column what is the degrees of freedom, control degrees of freedom.

[FL] Shoot [FL], 0 it cannot be minus 1 5 this 5 valves, of these 5 valves how many valves will be used to control non reactive inventories, two liquid level one at the top, one at the bottom and one pressure, which is with pressure in the sign of vapor of the column yah.

So, three valve go for inventory control yah; that means, study state operating degrees of freedom 5 minus 3 2 yah, design degrees of freedom if you are design in the column, what the degrees of freedom [FL] you know that degrees of freedom study state two, what is the operator free to set in order to get the separation to get, that this is, that we can set the reflux we can set the boil up, that is when the column is already design, when the column is not designed either of the tower that is plus one trace place is a typically standard, you have to feeds you know that we are hire the tray two inches and typical trade face is two inches, that is standard feet point good.

So, basically number of reactive number of rectify number of stripping trays, why I am not counting the diameter as degrees of freedom design degrees of freedom, I can also I can have basic, how tall is the tower, where I am feeding the fill also, how can is the column, I am not counting the thickness why is a question clear, why the diameter not being counted as a degrees of freedom no how do how do you fix the diameter of the column, I am sure you have done separation process right.

So, when you design the column how do you fix the diameter of the column depending on the fluorides, you set the reflux, you set the re boil, and the diameter should be sufficient, so that so that what y, so that so that to column is operated at under loading condition, you know that fables diagram eighty percent of flood in that right, you do not know that, that is but that how it is done it is like cycling the pump this is not flow that is the pipe.

So, what should be so this is you want to vapor and liquid traffic it is column is committed, so the diameter has to be that is it the diameter; it is not a degrees of freedom, yes.

So, number of stripping trays, number of rectifying trays, so 2 plus 2, why I am not counting the pressure, operating pressure of column, do you think the pressure of the column affects the steady states, how [FL] boss aglibar mike arranged karna hy that suppose to it is not been an arrange it is not been an arrange [FL] abi ny fine then do it, should be done.

So, why is pressure should counting as pressure of degrees of freedom why not ha no that is not, that the raise question is how does the pressure effect different state, does pressure effect in the study state of course, it does what does it affect the study state, no it is actually different, you see if you take the binary system and you draw the x y plot, I am sure that x y plain 45 degree line something like this yah vapor and equilibrium with liquid, what happen if you start jacking of the pressure, what happen to this may become will it remain the same will it change, which way change you see all this questions do not require any mathematic is just it difficult to separate difficult to separate means this will closer to the 45 degree line, so you will get something like this, so basically let us say these are three curves in this direction pressure is increasing or decreasing increasing yah.

So, if you jack up the pressure to the column what happens, separation becomes small difficult for the same amount of impurity in the distillate in the bottom, you will need more reflux more boil up yah.

So, what does I tell you operate the column at as low as pressure possible, because the lower to the pressure easier separation to the less will consume yes or no.

Now, how you set the pressure, you see if you cannot go below either it must be pressure, because creating a vacuum is very difficult, also if you create a vacuum things will leak in rather than leak out, what problem does it create air is oxygen what we are testing is typically high requirements, things that can explore right.

So, you would rather have leak out then leak in, because an air is leaking in and you are noticing one fine day, whatever something wrong boom. So, you will operate at slightly above atmospheric pressure, and as cheap source cooling condenser using what cooling, what cooling whatever is the cheapest sources of cooling, sometimes what happens for example, let say butane, butane at atmospheric pressure boil I do not know minus 13 minus 14, something cooling that degree Celsius.

So, if you are operating your column at atmospheric pressure butane is going up the top, you cannot condensate the cooling water, when you use some refrigerator system, well refrigerator is again expensive come because, requires compression etcetera etcetera, that needs a lot of energy, even you want to condensate something, in those situation what you would do is you jack up the pressure of the column, so when you jack up the pressure of the column what happens, butane condensed is at mine let say minus 10 degree Celsius at atmospheric pressure, at 5 atmospherics it condensed which is at 40 degree Celsius, then you will run the column at 40 degree Celsius, or at 5 atmospherics, so that the top temperature coming up the top which is mostly butane is 40 degree Celsius, and then you can use cooling water 15 25 degree Celsius to condensed the vapor, that make sense or no.

So, basically the pressure is being set by the condenser in such situation in other situation you are basically operating slightly atmospheric, because that is where then operation is operation is the easiest, you do not know unnecessarily jack up the pressure, because then the separation becomes the more difficult yah, that is make sense or no. So, basically either by condense cooling water is setting up the pressure of the column, or you are running at slight above atmospheric.

Only in situation where your material is getting damaged for example, juices you distilling juices and then, whatever you whatever takes to the juice, it essentially burns up and then you are getting a burn taste in the juice, nobody buy that king of juice yah, in those situation yah you will run it at under vacuum. So, that the operating temperature is the 30, 40, 50 degree Celsius does it make sense or no only in those situation will you create the vacuum, where ever possible, whenever possible you will run the column the way I just I told you cooling water at the top, if the vapor is not enough, pressure would you know slightly above atmospheric may be 1.5 hours.

So, thing leak out and not leak in because, detecting the leak in and detecting all the safety safety issues that come along with the leak in the system simply, makes it easier to operate the column at slightly above atmosphere the pressure that make the sense.

So, therefore, strictly speaking pressure is the degrees of freedom; however, we do not count it is either being set by the cooling water, or it is being set by atmospheric. So, really speaking it is not a degrees of freedom, does it make sense or no. So, pressure is not counted therefore, degrees of freedom for a distillation column design, degrees of freedom is what two operating degrees of freedom, how much reflux, how much boiler number of rectifying trace number of stripping trace actually, 2 plus 2 4 yah, let us get to something more complicated, which we saw last time.

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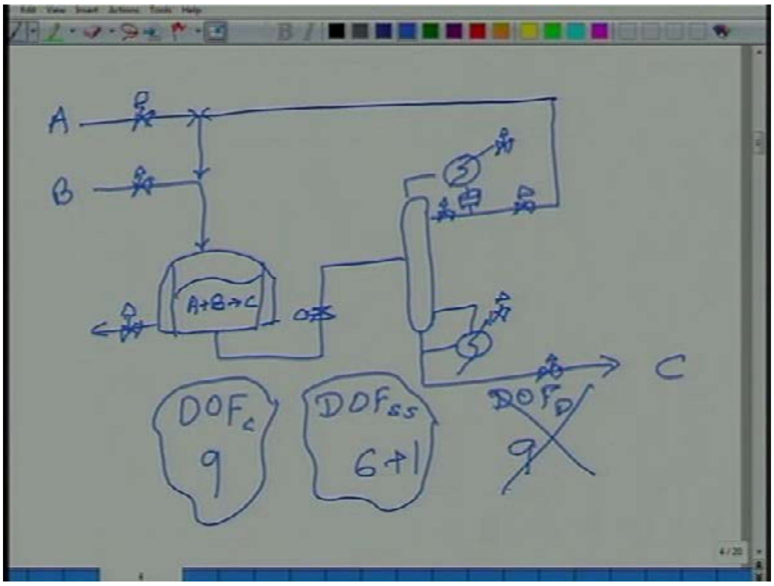

But let us now, so here is the process A plus B goes to C no side reaction it is a hypothetical process or let say negligible side reaction, the reactor the fluent contains A B and C, C is the heaver component, so it is goes down the bottoms of the column.

So, this the product see A un reacted A and B go up the top, and since material expensive you pay and buy it, you do not want to dump it, so independent valves last time we do that of course, it is a exothermic reactor or may be endothermic I do not know, it essentially heat source or will that be valve this one, on the stream between the reactor and the column this one, yes no why not, so there will be a valve, which is under level control yah sure, there has to be valve boss.

If there is tank you getting a feed, and feed out tank may be a reactive or non reactive, it term the valve any steam that join it that is going away from it we will have valve yes or no yah, so this will have a valve.

Now, what is the control degrees of freedom for this process, so DOF control, DOF study state, and degrees of freedom, what design [FL] eliminate me 5, 6 7, 8, 9. So, control degrees of freedom is 9 cut nine valves, 9 independent control valves, study state degrees of freedom.

Non reactive inventories are 3, vapor in the column and the 2 levels in the column, yah top level and bottom level, yes or no. So, if discount the non reactive inventories controls, you let 9 minus 3, 6 study state operating degrees of freedom is 6, if you designing the process how much, what is the design degrees of freedom, how big is the reactor plus 1, how many how many rectify crisp, how many stripping crisp, design degrees of freedom is 6 plus 3 9, yes or no do not confuse this 9 with this 9, study state operating degrees of freedom.

And number of whatever each to be fixed the size of the units, what you need to size o fix this how big is the reactor, how tall is the stripping section, and how tall is the rectifying section, yes or no the diameter is not a degrees of freedom, because the flows set how thick the column should be yes or no, these are way of looking at it, I am simplifying it, you just mug up CSTR degrees of freedom, operating degrees of freedom two, level and temperature.

Distillation column simple operating degrees of freedom two, study state operating degrees of freedom, when I say operating degrees of freedom; that means, study state two, reflux and re boil. Look at the flow sheet study state degrees of freedom two for the reactor, two for the column, and two for the fresh feeds, that give you say, that is another way simple way of doing it, you just look at number of units, what is the degrees of freedom each of those units, and how many reading into the process that is it; that is degree of freedom, that is another simple way of doing it, yah.

The point is you do not have to count equation and variables, and then subtract the two and then figure out the degrees of freedom process, if think simple figure out, how many independent valves are there the process, you essentially know the control degrees of freedom, and from there you can tell the study state degrees of freedom, that is the degrees of freedom, no not the modeling this etcetera etcetera is needed it is very straight forward.

Of course, once you have done this you can always the number of variable, count number of equation, and show that of which if you do it regressly, the answer is the same, but I guarantee if you do not know this you always answer, when you counting this or that, because some variable we get missed or some equation, will get missed and that is it, when you struck it yes or no, so this is the very straight forward way degrees of freedom.

Now, when you operating the process our concern will be this for this course, because the process is already there, it is designed, you want to run it, this one of course, two this how many independent valves are there, yes or no.

We will not be worried about this, but the approach is general. So, steady state operating degrees of freedom, I have these degrees of freedom given the amount of process rate I want even the through put I want the through put given to me, if through put is not given to me of course,, I can also add plus 1. [FL]

So, now next it will come I am getting there, it will come just hold down, now let us take this same process, may be let us take distillation column first, we will take distillation column first, and then we tried reach together, and then you will see what I want to tell you.

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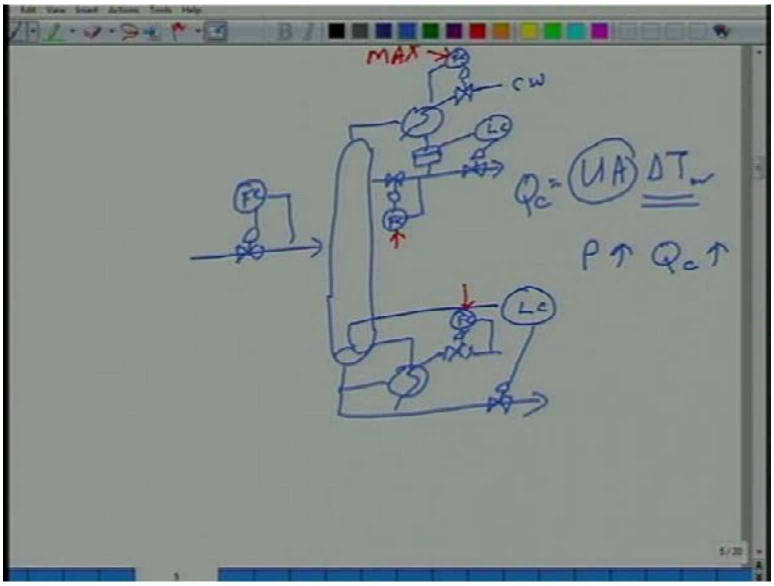

Let us take a column, and put in place the control system on it, by the way I ask the question is pressure inside the distillation column self regulating, you know what self regulating and non self regulating right, we discuss last time is pressure inside the column self regulating or not, you guys also done a process control course yah, very fundamental question is pressure in the column self regulating or not why, no we are not changing the pressure, let me put it differently I am running this column let us say top level is being control, using the desolate. Let us say bottom level is being control using the bottom.

Feed is given, whatever it is of course, maybe I did not draw this properly, where it is easy to draw this way, the operator has set, how much reflux is being put in, operator is also set, how much steam is being put in.

So, basically what I am saying is the operator is said to set this to some value, the operator is set this also to some value, this is also cooling this cooling water right, this cooling water is under flow control, and it is set point let say the operator is set the let say the operator is set, the cooling operator said, I want to run the column at as low operator as possible, because that makes the separation as easy as it can be and therefore, I consume as little steam as possible right.

So, let say e set the cooling water maximum, because if full flow is the maximum, cooling is maximum, if cooling is maximum pressure is as low, as it can be that make sense or no right.

If the condensed duty is increased the pressure will go down, yes or no. So to keep the cooling due the condensed duty at max, I max out the… You know that my valve is fully open, my cooling water valve is fully open, and I am not going to move it, let us say this is at max.

Now my question to is what happen is the operator say, well I got too much impurity coming down the bottoms too much light material is going down the bottoms, I need to send it back up, so what to does it do, he increases the steam.

So, that whatever dropping down goes up, now he increase the steam, what will happen to the pressure, reflux is kept the same cooling water is kept the same, feed is the same, what will happen to the pressure is the question clear, so what does happen is you have a column you made a change you increase the steam to the column, now my question is will the pressure set it to new value will it keep on increasing or nothing will happen to the pressure, it will be where of course, we will go to new value, it will not keep on increasing why, answer is correct.

So, well it is got to do due point, or double point, if the pressure of the column increases, thinking is correct, you increase the steam is generating the more vapor then your condensed, how much are you condensing the condensed is govern by eight transfer coefficient times area of the condenser times delta t, inside the condenser, so delta T average may be, these does not change much is almost constant, the only thing that changes is delta t, how delta T change is the pressure is increasing at higher pressure things boil at higher temperature yah.

So, the vapor will at higher temperature is the vapor at higher temperature, cooling water at the same temperature delta T gone up.

So, Q has increased, Q condenser increases right. So, if P goes up pressure in the column goes up, Q condenser actually goes down, or goes up more it is being remove, what will happen is whatever is the extra will raise as much as extra vapor,, to get condensed, you are generating a extra vapor, because you increase the steam, you need to increase the cooling duty to condensed it, well that delta T, because the delta T has increased, the pressure will increase as much as for the delta T to increase as much as is necessary for that, extra vapor to get condensed does that make sense or no yah.

So, yah the pressure will increase settle down to a new value, particularly columns that are that consume a lot of steam, they are run in this mode you just let the pressure float, so what will happen at night time, if the heat removal is more because, nights are colder then days, the column would run at lower pressure, steam consumption will be lower, peak day time because ever thing is hotter therefore, pressure would be higher, and you would be consuming most steam, particularly supper fascinated for example, where you trying to separate close boiling components using distillation, which requires a lot of steam lot of reflux, and lot of boil those kinds of columns are run with their pressure floating, and cooling water valve fully open, you just let the pressure float. I just introduce to do that floating remember, why the held did I do this.

So, this idea self regulation and non self regulation, you have to think about the process and if you have to think it right if I even I greaser temperature in a greaser, you increase the what is let say you got one heater, and you got two heaters, and even I greaser temperature you increase you set this heater full blast this coil is on temperature reaches some value, then you put the second coil on is not that the temperature keeps on increasing, it set to new value, why because the heat loss has increase the greaser is hotter right, ambient temperature is at the same temperature. So, delta T heat loss to ambient to be increase, that gives you self regulation, did you sees what I am saying all right.

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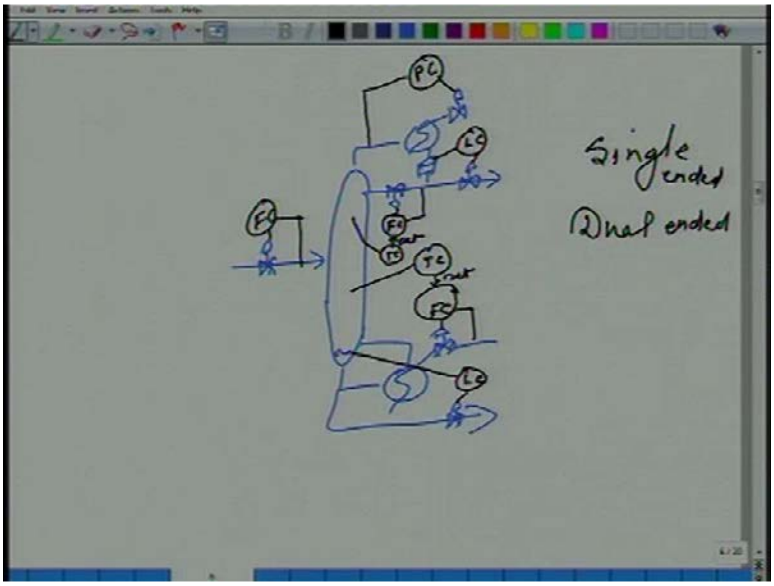

So, we are looking at column, and I was think of simple drawing a control system for it. So, this is my column distillate, this is my re boiler and we got the bottoms, heat is given you got the reflux, well may we do this latter on, you got the steam, and now let us put it in this the control system for this guy.

First of all, feed is given to me, feed is under control. In fact, every valve will have a flow controller on it, is this convenient I am not showing it, that flows at point could be said by the operator or it could be set by the level controller, or it could be said by pressure controller, or it could be said by something, else composition controller,, but nevertheless every valve has flow controller on it, its set points comes from somewhere, that is called cascade by the way.

So, we want to control two levels, because there are non self regulator, let us say I am controlling the level at the top, that is the most naturally way of doing it right, level at the bottom is controlled I did not draw well sorry, level at the bottom is controlled using this (( )).

Pressure is controlled this way, now I am left with this team and the reflux, so I have got reflux and flow control, re boil under flow control or the steam to the column under flow control, s r s is the operator is concern is not really bother about levels, the level could be 30 percent or 80 percent 50 percent or 60 percent, it does not really matter, pressure also as long it is fixed, does not really matter for the operator the real concern is what the impurity in the distillate, and was the impurity in the bottoms, and you order to maintain that just respectively reflux.

And the re-boil, how much reflux is been put back in to the column and how much steam is been put into the column, as for as the operator is concern heat plays with these two set points, replace with these set points to get the separation, that is design maintain the separation at the design value.

Well company says operator can be logy, they may be drinking tea and would rather that is get done regard less, whether the operator is taking attention or not, how do they do it, well the way it is done, you would to like to let us say for example, to maintain the composition of bottom stream.

If too much lights of falling down the bottoms, what would you do this steam, you would say I will take this composition, and this composition controller will increase or decrease the steam, it setting the set point of the steam, problem is this composition measurement are far and few, you may get one composition measurement, and once you shift, and once you shift means the whole shift is quality was not good; that means, all of that not batch all of that 8 hours, whatever was dump in to the product time was substandard.

Now to compensate for that substandard product the next 8 hours you would like to over purify. So, that the average composition inside the time, which is being sold to which ever being sold to is whatever, I am calming 91 of 10 or 87 of 10, whatever yah. So, this composition a expensive, b pressure, c un real able, d not very frequent once in a few hours, may be if you put g, c may once in a half an hour, so what is done in practice is…

You really do not have this, what do you do is you measure a tray temperature some place, some appropriate place inside the column, and what is the appropriate place that is a subject in itself that a topic itself, we will discuss later sometime.

But, not now you measure a temperature, if too much light stuff for example, falling down the bottom for example, what will happen the temperature of the stripping case, it will decrease light stuff is going on the bottom. So, if the temperature is decreasing that tells you what jack up the steam, yah that is what to do you put a temperature controller that is sets this way, sometimes you also put another loop which does this, temperature controller it sets the how much reflux if too much heavy reflux is going on the top; that means, I need to increase the reflux, that is what this the other temperature controller is doing is doing, this is done, but only some time, usually what you have is reflux is fixed at a regional able value, and revolve duty is adjusted stripping the temperature or may rectifying the temperature.

So, this is called single ended or dual ended control, single ended means you are controlling one tray temperature, dual ended means your controlling two tray temperature using both degrees of freedom, the problem with dual scheme is single and dual, well single ended and dual ended, the problem with dual ended is you see there is interaction between this temperature controller and that temperature controller what do you mean by a interaction, well I increase the boil because, too much stuff was going the bottoms, more way vapor goes up the top it condenses, level inside the reflux drum goes up therefore, I start taking out more because, I am taking out more impurity level in the top strain goes up.

Now the data I suppose to increase the reflux. So, I increase the reflux, but then it cools down this temperature, you see this temperature controls disturbs this the other one, action of the bottom temperature controller or stripping tray temperature controller the controller disturbs the…

So, it is quite possible, that the two temperature controllers fight each other, and when two controllers are fighting, what you do you essentially beat on them you may less and less aggressive.

And then the tightness of the temperature controller control will go down you have larger deviations from the set points, when you have larger deviation, what do you mean is larger purity deviation or larger impurities, do you see what I am saying. So, typically what you done is usually, very usually you have single ended control, because then one tray temperature can be very tightly controlled, and if few are over refluxing, if you over refluxing top impurity specification will never get a violated.

So, you consuming slightly more steam, because you are over refluxing; however, purity controller or impurity control is very tight is that make sense or no, nevertheless this is this is one of the more natural the controls steams, you could also flip the level control at the top could be using the reflux, temperature could be using the distillates similarly at the bottom, level control could be using steam, and temperature could be using the bottoms, and you can flip the loops, these schemes are also possible, when to use then we discuss them later.

Now, I want to get to that same process, we could taking about degrees of freedom, degrees of freedom means I am free to choose, whatever value I want.

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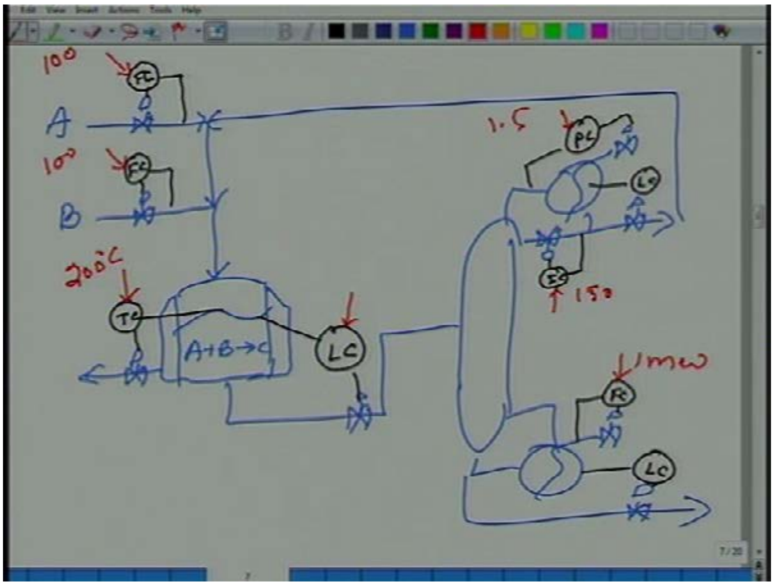

Now, I am going to argue that look, you may think you free to choose, but once you start applying in mind, you very reasonable values for then, you want to go way from those, you see what I am saying, which essentially saying freedom is a false concept, I am free to do this I am free to do that, I am free to do that right.

But when you start putting, what is best for you, then the choice is very straight forward you are not free to take, you are not free to cheat you are not free to do this of course, you are free, but then you are not free, because the price to pay right.

Similarly, even in process is the degree of freedom is good to the where these are my degrees of freedom, but when you start thinking what is reasonable for this degrees of freedom, that degrees of freedom, and that degrees of freedom, and when you start applying your engineering judgment to it, you will start getting reasonable values for them, that this is the thing to do that what I am going to try, and explain to you for this very simple process, it is too late it is maybe we continue this next time, but whatever we can finish today we finish.

So, this is my process very simple process I am removing the drum, because you know it takes a lots of space, and this is being recycled, and these are my valves, we discuss the study state operating degrees of freedom is 6, alright.

Let say I am [FL] guy I do not care I am a simple chart, I cannot handle complexity and I just decide, degrees of freedom number 1 is feed A, degrees of freedom number 2 is feed B, degrees of freedom number 3 is the temperature of the reactor, degrees of freedom number 4 is level of the reactor, degrees of freedom number 5 is how much team I am putting it into the column, degrees of freedom number 6 is how much reflux is I am putting into the column.

Now, A plus B goes to C, let see there is no side reaction. So, what the guys is doing is the following is this is having under flow control, this is having under flow control hum is this having under this temperature flow control, and temperature set point is what he said, let say level control become because these two things are used for setting the fresh feed controls level controls, and then has to be this way, pressure control is this way, level control of the top is this way.

And what the guy is doing is essentially setting reflux, and setting the amount of steam and of course, this under I just say level control bottom level control. So, what the guy is doing 6 degrees of freedom means, what are the 6 set points, that he is adjusting to run the process, what are those 6 set points, how much fresh I am putting in the fellow sets it, how much fresh B I am putting in the fellow sets it, what is the operator what is the operator what is reactor operator temperature it sets it, what is the level I am operator the reactor he sets it, he set this he set this, very thing is essentially level in pressure control inventory control.

So, we will see the number of red arrows is 1, 2, 3, 4, 5 and 6. Let say you are running the process like this, let says he sets A to 200 kilo moles per hour, he is free to choose, let say he choose 100 of kilo moles in hour, 100 kilo moles an hour anything in kilo moles per hour degree Celsius, whatever else energy I do not know kilo watts may be temperature.

Let us say whatever he sets may be 200 degree Celsius, how much team is putting in I do not know may be 1 mega watt, how much reflux is being put in I do not know may be 150 kilo moles in hour, what is the pressure of the column, may be 1.5 atmospheres, these are the set points.

Let says he set B at 100 or not may be, let say he sets it at 100 and 10 kilo mole in hour, what do you think that the purity steam is going out, the product steam here, the bottom from the columns, think material balance, even if all of the A reacts, I still have 5 kilo moles extra of B yah, where will the extra go it has to find way right.

So, it has to come down the bottoms, if this is the way you running the process you can run it, but then whatever extra B or a you are putting name it, would be other way if you are putting in extra A, it has to find way out what is the way out the only the way out is the bottoms from the column yah.

So, if you run in this way sure you can run the process, but then the purity of the bottom steam is depended on the… how much A and B you are putting the mismatch in A and B, if A is not exactly equal to B in terms of kilo moles yah, the excess has to find the way out, how does it find out a way out the way you know it has to come down the bottoms, well if you goes up the top, you are putting an extra you will continue to built up, until it starts to drop down ultimately, it bound to drop down does it make sense or no.

So, fair enough you got 6 degrees of freedom, you choose them the way I just told you, the problem with this is now you are bottoms purity is whatever the hell it is… the moment you put a constrain, the where I want a 99.9 percent pure C bottoms product, because that ‘s what my customer wants that is what I am going to sell him, that is what he going to pay the money for an any impurity he will not buy it, because I am guaranty in to this 99.9 percent pure the moment, I put the at constraint do you this that this is not workable no matter, what you will do this will, this will you know the impurity what it is, even if you put in even for example, even if you put in let say the set point operator say is it look, well oh shit, 99.9 percent purity I have to put it at 100, because a plus b see I am putting 100 in this I am putting 100 of that yah.

Even then, because your sensor is not accurate 4 sensors 5 to 10 error is very common, even though the set point is 100 the actual flows may be you are putting 5 percent extra A or maybe you putting 5 percent extra B is going very, unlikely they exactly match in that case also what will happen, whatever is excess will built up in the recycle yah, once it is building up the recycles, what happens ultimately it is going to drop down, because you your steam is not enough, you do not have enough to sent it up ultimately it is gone to drop down, and it will contaminate the product does it make sense or no.

Now this is I am treating the whole process, like a tank what I am putting in, what I am taking out, it turns out if I run this process like this, my component inventory is non self regulatory, if I want to maintain the bottoms at 99.9 percent purity, if I want to maintain the bottoms 99.9 percent purity, I cannot allow any A or B to go down, if I am putting in not exactly matched, whatever is the excess is bound to be build up in the recycle yah, if it building up the recycle, that like the level inside tank is going up or down, because the flow in the flow out are not exactly matched, does this make sense or no. So, where you speak you have a degrees of freedom.