Textured Yarn Technology
Prof. Kushal Sen
Department of Textile Technology
Indian Institute of Technology, Delhi

Lecture – 16
Draw Texturing Machines & Process Parameters

Alright, So we are starting again partly we have discussed Draw Texturing and part of some of the essentials of some machines, but we will continue further and the process parameter which are basically changed because of the draw texturing machines now are also draw friction texturing machines and therefore, some of the process parameter may be different. So, we start discussing in the change environment what will be the effect of those process parameters.

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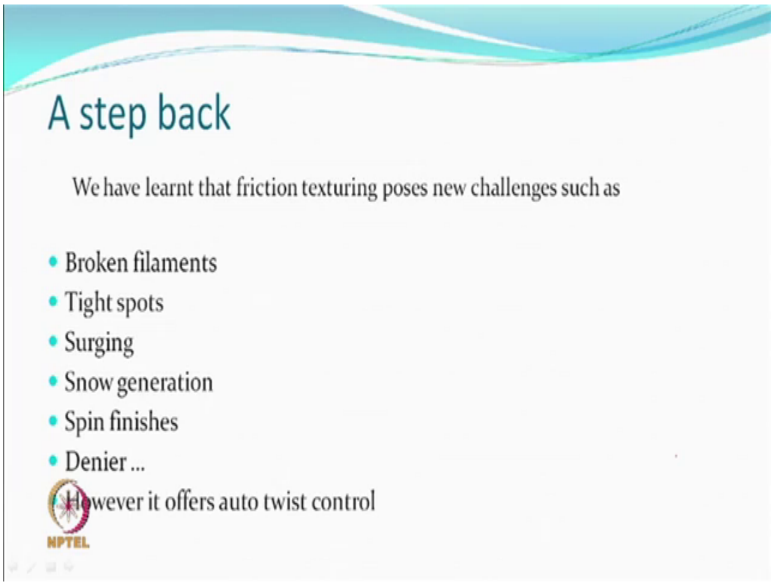

So, we learned last time that friction texturing has new challenges like we have to address issues related to broken filaments, tight spots, surging, snow generation, spin finish which may have to be specially designed spin finish and control of denim of course, it does offer auto twist control.

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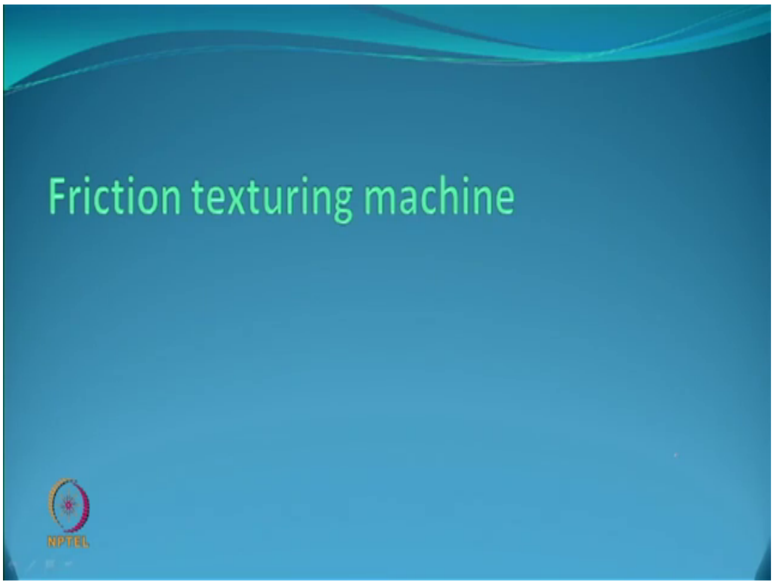

So, this friction texturing machines which of course, you must remember they are also draw texturing machines. So, we are not going to be using a fully drawn yarn now going to be using and POY and so there is a POY and you also have friction twisting system.

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So, we are talking last time about the primary heater, cooling plate, secondary heater auxiliary equipment these are some of the things which are essentials of any texturing machines.

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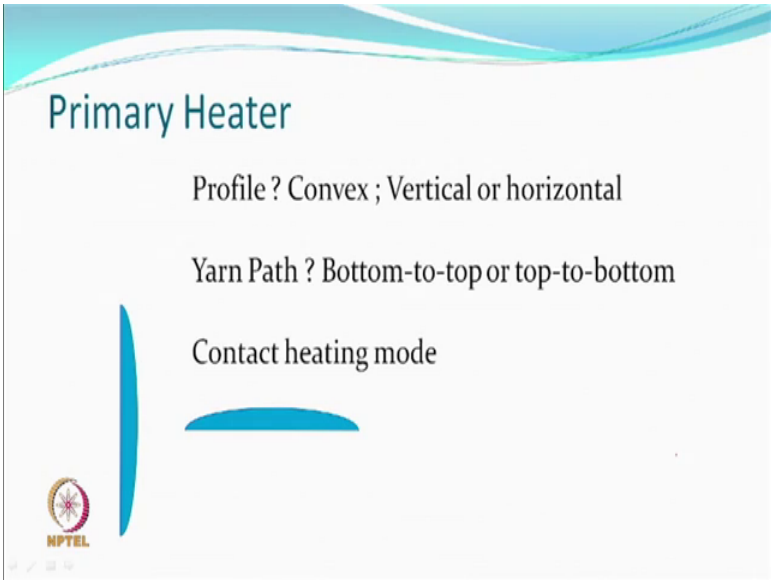

And we did talk about primary heater and we said the primary heater invariably will be convex the profile could be vertical or horizontal does not matter because the yarn is going to be contacting this heater and it has to be kept under certain tension and therefore, it does not matter whether you are taking the yarn from bottom to top or top to bottom, horizontal or vertical position of a heater. It is based on the convenience and desirability as far as the machine and this space is concerned and we hope that contact heating probably be more efficient.

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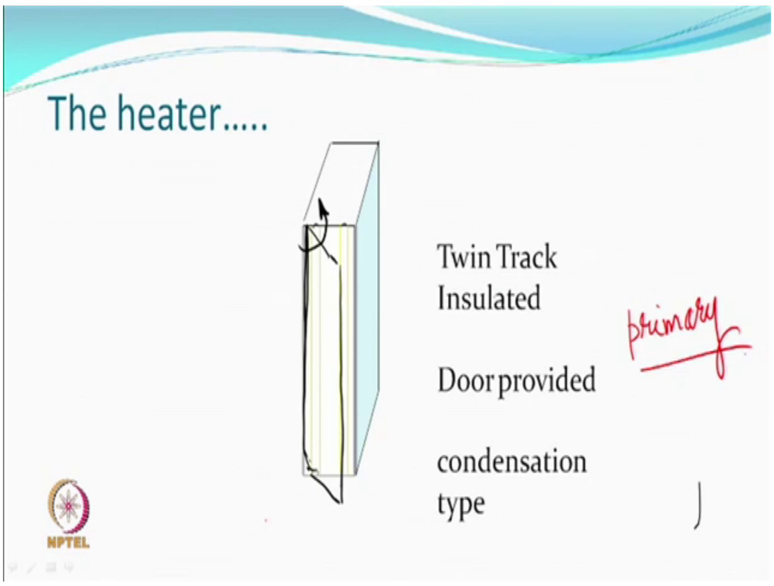

We did talk about the heater which is the primary heater here also is a twin track kind of a thing so you are handling individually arms, but maybe in one block small block you are having two yarns going together; obviously, this has to be properly insulated there is door, which is provided after running the machine you can close the door and the heating generally may be done by the condensation type that there is a fluid inside, which evaporates in a space which is there just behind.

For example, the heater plate so that the temperature difference is the least and more uniform heating can take place and that is what it. So, this is basically your primary heater.

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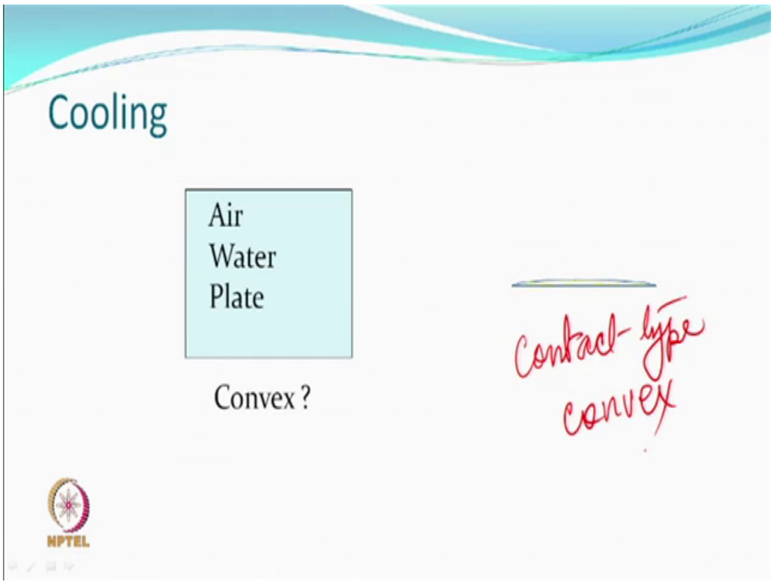

So, cooling also we said can be done generally which was initially all machines had the air cooling just the way it is, people then tried because the machine speeds are going to be now increasing therefore, the total time available for dissipation of heat also would reduce and therefore, the rate of cooling also had to be change and so either you force it through liquids like water where the yarn comes in contact.

One can always say well I can use for cooling liquid nitrogen which will take fraction of seconds to cool, but would you like to use that if the yarn comes out of a primary heater and immediately you want to cool because space is what you can reduce, just purge through a small thing called a an outlet which has liquid nitrogen being purged it will not take just fraction second you could cool like would you like do that

Student: No.

Because if you actually cool it so much liquid nitrogen can make any thermoplastic material very rigid because you go much below the room temperature and when you try to do anything with it untwist it will only have broken pieces in your hand. So, you still want the yarn to be the way it behaves just you have to bring down the temperature just below the glass (Refer Time: 05:57) temperature and then you can untwist.

So, what people found more convenient rather than using water or neither liquid was using a cooling plate ok, which is also a contact type convex cooling plate. So, heat transfer is quick machine speed can be increased and then of course, you have a friction twisted which runs at a higher RPM and so one can always work around.

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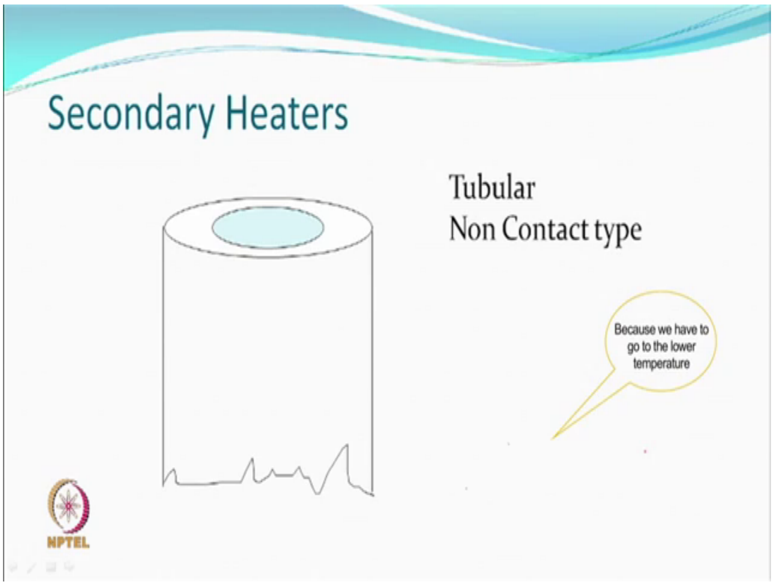

Then we have secondary heaters also, that is immediately after you have done the untwisting before winding for producing yarns which are called the modified state yarns you will have secondary heater. As you can see the shape the secondary heater is a non contact type of a heater, it's a tubular non contact type of heater.

So, one can always say well the rate of heating or efficiency of heating maybe not as efficient as a contact type, but you do not use contact heaters why do not we use why would not like to use a contact heater where the efficiency will be higher, why would you not like to use any response?

Student: Because we have to go to the lower temperature (Refer Time: 07:50).

Yarn is already cooled yarn is already cooled before it has been untwisted. So, it's maybe it is not at room temperature, but it's certainly below glass and the pressures we know, we have to heat it we have to heat.

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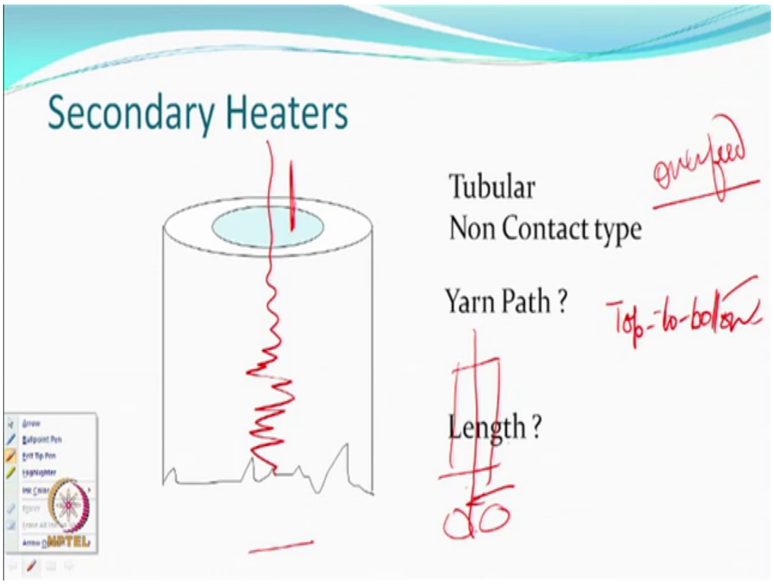

So, one of the things we can remember is in the secondary heater we give overfeed and what is the aim limited relaxation or limited extension whatever you want to call it; that means, you want the yarn which otherwise after the twisting may appear under some tension almost uncrhimpt you want the crimp to develop here. All though temperature of the heater will be lower than the primary heater, but still morphological changes are expected to happen.

But in a condition which a where the filament is not straight it is relaxed maybe not fully relaxed, but it is relaxed and if you have a relaxed type of environment how do you contact? If you contact any surface whatever part of the yarn comes in the contact that is the only one part of the contact rest will be far away. So, then you will be creating lot of non uniformity which can be seen at some stage when after time and therefore, you do not want the yarn to touch any surface because friction means tension; tension means crimp will be opened also.

So, you do not want whatever crimps can be generated in this so called overfeed they should be allowed to be generated and they would also occupy more space alright in the heater and so it is a non contact type. Also here the yarn path is also an important consideration invariably the yarn will be passed through the heater from top to bottom and not from bottom to top.

Similarly, this heater will always be vertical and not horizontal, in the primary heater we said does not matter it can be having horizontal it does not matter. Similarly cooling plate could be horizontal, could be vertical, could be at any angle definitely matter because there the yarn is under tension and it is supposed to be in contact with the plate. In this case yarn is not under tension and you actually wanted to relax to take up some configuration which has to be set in the time period that you have.

So, what I said is the yarn path is always top to bottom why do we have top to bottom? Let me also tell you when the yarn enters let us say this yarn is entering. So, it may be very straight yarn and this portion the straight is very straight, but as it goes inside it will start taking some shape. If you look at the end of the thing, where you will be actually collecting this yarn after the secondary heater if you measure tension here it will not be zero here there will be tension.

Because whatever overfeed you are giving it is going to be consumed by generation of crimped structure it may not be very high, but it’s not zero therefore, you can process you can take it and do whatever you want to do it, but it will be in a crimped state at this point and of course, by the time you pick up it would also have been cooled, but no contact cooling here; cooling in the air that is there right because it is again exposed. It is by the time it is picked up, it is still in the form in which the bulk is seen right.

So, there is no contact cooling, there is no contact heating the yarn is top to bottom because if you start from bottom to top when the yarn is not in a crimped form it will start falling on itself because it’s not been heated the crimp form comes when it gets heated. So, it will just keep collecting at the feed roll itself and then may wrap and break. So, it has to be use the method of gravity it just falls in and then relaxes. So, enough time of course, has to be given so that you can get modified stretch yarn right the length of the heater. The length of the heater here could be 1 to one and half meters, so length could be 1 to one and half meters.

Now, try to appreciate that you have a fast running texturizing machine a primary heater about 2 to 2 to meter 2.25 meters, the cooling plate could be 1 meter 1.2 meters 1.5 meters. Secondary heater could be 1 meter one and half meters what is the length of this whole path of yarn? So, it is not like a small machine where you are working this goes into different floors also.

So, the either it's a very high ceiling kind of environment and then think of somebody who actually find that he has to or she has to thread the yarn because they are broken. So, start from where go where work it out come down all type of things become therefore, nobody will like any breakage because it's a multifilament's you know yarn industry and plus it's its complex. So, this is not a small kind of a machine which can be operated.

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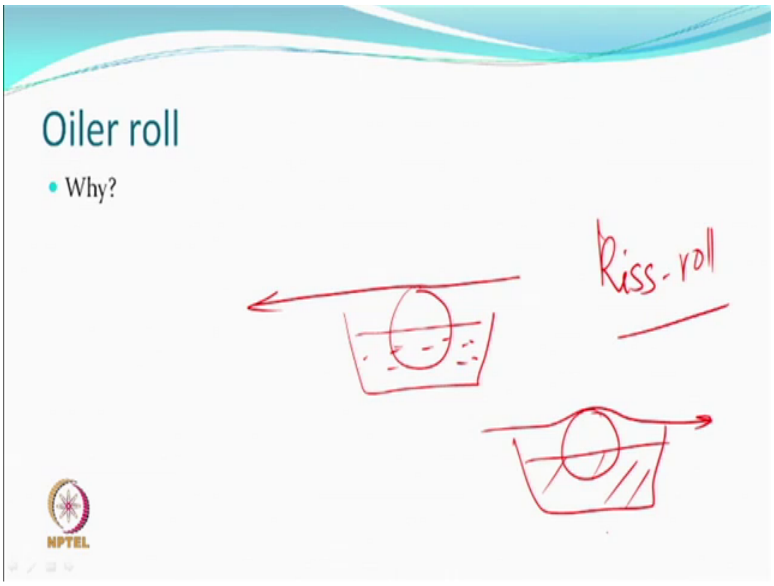

So, then in the modern machines in the friction texturing, draw texturing machines you will have a oiler roll why do we have a oiler roll? Oiler roll is like it applies oil, why do we need oil roll, why do we have to apply the oil? This oiler roll is just before winding the final package because we mentioned that this friction texturing machine may be using special spin finishes which where the lubricant can evaporate during the heating process the primary heater itself because after that you want the friction to be high. So, that the twist levels are high and so by the time it comes back to the winding stage we would like to replenish want to replenish whatever may have been lost.

So, that is a lubricant which is called oil alright and so an oiler roll which may be very simple equipment, but attachment let us say. So, you have an oil and a roll which may be dipping and the yarn may come in contact something like kiss roll technique, if you want more contact then of course, you can also have more contact.

Normally they will be moving in the same direction as the surface of the roller you do not want to create friction here just want to apply, but this technique allows very small amount of liquid to be added up very small amount which is what is required and then it; obviously, because of surface tension you spread across the whole yarn and you wind it.

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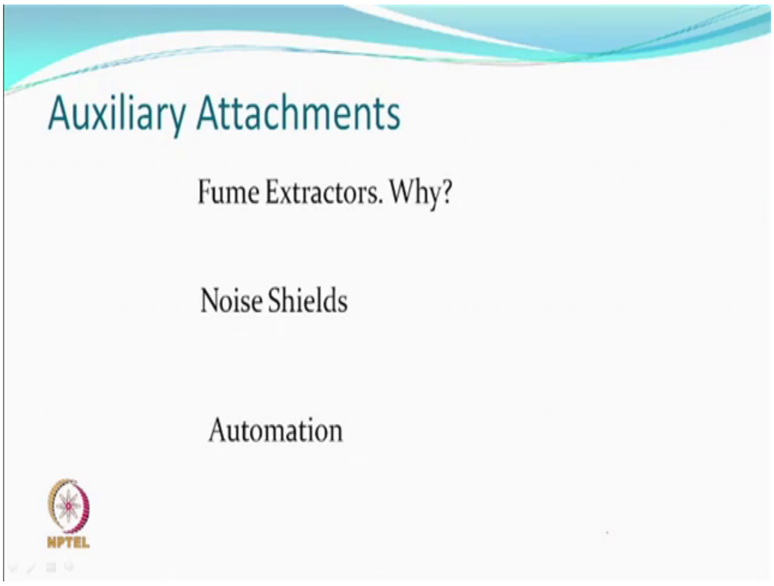

So, this is going to be a part of machines definitely, these days you may be getting fume extractors, so why we have fume extractors? Because this so called oil from the spin finish the lubricant, from the spin finish is evaporating now we will go is an vapor form. So, it will keep coming out of the main primary heater you extracts if you can condense and use it use it if you think you have done a lot of damage to this just above the primary heater, you can have extraction units which will suck the vacuum unit, so extraction and if we will taken to one side.

These machines can have noise shields also, the noise level in the pin texturing machine was very high you can think some part which is got a cut which is cutting the air like the spindle and rotating it’s 10 raised to 6 RPM. So, there is the kind of frequency which would be generated as per the noise is concerned, very shrill high frequency noise decibel levels also high and therefore, they had to be protected. So, their noise which can travel by transmission like a motor and a shaft and the noise transfers from one end to another.

Other is aerodynamic noise that the noise I mean generated it's actually moving in the air and it's coming to you this can be shielded by a barrier if you put a shield for example, what is happening outside hopefully we do not here because of the wall.

Similarly, if you put a shield just in front of the noise the next element which is making the maximum noise, aerodynamic noise can be cut pretty easily and if it is an absorbent then leaves otherwise it get reflected, so the wave goes and get reflected. So, noise shields could (Refer Time: 19:27) because if machines are running 247 so many spindle, so many machines in one of the sheds, then you can appreciate the total overall noise. This noise is very different than the noise that you actually are familiar with an viewing shed which is very low frequency noise.

But the friction texturing machines and the spindles thereof are not rotating at that high speed the yarn is rotating at high speed, but there is no other element which it rotates at that kind of a speed. So, here the noise is of a different kind lesser thing, but still things are rotating it fast. So, it is better that you have decibel levels these are 70 or less everybody is safe.

Automation is a part of every machine so that is, this is not something which we will see here, whether it is the threading portion, whether it is the contact, whether it is the detection, whether it is temperature control, whether it is speed control and tomorrow if somebody says well, as of now all the spindles are rotating from the main motor through a shaft and the belts; that means, the speed of all of them are supposed to be same right.

So, that is how it becomes the cheapest way of rotating all the spindles, but tomorrow you can think, if you think is an efficient way or working maybe every individual spindle could have it's own motor and so the automation in that sense would be different; that means, you can actually control the process parameter for each position which; obviously, is more costly, but may be more reliable sometimes.

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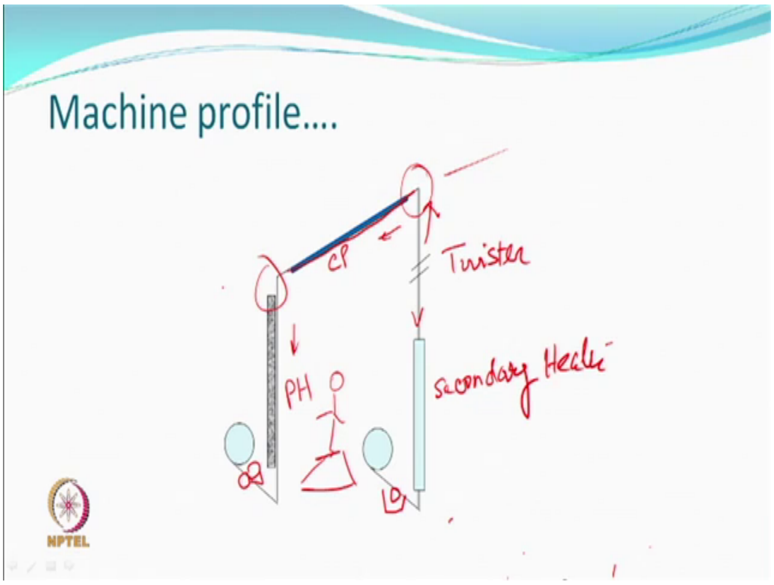

So, one of the profile in which people use these machines is what you see. So, here you are feeding this is primary heater this is cooling plate, this is your twister, this is secondary heater of course, I have not shown here, but you can always have a spin finish or oiler roll before winding alright. So, what does say it is trying to reduce the height of the machine?

So, the operator probably can maybe is here on some platform and can look at the threading of the primary heater can look at the top and see the cooling plate in this case the yarn would be going below the cooling plate the yarn would be below the cooling plate alright not on top so, on. This side he sees the yarn, on that side he sees the yarn then there is a twister, if something goes wrong we see the twister I mean this guy height could be little more. So, you are reducing the height of the whole machine despite primary heater being a longer heater everything else.

So, this is how you reduce the height of the machine smart way of adjusting, but the some of the people said well you are mishandling the yarn because it's bending too many times like the twist has to flow from this portion and go all the way go all; the way down to maybe a nip role. So, a long path of course, long is there, but it is bending what is say this is a very soft material here as it is coming out of the heater this is the twist flow right this is not direction of the yarn direction of the yarn is this.

But the twist is going from the twister downward here the twist is more twist is less; twist is less twist is less. So, if you bend the twist flow is going to be affected, then here it is still because yarn is already cooled, but at this portion yarn is really hot. So, a hot yarn being of course, is being twisted you say you are bending it also you say this is not the ideal position the yarn should have been handled.

So, you think of what you do the machine becomes too long total height maybe one plus 1 and a half 2 and a half plus 2 4 and a half to 5 meters you are talking about too much if you go straight. So, it did not work, but machinery were made by this also.

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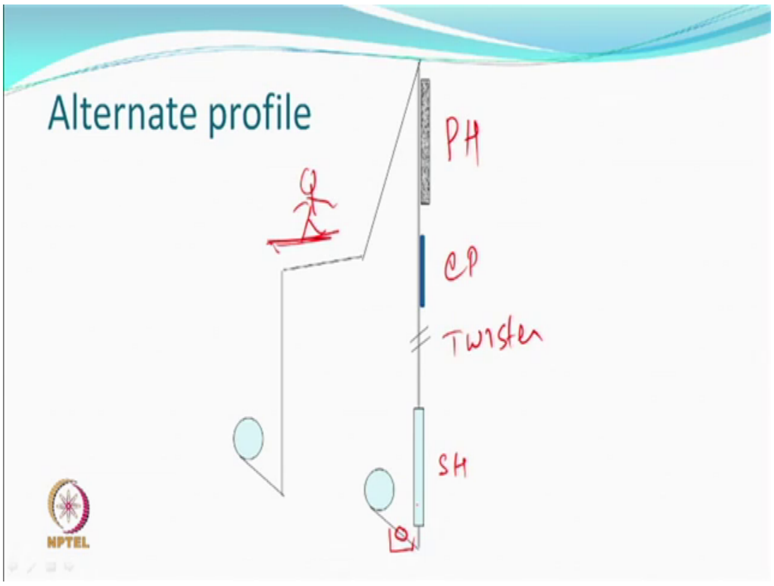

Another profile people thought is let us go all the way let us go all the way, there is a platform somewhere where the person may be standing working around. So, you are only taking all the yarn from whichever on the platform and this is your primary heater this is the cooling plate this is the twister and this is your secondary heater and of course, you can have an oiler role this is just a depiction alright.

So, people have used this profile as well going all the way straight so here you can see the threading for the primary heater is from top to bottom in the previous case of bottom to top, but secondary heater in both the cases were always top to bottom, people can use any profile which they think is good enough, but main thing what people wanted is that between primary heater and the twister the path should be as straight as possible then it would be nice alright.

So, there will be; obviously, I have not shown those nip rollers and so on and so forth, they are going to be nip rollers they controlling the overfeed and underfeed and everything else which you want to go the tension control and all the things will be there.

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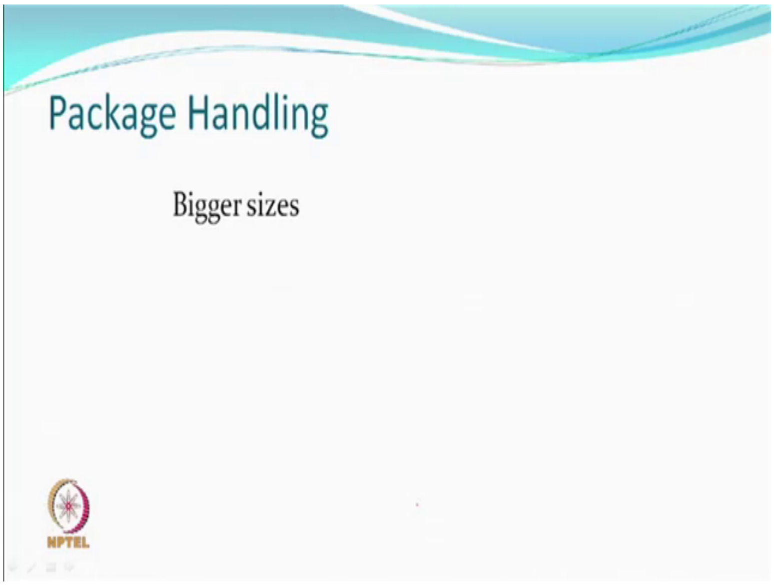

So, of course, people are handling bigger packages, bigger sizes, that is way. So, whole winding zone also it's a filament winding you may remember this is different than the spun yarn winding it has to be more precise and slippages could be more, so those are different kind of winding.

So, larger size is handling being done. So, that is what about some of the features of the machines.

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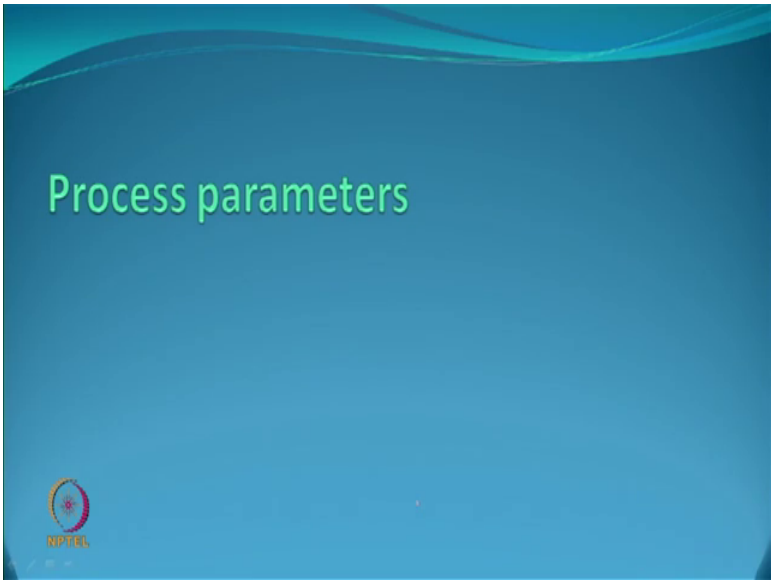

Let us look at the parameters process parameters, now we are having a draw texturing friction; draw texting machine with a friction twister.

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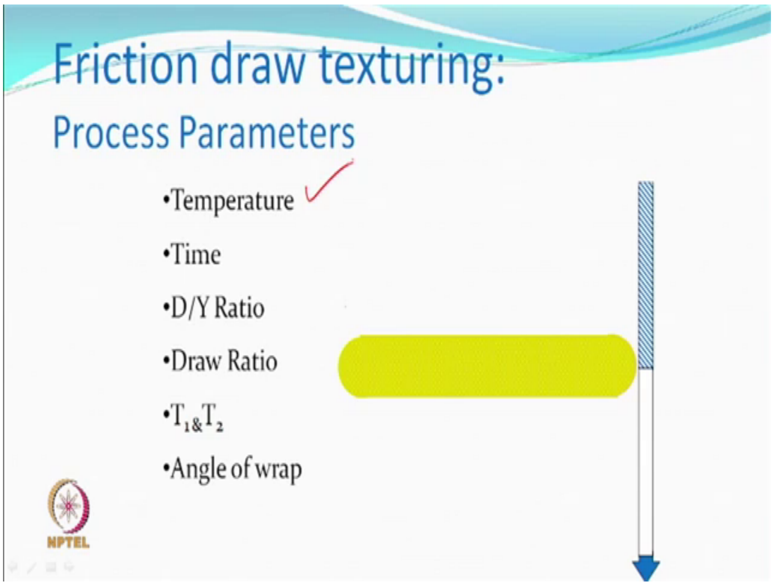

So, the process parameters, we have no problem on the temperature this has to be there time no problem is going to be same thing and we have to worry about it whichever way we want to look at it and of course, the D by Y the draw ratio the tension and angle of wrap are going to be part of this.

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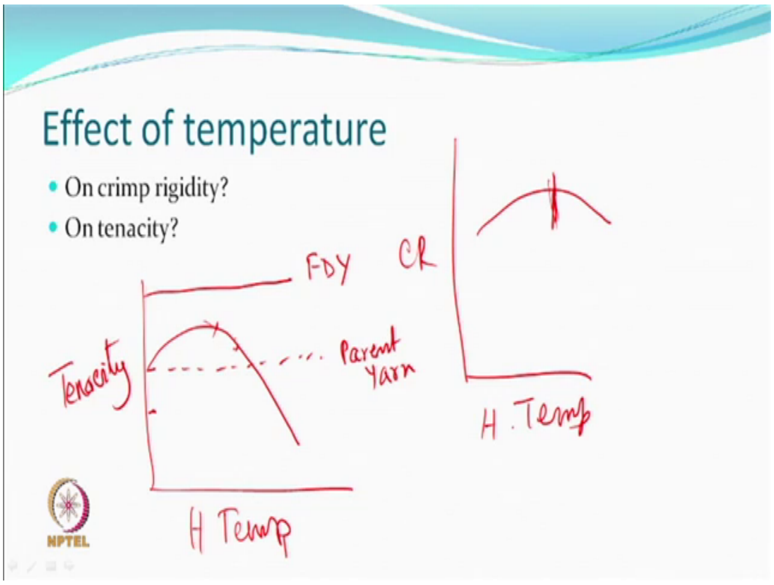

Let us say we want to now just see whether it is exactly same or different effect of temperature on crimp rigidity, what do we think would be the effect on the crimp rigidity now we have the change is machine has change, but let us say we are able to do whatever we are supposed to do and we are measuring crimp rigidity of a yarn with different temperatures what kind of a curve do we expect, what were we doing, what kind of a curve did we get in the fully drawn yawn?

So, the curve for the temperature and crimp rigidity you got something like this So,; obviously, theoretically once you find this you will say [FL] well I am not going to go beyond this temperature because what is the point that is the optimization you will do, but you will get this curve which is similar, we are not talking about the magnitude absolute value of the crimp rigidity we just talk about the trend, the trend will be same.

Now, let us look at the tenacity remember when we talked about temperature we are; obviously, talking about heater temperature right and not any other temperature and let us say we are still in the primary heater and tenacity on one side what do we expect?

Student: (Refer Time: 29:22).

High.

Student: (Refer Time: 29:25).

It will go down right. So, this is my parent yarn parent yarn tenacity. So, we are expecting the tenacity of a textured yarn will be.

Student: Lower than this.

Lower than this right, but it’s wrong because here our material has changed this is a material which can be drawn it’s a draw texturing. So, the parent yarn is very weak, if you try to use a parent yarn it’s almost unusable. So, what will fee is that when you increase the temperature; obviously, drawing will be taking place and temperature will facilitate the drawing also, draw ratio may be constant, but as the temperature increases not only the molecules will like to go to whichever position they want, but if you are pulling also pulling is also easy right and so molecules can get more oriented and therefore, tenacity can increase.

So, you may actually see starting from whatever the tenacity that you have in the parent yarn instead of going down it may go up and then go down of course, but it will never be able to reach the tenacity of let us say the fully drawn yarn, it will be lower than that. So, that fact still remains, but if you look at our own yarn which is the POY then you will find the with temperature the tenacity may seem to be increasing and after that all other process will be there.

And so you have to again optimize; obviously, why should you not get to the maximum tenacity or there may be other reason for using a temperature if you are looking at structural uniformity, non uniformity those could also be the reasons which may actually force you to think differently.

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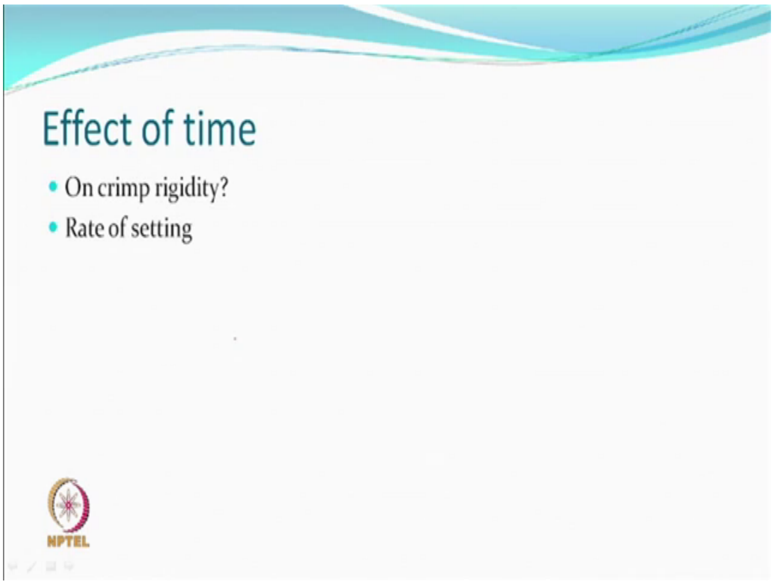

Effect of time has a similar effect as well as the crimp rigidity is concerned when temperature is constant and you are increasing the time if you have zero time let us say theoretically, then your crimp rigidity will be also not there you know you do not heat at all temperatures and all.

So, time; obviously, is important, but let us say within the time that we are looking at optimum time it can go up and come down alright the similar kind of a maximum could be observed with time as well what people would be interested is now we have started using a yarn called a POY does it anyway become different has it actually helped in reducing the time of texturing or does not, but let us say if the POY of polyester which has very low amount of crystallinity.

So, theoretically you should expect that the time should also change, the time required for optimum; optimum time required for texturing should change therefore, people started talking about maybe the rate of setting could be high. So, there is a rate alright. So, you understand rate of setting may be not let us say how can we define that.

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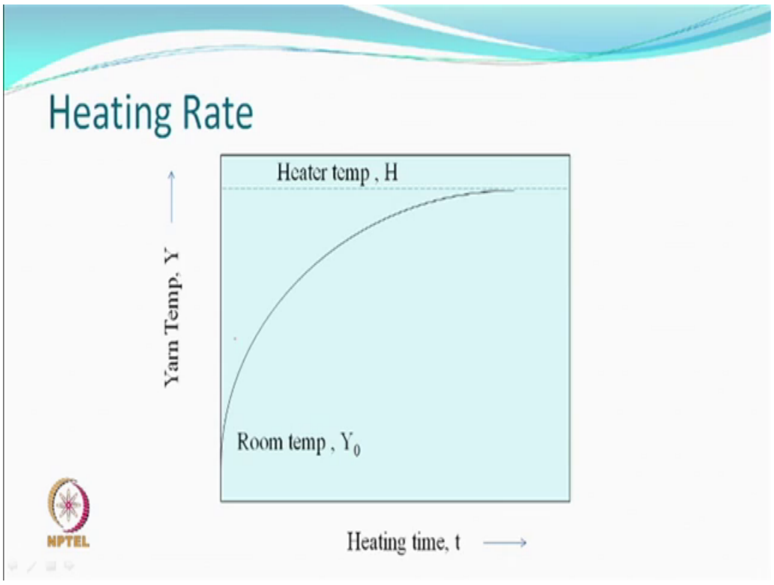

So, when you look at the yarn temperature this is the kind of profile that you see. So, room temperature is let us say Y naught and yarn temperature let us say is Y and heater temperature is H.

So, as the time in the heater the dwell time in the heater increases the temperature of the yarn will increase and you would like to go to a time definitely to a time where the yarn temperature is close to the heater temperature.

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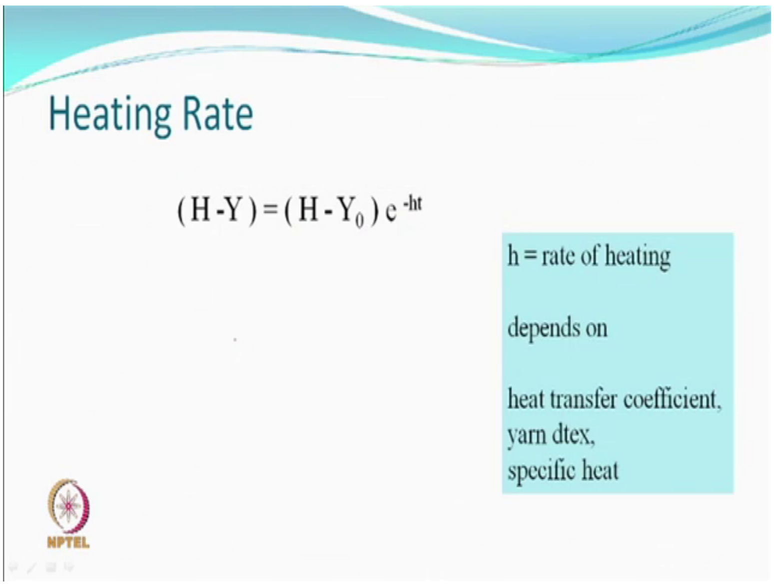

So, the curve this type of a curve if you want to express can be expressed like this, that the heater, temperature and the yarn temperature and yarn initial temperature is the room temperature can be linked by this type of a first order equation, where the rate of heating which is let us say H here would depend; obviously, on the heat transfer coefficient with the polyester nylon what kind of material that you have and the decitex or the denier of the yarn and of course, the chemistry physics part and the of which means specific heat as well.

So, all that we will determine the H, but then you can make sure this there is some kind of curve like this, if you know that then you know how much time it will require to heat, but that does not mean that the only thing you want what you want also is the morphological change is also may take place just because the yarn has attained a certain temperature does not mean that you have done your job. So, maybe they said [FL] that why not measure something like this.

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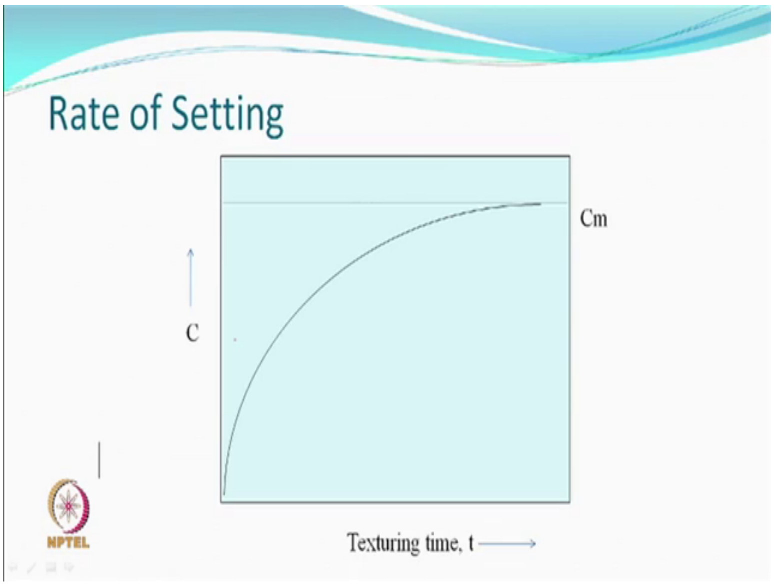

I mean if you are actually working from a zero time then we expect zero crimp rigidity and let us say under the optimum condition the maximum possible attainable crimp rigidity is C m which is the C max; a curve is approximately similar curve similar looking curve as the temperature curve.

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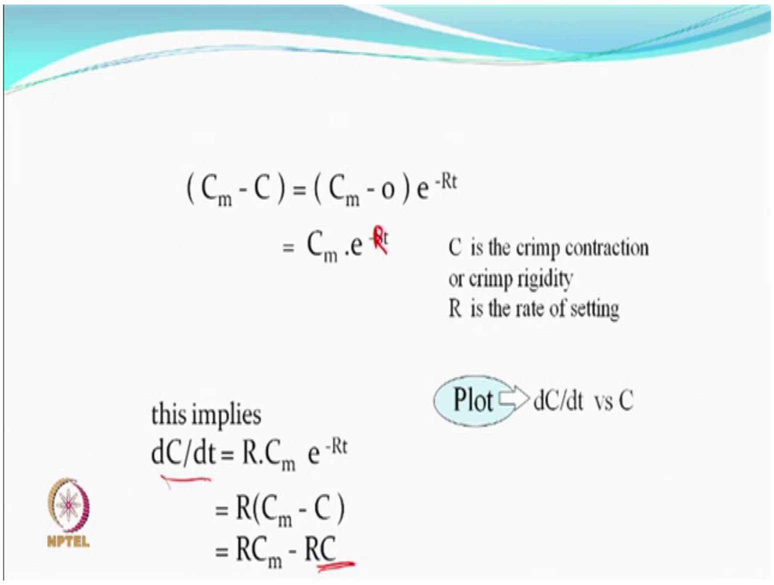

If this is so then you can also probably write an equation like this where you have R as the rate of setting and C is the crimp contraction or you can also say crimp rigidity and some similar equation can be written like this which would mean that, if you take a derivative you should be able to get a straight line alright between the dC by dt and C and then if you get that and there is a possibility that you can get the value of R also.

So, you can plot dC by dt versus crimp rigidity which is varying with time and the plots will look like this in some experiments were therefore, done let us say.

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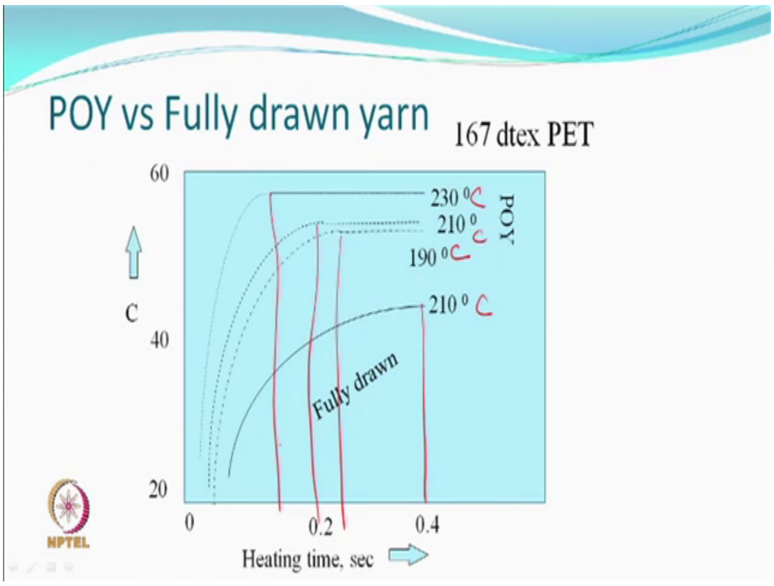

So, curves are not really drawn very nicely, but what is found is that the fully drawn yarn at a temperature in this case let us say 210 degree centigrade alright this degrees are centigrade, showing different rate you can appreciate that and that would probably mean that the time required maximum time required will also be different. For example, in this case maybe it is somewhere there, in this case maybe somewhere here, in this case maybe somewhere there, in this case maybe somewhere there.

That is the time required to attain an equilibrium kind of a thing would be less; that means, you can run the machine faster. So, one thing in this experiment was made clear is that if you have POY which are the top three curves texturized at different temperatures the one which is at 190 degrees also is giving higher crimp rigidity at lower time.

That means, using POY is always a good idea, polyester POY will be a the best idea, but if you have to use nylon it will still be good; that means, you can draw the curves which are similar curves where the rate of increase in crimp rigidity keeps on reducing the time.

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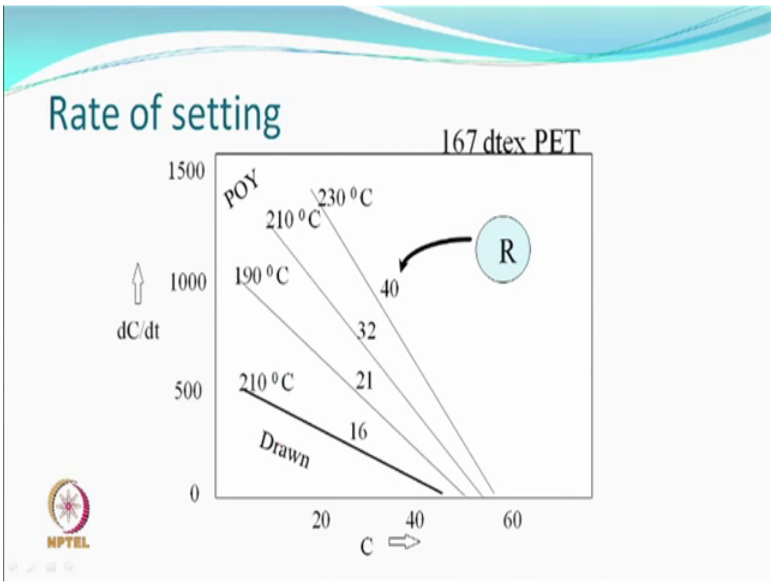

If we draw the dC by dt versus C you get straight lines and the slope in some way can give the value of rate of setting. So, what it says is that the rate of setting increases when you are using a POY, which means theoretically you can run the machine faster it is not just the temperature you are talking about now we are talking about the final property and if that also is true. So, if you compare 210 temperature for a POY and a fully drawn yarn you say the rate is almost double.

So, this is this is the value right as calculated by some experiments and conversions. So, people are happy doing working on POY

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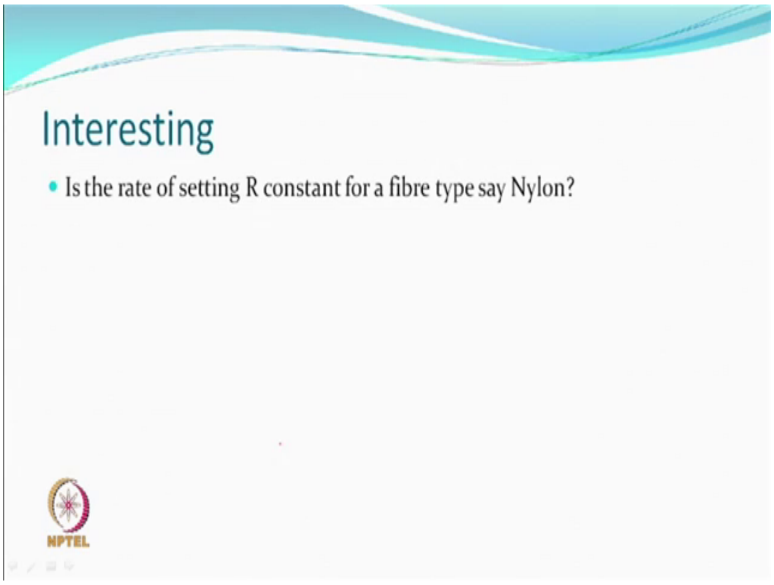

If this question is asked that is the rate of setting R constant for a fiber type let us say nylon is a constant like a specific heat is a constant, we can; obviously, say it is not constant because based on the temperature, based on the POY the residual draw ratio of the POY and even denier and so on so forth these values will keep changing and therefore, it is not constant it is only relative value based on your own material and your own specifications.

So, time which was the texturing time now can be reduced and therefore, machines can be run faster approximately you can think of a material which was running would require a fully drawn yarn about 0.3 to 0.4 seconds in a heater, they would require 0.1 second.

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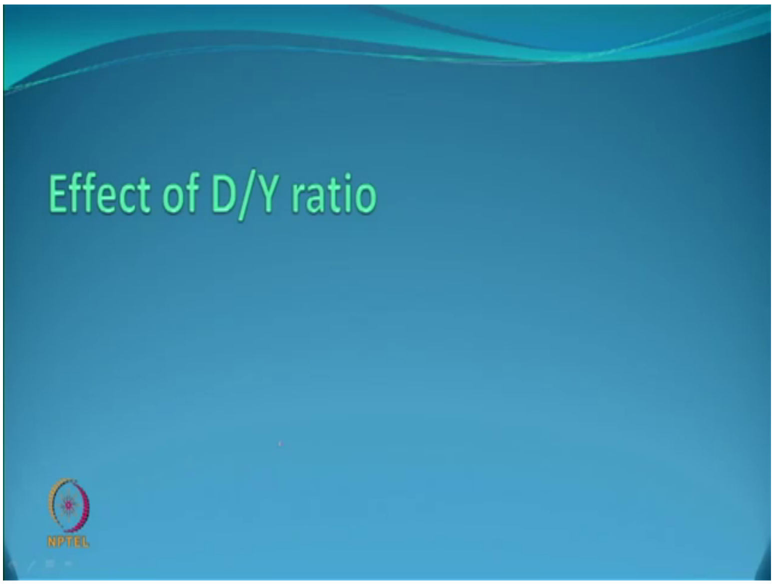

See other parameter, which is the D by Y and what the D by Y supposed to do? This is supposed to increase the twist in the yarn; if you increase the D by Y ratio then the twist in the yarn is expected to increase. So, whatever is the effect of the twist in the yarn that should also be seen.

So, if you look at and somebody ask what will happen to the crimp rigidity when you increase D by Y ratio, if we increase the D by Y ratio what do you expect to happen to crimp rigidity keep increasing D by Y ratio.

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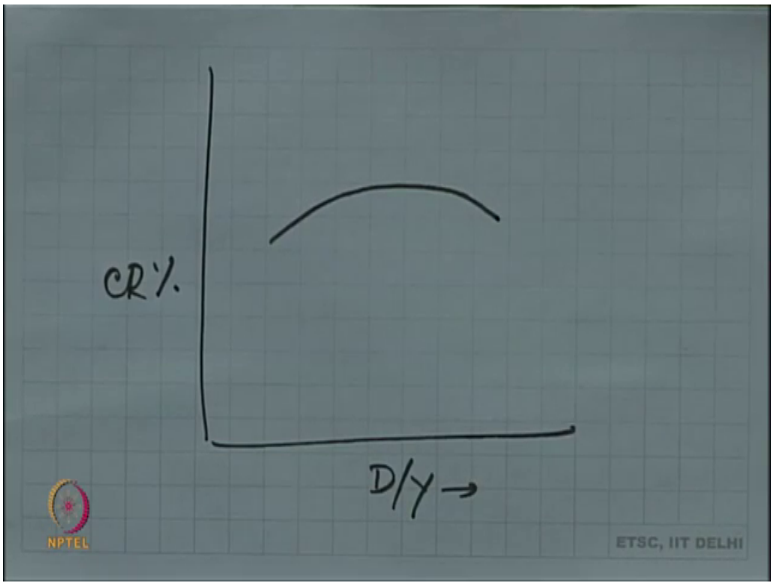

This actually means in some sense you are increasing the twist. So, if you including the twist what should happen? It should have similar kind of a thing because by increasing the twist keeping other parameters constant you are increasing the number of helices per unit length and out sometime the tension may be more and after if the tension has crossed the barrier then you may start getting the negative thing because relaxation not happening.

So, you will get similar results right, tenacity we expect the tenacity to fall because it is varying by increasing D by Y because draw ratio being same, temperature being, same time, being same only twist being increasing. So, this will only lead to more disorientation and therefore, whatever you want to see will be seen.

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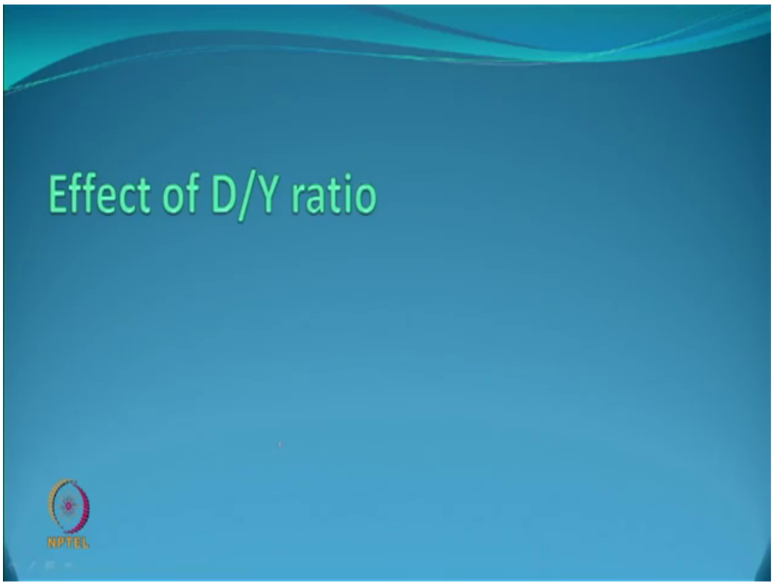

But more important will be some other characteristics that we just talked about last time.

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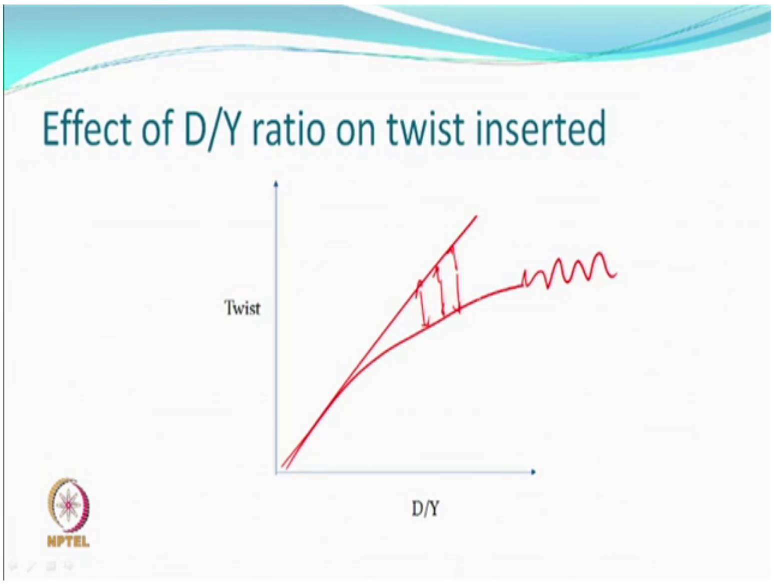

First let us say we did say that if you increase this normally we would have expected a straight line, but your twist does not increase. In fact, from the beginning itself there will be some lag and of sometime becomes unstable kind of situation. So, the difference between expected value and actual value may change, but the twist is still increasing, it will be very difficult for somebody to tell I am increasing D by Y ratio and after some time twist is decreasing average twist do you think it can decrease.

Student: (Refer Time: 43:20).

Cannot decrease, so it will keep on increasing, but if there is more slippage so stick slip phenomena will be too many and so you will have more and more quality characteristic issues and so quality becomes an important thing right if quality becomes an important thing. So, one of the first thing that we should be talking about is let us say the tight spot.

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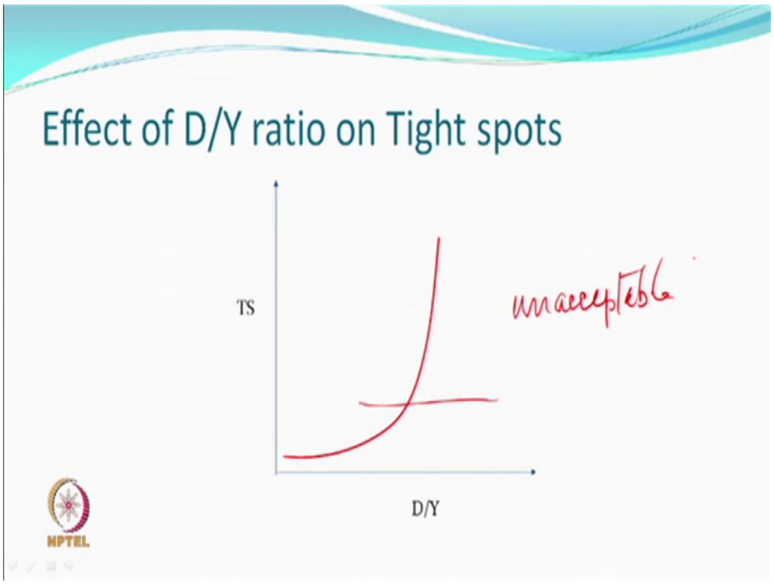

Now, you know what is the tight spot? So, there is a real twist which has been inserted and why it has been inserted? Because there must have been some slip.

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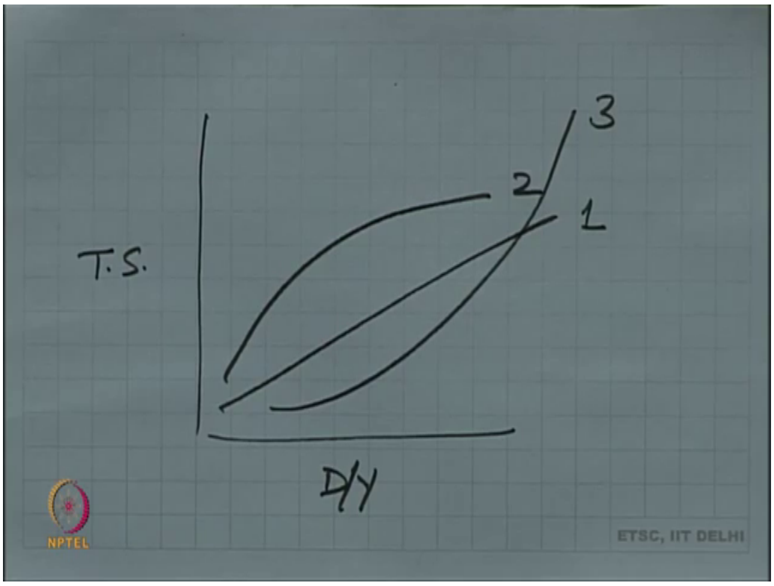

So, if you look at the previous curve and now we want to draw attention and want to see the trend possible trend of the tight spot and D by Y ratio. So, what kind of a trend are we expecting when we increase the D by Y ratio? Yes, when the tight spot increase or decrease.

Student: Increase.

Right.

Student: Increase.

So, increase in which way this way; this way yeah which way yeah.

Student: Second.

Yes.

Student: Second.

Second one why not third one?

Student: (Refer Time: 45:00).

Can there be any other trend.

Student: No no.

Yeah.

Student: (Refer Time: 45:09).

Is the right.

Student: (Refer Time: 45:17).

So, which one do you think is going to be right one two three.

Student: Three.

Hm.

Student: Three three.

Three alright, so let us assume that we believe that the tight spots will increase exponentially because as the speed is increasing the slippage and unstability instability will keep on increasing as for as the twist and tensions are concerned more vibration more slipping every time you slip some real twist is going to get inserted and more and more tight spot going to form.

So, you can appreciate that it is going to be one of the most important parameters and somebody would like to control, this can actually change the whole complex complexion of the yarn. That is this some yarn may be beyond a certain limit will be absolutely unacceptable, you have nice temperature, you have beautiful time, nice machine, good twister, but you will land up into this.

So, there is a portion there is a area where it is possible that you would be able to control the damage. So, you should know what is the damage control zone.

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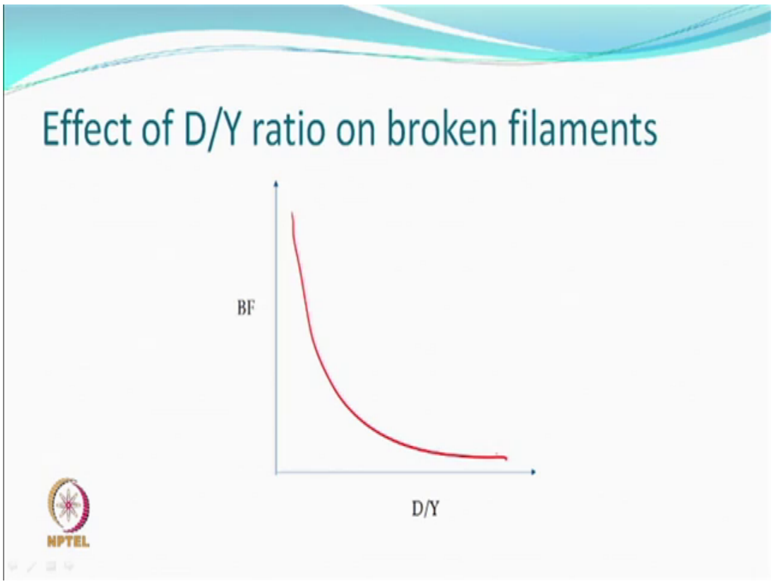

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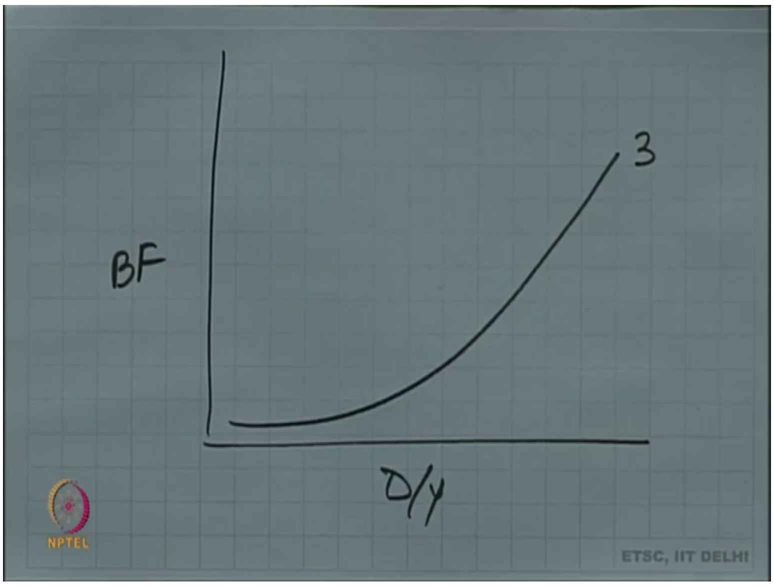

Let us go to the next one the broken filaments [noise, so the broken filaments with the D by Y, we should remember what is a broken filament problem, why does it happen right, if you understand this then we can probably think of the trend what trend?

Student: Third one.

Third one this is smart people have become smarter I am writing the number third first before anything else because there is the number is come is that right yeah why because there is a lot of slippage

Student: (Refer Time: 47:47).

Right very good wrong.

Student: (Refer Time: 47:48).

Alright, I am just drawing the trend and next time when you meet you talk about the reasons this curve is like this.

Student: (Refer Time: 048:08).

Not possible.

Student: (Refer Time: 48:12).

So, the curve is likely to be this so as the thing says that you can now think about it where we went wrong all intelligent people how did we go wrong in assessing the trend alright we stop here and next time you continue from this place.