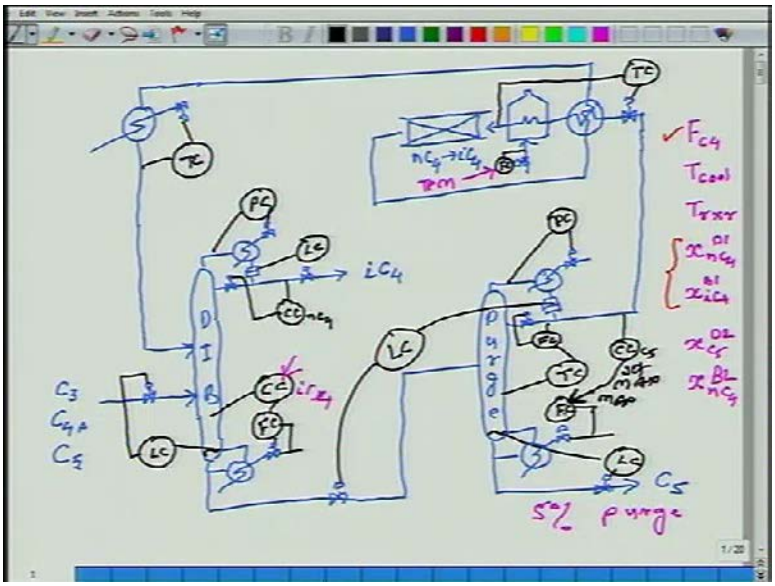
Plantwide Control of Chemical Processes
Prof. Nitin Kaistha
Department of Chemical Engineering
Indian Institute of Technology, Kanpur

Lecture - 35
C4 Isomerization Process Case Study (Contd.)

(Refer Slide Time: 00:37)



So, welcome to today's lecture anyway, so last time we were looking at what optimal operation for giving throughput for this isomerization process and written out that after thinking about it, we had two degree, unconstraint degree of freedom left, there are total seven steady state of freedom of those two are left; what are those seven constraint constraint; what are those seven degrees of freedom respect to rate, cooler temperature, reactor temperatures; the amount of nC 4 leaking down the bottom of the first column, the amount of oh sorry, the amount of iC 4 leaking down the bottom through first column; amount of nC 4 impurity in the distillate in the first column D is botanizer; in the second column the amount of nC 4 contaminating the bottom and the amount of C 5 leaking or the top right. So, these are the seven degrees of freedom and we argued and after those arguments, we turned out that we left this to these 2 unconstraints degrees of freedom.

Now, let us say instruction comes from above to increase the throughput; constant additional constant will become active, so as I am increasing the throughput, let us say

the first constraint to become active is the furnace duty, I am processing more, I want to operate the process at maximum inlet temperature, and now the flow though a furnace is so much that the furnace cannot give you the maximum temperature that you desire, so furnace duty is maximum up, first constraints to become active then they say well, we still want to keep jacking up the production jack up that as much as you can, so I keep increasing the whatever is my throughput manipulator will talk about that later.

I keep doing that then what happens is, this guy goes active, my boiler becomes max, my second column becomes flatted or approaches flatted alright, you see for a given throughput, initially I had two unconstraint degrees of freedom which I marked in earlier, for a given throughput I lose two degrees of freedom, for a given throughput if I lose two degrees of freedom that is it, but if I want to maximize throughput then FC4 also a freedom right.

So, FC4 is a degree of freedom that mean I can jack up my production still and when I jack it up what happens this that becomes active, so the point is, if this itself is a degree of freedom which I am not specified then I have two unconstraint degrees of freedom from mode one plus this as an additional degree of freedom right.

So, when three constraints become active, I would have exhaust; all my degrees of freedom then I cannot jack up my production anymore yes or no? Does that make sense or not? If am operating at the base whatever my design throughput, we argued design those arguments design throughput means FC4 is given and from whatever we argued last time to two unconstraint degrees of freedom were there right, everything else on a certain constraint purity at impurity at maximum, temperature at maximum etcetera, whatever is the leakage down the bottoms at minimum in the punch yeah, so from all those arguments, we basically say what that there are two unconstraint degrees of freedom, if throughput itself, if a degree of freedom, it is about to float right. Now, I am saying throughput must be 100 kilo moles per hour of fresh field or 150 moles per hour of fresh field, if I say throughput itself, if a degree of freedom it is allowed to float. In fact, an instruction is allow it to float to maximum.

Then at most I can write three constraints active, two unconstraint degrees of freedom plus the additional degree of freedom which is the throughput itself yeah, at most three constraints can be driven to maximum through put; the moment three constraints become

active, I have lost all my degrees of freedom, every degrees of freedom is being used to push the freedom towards an active constraints; there are seven degrees of freedom, I can have at most seven active constraints yes or no yeah. So, I am just arguing that look for a given throughput, I have two constraint degrees of freedom, if throughput itself is a degree of freedom and I want to maximize it, I can at most three further constraints active and then whatever is my throughput, that is my maximum throughput that makes you sense or not yes or no.

And now I am saying, and I am increasing throughput first constraint to be active in a furnace duty, next constraint to be active is a column of whatever boiler and the last constraint to become active is the DIB boiler, and then I have all seven degrees of freedom exhausted yes or no.

Now, let us draw a control system that will give me optimal operation through and through, whether I am in maximum throughput or I am at the given throughput at a given lower throughput which could be low intermediate, high or max alright.

So, if I have to do that let me first draw the valves, I think you guys can also draw the valves, anything left connection between two valves, oh yes, there is a valve 2, you see a back up of all the active constraints, it turns out the back up, I am just telling you this, a backup in the temperature in the reactor or give you what maximum throughput loss or rather maximum economic penalty why is that so, because if a temperature goes down, recycle rate goes up, steam consumption goes up alternatively throughput goes down.

So, economically what hits me the most is, the fact that if furnace becomes active, furnace duty becomes active and if I had to back off from maximum furnace duty ordinary, what ordinarily what would I do? I would use the furnace duty to control the reactor inlet temperature yes or no; however in this case, I have told that the furnace duty is the first constraint to become active right.

I would like to operate at high through put, so I would like to operate at high through put at 100 percent furnace duty; to define using furnace duty is a control temperature then I will be operating may be at 90 percent and that back off will represent a significant economic penalty in terms of high through put or energy consumption; in this process note that there is no field conservation, because there is only a single reaction, single reaction goes to be, there is no side reaction all right.

So, I would like to operate at what maximum furnace duty, if I want to operate at maximum furnace duty what; that means, is I should not use furnace duty for controlling anything, then only I can maximize it yes or no, if I am using it for controlling something; it will show transient to control whatever it is controlling and because of those transient, I would have to back off, if I want no back off or as small as back off possible, I should not use furnace duty for controlling anything, I should let it be leave it alone; does that makes sense yes or no?

If that makes sense then what is say, if let us get on with it, because furnace duty is going to be an active constraint, I going to do things in this way and I am not going to use this for temperature control, but temperature control of the reactor inlet is essential; how will I do that? By adjusting this step which is a moment, I said this is not use for temperature control of reactor inlet, the furnace duty is not going to use for temperature control for a reactor inlet, I need an alternative handle yes or no, and that alternative handle has to be such that the temperature control is remains tight, because particularly reactors tend to be can become unstable right. So, therefore, tight controller of unstable thing is essential since this is a flood flow reactor, it does not have a size of a hold up, reactor temperature control or rather you can control the inlet temperature by adjusting the flow yes or no.

So, what I am now saying is, because this is already taken; what you do is, you control the temperature, maybe I should draw this valve elsewhere, I will draw the valve here; this is the same valve drawn here; you do it here for a reason that will be clear now.

So, what I do is? I control the reactor inlet temperature by doing this; will this give tight control? Yes, why yes imagine there is a, there is a hot fluid flowing through a pipe, if it is becoming hotter, you will increase the flow; if it is becoming colder, you decrease the flow, control will be tight, yes or no; you can control a temperature though something is boiling on the pot, by either changing the gas or by adding cold water to it, cold or hot water, cold or hotter water doing it is something like that.

So, this will give you tight control of temperature, reactor inlet temperature right; yes or no. So, there are two options; I could have done temperature control using furnace duty right and held the recycle fluid constant or I can hold the recycle or I can hold the furnace duty constant and control the temperature using the recycle flow rate, because furnace duty is a constraint that becomes active and because control using, using what

using the recycle flow rate will be as tight as if you were using the furnace duty I choose this over that.

Suppose it turns out at no disc temperature controller will not provide as tight control on it in the reactor temperature as if I were using the furnace duty, suppose it turned out like that for various reasons; I I whatever may be the reasons, suppose it is like that then I would not go then is it not clear, this is better or that is better, because reactor temperature will now require a back off from maximum and that will again affect conversion and therefore, how much is circulating around etcetera, how much is the energy consumption right; this is under the consumption that the temperature control unit using this way going to be about this tight, so that the back off is comparable, back off in reactor temperature is comparable, you see T reactor max is also active. Yeah. I want tight control of T reactor max too; I am assuming that this will give me tight control about as tight as straight as if I were using the furnace duty, because furnace duty becomes active; I am going to say, let us keep furnace, let us not use furnace duty for controlling because it is going to become active, in fact, it is the first active constraint that become the active as a jack up max through put yes or no.

Now, because flow to the for tight control of the temperature, I am using flow to the you know the distillate from the first column, yeah that means; first column reflux control level cannot be control using what using ordinarily you will use the distillate to control the first column all right, so what is what can what should I do? Somebody measure the valve, you can control level using reflux well; there will be problem because of that, I can force, it is not really purity, it is not inventory control, maybe I revisit this later on; I would have to think it through, I think there will be a problem; what is the problem? I will discuss later, once I have thought it through; right now, I have not thought it through,

I would rather prefer this, you see if the float to the reaction section is increasing, what does it mean? I am increasing the throughput, what does it mean? I need to suck most of it, increasing or decreasing reflux will not suck most of it, will just cause material to go round and round circle in the first column right, what I really need to do is suck most of it; therefore, this level controller should in my opinion, I will put it this way, this you can see, but level control will be taken on later on.

First of all boiler furnace duty is active, so I am not using it for control; what are the other constraints that become active? The second constraint to become active is this yeah. So, I would not use this for control, the last constraint to become active is what, is there yes or no.

My analysis is telling me, these are the constraints that would become active, so I use the use I I basically flow control alright, I also need tight control of the product purity or rather the impurity in the product right. How do I do that? Well the tightest handle I can think of is, what is the impurity here, nC 4, so this will be the tight control of impurity in the product yes or no, yes or no. Anything else that needs tight controlling, I also need tight control of sucks, I do not think it through properly, I also need tight control whatever is dropping down the bottom yes or no.

Why do I need tight control or whatever is dropping down the bottom, because nC 4 is what is getting loss and if I lose it that loss production, that loss value at the product essentially that lost IC 4 this is what I want to make right; I do not want that, so I also need tight control or whatever is getting lost down the bottom right, I can do it this way then the question is how do I control the level hit.

Now, we will have to put level controller; of course, this is temperature that is obvious, now we need to put in level controller; question is how do we do that? Let me think it through just hold on. Well about this, will this works that is my question; now the only way that I can control this level is by doing, this will this work; if this level is increasing, I will increase the reflux; if I increase the reflux, what happens this, level will starts to go up, we are putting more liquid in that liquid will reach the bottom; if this liquid goes up, the level controller will reduce yes or no; will this work, I think this will work, it should work and then how do I control the level here yes or no, now how do I control the level here, when this, we have thought through, I thought I had it though to, but I think I am slightly confuse, but we will think through pressure control that is it.

Now, now let us think about it, I think there is some problem in this, you know managing the two levels in the first column that has to be thought through, thought through properly; what should be throught throughput manipulator, I make a recommendation, let this being my throughput manipulator, why I am using this as throughput manipulator, because this is giving me is a maximum economic loss for a back off so so fine. So, I use

this, when I start using this as my throughput manipulator, this maxes out, this will be the first constraint to max out, I think I got it, I argue it will you later on just in a sec.

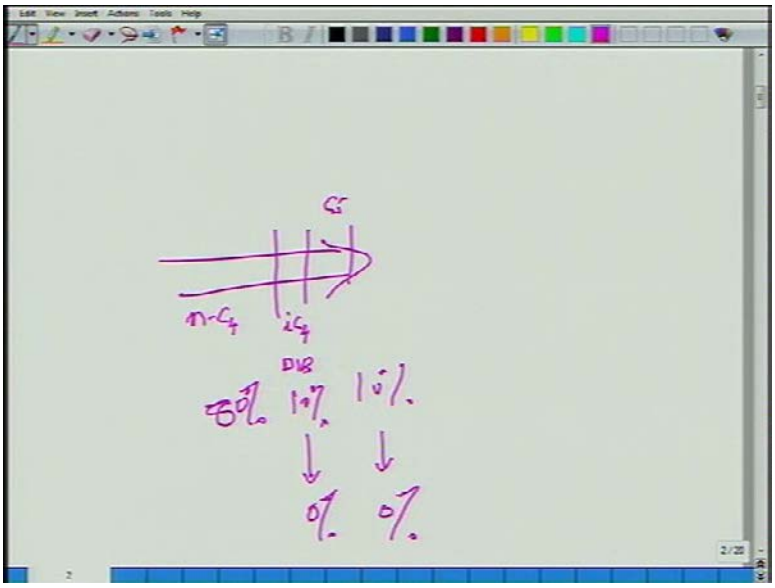
I lost this in a temperature control and I will have level control this way which should work and what I will do is? I will have level control here this way; reflux is fixed to do something, reflux is fixed to, let just say reflux is fixed. Now let me think is through this is, what I do and I also use a temperature controller that does this all right, by the way in the D I b controller, you cannot really control the temperature, because separation is easy, separation is very difficult. So, the temperature does not change a lot form one tray to the next therefore, temperature will not be a good integrator or separation. So, you will have to use some kind of a composition controller here, I do not know what kind, but it is a changing, changing the boiler.

Now, I say, how I am going to maximize my through put, I am operating at a certain throughput then so I adjust this throughput manipulator to get it, to get whatever fresh C 4 field consumption rate that I desire, then somebody says jack up throughput so I start increasing this throughput manipulator set point, what happens if I increase the furnace fuel flow, if I increase the furnace fuel flow what happens temperature will rise; if temperature rises, I will start putting in more what more distillate, if more distillate is being putting then level in the reflux zone will go down; to make up that level, I will sucking more, more what more form the D ISO from the bottom then the level of the D ISO form bottom will start to go down and then I will start sucking more fresh field.

So, sucking in more fresh field to a change in the furnace duty makes sense yeah, after sometimes what happens I I kept jacking up furnace duty, so it went form a 80 percent to 90 percent or 50 percent to 80, 70 percent, 80 percent, 90 percent, 100 percent, valve is fully open, the furnace duty is operating at maximum at its maximum capacity.

Can I further jack up the throughput; obviously, there were unconstraint duties and freedom and I was able to, how was I able to, you see if you look at whatever is flowing to the reactor, what is flowing to the reactor? Mostly nC 4 some amount C 5 leaking from the top in the first column and some amount of IC 4 leaking from the bottom of the DISO, so if I look at whatever is flowing so so if I look at whatever is flowing well well.

(Refer Slide Time: 22:01)



If I look at whatever is flowing to a reactor, it is most of it is nC 4; part of it is IC 4 leaking from D I B, this is coming from D ISO from the bottoms and the remaining part small part of it is what C 5 leaking from the first column right. Now, what is happen is? My furnace is max out; I want to jack up the production further, how can I out the production further, if I reduce C 4 and C 5, so let us say this for seven, I do not know 80 percent nC 4, 10 percent IC 4 and 10 percent yeah. If I reduce this to towards 0 percent, if I reduce this to 0 percent, flow rate of the stream to the furnace has gone down yeah yes or no. If flow rate is gone down, the temperature will go up as I can note throughput go up yes or no.

So, what is circulating around, if I minimize the nC 4 and if I minimize IC 4 and C 5 and whatever it is circulating around, I can actually sucking more even though the furnace is at max, that because I do not want to keep it already at the lowest level; because then I will consume too much steam here and too much steam here, you see if I do not allow anything to leak out here; steam here will go up because nothing can leak out; if I do not allow nothing to leak out the top, reflux will go up which indirectly will cause to steam will go up yes or no.

So, I am producing the same amount, but I am consuming more steam per k g per k g product no see at fine, when the furnace is not active and low through put then my process operation is I want to process so much of C 4 heat, what is the most economical

way of doing it, the most economical way of doing it is by minimizing the steam consumption how do you minimize the steam consumption by maximizing the conversion in the reactor and allowing things to lead down, allowing leakage of impurities, because that is what will reduce the boil up, you cannot, you cannot reduce the, you cannot increase the impurities to much because then there is a buildup; what do you mean I see of course, I see for it costly, so the impurities is nC 4 not IC 4; why do you want to sent IC 4 in the reactor, because deisobutanizer or column is extremely tall where you there in the last class, you are not there therefore, therefore, all these are arguments.

Deisobutanizer is a what is a heart separation, if you are doing nC 4, IC 4 separation; if you want 0 percent or 0.1 percent IC 4 going down; you will require very tall tower to begin with and lot of reflux and lot of reboil; your steam consumption will be heavy yeah.

So, your processing some amount, so it so therefore, it makes sense to allow some to leak out, because then the steam consumption goes down dramatically; you do not want to allow too much to leak out because then it is circulating around, because ultimately you have to send it up in the first column too, whatever leaks out has to be sent up in the first column, so there is a increase in the boil up in the first column, if you allow too much to leak out, you do not want to little to leak out because then the D I b steam consumption goes up, you are processing the same amount of F C 4, but you are consuming too much stream all right, so you want some leakage reasonable leakage may be 5 percent; may be 10 percent; similarly you want some leakage in the first column to, because if you say of none of the, none of the C 5 should leak up the top, then what that mean is the boil up and, and the bottom will be very high.

So, you are processing the same amount of FC 4 fresh C 4; however, you are consuming more steam that is an inefficient way of doing it; does not matter, so you say I will allow FC4 and I will allow IC 4 and C 5 to leak, so my steam consumption is reasonable near optimal. Now, the instruction is jack of production to the max, so what you do you start jacking a furnish duty as you jacking a furnish duty, you start sucking in more the way we just argue, but then furnish duty maxes out.

Now, the question is can you still jack of the production and what I just argued is; yes you can; if you forced this which was being allowed to leak to 0, towards 0; you cannot it to 0, because when you tried to force it to 0, this maxes out that makes sense; this maxes out too yeah. How do you force it to 0? How do you force the C 5 impurity toward 0? Just start increasing the reflux; if you just start increasing the reflux the C 4 impurity is that the C 5 impurity that is going of the top, start reducing; of course because you want to maintain the leakage of nC 4 down to the bottoms, the temperature control will also increase the water the boil up yeah then the boil up becomes maximum; once the boil up becomes maximum my temperature controller becomes over, becomes you know it essentially lost control of temperature yes or no; fair enough I want to increase production further.

Once I lose this temperature controller, because this is become max, because this this signal became max first thought put manage furnish duty became max; I want to increase production further, so what do I do? I started increasing the reflux as I start increasing the reflux, the temperature controller will start increasing in the steam yes or no.

So, as the temperature controller is increasing the steam slowly, but slowly; once this reflux has been sufficiently increased, the boil up pair will become active; in the boil up active, I cannot control the temperature anymore, because I cannot control the temperature anymore, I say well, does not matter I would not control it.

Why can I say that? Because this C 5 is a per steam; it is very small. What am I loosing? I was losing 5 percent nC 4 down the bottoms, now because boil up will becomes maximum, I may lose 6 or 7 percent, I am saying that that is because C 4 C 5 per stream is anyway very small, let us say 2 or 3 kilo more than a hour, even 5 percent goes to 10 percent and C 4 lost on the bottom that is acceptable; does that make sense. So, when boil up becomes max, I say no problem; I am slightly more nC 4 down the bottom that is because anyway the lost steam is very small; it is like a leak steam that is ok, then so I have driven C 5 to as small as possible; now I need to drive IC 4 to as small as possible; how do I drive it? Basically we just start adjusting with this said point, so you make it tighter and tighter and tighter.

The amount of IC 5 leaving down the bottoms, C 4, IC 4 leaving down the bottoms, you just make it tighter and tighter and tighter; if you are allowing 5 percent; just start

reducing it towards 0, 4 percent 3 percent 2 percent as you do that boil up will increase; as boil up will increase what happen, it will reach max; when it has reached max that is the maximum that you can process that is the last degree of freedom that you lost, so furnish became max; boil up became max; boil up in the first column and finally, boil up in the deisobutanizer became max and then what ever is the through put that I am getting, well that is what I am operating at does this makes sense or not.

The one thing that I did here that does bother me is the time allowing the leakage of nC 4 down there to float, see once the boil up becomes max in the temperature control controller is not able to control the temperature yeah; because it is not able to control the temperature, leakage of nC 4 to the bottom is not in my hands; if more is leaking, more is leaking; if less is leaking, less is leaking; it is not in my hands ok. This is one thing that bothers me can I improve it, maybe I can; how do I do it? Well I will just suggest you a way and you think about it; why it works? I will say max this out, control the leakage down the bottoms, control the leakage down the bottoms by adjusting the reflux, so this is at max.

Now, this is ensure and solve is in my hands, if I am operating at low through puts; if I am operating at low through puts, I can always reduce this for what for maintain the amount of well compositions control the measures, this compositions controller; what is impurity here? C 5. In the previous case, what was happening was when the boil up became active; I lost control of the impurity leaking down the bottom. In this case what is happening is when the boil up becomes active and losing control of the C 5 impurity of the top, look at just look at this, when this becomes max; what do I lose? I lose control of how much C 5 is going on the top yes or no yeah, which one is better? So, in the previous case nC 4 lost down the bottoms floated, once the boil up became maximum; in this case C 5 going on the top is what is floating yes or no.

The difference between the two is clear which one is better? Why? First one, second one. This one is better, because what is recycle does not hurt me, not that much, not that much what is lost down the bottom while it lost? You see what I am saying. So, I would prefer this to what I did previously, is the, is the difference between the two clear yes or no. You see when a constrains become active; control of something has to be given up whatever you are controlling using that you cannot control it anymore anymore; the way the

control system was structured previously, I was controlling leakage down the bottoms using boil up.

When boil up becomes active that leakage cannot be controlled anymore yes or no. The way I have structured it now, I am controlling the leakage of the top using the bottoms using the whatever the boil up, so when boil up became active that is what I lose control off; economically speaking this is better at least from the steady state point of view, dynamically speaking what is the problem, you see the temperature controller for the leakage down the bottoms will be slow one, on the other hand if you are controlling leakage down the bottoms using steam, when steam is not saturated; when boil up is not saturated; control will be really tight, you see what I am saying, you see what is happening is, I am trying to control the leakage down the bottoms or tree temperature here in the stripping section by adjusting the reflux, reflux takes a long time to flow down then for temperature will flow down slowly.

Therefore the control will be not as tight yeah. I do something output takes a long time to respond. If output is taking a long time to respond to bring it back, it will also take a long time to bring it back to set point will also take a long time, in that long time you will get large deviations you see what I am saying, boiler the moment I change the boil up the steam changes the vapour, you know the vapour going through the column changes; the vapour whatever vapour generally, it flows immediately to the top; energy balance on every trig its changed, composition of every, every trays starts to respond immediately temperature of every tray starts to change immediately yes or no.

So, to me it is not clear whether this is better or that is better, but I will just argue through why? If the dynamic control of the temperature was as time to the reflux, first I got another idea; I think that is an idea that will work forgive me, this is more structuring goes.

The problem with this is you are not getting tight control of what is leaking down the bottoms, because you are not getting tight control of temperature, one way of getting tight control of temperature is to in this way, now this is not sluggish, no; because your control tray will be closed to the feed tray, you changed the feed the temperature will changed reasonably fast, it will be much faster than reflux. Reflux of depth by the time, it goes down here takes a long time you know and then do never control this way, this will

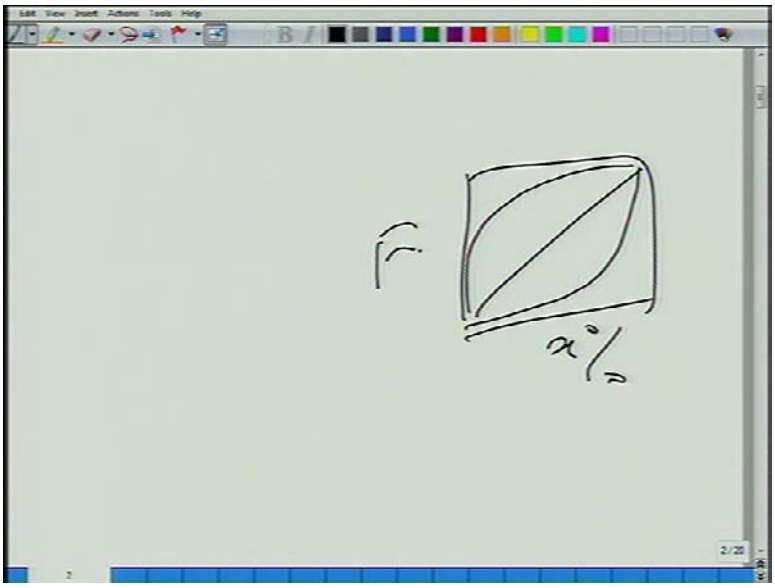
work. So, now, you are getting tight control of both the leakage and then what you give up is C 5 leaking up the top when boil up became active. Yeah. I think this will be probably the better structure.

Do you see the reasoning, how the reasoning has to go; what must be control tighter? What would be a good manipulation handler which is closed by which will give me a fast dynamic response? What should I lose when constraint becomes active, I am gone a loose control of something; should I lose control of impurity in the recycle or impurity in the byproduct stream; obviously, byproduct stream, because byproduct stream is lost recycle; you know it is all gone a comeback, it does not really matter it is not lost its still there in the system yes or no correct.

So, I think this is probably the best control system. So, you want the explanation of how this works sir oho oh this. Whenever I draw level controller, it is always done this way in practice, the way I have done it right now, it is just that if I start drawing it for every dynamic thing, there will be a flow controller and there will be a level controller of top of it, the drawing becomes very messy, so any stream that has a control valve will have a flow controller on it then flow controller set point may come from level controller; it may come from a pressure controller; it may come from a temperature controller; it may. no there is a difference, there is a difference.

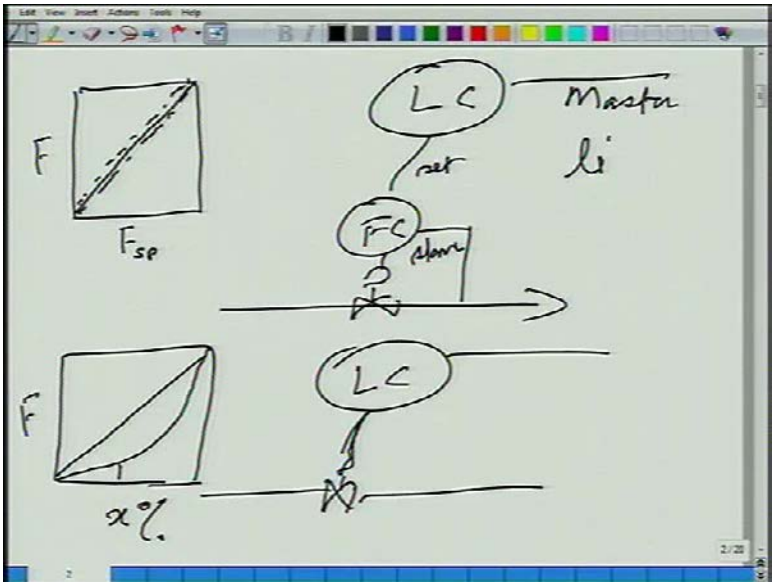
Well this is a digressing little bit class time is over, but never the lesson is vast, I will give you a quick explanation, you see valves are non-linear right, so if your position is x, flow rate will not be x percent, flow rate will typically you know valve characteristics quick opening valve, linear valve; I do not know those things you would have seen.

(Refer Slide Time: 39:35)



So, x percent versus flow rate right, valves are non-linear, because valves are non-linear, so flow control will be always fast, you changed the valve position flow will immediately response, so you can tune the controller to give you whatever flow you want and within half a minute, it will give you flow that you want kind or like if you are opening a tap in half minute, you will get flow that you want exactly right.

(Refer Slide Time: 40:09)



So, let us say I got a stream which got a lot of flow controller, and level controller is adjusting this flow set point, alternative arrangement is I have got the same stream and

level controller is doing it directly, this is what you are asking right what is the difference between the two? Well what is the level controller ask inputting flow set point right. here what is the ultimately level controller is adjusting the flow through the tight either directly or through the flow controller yeah.

Now, I this will be more this, this flow controller will take care of non-linearly associated because of the valve characteristics, if the if the level controller is same give me this flow; the flow controller will within 30 second give you that flow right, so if level controller output, if I look level controller output is y percent, level controller output in this case is flow set point right, and what would be the flow that the flow controller will give you will essentially get a straight line, if you average every 30 second, you will get you know data that is scatter around the straight line with very little scatter, because it is almost you know the level controller is asking a flow of x kilos moles in r or x kilo grams in r flow controller is giving to you in 30 seconds.

So, as far as level controller is concerned whatever it is asking it is getting, now level controller in this case output of the level controller is x percent valve opening, what really affects the level is the flow, so level controller is actually saying adjust the flow, but because the valve is non-linear, level controller is level controller think if I say x percent I will get x percent flow, but actually the percentage flow that you are going getting because of valve characteristics which is actually non-linear. If the valve opening is x percent flow is actually only whatever; on the other hand if you are here, you are getting something else you see what I am saying.

So, now the problem is the level controller has to compensate for the non-linearity associated with the valve 2 through feedback. Yeah. In the previous case, in a case drawn a box which is what is done; the flow controller takes care of that non-linearity for you see what I am saying, so in any cascade array, this is cascade control system, level controller is cascading at set point towards slave controller.

In any cascade system, local non-linearity in the slave loop get taken care of by the slave loop; if you do not have it, those local non-linearitys have to be compensated through feedback by the master controller; this is called the master controller; this is a master and this is the slave yeah. So, things that are local non local non-linearity, local disturbances those get taken care of by the local loop, the slave loop; the master can now go about

doing it chop not have to worry about, I have to compensate for this two the valve is non-linear etcetera etcetera.

Suppose something gets stuck in the valve, there is the flow something get stuck in the valve; if something got stuck in the valve, flow will become different; if the flow becomes different; level will changed then the level controller will adjust the flow set point or the valve opening otherwise in this case flow controller, itself will itself will you know so so so, something got stuck in the valve, flow changed that was detected by the flow sensor when the valve opening got changed immediately nothing happen to the level, you see what I am saying, so local things are getting removed, whether it is a local non-linear, local disturbances or local problems slave controller will take care of you take care of them right. So, this is actually much more ropes than this, so A is much more robust than B, so in practice it will always be done this way; when I am drawing, I draw it this way, because man keeps on drawing flow controller nothing will be visible on the flow set, it will become messy ok. So, whenever there is a control valve; there is always a flow controller with it, if I am dying doing directly to the valve which actually to the flow controller, just I show alright, I think it is time to end boss.