New Spinning Technologies
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Lecture - 29
Productivity Enhancement : Limitations

So, we will discuss now Productivity Enhancements and what are the Limitations. We all try to enhance the productivity of the spinning systems that people have developed. Now, if we try to increase the production rate of these technologies, what are the difficulties that we are going to face and what could be the ways to mitigate those difficulties.

Machine manufacturers are always trying to enhance the productivity and we will see that, in some technologies we have almost reached a limit that is we have reached the, a plateau.

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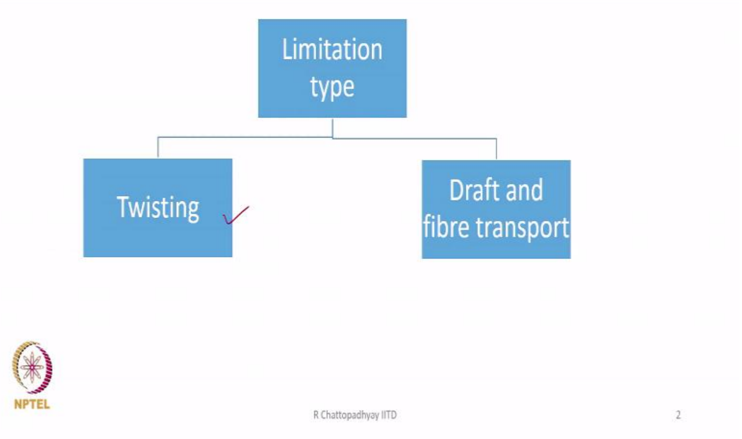

A significant improvement in productivity may not be possible. Therefore, we need to know what are the real you know difficulties that we will face, with respect to enhancement of productivity in the technologies that we have discussed till now.

Now, the limitations that we face, can be classified into two groups; one is limitation of twisting and the limitations related to draft and fibre transport. So, we will take them up one by one.

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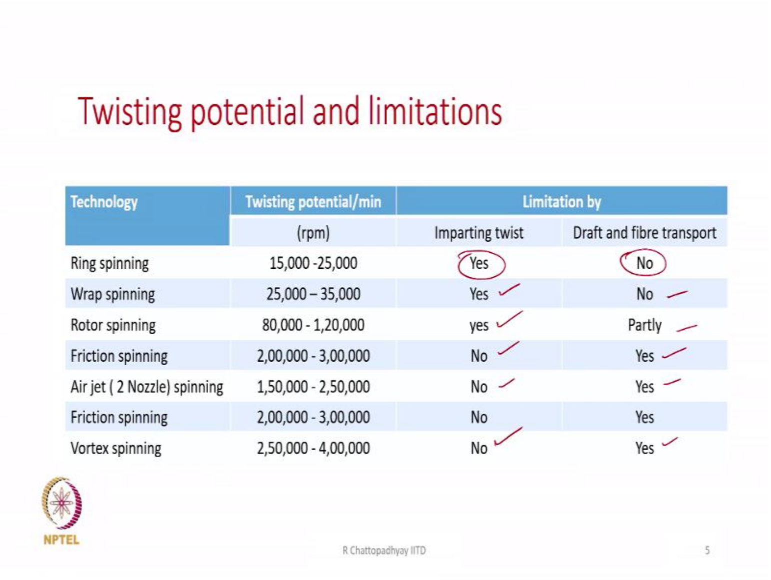

Technology	Twisting potential/min	Limitation by	
	(rpm)	Imparting twist	Draft and fibre transport
Ring spinning	15,000 -25,000	Yes	No
Wrap spinning	25,000 – 35,000	Yes	No
Rotor spinning	80,000 - 1,20,000	yes	Partly
Friction spinning	2,00,000 - 3,00,000	No	Yes
Air jet (2 Nozzle) spinning	1,50,000 - 2,50,000	No	Yes
Friction spinning	2,00,000 - 3,00,000	No	Yes
Vortex spinning	2,50,000 - 4,00,000	No	Yes

First, let us look at the twisting potentials of different technologies. Ring spinning, we all know that the spindle speed of a ring spinning machine can lie between 15,000 to 25,000 rpm.

That is twisting potential is at the most 25,000. Beyond that, is really very difficult and we cannot we do not foresee a significant rise in productivity in terms of spindle speed on ring spinning system. Why we will be discussing them? For wrap spinning the spindle speed is around 25,000 to 35,000.

See productivity is proportional to the twisting rate and therefore, the twisting potentials values have been quoted. We are not really giving the values in terms of meters per minute. It is the twisting rate that is directly proportional to the production rate and hence the twisting rate for twisting potential values are quoted here. Rotor spinning, typical range of speeds is 80, 000 to 1,20,000 rpm.

Friction spinning is between 2,00,000 to 3,00,000. Air jet spinning it could be 1,50,000 to 2,50,000; were the speed of the twisting unit. Friction spinning it is 2,00,000 to 3,00,000; this is getting repeated; Vortex spinning is 2,50,000 to 4,00,000.

So, these are the twisting potential. Now, the limitations could be because of the how much how first twist we can impart and the other limitations could be limitation because of draft and fibre transport. Like ring spinning it is written that, the limitation is mainly because of twisting rate, but from the draft and fibre transport point of view, there is no limitations.

So, we will now discuss about these limitations in the next slide, ok. Why for ring spinning the limitation is because of the imparting twist; for wrap spinning, it is because of twisting rate, but not because of draft and fibre transport; for rotor spinning it is also because of twisting rate draft and fibre transport limitations as partly. Friction spinning twisting rate there is still no limitations, but draft and fibre transport there is a limitations.

Air jet spinning imparting twist there is no limitation, but draft and fibre transport limitations are there. So, and for vortex spinning there is limitations from the point of view of, there is no limitation form the point of view of twisting rate, but there is a limitations from the point of view of draft and fibre transport. Now, the results are given here, we are going to find out the reasons.

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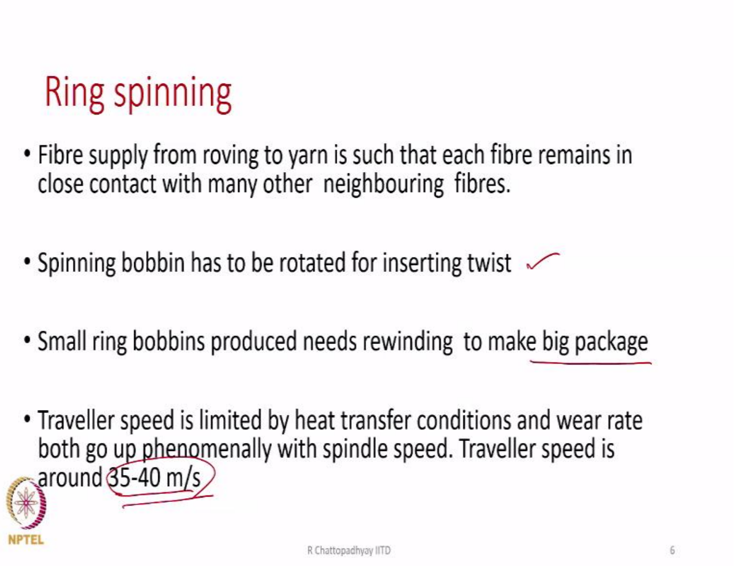

So, let us go first to the ring spinning machine. Now, we are all familiar with the ring spinning process; it is one of the oldest process, but the most versatile machine is the ring spinning machine, as I have already told, it can process all types of fibres and it can produce a wide range of counts. Now fibre supply from roving to yarn is such that, each fibre remains in close contact with many other neighbouring fibres in ring spinning.

Spinning bobbin has to be rotated for inserting twist here. So, it is the spinning bobbin that we have to rotate and to rotate spinning bobbin we have to rotate the spindle and also, we have to rotate the traveller. Now, small ring bobbins produced needs rewinding to make big packages; this is one additional you know constraint that we have. We cannot produce very big ring bobbins.

The cops are quite small in size. It hardly contains at the most 150 gram of yarn, 100 to 150 mostly. If you go for fine count, it may be still less. So, the package size is very small and people have been trying to increase the size of the package, but there are difficulties in increasing the size of the package and what are those difficulties?

If we want to increase the size of the package, we have to produce a big balloon. So, the bigger the balloon, more is the spinning tension. So, there will be breakage to the yarns. So, frequency of end breaks will go up and therefore, we will not be able to run the machine at a higher speed. So, we have to compromise if we want to go for a bigger package, we have to reduce speed.

If we reduce speed, our productivity is going to suffer. And therefore, there is no solution. So, it will be at the cost of reducing productivity that we have to we can only go for a big package. The other limitation in ring spinning is, that traveller speed. The tiny traveller which runs on the ring, the maximum speed that is attainable is around 35 to 40 meters per second.

If we try to go for higher speed, the traveller will burn very quickly and we have to replace travellers. So, replacement of traveller is a very lengthy operations and we have to stop the machines, remove all the burnt-out travellers, replace them. So, if it is done very frequently then lot of production time is lost.

Therefore, the traveller speed is could be at the most 35 to 40 meters per second. And, if we keep this speed in mind and if we know the size of the ring which in turn depends on the size of the bobbin that we produce, so we can find out what should the rotational speed of the traveller.

From the rotational speed of the traveller, we can say what could be the speed of the spindle. So, speed of the spindle is limited because, the traveller cannot be done more than 35 to 40 meters per second. So, the traveller burning rate or traveller life is also a constant in the case of ring spinning as far as the productivity enhancement is concerned.

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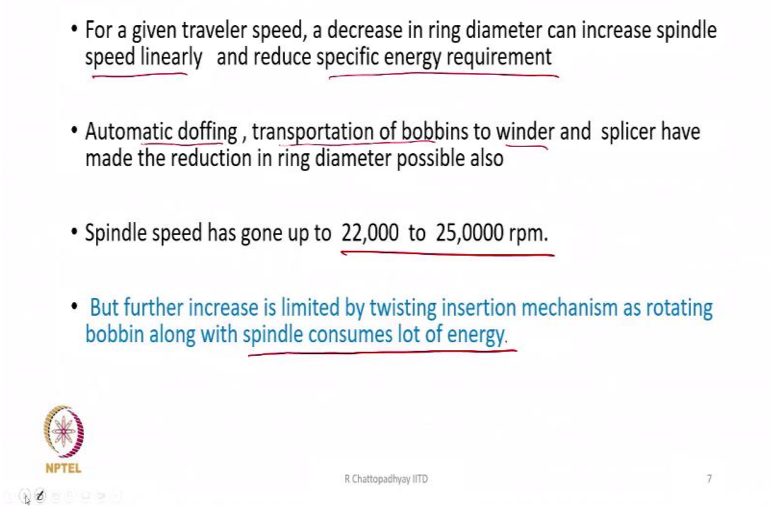

So, for a given traveller speed, a decrease in ring diameter can increase spindle speed linearly and reduce specific energy requirement. So, that has been tried. So, with some design modifications of the spinning zone or you can say spinning geometry, some increase in speed and the spindle has been possible.

The other thing is the moment we go for smaller you know size package, in order to raise the speed, what we need is automatic doffing and transportation of bobbin to the winder that also is a task that used to be performed manually earlier, but nowadays this is mostly done by automations; that is the cops are lifted by automatically by some machines.

And these tops are then transported from ring spinning machine to the winding machines. So, the automation was required because of the labor cost are going up and up, at the same time, the doffing time was getting reduced because of enhancement of spindle speed. See, earlier even you know the spindle speed used to be around 18,000 rpm.

Before that it was limited to only 15,000, 16,000 rpm. So, with time, on improvement, the spindle speed is going up and it has gone to a level of 25,000 or 22,000 around that, but since we have gone from 15,000, 16,000 to almost 25,000 nowadays, the filling up time of the cop got reduced and hence frequency of doff increased and that would mean more loss of productions.

And if it is done manually and you need to have more number of operators and labors to do the job and therefore, the machine manufacturers you know decided that we need to go for automatic doffing and transportation of bobbins from ring spinning machine to the winder. Spindle speed as I have said the maxima spindle speed which is attained by this machine is around 22,000 to 25,000.

But is not that all types of yarns or all types of counts can be spunned at such a high speed. If you go for very fine count, even a speed of 22,000 will be very very you know will be practically impossible to achieve; because, the moment you go for fine counts the absolute strength of the yarn goes down. So, we have to run the machine at a lower speed. So, the maximum speed which is attainable for 30s count and the maximum speed attainable level for 60s or 18s count are not same.

Even maybe 18,000 rpm is quite high when you are trying to spin 60s or 80s count yarn or as if you try to spin 25s or 30s count yarn we may go up to a speed of 22,000 or 25,000. So, speed attainable also is a function of the count of yarn that you are going to spend. So, what is high speed for medium count range, is not necessarily same for fine count range.

Therefore, if we look at this, we can say that further increase in speed of the spindle or twisting rate is almost it is very difficult; because of the constraints that we have. And the same time, the spindle will consume lot of energy. The spindle is quite heavy and if we want to turn it at higher and high speed the energy consumption also goes up.

So, there are quite a few problem that we face when you try to raise the productivity of the ring spinning machines; one is the traveller burning becomes very quick, the other thing is the energy consumption also, that also is the problem and the third is the end breakage rate. The end breakage rate also will go up. And, therefore, we say that the raising productivity on ring spinning machine is actually limited by the twisting rate or twist insertion mechanism, that is we have the spindle and the ring and the traveller.

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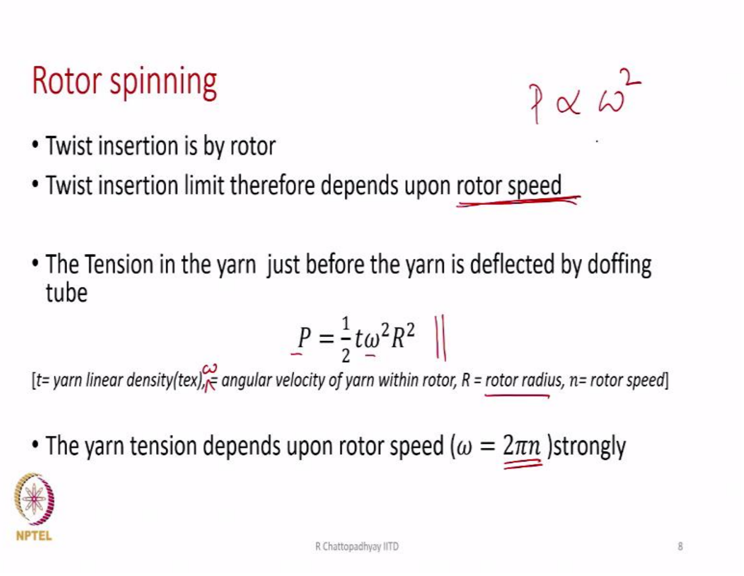

Now, we go to rotor spinning; in rotor spinning, twist insertion is done by the rotor. The rotor is the twisting unit. So, twist insertion limit is therefore, dependent on the rotor speed. Now, what happens when you try to go for higher speed. The tension in the yarn just before the yarn is deflected by the doffing tube can be given by this equation which has been stated by some researchers.

So, its look at the spinning tension value it is a function of for a given yarn it is a function of ω; ω is the angular velocity of yarn within the rotor. So, this is ω, R is the rotor radius and n is the rotor speed. So, the yarn tension depends upon rotor speed for a given diameter of the rotor; that is omega which is 2 π n; where, n is the speed of the rotor in rpm.

$P = 1/2t\omega^2R^2$

Hence, if we try to go for higher and higher speed, the P value is going to rise, P is proportional to ω square. So, P will raise, at a very fast rate as you go for higher values of omega. And, as a result what will happen, a specific tensions, for a practical mill operation in the yarn lies in between 1.5 to 2, that is it should be less than this; this value.

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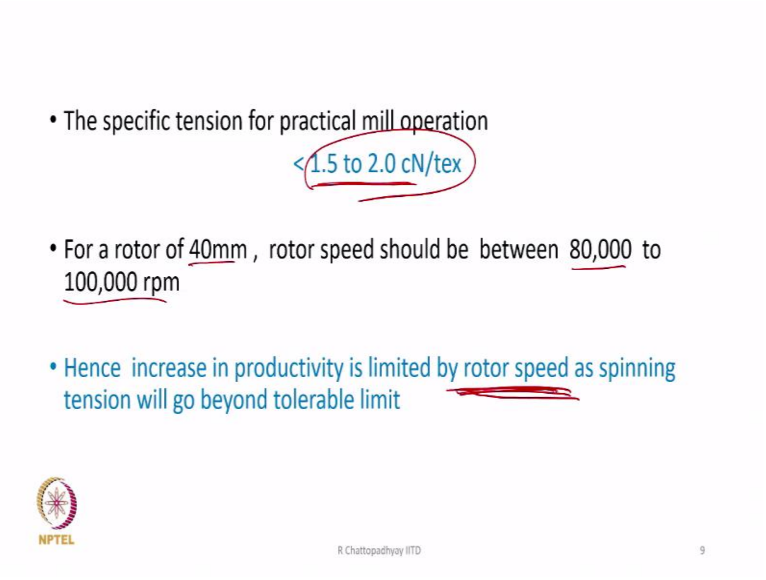

Now, for a one can calculate using that equation what should be the allowable you know rotor speed if we use a rotor of 40 mm and for a given count of yarn we can choose some count value maybe 20s Ne or maybe 60s Ne and work it out, it will give a value of n which will be between 80,000 to 1,00,000 rpm; that means, if I try to surpass the speed of 1,00,000 rpm the spinning tension is going to be more than 1.5 or 2.0 cN/tex.

And hence the breakage frequency is going to be very very high. And therefore, practical spinning will be almost impossible, free frequently there will be breakage. So, increase in productivity in the case of rotor spinning is limited by rotor speed. Because, the increase in rotor speed will immediately increase the spinning tension, rotor speed and the spinning tensions are related by the equation that was shown in the previous slide.

So, this is spinning tension has a threshold value and we cannot in go beyond that value, if we try to go, we will encounter many breaks. Therefore, what people have done to solve this problem that if you go for higher rotor speed with the higher rotor speed is connected to productivity. More rotor speed means more production or more rotor motor means more tension.

But if I want to go for higher speed, keeping tension at the same level, then the choice that we have with us is to reduce the rotor diameter. Now, how far you can go in reducing rotor diameter? There is a limit there also, because rotor diameter is connected to fibre length. For a given fibre there is an optimum diameter.

Below that diameter if we want to go, lot of wrapper fibres will be generated and yarn will be weak within the rotor and it will also start breaking. So, if we try to go for higher speed at a lesser rotor diameter, there is a every possibility that the yarn is going to break again, even though the tension may not increase.

Because now we will be generating more and more wrapper fibres. And therefore, there will less and less core fibres and hence the yarn is going to be weak and break frequently. So, this is the, you know the problem that you are going to face. So, it is limited by the rotor speed.

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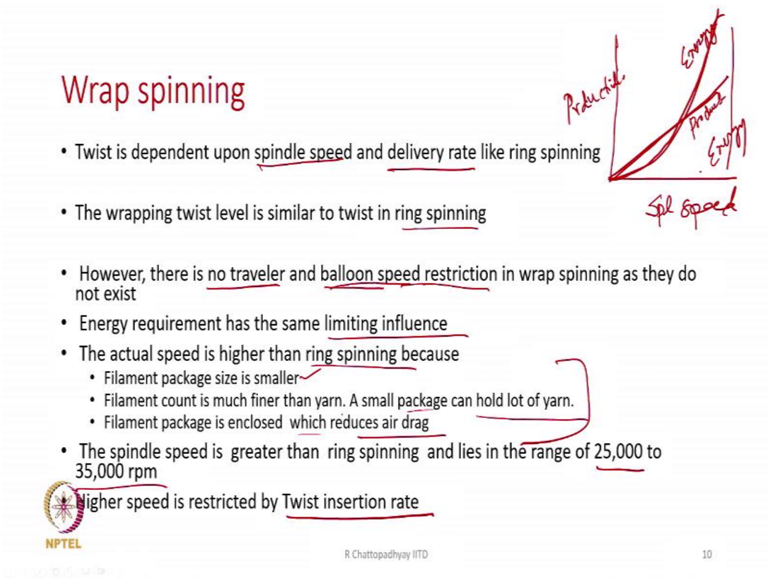

Next, we go to Wrap spinning; the wrap spinning is similar to ring spinning. So, twist is dependent on spindle speed and delivery rate like ring spinning. Wrapping twist level is similar to twist in ring spinning; however, there is no traveller in wrap spinning and there is no balloon. So, balloon speed restriction and traveller burning problems are not there in the case of wrap spinning, because they do not exist.

Energy requirement has same limiting influence, but energy requirement; obviously, will go up as you go for higher speed in the case of wrap spinning. The spindle is there, on the spindle there is a package, that package contains the filament yarn. So, for the higher speed if we go, the energy requirement will go up disproportionately.

So, actual speed is higher even then the ring spinning, slightly higher. We all know that wrap spinning the speed can go up to 30,000 to 35,000 rpm for ring spinning it is limited to maximum 25,000 rpm. So, it is little higher because, filament package is smaller in size. Filament count is much finer than yarn, a small package can hold lot of yarns.

And filament package is enclosed which reduces air drag. Air drag is also not there, because of these reasons, the speed the spindle speed has gone up in comparison to ring spinning. The spindle speeds is greater, in the range of 25,000 to 35,000 rpm.

Higher speed is restricted therefore, is by twist insertion rate is mainly from the consideration of energy. Energy consumptions is going to increase. See, with the spindle speed increased productivity will increase linearly. If we plot, spindle speed and productivity it may go up linearly, but energy will go up like this. So, productivity and this side which suppose we write energy.

So, this is for the energy and this line is for the productivity. So, this will goes off very fast; where this will increase linearly with speed. So, beyond a certain spindle speed, the energy consumption per kg of yarn production is going to increase. And therefore, it is not going to be economical. So, that is the issue that we will face if we go for higher productivity in case of wrap spinning.

So, if we can design a spindle, so that energy consumption does not increase much, but still, it allows us to go for higher speed that could be the solution.

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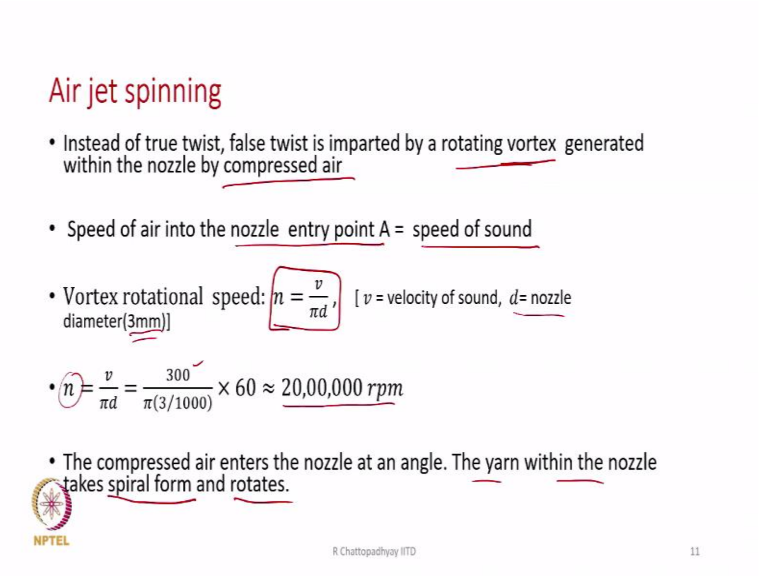

Now, we go to air jet spinning; in air jet spinning instead of true twist, false twist is important. By a rotating vortex generated within the nozzle by compressed air, we have already learned this air jet spinning, how? A rotating vortex is generated or created by forcing air to enter the nozzle house at a quite high pressure.

Now, speed of the air as it enters the nozzle is equal to the speed of sound. Therefore, Vortex rotational speed is going to be this; n is going to be v/π d where, v is the velocity of sound and d is the nozzle diameter and we can find out if we put some values and the value of velocity of sound is 300 meters per second. And, d if we choose to be a value of around say 3 millimeter, then the value of the n is going to be almost this, 2 million or 20 lakh.

$$n = v/\pi d$$

So, that is the speed at which the vortex is rotating within the nozzle. The compressed air enters the nozzle at an angle. And therefore, the yarn within the nozzle takes a spiral form and rotates. So, the yarn within the nozzle house is actually also rotating, but it is in the form of a spiral.

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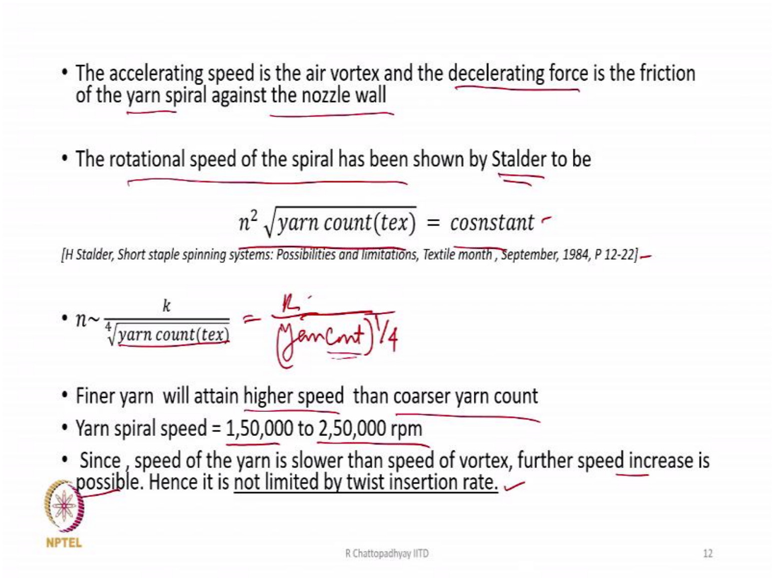

And the accelerating speed is the air vortex, but the decelerating force is the friction of the yarn spiral against the nozzle wall.

It is only 3 millimeter and the yarn is following a spiral path and rotating. So, it is coming to contact of the inner wall of the nozzle and the friction between the yarn and the wall is trying to decelerate it, but the air vortex, because of this the air vortex is trying to accelerate also.

So, the rotational speed of the spiral has been shown by Stalder to be like this, that is he has developed an empirical equation that shows, n square root over yarn count in tex is constant. The reference is given here. Therefore, n is k is the constant by 4 square root yarn count in tex or you can write like this, k by yarn count to the power 1 upon 4. This is the speed of the vortex.

$$n^2\sqrt{yarn\ count(tex)} = \text{constant}$$

$$n \sim \frac{k}{\sqrt[4]{yarn\ count(tex)}}$$

So, if the count of the yarn becomes finer, it will attain the higher speed than a coarser yarn count. Because, if numerator remains same, but denominator will go down as the yarn count becomes fine. If you remember the count, expression or count units is tex. So, find out the count, lower with the value. And, here spiral speed has been shown to be around 1,50,000 to 2,50,000. Whereas, the vortex speed is 20 million.

That means, the entire vortex speed is not being utilized in rotating the yarn. So, since speed of the yarn is slower than the speed of the vortex, further speed increase is therefore, possible. Hence, it is not limited by twist insertion rate. Actually, there is lot of slippages which is happening. So, if we can avoid slippage, the speed of the yarn spiral can be further increased.

Because, if vortex is rotating at a much faster rate than the yarn within the nozzle.

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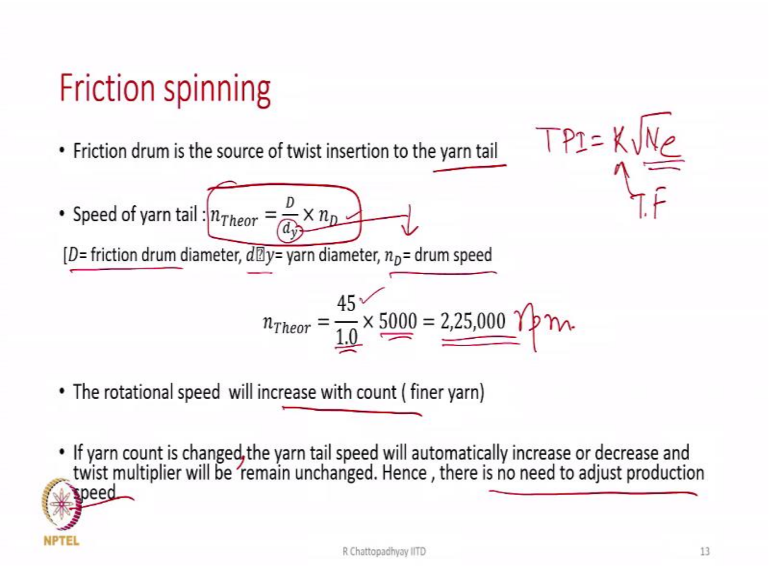

In friction spinning, friction drum is the source of the twist insertion to the yarn tail and speed of the yarn tail can be given by this equation, n Theoretical is D / small d_y into n D; D, d_y and n D these are given here.

$$n_{Theor} = \frac{D}{d_y} \times n_D$$

As a typical case, if I choose a drum diameter of 45 mm and yarn diameter of 1 mm and choose the drum speed as 5,000 it can give you a rotational speed of the tail which will be 2,25,000 that is the possible speed of the yarn tail. The rotational speed will increase with count. Because, if the count is finer the diameter value this diameter value will go down as the count becomes finer.

And therefore, the tail speed is going to increase, rotational speed is going to increase. So, if the yarn count is changed. The yarn tail speed will automatically increase or decrease, if I change the count if I make it coarser the speed of the yarn tail is going to reduce because, d_y is going to, small d_y is going to increase; if I go for fine count small d_y is going to be less and therefore, speed of the yarn tail will increase.

So, the speed of the tail, a rotational speed of the tail is actually inserting twist. So, rotational speed of the tail will automatically change with the change in count. There is no need to do anything else. Hence, there is no need to adjust the production speed in order to change the twist value.

Otherwise, in normal circumstances suppose in the case of ring spinning, if we want to go for fine count yarn keeping the twist multiplier same, what we need to do? If the twist multiplier remains same and we are going towards fine count, we need more twist in the yarn. Because, if you remember Twist Per Inch is, K root over Ne; where K is the twist factor. So, if the twist factor remains same. And, if I go for higher value of Ne, that is by going for finer yarn in any term the value is going to be more, TPI is going to increase.

$$TPI = K\sqrt{Ne}$$

Now, if I want more TPI in the yarn, we have to set the machine accordingly. Now, if the spindle speed remains same, the delivery rate still remains same then this TPI is not going to change, but if we have to go for higher TPI, then we have two options with us either we reduce the delivery rate or do we increase the spindle speed, when you go towards fine count.

Out of these two choices, spindle speed is not normally changed. What we change, is the delivery rate. So, delivery rate had to be reduced in order to insert more twist into the yarn when you are going from coarser to finer count; that means, we are losing in terms of productivity. Because, we are reducing the delivery rate. This is something which is not required in the case of friction spinning.

Delivery rate remains same, but speed of the yarn tail is going to increase, because diameter has reduced. So, that is the, you know important aspects about this friction spinning. So, production rate remains fairly same over a wide range of count. There is no need to change it, even if we go from coarse to fine count.

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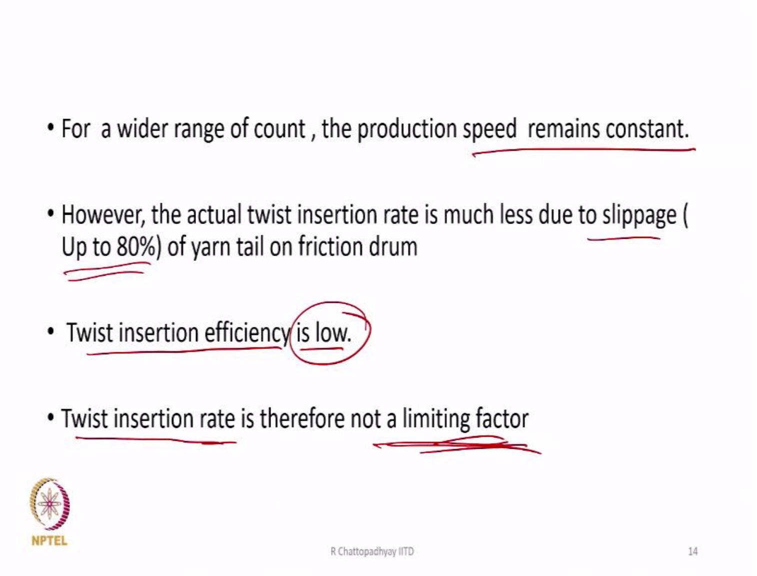

So, for a wide range of count the production speed therefore remains constant, in friction spinning; however, the actual twist insertion rate is much less due to slippage and the slippage could be to the order of sometimes it can go up to 80%. 50% is very common. So, even if we expect the yarn tail to rotate at suppose 2,00,000 rpm.

Usually actually rotate it much less rpm; that means, there is a slippage. So, twist insertion efficiency if we say is actually low. So, the friction drum can actually you know impart more twist, but because of the slippage between the fibres and the drum surface, the actual twist inserted is less. So, twist insertion efficiency is low. Therefore, twist insertion rate is a limiting factor, in this case.

If we can increase the twist insertion efficiency, if we can reduce the loss or slippage, the slippage rotational slippage of the yarn tail on the friction drum then our twisting rate will go up. And if it goes up, it can increase the productivity. So, the limiting factor is twist insertion rate or you can say twist insertion efficiency in this case.

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So, that is all about twisting, we have discussed. Now, we go to draft and fibre transport, that is from the drafting point of view or fibre transportation point of view, do you face any problem that puts limits on the enhancement of productivity? So, let us go to the very first one; ring spinning, compact spinning, wrap spinning they are basically all similar. So, they can be discussed together. Here, the drafting system is same; 3 over 3 drafting system with aprons.

Drafting speed in ring compact spring is actually always low, 15 to 20 meters per minute. For wrap spinning it can be little higher, it may be 25 meters per minute. So, speed is very very low and you compare it with air jet spinning or vortex spinning which goes up to 200 meters per minute.

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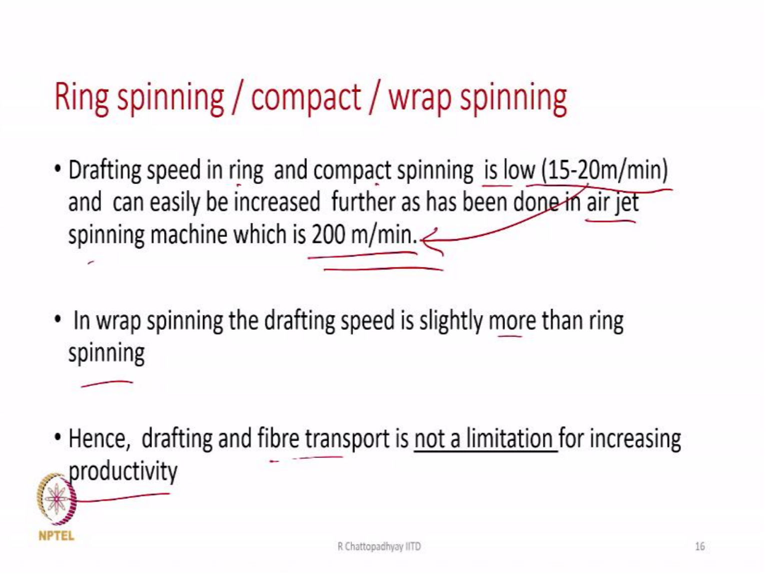

So, 15 to 200. There is a jump in speed by 10 times, but the drafting system is still same on air jet spinning or vortex spinning we also use the same 3 over 3, roller drafting system with aprons.

So, these roller drafting system with aprons can be run at 200 meters per minute or 220 meters per minute; however, in ring spinning, we run it at 15 to 20 meters per minute. Wrap spinning drafting speed is slightly more than ring spinning. Hence, drafting and fibre transport is not a limitation for increasing productivity for ring spinning, compact spinning or wrap spinning.

Because, actually the drafting system can be run at much faster rate, but we are forced to run it at a lower speed. Because. Because of what? Because, the twisting unit cannot be run at a higher speed. And drafting speed and twisting element speed are connected by the twist that we need in the yarn, because ratio of these two will give you the twist density in the yarn.

And hence, we cannot run at more than 15 to 20 meters per minute. Even though technically it is possible to run the drafting system at higher speed. If we try to go from 15, 20 to 50, the twist value will be so low that the yarn will not form at all it will break then and there; because spindle speed has to increase proportionately. If that does not increase and we only increase the drafting speed twist in the yarn will go down and down and down.

And it will be so low, that the yarn will be so weak, that we will not be able to make the yarn at all.

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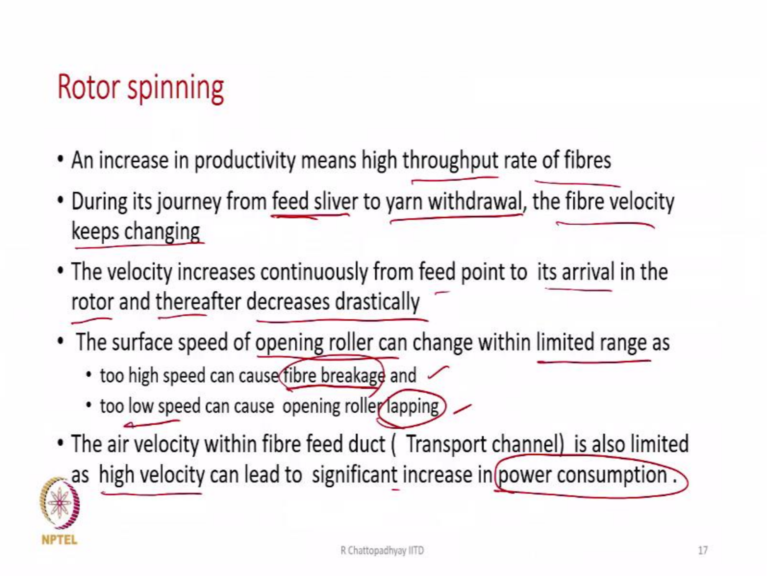

Now, rotor spinning is little interesting in this case. In rotor spinning an increase in productivity means, higher throughput rate. It is true for all spinning system, if we want to increase productivity means throughput rate is going to increase.

During its journey from feed sliver to the yarn then withdrawal, the fibre velocity keeps changing, in rotor spinning. The velocity of the fibre from the feed point of feed point that is where the sliver is being fed to the point where the yarn is withdrawal, the fibres is always in a flowing state and the velocity of the fibre keeps on increasing.

The velocity profile of the fibre neutral spinning was discussed when we actually you know discuss rotor spinning in details. The velocity increases continuously from feed point to its arrival in the rotor and thereafter it decreases drastically. When you form the yarn and then take out the yarn from the rotor, then there is a sudden decrease, sudden huge fall in the velocity, but it does not fall to 0.

It falls, depending upon at what rate I am withdrawing the yarn, which could be 80 or 100 meters per minute. So, the velocity at different stages are different for the fibres. So, you look at this. First the sliver is fed at a slow speed by the feed roller. So, velocity of fibre is equal to the velocity of the feed roller, which is very very low maybe 1.5 meters per minute or 1.2 or maximum of 2 meters per minute not more than that.

Surface speed of the opening roller, can change within a limited range opening roller in the case of rotor spinning runs at around 7,000, 8,000 rpm or sometimes may go up to maximum 10,000 rpm, but we cannot go for very high speed because, this problem fibres will break. And, if we cannot go for low speed also because, lapping tendency will be there.

It is not that, it to avoid you know breakage I run the opening roller at a speed of 4,000 rpm that will also be dangerous because there will be lot of lapping of fibres on the opening roller surface. And therefore, within a limited range the opening roller speed can be changed. So, opening roller surface speed is therefore, gets limited by these two facts; neither too high not too low, in between within a certain range we can keep it. So, it is typically maybe 8000 rpm for cotton.

Now, comes next from opening roller of the fibres will be entering the transport channel. There, within this transport channel also is known as fibre feed duct, the air velocity is limited. Air will be flowing through that channel because, it has to carry the fibres from the opening roller surface to the rotor. The fibre has to travel from opening roller surface to the rotor and it is the air which is actually carrying the fibres.

Now, here, if we want to go for high velocity, there will be significant increase in power consumptions. This you know, the we generate negative pressure within the rotor chamber and because of that, the air is sucked from the environment and it enters and it passes through the transport channel and from there it goes inside the rotor and then it is taken out from the rotor also.

So, if I want to suppose, I want go for higher productivity, the automatically means I have to feed more fibres and if I want to you know make them travel at a higher speed and I have to go for higher velocity of air within the transport channel and that would mean very high power consumptions.

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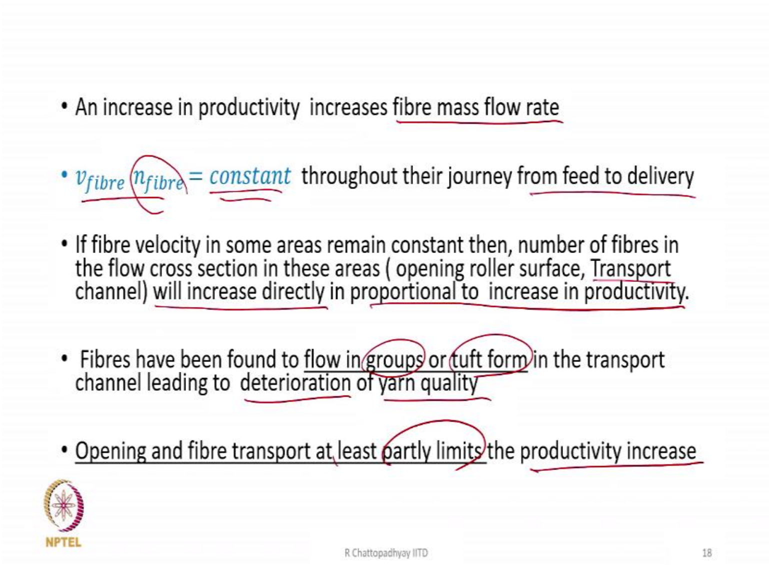

An increase in productivity, increases fibre mass flow rate is obvious throughput is going to increase. So, I have more fibre should flow from you know from the feed point to the yarn formation point; that means, velocity of fibre and number of fibres in the cross section will remain constant throughout their journey from feed to delivery for a given production rate.

$$v_{fibre}\, n_{fibre} = \text{constant}$$

This has to remain constant. If the velocity in some areas remains constant, the number of fibres in the flow cross section in these areas will increase directly in proportional to the increase in productivity. See, if we increase the fibre flow rate; that means, I have to feed this sliver at a faster rate, ah, but because the opening roller speed has not changed, the number of fibres in the cross section of the flow over the opening roller surface will going to increase.

And also, in the transport channel when the fibres are flowing, the number of fibres in the cross section of the flow is also going to increase. There we are we will not be able to maintain the same level of fibres in the cross section as it was earlier. The fibres have been found to flow in groups therefore, the moment we try to go for higher productivity fibre will flow in groups or in the form of a tuft.

Especially, through the transport channel, leading to deterioration of yarn quality. If the fibres are flowing in the form of groups or tufts, they need to land in the rotor in the form of a tuft.

And once they are you know transformed into yarn, it may lead to generation of thick place or sometimes the twist transmission may not be efficient enough and the yarn formation may be interrupted. At the same time if it is cotton, the dust flow rate also is going to increase. So, the rotor chamber will be filled with dust very quickly, because flow rate has gone up.

So, along with fibres the dust flow rate also will go up. So, the grooves within the rotor also will get filled up fast. So, these are the problems we will face and hence, opening and fibre transport at least partly limits the productivity increase. The dust problem may not be there in the case of synthetic fibres, but the problem of opening and fibre transport will be there. So, it will partly limit the productivity increase.

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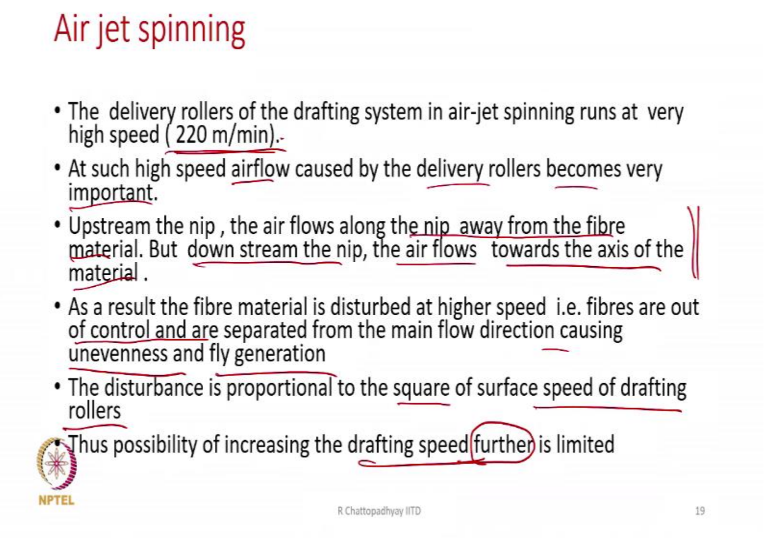

If we go to air jet spinning, we all know the delivery rollers of drafting system of air jet spinning, they may run at a speed of 220 meters per minute or 200 meters per minute. Typically, these are the speeds, at such high speed air flow caused by delivery rollers become very very important. At such a high speed as the roller rotates the air surrounding the roller also rotates and that has got an implications.

Upstream the nip, the air flows along the nip away from the fibres, but downstream the nip the air flows towards the axis of the material. These points I have discussed while we were discussing air jet spinning. So, the strength of the air current is going to increase as you go for higher and higher speed higher delivery speed.

This is going to disturb the fibres, just behind the nip of the front pair of rollers and also after the nip of the front pair of rollers and these disturbance is going to affect the arrangement of fibres in the yarn, that is if the fibres will go out of control especially when it is behind the nip because that air current is going to deflect the fibres and it will lead to what one is unevenness and fly generations.

These problems will be there, if we try to go for higher productivity; that if we want to go for from 222 let us say 250, 300 meters per minute. This disturbance proportional to the square of the surface speed of the drafting rollers. So, it is not linear it is non-linearly, they are connected.

So, there will be disproportionality increase in the you know in the disturbance. So, there is the possibility of increase in drafting speed further is limited. So, further speed increase of drafting in air jet spinning is very very limited. Though, the vortex are running at a very high speed. So, twisting potential is still there you can you know twist at a still higher rate.

But the drafting rollers cannot be run beyond the speed that we have attained nowadays which is 220 meters per minute in the case of air jet spinning. In the case of vortex spinning, similar problem is there, though the vortex spinning machines are running the delivery rate is around how much 350, 400 meters per minute.

So, that much speed has been attained there in the case of vortex spinning because, it is because in the vortex spinning there are more wrapper fibres which are wrapping the core part of the yarn, the yarn a little stronger in comparison to air jet spinning therefore, we could go for higher you know delivery rate there.

And the way the fibres there is little guidance given to the fibres in the case of vortex spinning. So, higher speed delivery speed has been attained there.

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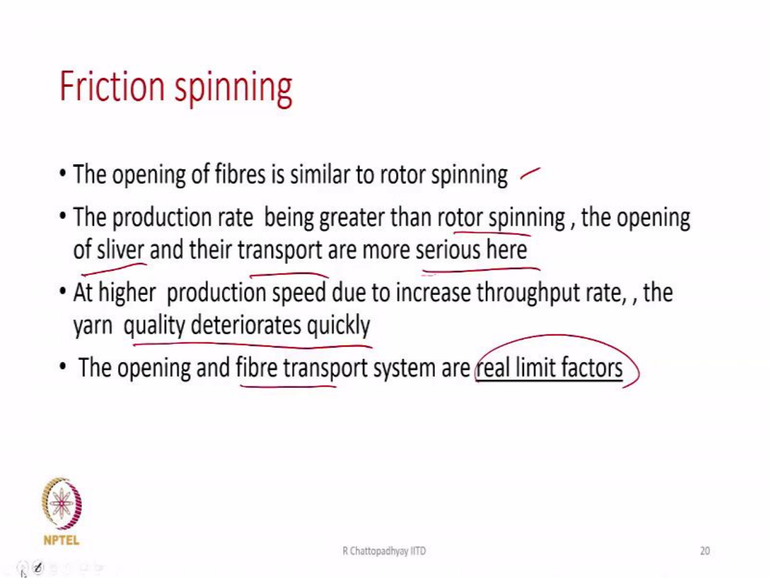

And in case of friction spinning, is there any problem with drafting. Opening of fibre is similar to rotor spinning, here also we have opening rollers and then also we have fibre transport.

So, the problems for friction spinning and rotor spinning are exactly similar. Production rate being greater than rotor spinning the opening of sliver and their transport are more serious here. At higher production speed due to increase in throughput rate the yarn quality will deteriorate quickly. So, the opening and fibre transports are real limit factors in the case of friction spinning.

So, friction spinning and rotor spinning are more or less similar sort of limitations are there and that is mostly related to fibre opening or separation of fibres. If we want to feed more fibres to separate them out, we have to raise the speed of the opening roller and that is going to damage the fibres, break the fibres.

And then, the problem of fibre transport through the transport channel will also be there. Ultimately, fibres has to be taken from the opening roller to the twisting point. Since, that process transport is basically a unguided transport it is only by air the fibres are going. So, fibres will move to the form of groups similar problem will be there.

And with that, this discussion on the limitations is almost over now. So, we have seen that, these spinning technologies that the new spinning technologies are definitely you know superior in many respect when it comes to productivity especially. Their productivities are much more in comparison to ring spinning and when you think of further raising the productivity, then the problems that you are going to face that we have discussed.

Problems may come from the point of view of the drafting of the fibre, transporting of the fibres to the twisting point or the twisting rate, twisting efficiency, the energy consumption in twisting the fibres, these are the issues that we have to tackle if we want to go for a higher productivity in these technologies, ok. With this we close today’s discussion and.

Thank you.