New Spinning Technologies
Prof. R. Chattopadhyay
Department of Textile and Fibre Engineering
Indian Institute of Technology, Delhi

Lecture - 21
Influence of machine and process parameters

So, today we are going to discuss Influence of Machine and Process Parameters. Also, we will see the effect of fibre parameters as well. So, basically, it is fibre, process and machine parameters on the quality of the yarn or how the yarn properties are affected by these parameters or variables, whatever we say.

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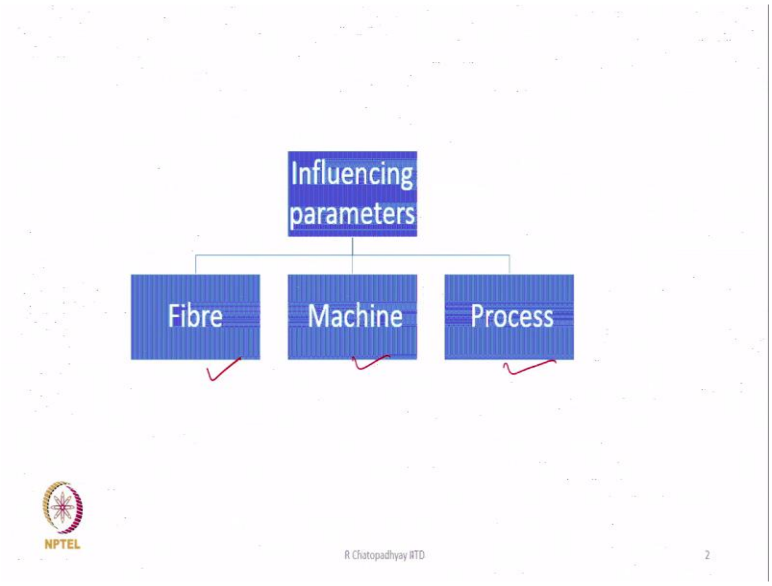

So, basically influencing parameters are fibre, machine and process. So, we try to produce fibre, which I have to basically process fibres of different types or we can change the you know, fineness or length or cross-section, different types of fibres we can process with different dimensions.

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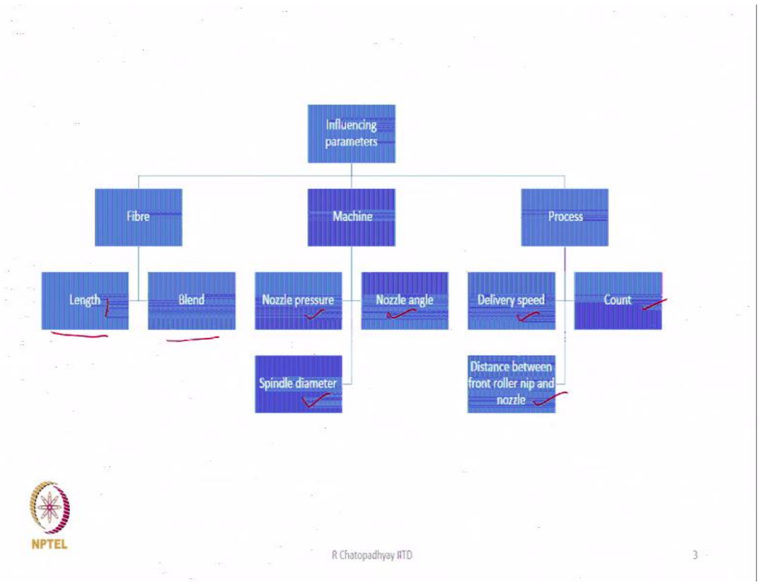

So, if we go further details into these parameters. Then we see fibre parameters, simpler length, the blend in the case of we go for blend ratio. Length is just not ones, but we will also add fineness along with length. The machine parameters are in this case are one is nozzle pressure, nozzle angle and spindle diameter. The nozzle pressure is we can say is more you know related to the process. Whereas, the nozzle angle and spindle diameters are basically part of the machine parameters in this case.

The process parameters are one is the delivery speed that is the production speed, the other thing could be the count of the yarn and the distance between the front roller nip and the nozzle. So, these 3 types of parameters that we have listed here they can be further you know classified. So, fibre parameters it could be length, it could be fineness, or it could be the proportion of two fibres when they are blended together and processed.

And the machine parameters are nozzle angle, spindle diameter, nozzle pressure also we have listed here under machine it could be a part of process as well. The process parameters are basically delivery speeds, the count of the yarn that we are going to process and the distance from the front roller nip to the nozzle mouth or entry to the nozzle.

So, these are the parameters. And all these parameters have some effect on the processability of the fibres and also on the property of the yarn.

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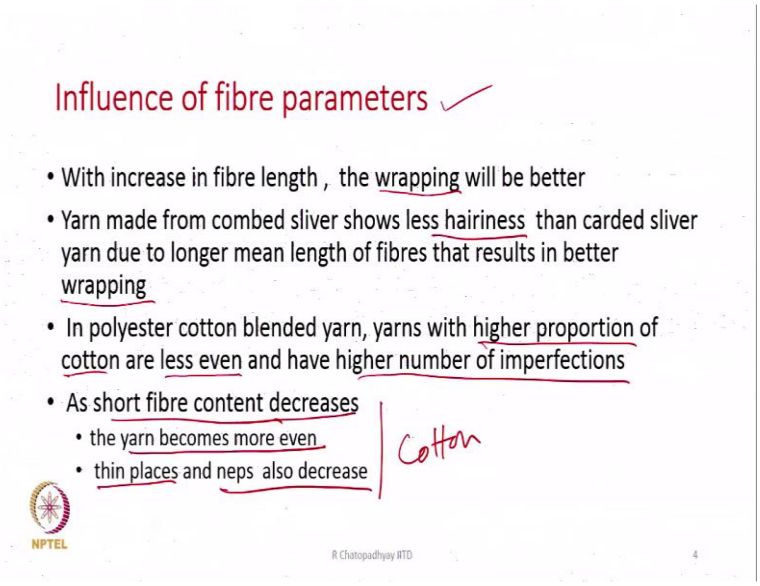

So, first we will discuss the influence of fibre parameters. Generally, with increase in fibre length the wrapping is going to be better. The more fibre length will be available better will be the wrapping because the wrapping length availability also will increase. And hence wrapping is going to be better.

Like, if we compare between combed sliver yarn and carded sliver yarn, we all know that in the carded sliver we have lot of short fibres present. When you go for combed sliver, short fibres have been eliminated; that means, there is a change in fibre length. Not only that there is an elimination of short fibres as well.

And it has been shown that yarn made from combed sliver will also have less hairiness and they will also be better in terms of evenness of the yarn. The yarn will be much more regular. At the same time the yarn is also going to be little stronger because in the combed fibre we have most of the fibres are long and they can better wrap the core part of the yarn.

So, since longer fibres will be more in number now, so they can wrap better. And as a result, the yarn will be stronger. The uniformity is better mainly because of the evenness that is the drafting system will be able to process the fibres much better because the short fibres are not there.

And the fibre loss that happens during spinning operations, that fibre loss is going to be less because short fibres are not there in the case of combed yarn or combed sliver when you fit. So, there is always an advantage in having the combed sliver is for cotton. At the same time the additional advantage will be that in combed sliver the dust particle also going to be less. The trash particles also going to be less.

So, they will also have effect on the processability. So, they have advantage that processability also will be better if we go for combed sliver as a feed material in comparison to carded sliver. In the case of polyester cotton, blended yarn it has been shown that higher proportion of cotton will make the yarn less even, and we will also have higher number of imperfections in the yarn.

So, more cotton means inferior quality yarn that will be produced because cotton will contain some short fibres every bit is combed, there will be some short fibres still left. Because through combing we may not be able to remove all the short fibres which are present in the sliver, some short fibres are still left. And therefore, if we have more percentage of cotton, in polyester cotton blend relatively, the yarn will be inferior in comparison to when we increase the percentage of polyester in the blend.

The other important thing is already stated here the short fibres content decreases as they decrease yarn because more even and thin places and neps also decrease. So, this is all in the context of cotton or a blend which contains cotton. So, it could be cotton polyester blend, it could be cotton viscose blend, it could be now cotton modal blend. So, any blend that contains cotton and the other fibre which could be any you know either synthetic fibres or regenerated cellulosic fibres.

We remember that cotton basically means short fibres are there, dust is there, some trash is there and therefore, presence of cotton will always make the yarn little more uneven. And there is a chance that thin places also can increase and but so therefore, the reverse is true, if the proportion of cotton is less.

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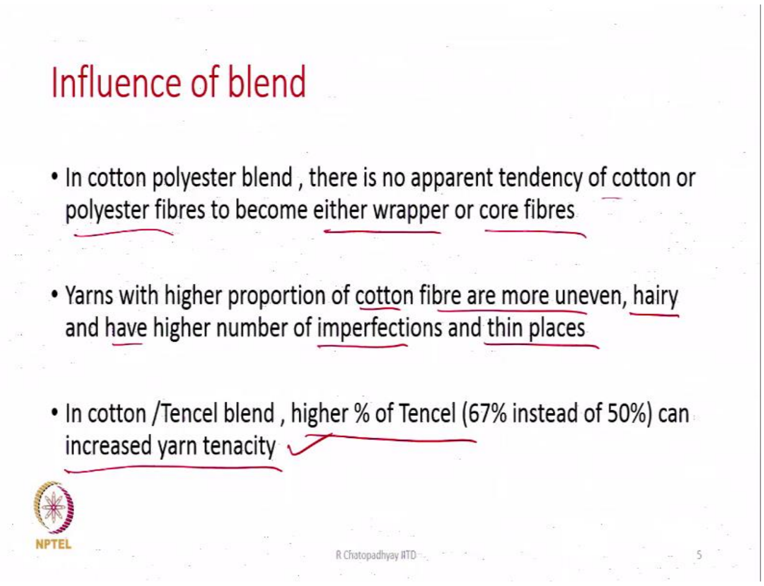

The another one we come to blend, in cotton polyester blend there is an no apparent tendency of the cotton or the polyester fibres to become either wrapper or core fibres. That means, if the sliver has cotton and polyester both, and they are intimately mixed, then each fibre has equal probability to make wrapper or becomes a part of core. See, probability of becoming a wrapper or becoming a core is same for both polyester and cotton fibre.

The other thing is yarn with higher proportion of cotton fibre are more uneven, as we have already discussed in any blend if cotton percentage increases the yarn becomes more uneven. It becomes more hairy and have higher number of imperfections and thin places.

This is what happens when we go for blend where cotton is there. We can also have 100 percent you know yeah, 100 percent polyester yarn, 100 percent viscose yarn on vortex spinning system, or we can have a polyester viscose blend where cotton does not exist.

But when cotton is there, though many times we need a blend where cotton is required, but with cotton we have to remember that more the percentage of cotton the yarn is going to be uneven, little hairy and there may be higher number of imperfections and thin places.

Like, it has been shown that in a cotton Tencel blend, higher percentage of Tencel can increased yarn tenacity. Then, with Tencel is a stronger fibre than cotton. So, if we add more Tencel, the strength of the yarn is going to increase.

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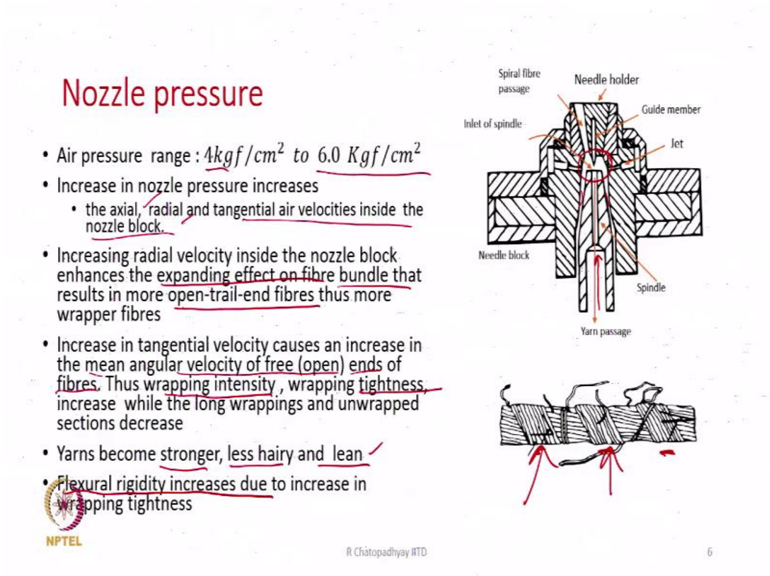

Now, we go to the one of the most important parameters that is nozzle pressure. So, if the pressure is increased the velocity of the air which is entering the nozzle is also going to increase. Typically, air pressure ranges between 4 kg force per centimeter square to 6 kg force per centimeter square.

So, increase in nozzle pressure will increase the axial, radial and tangential air velocities inside the nozzle block. Now, increase in radial velocity is going to have an expanding effect of the fibre bundle that will result in more open trail ends of the fibres. See, some fibres as we have already discussed that whatever fibres are flowing from the front roller nip to the nozzle, and first they enter the nozzle entry point, and then they move towards the tip of the spindle.

Now, when they reach the tip of the spindle, some of the fibres will be detached, especially the trailing end of some of the fibre. The leading end will be a part of the core always, but some trailing ends will be detached. And this detachment process is because of the sudden expansion effect that is there because this radial velocity component that is going to expand.

So, they are going to; that means, it is going to separate the fibres from the bundle. And therefore, the fibres which are lying at the periphery of the bundle they are likely to be separated from the rest. So, the trailing end which are lying at the periphery of the bundle they are going to be separated. The leading end of those fibre may still be a part of the yarn core.

So, the separation also is due to the flow of air through the hollow part of the spindle. And therefore, when the nozzle pressure is high, expanding effect is going to increase in the twisting zone which is here and we expect more fibres to get detached from the main bundle and form wraps. So, wrapper fibre you would expect to increase if we go for higher nozzle pressure.

Increasing tangential velocity causes an increase in the mean angular velocity of the free ends of the fibres. See, the fibre ends the trailing fibre ends will hang and will actually roll over the spindle top or say that is what is called swirling action which we have discussed in the previous class. So, that swirling speed is going to increase, if we go for higher nozzle pressures.

So, that means, the trailing end which are detached and now they are swirling and they will swirl at a very high speed. And when they are swirling here in this zone, that is here or here, there is chance that there will be lot of friction that will develop between the fibre and because it is in contact with the surface of the spindle, and it may also come into contact with the inner wall of the nozzle block. So, that will be tension also could be quite high.

Now, the angular velocity it increases, the swirling speed increase, basically means there will be more wrapping intensity, and tightness of the wraps are going to increase because the fibre end which is now swirling at a high speed, it will develop more centrifugal force and more tension on the ends. And they will finally, get wrapped around the core of the yarn and they will be quite tight in nature.

So, tightness is going to increase, and wrapping intensity or wrapping density whatever we say or frequency of wraps is also going to increase. That is the you know advantage we get from going from force towards the higher side.

So, as a result of this, one can expect yarns to be stronger, less hairy, and yarn lean, because if I have tight wrappings yarn diameter is going to decrease, so yarn will be lean. Then, because wrappings are there the hairs will not be able to project out, so it will be less hairy. And because the wrappings are tight as it is shown here, these wrappings are there, the yarn is going to be stronger.

So, we can expect yarn to be stronger, less hairy, and more compact, if we go from lower nozzle pressure versus the higher nozzle pressure. And if we have a tight wraps automatically it means flexural rigidity will going to increase, the yarn will be difficult to bend.

The wrappers these are the wrappers fibre, these wrappers are going to tightly hold the core and therefore, the relative moment between the fibres within the core is going to be difficult when we are trying to bend the yarn. So, yarn is going to be quite rigid in nature. It is the flexural rigidity is difficult to bend in comparison to other yarns.

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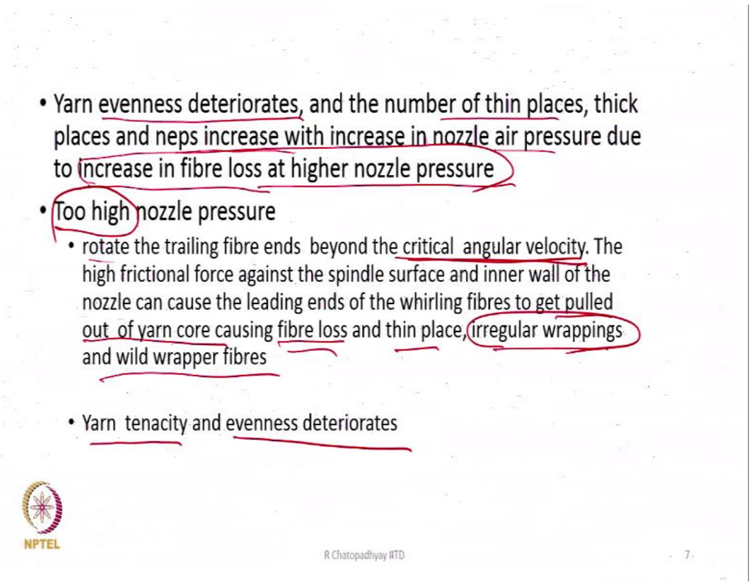

But with nozzle pressure increase, yarn evenness may deteriorate, number of thin place thick place neps may increase because of increase in fibre loss at high nozzle pressure. This is also you have to remember. That, loss of fibres are going to increase now at a higher nozzle pressures.

And if the loss is there, there is a chance that more thin places will be developing and with the higher pressures, the there will be more thick place and neps because the loose fibres which will be moving out they may suddenly accumulate somewhere and they will be may become a part of the yarn also. So, actually, the yarn becomes more you know imperfect in a way, thin place may increase, thick place may increase, neps also might increase. Though the yarn at the same time may be stronger now.

So, that has to be some amount of now we have to find out where is the optimum. And the nozzle pressure is too high, then the trailing end of the fibres they rotate, and it is goes beyond the critical angular velocity. Critical angular velocity is the velocity or rotational speed beyond which some of the fibres will be plucked out from the core.

The trailing ends which are rotating violently now at a very high speed, the tension will develop so much that their leading end will move out from the core of the yarn. So, they will be basically pulled out of the yarn core, causing fibre loss, thin place, irregular wrapping, wild wraps everything will be there if we go for very high speed, very high or it is not speed, very high nozzle pressure.

That means, there has to be an optimum nozzle pressure, not too low, not too high, too high will be bad, too low also will be bad. So, you have to find out an optimum. The optimum will depend upon the count of yarn we are going to produce, and we will also depend upon the length of fibres that we are going to process.

And because of this at very high pressure, the yarn tenacity may even decrease because of this irregular wraps. Wrappings are not going to be very regular. They will be haphazard in nature. So, wraps are the source of strength that we have to remember. So, what we need is basically regular wrapping or uniform wrapping and tight wrapping.

And the sections of the yarn, then the sections which are devoid of any wrapping fibre, they should be minimum because any section which is not having wrapping fibres is a source of weak place in the yarn. So, that is also we have to see. So, very very high nozzle pressure therefore, may not be working in favour of the quality of the yarn.

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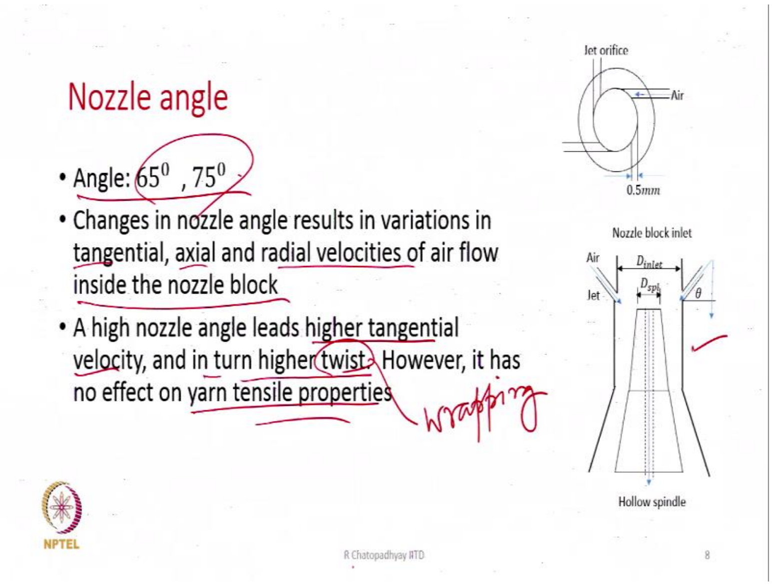

Now, nozzle angle, see here the diagram is shown here. The nozzle block inlet and this is the spindle, hollow spindle, and these are the nozzle, before nozzles and they are placed at an angle. This angle typically is 65 degree or 75 degree or may be some other value, but typically these are the angles.

The changes in nozzle angles results in variations in tangential, axial and radial velocities of the air flow inside the nozzle block. Now, radial velocity we know, it is going to be expand the fibres, bundle is going to be little expanded that is the benefit of this. And tangential velocities are going to increase the twisting rate or the swirling rate in this case.

So, at high nozzle angles leads to higher tangential velocity, and in turn higher twist. This twist basically means wrapping twist. However, it has no effect on yarn tensile properties. That has been stated by some people that though if even if it is wrapping more, but still the tenacity has not been seen to increase much. Maybe the angles 65, 75 degree are probably the optimum value of the angles.

So, if you want to study the effect of nozzle angles, unless we go for very extreme values, we will not really know that if we what happens at those extreme values of the nozzle angle. So, maybe if we go for 45 degree or 30 degree, 75, if we go 85, 90 maybe there will be difference will be seen. But somewhere in this range, probably it is close to optimum and therefore, even though there are some changes in the wrapping, the tenacity was found not to change much.

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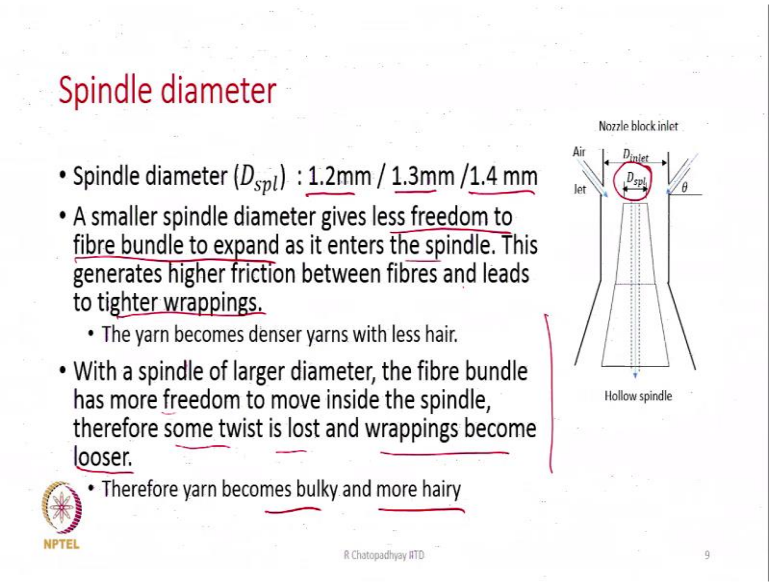

Now, spindle diameter. So, this is the spindle. So, this is the spindle diameter is shown here. This diameter of the spindle. This is hardly 1.2 mm or 1.3 mm or 1.4 mm. And within this diameter also there is a hole, through those holes the fibres are passing. So, you can imagine that you know how small these holes are.

A smaller spindle diameter gives less freedom to the fibre bundle to expand as it enters the spindle. These generate higher friction between fibre and leads to tighter wrappings. Expansions will be less; Wrappings are going to be tighter; the fibres are going to be more compact. And with spindle of larger diameter, it will be just opposite of that. Fibre bundle will have more freedom to move inside this spindle. Therefore, some twist is lost and wrapping becomes loose.

So, smaller diameter means tighter wrappings or compact yarn. Whereas, larger diameter means little bit of for voluminous type of yarn and wrapping also can be looser, it is not tight become looser. Therefore, the yarn becomes bulky and more hairy in the case of larger diameter spindle. But the diameters are actually 1.2 to 1.4 millimeter. This is the range in which the diameter of the spindle top lies. So, that some whatever research has been done, these are the observation that has been made.

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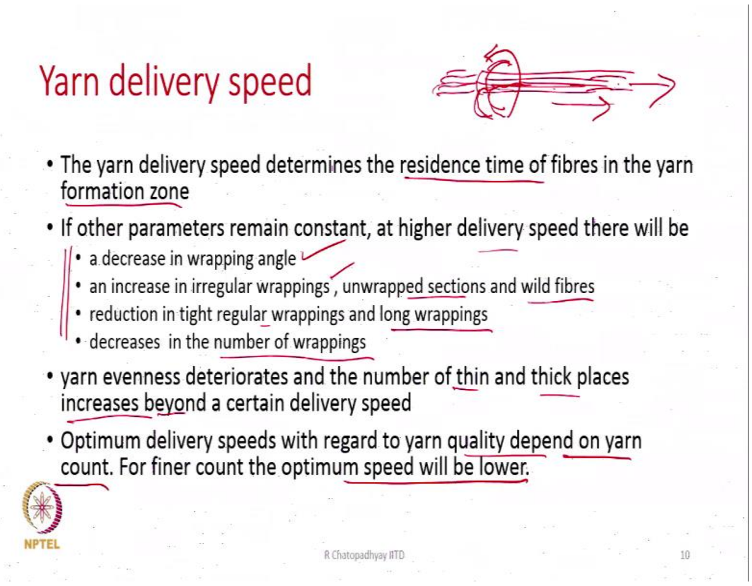

We come to yarn delivery speed. So, the within the nozzle, the some fibres are trying to wrap the yarn core. And at the same time the yarn is moving forward. We are trying to pull the yarn out from the twisting chamber or nozzle chamber. So, that is what the delivery speed are.

So, the yarn simply, but very you know if you try to understand, if the trailing end that is swirling and actually wrapping or the getting wrapped you can say. So, if this is the (Refer Time: 27:45), suppose this is the bunch of fibres which is representing the core, moving in these directions. And some fibres ends are rotating. They are hanging like this and this is rotating.

So, if the rotational speed of these fibres are not going to change because we are not changing the nozzles nozzle pressure. Then, for the same rotation if I pull the yarn at a faster rate the wrapping angle is going to change. That means, the wrapping intensity will change. Higher delivery speed, wrapping intensity will be less and opposite will be true if the delivery speed is reduced.

That means, the other thing is delivery speed determine the residence time of fibres in the yarn formation zone; how long a fibre is going to stay in the yarn or in the twisting you know zone or how long the core is going to stay in the twisting zone. Everything will depend upon the speed with which I am delivering the, or I am taking the fibres out of the twisting chamber.

If other parameters remain constant, a higher delivery speed will mean a decrease in wrapping angle. This will be obvious because the speeds of this hanging ends are not changing because that is decided by the nozzle pressure. If I take this thing out, the yarn is moves at a higher velocity, the wrapping angle is going to be less. Like, twist in a ring-spun yarn is the ratio of rotational speed of the yarn and the yarn delivery rate.

Similarly, the wrapping twist in this case will depend upon will be the ratio of the rotational speed of the trailing end of the fibres divided by the yarn delivery rate. So, there is simple you know the analogy is there, there the yarn itself is rotating because the traveler rotating is rotating.

So, the ratio of these two that is when I take a unit length of yarn out, how many turns the yarn rotates that decides the level of twist. Here, when I take a unit length of yarn out, how many times the trailing end of these wrapping fibres are rotating, that will decide the wrapping twist or that will decide the in a way a wrapping angle. Twist, we can say from twist to twist angle.

So, higher delivery speed means decrease in wrapping angle. An increase in irregular wrapping, unwrapped sections and wild fibre generations, the speeds are very high. Reduction in tighter regular wrapping and long wrappings. Decrease in number of wrappings. So, everything goes on the wrong side.

Wrapping quality suffers when the speeds are very high. When the speeds are very high basically means in this case vortex spinning, a speed of 300 meters per minute will consider to be low speed, whereas, speed of 450 or 500 meters per minute will be considered to be a higher speed.

So, when you work at the speed of maybe 300 or 320 or 350 rpm, delivery you know meters per minute, the yarn will be quite good. But as we go from the higher side in order to increase the productivity, there is a chance that the yarn quality will suffer because of the problem listed here because the quality of wrapping is going to change because the residence time of the fibre is too short now.

Yarn evenness deteriorates and the number of thin and thick places we are going to increase. See, the yarn evenness; that means, the drafting speed also has to increase when I am trying to increase the delivery speed that is the speed of take up roller.

I have to feed the fibres also at a very faster rate using the drafting systems. So, there at very high speed as a deterioration in the drafting of the fibres may also suffer smooth drafting of the fibres is going to be affected at very very high speed.

The other thing is that because the residence time is also very poor or very very low therefore, the yarn as a whole is going to suffer in terms of that thin place is going to be more and thick places also can increase because maybe lot of drafting wave is going to be generated at very very high speed. The control of fibre in the drafting zone of the rotors the apron drafting system may not be so good when we go for very high drafting speeds.

So, if the control, the control that we exercise on the fibres as they move through the drafting system as well as the twisting assembly, if that control is poor, then lot of faults will be seen in the yarn. So, faults in the yarn is a reflection that the control that we exercise on the movement of fibres is not really good.

So, there is an optimum delivery speed with regard to yarn quality, and it depends mostly on the yarn count. For finer count the optimal speed will be always lower. Finer count basically means will be going for this case number of fibres in the cross section of the yarn is going to be less. And therefore, the fibres that may choose also may be little finer. And hence, the speed needs to be reduced, so that we can get quality wrapping around the core.

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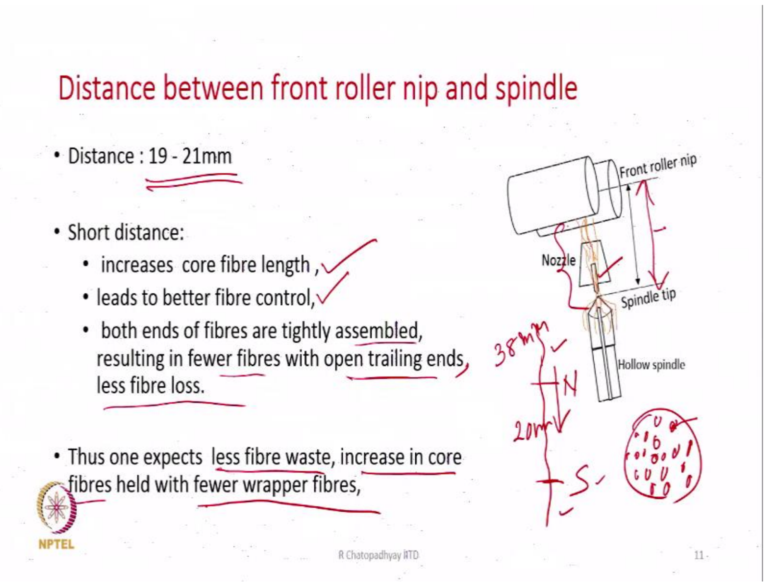

The other important parameter is the distance between the front roller nip and the spindle. It is shown in this diagram, so this is the distance. Front roller nip and the spindle tip is here. This distance is typically could be 19 to 21 millimeters. So, shorter the distance means it increases core fibre length, part of the fibre that is see the all the fibres are not forming wrappers.

Some fibres are or entire fibre length itself is in the core, but fibres which are forming wrappers part of it is in the core, rest of is on the surface of the yarn. So, short distance mean increases the core fibre length leads to better fibre control from here to there. See, from here to there, this length, we have what control we have on the fibre movement.

The fibres are very fine you know they are fine, they very very fine and they can be easily disturbed by the by the movement of the air. They are so fine. So, when it comes from front roller nip, they are released and they come to the spindle tip the guidance is given because we have a spiral path and then we have a needle. They are giving some kind of guidance to the fibres. So, that they remain to some extent under control.

So, if the length is short, then the control will be better. If the length is long, then control will be less. When both the ends of the fibres are tightly assembled resulting in fewer fibres with open trailing ends and it will lead to less fibre loss; from here to there. So, if the for many fibres see this is the nip point and this is the spindle tip. From here some of there is a fibre going like this. This is the nip. This is the spindle.

So, when both the ends of the fibres are gripped and this length let us say is, suppose the fibre length is let us say 38 mm and this length is 20. So, for a for quite some time the fibre as the fibre is traveling in these directions, initially when the fibre is approaching the leading end is not under grip of the easier to reach the spindle. A time will come when it will reach the spindle.

Now, one end is gripped by the spindle because they are actually within the bundle of fibres which are there. The other end is gripped at the nip point. So, when both the ends are gripped and they are moving also in the forward directions. In that case, these fibres are well guided and they are not going to really you know get detached from the main body of fibres. And hence, they will be mostly part of the core.

Or when the trailing end is will be released from the nip, maybe depending upon the location in the fibre bundle, if they happen to be on the periphery of the bundle, they might you know might get detached. But if they remain within the, suppose these are the bundle cross sections and you have many many fibres. If your fibre happens to be in the periphery chances of it getting detached and then forming wraps is going to be more.

But the same fibre happens to be in the core part, the center part of the bundle as the entire bundle is moving forward then chances that it will remain in the core is going to be very high. So, all depends upon the location of that fibre with respect to the bundle of fibres which are moving together from nip point to the spindle tip.

So, longer the fibres, since most of the fibres will be simultaneously gripped by the front roller nip and by the spindle tip, they are not going to be lost. Fibres which are shorter or if the if I increase this distance 20, then chances are that many fibres will be may be lost.

Thus, one expect that the there will less fibre waste, increase in core fibres held with few wrapper fibres. So, when the distance is short, from this distance, then we can expect less waste of fibre in the spinning zone. And there will be increase in core fibre percentage held with fewer wrapper fibres. The shorter distance is has a beneficial effect.

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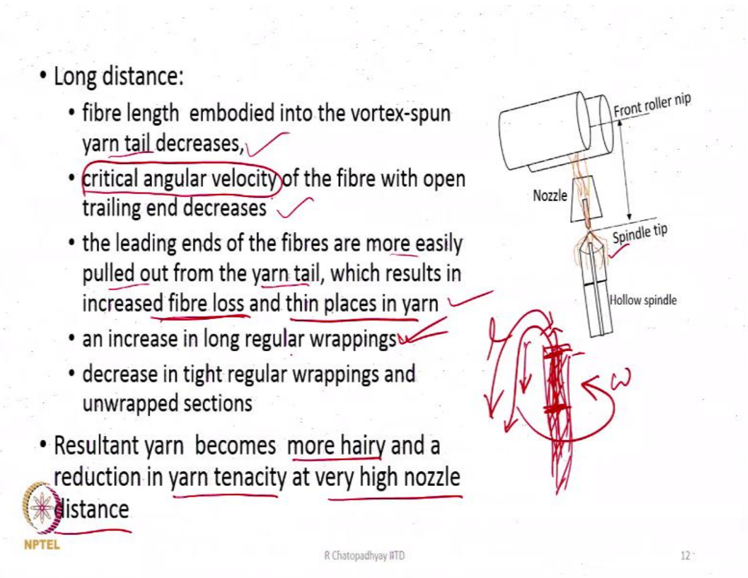

And if you go to the other extreme that is the longer distance, fibre length embodied in the vortex-spun yarn tail will decrease. Critical angular velocity of the fibre with open trailing end is going to also decrease. The leading ends of the fibres are more easily pulled out from the yarn tail, which results in increased in fibre loss and thin place in the yarn.

As I said that these are the hanging fibres now. So, if the distance is more, then the fibre length that is embodied in the vortex-spun yarn tail is going to see every fibre which are forming wrappers. If these are the fibres in the core and I have wrappers. So, part of the wrapper, every wrapper fibre which is hanging here, part of it is inside and the rest is hanging and there then swirling around the spindle or around the you can see the main bundle of fibres.

So, in the fibre length embodied into the vortex-spun yarn tail decreases. So, this length from here to there, if this is the fibre tail length, this length is going to decrease, if I increase the gap between the front roller nip and spindle tip.

And therefore, a longer length is going to hang; from the longer length is going to hang means a; for the same rotational speed the longer length is length is the fibre is hanging, it is swirling around the centrifugal force is going to be more on them. And they are likely to be going beyond the critical angle of velocity.

What does critical angle of velocity means? I have already discussed. That means, it is a velocity which is so much that this tailing end of the fibres which are hanging and then swirling they will develop so much tension that the fibre will actually move out from the main body of the bundle.

So, there will be so much tension acting this way now because of very high speed that even though they will leading end of the fibre is buried inside the yarn, this yarn, this fibre will be pulled out gradually. And if it is pulled out, then it is going to be finally, lost.

So, every wrapper fibres has a chance to get lost. All depends upon how much of the leading end of the fibre is buried inside the main bundle of fibres, that we call yarn tail. See, yarn is already there here. This is the tail part of the yarn. See, the yarn which is moving through it the tail is existing near the spindle tip, and the free flow of fibre which is coming is joining the tail part of the yarn.

So, tail part of the yarn is basically wrapped part of the yarn, where the fibre wrapping is there. And there is a flow of fibres which is coming from the front roller nip and joining this yarn tail. So, within the yarn tail, part of the fibres are buried. Which fibres? Fibres which are actually swirling. Fibres which are not swirling, they are the part of the main body. So, they are; they have nothing, they are not move rotating at all.

So, the angular velocity basically means, critical velocity means that this is rotating at a such a value of ω, the centrifugal force is so much, tension is such that the tension will be good enough to pull the fibres out. So, all depends upon the value of ω and what is the length from here to there of this fibre, which is hanging. This length l is going to be more, if the distance is long. That is what it is being now we are trying to, I trying to emphasis on it.

So, therefore, the leading ends of the fibres will more easily pulled out from the yarn tail which results in ultimately these fibres will be lost. So, it will be fibre loss. If the fibres are lost, number of fibres in the cross sections are reducing, it will lead to thin place generation. That will be the net effect of it.

And increasing long regular wrapping is also possible those who are going to wrap finally, some suppose some fibres. So, every fibre is not going to be lost, some of them may be not be lost. So, a longer length of the fibre will available for wrapping. A shorter length goes inside the main bundle or within the core.

The rest of the length is available for wrapping, that is what it is saying that long regular wraps will be formed, that possibility is there, and decrease in tight regular wrappings, and unwrapped sections. These are the various possibilities which are there which have been observed by the researchers.

Though resultant yarns becomes more hairy and reduction in yarn tenacity at very high nozzle distance. So, very high nozzle distance may actually deteriorate the quality of the yarn. So, there is a shorter distance, there is a longer distance.

So, we have to see that there are certain you know influences, some of these influences are positive in nature, some of them are negative in nature and therefore, there has to be an optimum distance between these two which one has to you know find out when somebody is taking by taking some trails.

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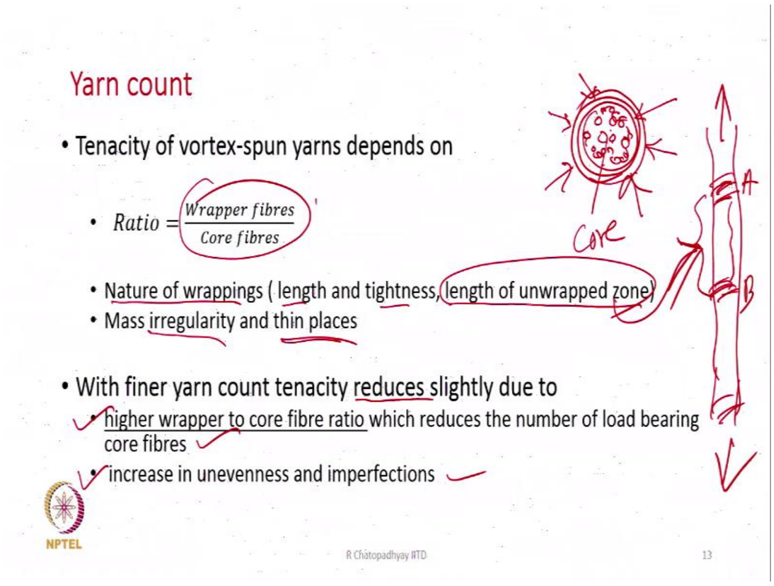

Now, we come to yarn count we can make a finer yarn, we can make a coarser yarn. The count range, I have already said it can vary between 15 to 65 Ne that is the range in which the yarns are spun.

$$Ratio = \frac{Wrapper\ fibres}{Core\ fibres}$$

Tenacity mainly depends upon this ratio of wrapper fibres and core fibre. Now, let us see, the in the cross section of fibres, you can say the you can categorize them into two groups, one some fibres which are wrapping and the other side basically a part of the core. It is something like this.

So, how many fibres are forming the wraps? The more the wraps the more compression will be developed on the core fibres and therefore, the core fibre is able to resist the load because more friction resistance will develop. These wrapper fibres are actually developing radial pressure when the yarn is pulled. You want to break the yarn.

Now, these pressure that develops because of the wrapping. So, how many fibres are wrapping, that will decide what is the magnitude of this force. And how much strain we have imposed on the yarn? The other thing is if I use more fibres, make more fibres to wrap, the number of fibres in the core, this is the core will go down. It will be less and less. So, that has to be again, here also there has to be an optimum.

So, besides it also depends on the nature of wrapping, whether these wrappings are tight or loose or irregular what it is. That means, length, tightness, length of unwrapped zone of the yarn, say the yarn if this. This part is wrapped, then this part is wrapped, and again this part is wrapped like that.

So, what is this zone which is not wrapped? If this zone length is longer than the fibre length, then if I pull the yarn, it will easily slip from here. Suppose, A and B, AB if it is long then possibility of fibre slipping is going to be more when the yarn is going to rupture. Because there these fibres are not experiencing much radial force. So, they can break easily. The yarn can break easily.

So, that is that is why the length of the unwrapped zone is also important. That is this zone. And the mass irregularity of the yarn, unevenness of the yarn, besides the thin places in the yarn, all of them will have influence on the tenacity of the yarn other than this ratio. With finer yarn count, tenacity has been shown to reduce due to higher wrapper to core fibre ratio, which reduces the number of load bearing core fibres and increase in unevenness and imperfections.

So, going towards the finer count side means, the tenacity if I choose the same fibre and then keep producing finer counts, we will find tenacity to reduce. The fibre remains same, tenacity will reduce because of the reasons given here, one is this, and the second one is increasing unevenness and imperfections.

And increase in wrapper to core fibre ratio. So, wrapper fibres becomes more in comparison to the core fibres, that the core fibres becomes less then obviously, load bearing fibres will be less. That will also reduce the tenacity.

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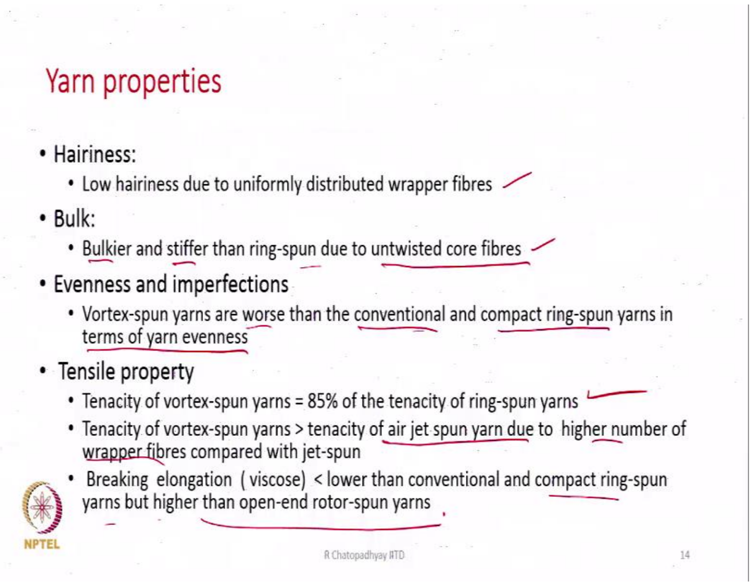

Now, we will just go, just you know the properties in general not in details. Typically, we can expect the yarn to have low hairiness. The reason is simple because wraps are there, wrappings are there.

So, most of the projecting hairy ends will be forced to be on the surface of the yarn. They will be under the wraps. So, they will not be able to project out, bulky. It will be bulkier and stiffer than ring-spun yarn due to untwisted core fibres. That is why, the yarn is going to be diameter of the yarn little bit more than the ring yarn. But it will be stiffer because of the wraps, tight wraps are there.

Like rotor spun yarn also is stiffer because of the wrapper fibres. So, the tight wraps which are there. Loose wraps will not make the yarn stiff. It is the tight wraps which are going to make the yarn stiff. So, the wrapper fibres increase means if more loose fibres are there, loose wrapper are there.

The yarn may not be stiff. But if more tight wraps are there, then yarn will be stiffer. That means, flexural rigidity is going to increase. Yes, stiffness is basically with respect to flexural rigidity. And this is also true in the case of tensile, also the initial modulus.

Evenness, vortex-spun yarns are worse than the conventional and compact ring-spun yarns in terms of yarn evenness. So, conventional ring-spun yarn and compact ring-spun yarns are much evener than this vortex-spun yarn.

Tensile property, tenacity of vortex-spun yarns which is 85 percent of the tenacity of ring-spun yarns. So, compared to ring-spun yarn, they are little weaker. Tenacity of vortex-spun yarns is greater than the tenacity of air jet spun yarn, due to higher number of wrapper fibres. May be compared between air jet and vortex, then vortex-spun yarns are stronger.

Breaking elongations are lower than conventional and compact ring-spun yarns, but higher than open-end spun yarns. That has been seen. That is, breaking elongation wise it is low lower than conventional and compact ring-spun yarns because most of the core fibres are actually straight and parallel.

They are not following a helical path like a ring yarn is there you know. Fibres are following helical path, so they can extend when we are trying to stretch the yarn. The fibres are perfectly straight and parallel. The fibre will stretch, there is no you know the spiraling of the core fibres is not there. So, they will not really extend much. That is why breaking elongation is less.

With that, we come to the end of our slide. So, few you know effects of few parameters we have discussed. There are still lot of research is going on the vortex, you know, spun yarns and there has still scope for doing research because there are lot of you know you know contradictions in the findings of the researchers.

So, whatever and because maybe that you know many things have not been studied in details. So, those who are interested to pursue some research in the vortex spinning, there are still lot of scope to do that. Not many articles have been published and rest in some scope still left.

And in some of the articles, we find that there is a some kind of you can say the contradictions in the findings of the researchers and the conclusion drawn out of those you know observation that have been made by the researchers.

With this, we close this session.

Thank you.