New Spinning Technologies
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Lecture - 17
Friction Spinning: Dref-2

So, now we are going to discuss Friction Spinning and Dref-2 Friction Spinning.

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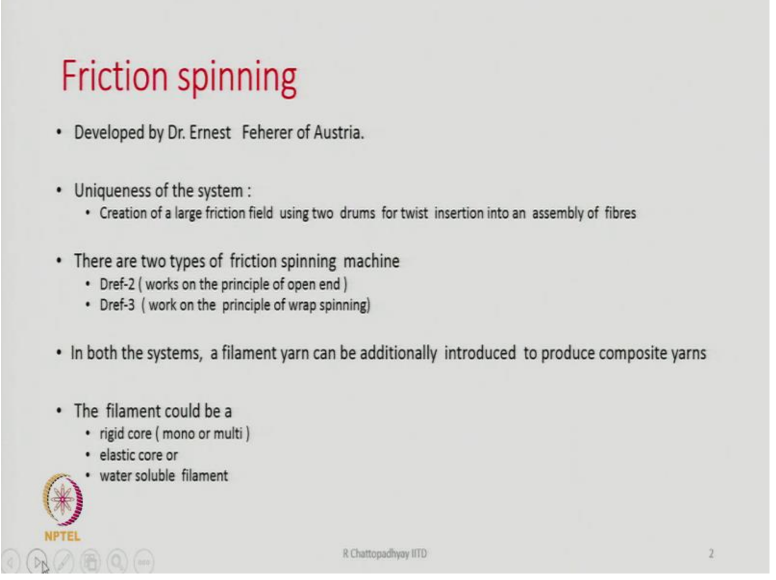

Friction spinning was originally developed by Dr. Ernest Feherer of Australia, Austria, not Australia, Austria. The uniqueness of the system is that creation of a very large friction field using two drums for twist insertion into an assembly of fibres. That is the uniqueness of the system.

There could be two types of friction spinning machines or friction spinning technology, Dref-2 and Dref-3. Dref-2 works on the principle of open end spinning and Dref-3 is basically on the principle of wrap spinning. Our forecast today will be mostly on Dref-2 machine. In both the systems, additionally a filament yarn can be incorporated to produce composite yarns.

That sort of you know flexibility exist that we can always add additional yarn and this yarn preferably it is a filament, could be either a filament with rigid core, which could be mono or multi filament, it could be an elastic core material or it could be water soluble filament.

So, all types of filaments can be incorporated at the center of the yarn and that can be covered by another fibre and will be able to produce composite yarns. So, this is also possible and this is possible on both Dref-2 and Dref-3 technologies.

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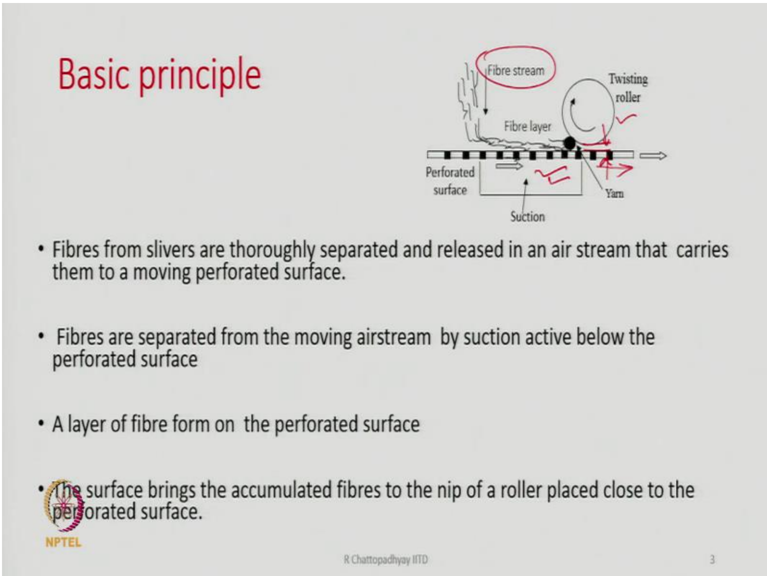

Basic principle, now a diagram you see on the right hand side. Now, fibres from a sliver or from a group of slivers are thoroughly separated from each other by some means mostly with the help of a opening rollers and these separated fibres are then released in an air stream that carries them to a moving perforated surface like it is shown here, this is the perforated surface which is moving on the right hand side and the fibre stream is here.

So, we generate a stream of fibres and the stream of fibres will be landing on a perforated surface. Fibres are then separated from the moving stream by this suction which is active below the perforated surface. So, therefore, this region there is a suction acting. So, the where is the fibres are landing on the perforated surface the air is sucked out and the fibre rest on the perforated surface which acts like a screen.

So, there are lot of perforations are there and the air is sucked the fibres remain on the surface. As a result of this a layer of fibre will form on the perforated surface and now the surface is not stationary, but it is moving from left to right. So, all the accumulated fibres or the layer of fibres which are there will be brought close to a twisting roller as shown here.

The twisting roller is closely spaced with respect to the perforated surface. So, the perforated surface and the twisting rollers are very close to each other, the space is very very narrow. It is so narrow that this accumulated fibres cannot really pass through this gap. This is the gap which is here, but this gap is very very narrow and the fibres cannot pass through. So, accumulated fibres will be coming and it will come into contact with the twisting roll and will gather there.

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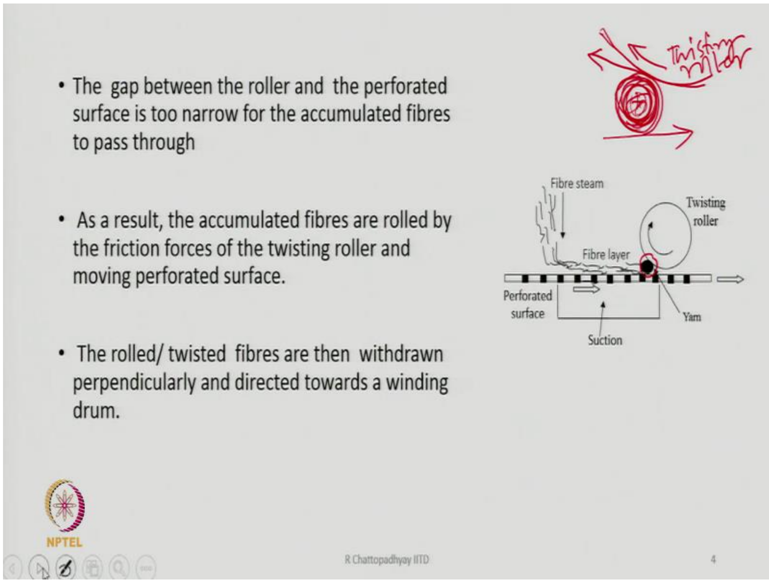

Now, what is going to happen? The accumulated fibres are will be rolled now because this as it is shown here this region if we look at this if this is the accumulated fibres like fibres are accumulating here and then this surface is trying to move this way and the roller surface is also giving a friction it is going this way and therefore, this bunch of material which is here is receiving a torque and as a result of this torque this is going to rotate and therefore, it will get twisted.

So, the movement of the perforated disc and the movement of the twisting roller so, this is the twisting roller these two are actually twisting the accumulated fibres. So, the bunch of fibres as soon as they arrive over there they get converted into a twisted bundle of fibres and then we remove this bundle of fibres twisted bundle of fibre which we call yarn and then we try to wind the yarn on a package.

So, this is the principle that is we have to have a bunch of slivers separate the fibres from each other and then carry them forward by a stream of air, allow them to settle on a perforated disc through which the suction is acting. So, the fibres will remain there and the air will move out.

Perforated disc will carry the fibres forward where strategically a twisting roller is placed and the gap between the perforated surface and the twisting roller is so narrow that the fibres cannot really not be able to pass through, because the fibres was already you know it has a thickness now.

The movement of the perforated surface is quite slow so that the fibre arrival speed is much more than the fibre movement from left to right. So, fibres will come and many many fibres will come and settle on the perforated surface it will form a thick layer and that the, layer is so thick that will not be able to pass through that narrow gap and as soon as they arrive near that narrow gap it receives a torque and as a result of this it get twisted. So, that is the principle of friction spinning.

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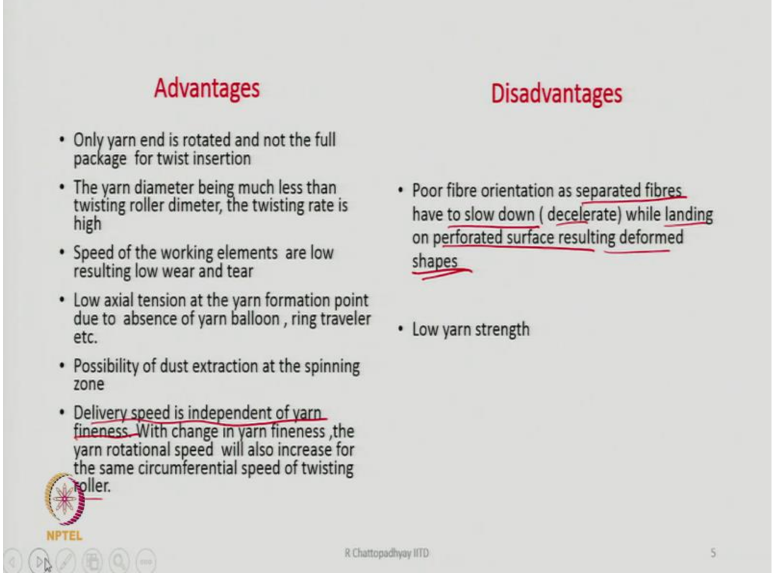

Now, because of this principle what are the advantages we get? Only yarn end is rotated and not the full package for twist insertion that is the first point, that is if I want to wind side twist by only rotating the yarn end not the package that we rotate in the case of ring spinning to insert twist. And the yarn diameter being much less than the twisting roller diameter, the twisting rate is very very high.

Ultimately the roller the twisting roller diameter and the yarn diameter these two are actually you know we will decide the speed of the yarn end. It is diameter ratio that will matter and therefore, the this is the ratio is quite big therefore, for every revolution of the your twisting roller we get many more revolutions of the yarn because yarn diameter is much much smaller in comparison to the diameter of the twisting roller.

Speed of the working elements are very low resulting less wear and tear because in the twisting roller if you see we will see the speed of this, they are much less in comparison with the speed of spindle or the speed of the you know rotor in the case of rotor spinning or ring spinning spindle comparison to both of them the speeds of the twisting element in this case which is a we will see that there is a twisting roller is much much less. So, wear and tear also will be much less.

Low axial tension at the yarn formation point due to absence of yarn balloon, there is no ring traveller combinations. So, tension is very low and therefore, we will expect the less number of end breakages during spinning and possibility of dust extraction at the spinning zone is possible, because there are perforations on which fibres are coming and depositing through those perforations we can suck out the dust along with the air also so, that possibility exist.

The other important point is delivery speed is independent of yarn fineness. This is very very interesting in this case. Delivery speed is independent of yarn fineness, we will discuss more about it with change in yarn fineness the yarn rotational speed will also increase for the same circumferential speed of the twisting roller, because the yarn tail is receiving motion from the twisting roller through frictional contact.

Therefore, if the yarn diameter reduces when we try to make a finer yarn then the speed of the yarn also will goes up and therefore, we can say twist will also goes up. So, that advantage you need not to adjust the speed of the twisting roll it will automatically speed up the twisting roll will not change, but speed of the yarn tail which is actually rotated.

And therefore, the yarn receive twist that speed will automatically increase, but disadvantages are poor fibre orientations because separated fibres have to slow down or decelerate when landing on the perforated surface resulting in deformed shapes this is something which is quite dangerous because most of the fibres will change their straightened configurations.

They come at a high speed and then they slow down they are made to fall on a slower moving surface. So, they deform because of decelerations and hence the yarn becomes very very weak because most of the fibres are highly deformed. So, utilization of the length of the fibre is not fully realized that is one of the serious drawback with this technology.

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Now, that is the basic principle now we will be focusing more on Dref-2.

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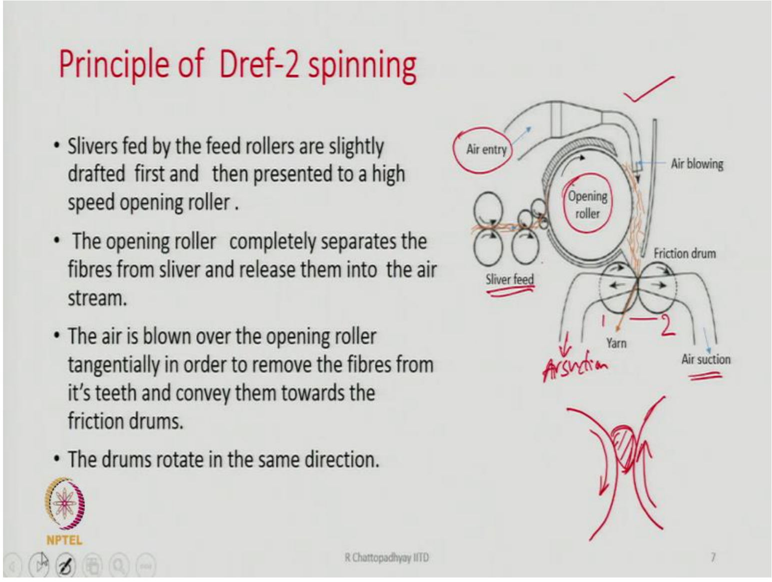

A picture of Dref-2 is shown on the right hand side, what we see here this is the sliver feed that is we are feeding a sliver there has to be some kind of feed arrangement and then there is opening roller and then the opening roller is separating the fibres from the sliver and making a stream of fibres.

Now, from the opening roller surface the fibres have to be removed and for that we have an air entry through this air is blown and that air is at going to act on the surface of the opening roller and remove the fibres from the surface of the opening roller teeth. And once the fibres are removed from the teeth that is; that means, the opening roller surface is completely stripped off, the fibres are going to land on friction drums which are here drum 1 and drum 2 there are two drums on which they will land.

So, slivers are fed by feed rollers they are slightly drafted and then presented to a high speed opening roller. Opening roller completely separates the fibres from the sliver because of their high speed. So, the draft between opening roller and the sliver feed arrangement is very very high. As a result, the fibres are thoroughly separated from each other.

The air is blown over to remove the fibres and they are made to land on the friction drum. Friction drum are connected to suction air suction you see this side and this side also. This is also connected to air suction. So, the fibres are landing near the nip area of the friction drums.

The drums rotate in the same direction. If they rotate in the same direction then at the nip point if you look at the directions direction of you know of the two surfaces then you will find that they are opposing each other as if.

Let us say suppose this is this drum is rotating in a clockwise direction the other drum is also drum two is also rotating in the clockwise directions. But at the nip point at the nip area this drum is going this way this drum is going this directions. The directional rotation is exactly same both are clockwise. But here at the nip area the two surfaces are moving opposite to each other. This is what is going to help us. This is going to actually create friction field.

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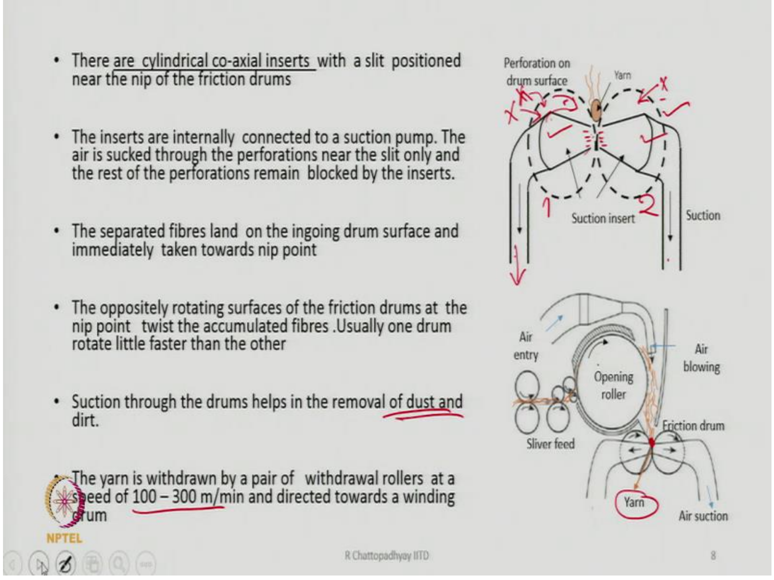

We will see that the cylinders have these drums, they have cylindrical co-axial inserts this is the inserts with a slit position near the nip of the friction drum the slit is here, here is the slit. The inserts are internally connected to a suction pump like this is connected this side also is connected.

The separated fibres land on the ingoing drum surface and immediately taken towards the nip point. So, we allow the fibres to land like if this is the surface the drums are basically perforated. But internally most of the perforations are blocked by some suction inserts and we draw the air, but the air is drawn from the nip area only, rest of the area air cannot really enter.

So, if this is the suction is acting here the air is entering in these regions near the nip area. There is no air entry from here or here they cannot enter because these holes are blocked. There is no chance of air to enter from here or from here or from here. Only near the nip area the air can enter and there rest the fibres. So, fibres are there air is trying to enter and therefore, these accumulated fibres will be under some pressure.

The oppositely rotating surfaces of the friction drums at the nip point will basically twist the accumulated fibres. Usually, one drum rotate little faster than the other. Between the two drums this is one drum this is another this is the you see this is drum 1, this is drum 2 one of them will rotate little faster than the other. We will see why it has been done later on. They are practically same, but one is little more maybe 5 percent or 10 percent more than the other. This is going to help to make the yarn little stronger.

Suction through the drums suction through the drums help in removal of the dust particles which are still left in the sliver. The yarn is withdrawal by a pair of withdrawal rollers at a speed of 100 to 300 meters per minute. So, once the fibres are at this nip point they are accumulating there because they are coming at a much faster rate, but their removal rate is slower and therefore, there is always an accumulations.

An accumulation that is equal to whatever count of yarn we expect and they are receiving twist because of the; because of the two drums which are there and we will see that when we will discuss the twisting actions in little detail. So, once the yarn is formed here it is withdrawn by a pair of rollers and once it is withdrawn it goes to the winding drum for winding in the form of a cone or cheese both are possible.

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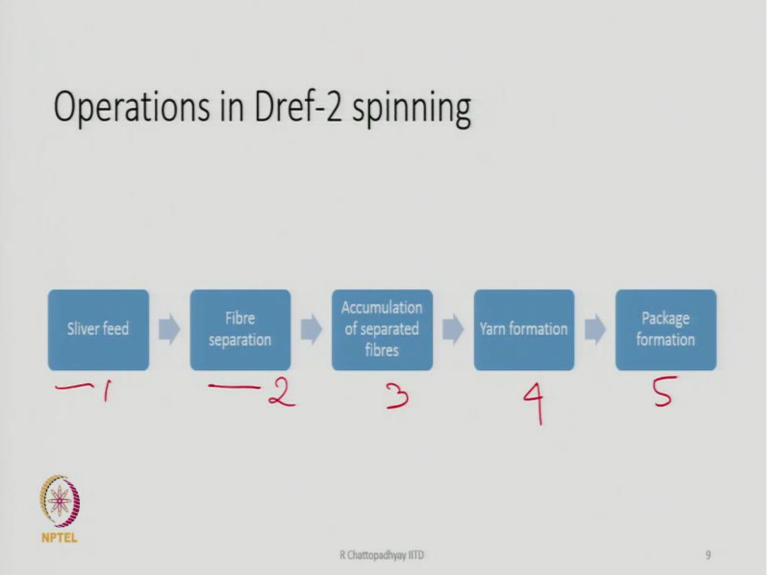

So, if you look at the operations which are there in Dref-2 spinning sliver feed, fibre separations, accumulation of separated fibres, yarn formations and packaging.

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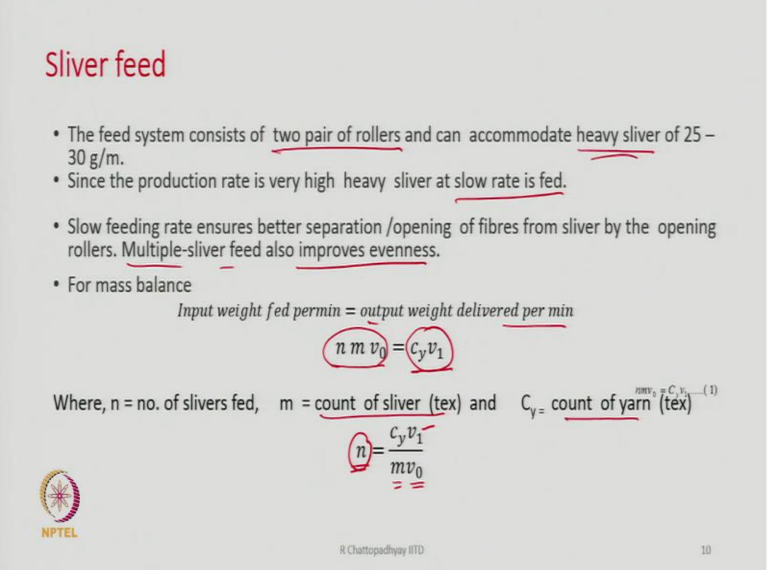

So, sliver fit is simple sliver feeding arrangements the feed system will consist of two pair of rollers and can accommodate heavy slivers of 25 to 30 gram per meter that is 30 almost 30 kilo tex for Dref-2. Since production is very high heavy slivers at a slow rate is fed. Slow feeding rate ensures better separation of opening of fibres from sliver.

If I feed the sliver slowly and then I they are acted by very high speed opening roller in the separation of fibres is going to be much better. Therefore, we feed heavy slivers. So, multiple sliver fit also improves evenness as well. For mass balance input weight fed per minute is will be equal to output weight delivered per minute. So, whatever I am feeding same has to be the output.

$$input\,weight\,fed\,per\,\min = Output\,weight\,delivered\,per\,min$$

$$n\,m\,v_0 = \,c_y\,v_1$$

Therefore, n m v0 is going to be Cy into v1. What is Cy into v1? When n is the number of sliver fed, m is the count of individual sliver in tex and Cy is the count of yarn also in tex and v0 and v1 are the speed of the feed roller and v1 is the speed of the withdrawal roller. So, v0 is the speed of the feed roller and v1 is speed of the withdrawal roller.

$$n = \frac{c_y\,v_1}{m\,v_0}$$

So, c1 v1 that becomes the yarn delivery per minute in terms of gram per meter or in terms of per sorry per meter gram per minute and this side loss will be the amount of sliver fed per minute that is gram per minute. So, these two mass balance always and if it is so, we can find out the value of n.

How many slivers I have to fed for producing a certain count at a certain speed. A certain count which is Cy at a certain velocity or certain delivery rate which is v1 and if I know the my delivery feed rate is v0 and if m is the sliver gram per meter that is the you know kilo tex value of the sliver individual slivers then how many slivers I have to feed in the system, we can easily find it out. So, that is a very simple straightforward type of you know relationship.

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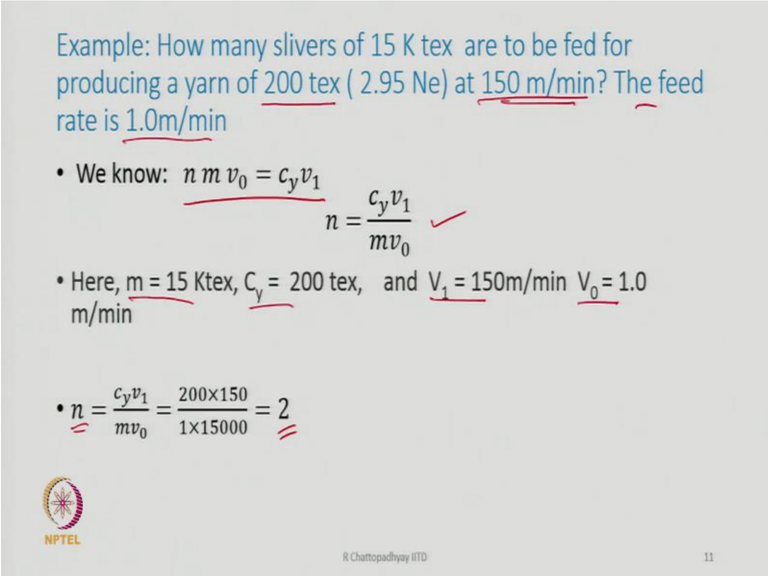

$$n\,m\,v_0 = c_y\,v_1$$

$$n = \frac{c_y\,v_1}{m\,v_0}$$

$$n = \frac{c_y\,v_1}{m\,v_0} = \frac{200\times150}{1\times15000} = 2$$

Like in the example how many slivers of 15 kilo tex are to be fed for producing a yarn of 200 tex at 150 meters per minute the feed rate is 1.0 meters per minute. Now, we have to think of feeding very slow always. So, 1 meters per minute is a slow feed rate. So, if I use that equation mass balance equations from there, we write n equal to this in this case value of m value of Cy value of V1 value of V0 they are all given and we can find out n to be 2 then we need to feed 2 slivers of 15 kilo tex.

If the slivers are not 15 kilo tex typically cotton slivers cannot be 15 kilo tex it could be 5 kilo tex or 5.5 kilo tex something like this in that case 15 you will replace by maybe 5 or maybe 6 and we can find out how many n value will be there.

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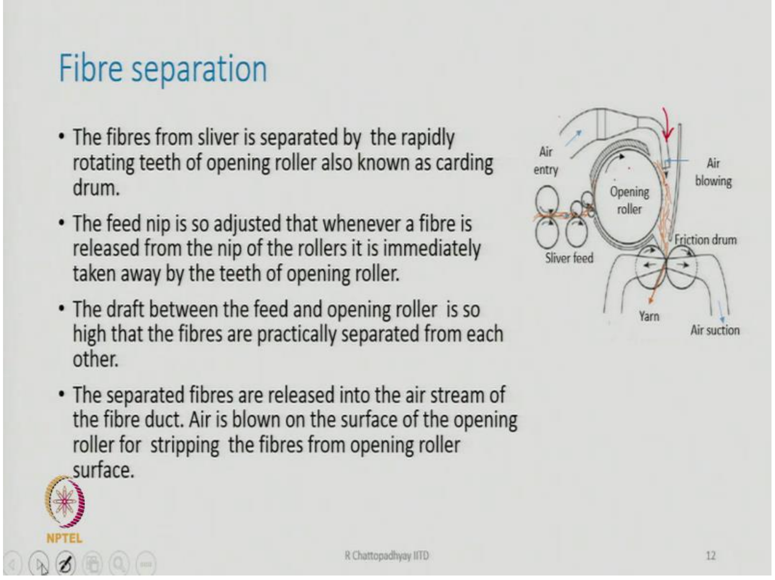

But n has to be always a integer that we have to remember that n value has to come in integer. So, some we have to match F cannot be 2.5 or 2.4 or some 3.2 something like this is not possible or keeping n fixed I can find out what should be the input sliver linear density in kilo tex.

Now, when it comes to fibre separations fibres from slivers is separated by rapidly rotating teeth of the opening roller, opening roller runs at a very high speed maybe at the speed of 10000 12000 rpm. So, surface speed is very very high and therefore, fibres will be separated from each other from the sliver. The separated fibres are now released into an air stream and air is blown on the surface of the opening roller by stripping for stripping the fibre.

So, this is the a blower is here, this blower is actually blowing air and the velocity of the air at this point must be more than the velocity of the opening roller surface then only the air will be able to remove the fibres from the surface of the opening roller. And then these fibres will be approaching the friction drum because they are now going to actually get deposited on the surface of one of the drum or almost close to the nip line.

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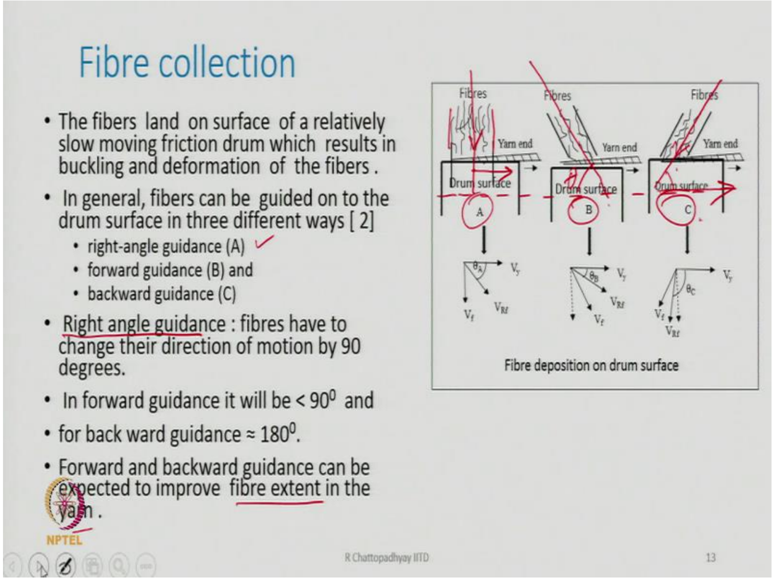

In a fibre collections the fibres land on the surface of the relatively slow moving friction drum. See friction drum in this case is a very they are both are perforated and their rotational speed is relatively less in comparison to the incoming speed of the fibres, because fibres are coming in the form of a very thin stream of fibres are coming. We have to actually allow the fibres to form a bundle and then this bundle has to be twisted.

So, in order to you know make sure that the layer of fibres gets formed on the surface of the drum the drum speed is slow in comparison to the incoming speed of the fibres. The negative consequence of this is that a fibre is coming at a higher speed and settling on a drum surface which is moving at a slower speed.

As a result, the fibres will be buckled. So, that is the you know situation and that exists as of now the fibres are bound to buckle because they are coming and hitting a slower moving surface. Anyway, after landing there while they are approaching the drum surface there are three possibilities A, B and C.

A is right angle guidance of fibres on the drum surface. See here they are basically they are coming straight with respect to the drum axis it is perpendicular. Drum axis is here. With respect to the axis these fibres in the case of A is coming perpendicular. In the case of B, it is coming at an angle like this is the angle and in the case of C they are also coming at an angle.

There are three different way of guiding the fibres on the surface of the friction drum. Here it is perpendicular. Now, out of this what happens we will try to you know find out or create a situation so that the buckling effect of the fibres can be minimized.

Now, if you go for right angle guidance fibres have to change the direction of motion by 90 degree. They are coming this way and then suddenly they will be falling on it and they will move in these directions. So, coming this way and then moving in these directions; that means, directional change by 90 degree.

In forward guidance that is in the case of B the theta angle is much less than 90 degree; that means, the fibres directional change is going to be less than 90 degree. And in this case the third case C the fibres are coming in these directions and then it has to completely change direction in this way. So, almost 180 degree change in directions in the case of C.

So, out of the three different configuration of the feed duct the duct that is carrying the fibres from the opening roller surface to the drum surface this space is actually in the form of a duct. And there are three different configuration A, B, C we have to choose a configuration which will distort the fibres to the minimum extent.

Forward and backward guidance can be expected to improve the fibre extent in the yarn. Can be expected both forward and this is called in the C is the backward because of change in directions there is a chance that they may able to straighten out the fibres a bit and therefore, improve the configuration of fibres.

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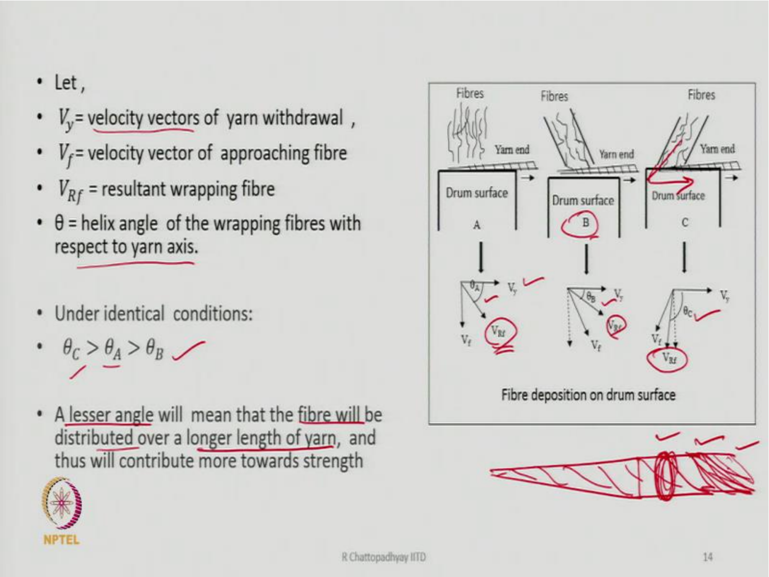

Now, this has been you know depicted also by this you know diagrams like Vy if we consider the velocity vectors of the yarn withdrawal and Vf is the velocity vector approaching fibre and VRf become the resulted wrapping fibre and theta is the helix angle of the wrapping fibre with respect to the yarn axis that is on the yarn tail as soon as the fibre arrives. Once the fibre arrives and it is starts getting wrapped around the yarn end which is resting on the drum surface.

Now, when it is trying to getting wrapped because ultimately fibres after landing on the drum surface it is immediately receiving a torque because the two drum surfaces are acting on it and any fibre all fibres whichever coming, they are getting some kind of torque from these two friction drums.

$$\theta_C > \theta_A > \theta_B.$$

And as a result, they are trying to get wrapped around the already existing tail of yarn which is already there. So, this wrapping angle theta A in the case of B it is going to be theta B in the case of C it is going to be theta C. So, the resultant velocity of vector is shown V Rf in this case in this case and in this case and if you look at the wrapping angle then under identical condition theta C is greater than theta A than theta B.

A lesser angle will mean that the fibre will be distributed over a longer length of the yarn and thus will contribute more towards the strength. So, the fibre is getting wrapped over a longer length of the yarn that is a better you know way of wrapping the yarn or following the axis of the yarn then if it is wrapped almost perpendicularly to the yarn axis; that means, if the yarn tail see; instead of getting wrapped this way if the wrapping angle is this is better than this that what is trying to say.

So, if you allow them to land perpendicularly then we will get such kind of wrappings; that means, the fibre extent will be less, fibre will be wrapped over a smaller you know length of the yarn and that will not be fibre will not be able to contribute fully to the yarn strength. Whereas if they are inclined with respect to the axis to a certain extent then that kind of wrapping will be better from the point of view of realization of the yarn strength.

Therefore, theta A theta B is the best; that means, this kind of configuration is the best followed by theta A and then theta C, theta C can disturb a lot because the fibres are going this coming this way and then taking turn these directions and therefore, it is wrapping angle is going to vary a lot. So, that kind of configuration of the feed duct is not really very helpful.

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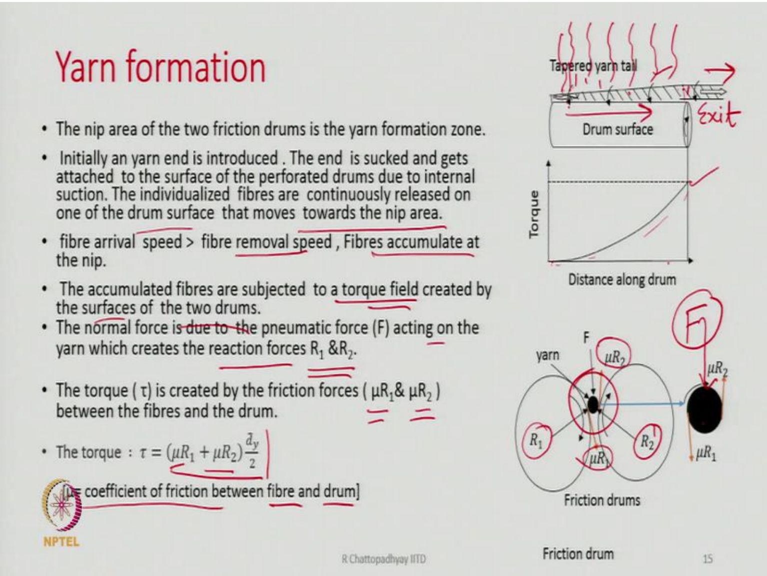

Yarn formation if we come on the drum surface if we look at the see initially, we have to feed a seed yarn and then as soon as the fibres keeps coming and they getting attached to the yarn already existing there and we are pulling out the yarn after some time the original yarn will be taken away, will be left out with a yarn tail which is tapered as shown in the diagram because fibres are coming like this fibres are coming over the.

So, whenever fibres are coming from here and then it is ultimately it is going to form left to right. So, fibres as fibres which is from the left hand side as it starts moving towards the right hand side it receives more and more fibres on the top of it and therefore, what happens; that means, the yarn will be gradually thicker towards the exit end of the machine this side is the exit.

Here whatever fibres are there it is coming and falling they are always less in number, when this goes from this section segment goes to the next segment on the right hand side, it receives some more additional fibres then that segment is going also moving toward the right it receives still more fibres.

So, as these segments if we imagine that this tail is actually if I divide it into number of segments and if we imagine that the segment which is at the extreme left it will keep on receiving fibres as it going from left to right. So, by the time they are reaching the exit end they will be very very thick and the part which is in the extreme left will be thinner. So, at any point of time the yarn tail will look tapered.

Now, the nip area of the two friction drum is the yarn formation zone. So, this is the nip area. So, yarn formation zone is this is the place this is the yarn formation zone. Initially all yarn end is initially and yarn end is introduced; that means, a fresh yarn is always first introduced. The end is sucked and gets attached to the surface of the perforated drum due to internal suction.

The moment I insert the yarn end it will be immediately sucked and the yarn end tail is going to ultimately settle where it will be settled at the nip area because that is the area which is through that area perforations of that area the air is actually going inside. So, the yarn end also will ultimately settle there.

The individualized fibres are continuously released on one of the drum surface that moves towards the nip area. So, any fibre which are getting released from the rectangular surface will also reach that area. If fibre arrival speed is greater than fibre removal speed so fibre will start accumulating in the nip zone.

The accumulated fibres will be subjected to a torque field created by the surfaces of the two drums. The normal force is due to the pneumatic force the pneumatic force which will be acting on if this is the yarn cross section also. So, this is the value of F which is the pneumatic force which is acting. See the we are trying to suck the air to the perforations fibres are coming and blocking that air blocking that perforations.

So, a pressure differential will be created that is what will lead to giving you the force F that is the pneumatic force. Now, the pneumatic force acting on the yarn which will create the reaction forces R 1 and R 2. So, F which is acting on the yarn cross section can be resolved with two components R 1 and R 2 and R 1 R 2 are the reaction forces.

So, torque created will be by the frictional forces mu R 1 and mu R 2 like mu R 1 is shown here and mu R 2 also shown here. So, torque is going to be mu R 1 plus mu R 2 into d y by 2, where d y is indicating the average yarn diameter. That is the average diameter of the yarn tail actually.

See yarn tail is not uniform. Its diameter is not uniform. It is thicker here and thinner than other end. So, tail is not of uniform diameter. So, we go by the average diameter of the yarn tail and that is d y dash. So, this is what is going to be the torque and this torque is going to actually rotate the yarn.

$$\text{The torque: } \tau = (\mu R_1 + \mu R_2)\frac{d_y}{2}.$$

μ is the coefficient of friction between fibre and the drum. And this torque if we plot distance along the drum and torque this is the graph we get. That is the torque is almost 0 here because the diameter of the yarn is almost in, and the diameter increases. The torque value also goes up because diameter is more here and minimum here.

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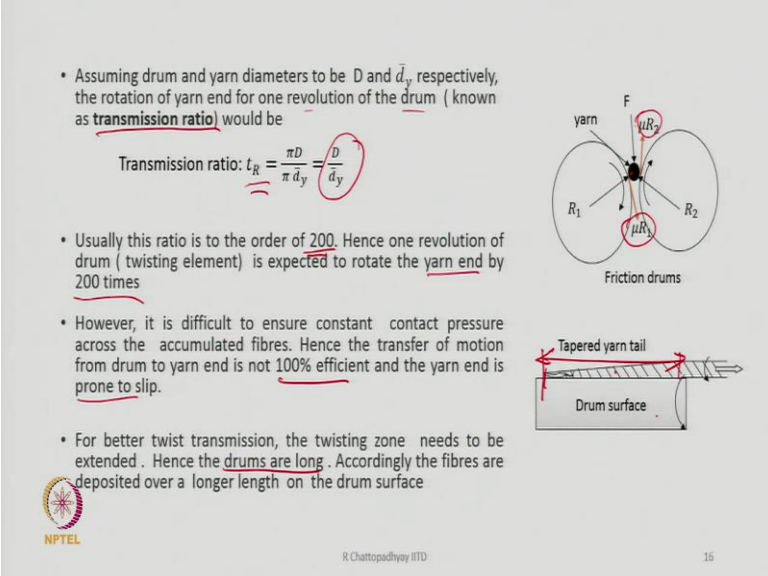

Assuming the drum and the yarn diameter like capital D and small d y respectively the rotation of the yarn end for one revolution of the drum is also known as transmission ratio. The transmission ratio t R is pi capital D by pi d y. So, this is D by d y. Average diameter of the d y is known as the transmission ratio.

$$Transmission\,ratio{:}\ t_R = \frac{\pi D}{\pi d_y} = \frac{D}{d_y}$$

Usually, this ratio is with the order of 200. Hence one revolution of the drum with expected to rotate the yarn end by 200 times. So, we get a transmission ratio of 200. However, it is difficult to ensure constant contact pressure across the accumulated fibres. Hence the transport of motion from drum to yarn end is not 100 percent efficient and the yarn end is prone to slip.

This end very difficult to ensure that it remains in contact with the drum surface, there are many reasons why it loses contact and therefore, the transmission of motion from drum to yarn tail this is the friction drive. Drum is rotating at its own constant speed. The Tail is resting on it. So, tail is actually friction driven. So, there is a chance of slippage due to many reasons.

For better twist transmission the twisting zone needs to be extended. Hence the drums are long, otherwise why should we go for long drums? The idea is that if you have a larger surface area of contact from here to there then transmission of drum speed to the yarn tail speed will be better. Slippage will be less.

And this is diagram we have already discussed. That friction drums this is the yarn cross section μ R 1 and mu R 2 are the two frictional forces resulting into development of torque in the yarn cross sections. That is leading to twisting of the yarn.

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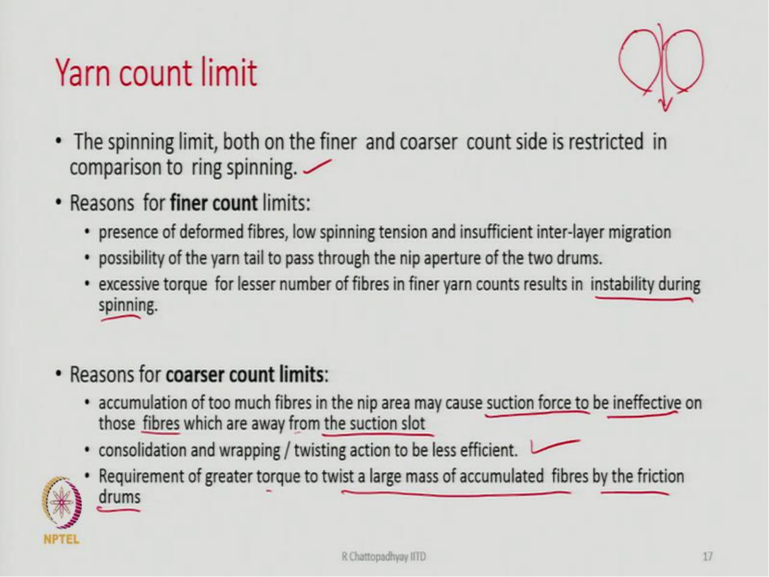

Now, the count limit in the system; the spinning limit, both on the finer and the coarser count side is restricted in comparison to ring spinning. Reason for finer count limits, presents out deformed fibres as low spinning tension and insufficient inter-layer migration. Means as we go to our finer and finer counts the yarn will be more and more weak and therefore, spinning will be almost impossible. So, very fine count we cannot therefore, clearly produce here.

Possibility of the yarn tail to pass through the nip aperture of the two drums that means that if the yarn is too fine through this nip apertures. Next is the possibility of the yarn tail to pass through the nip aperture. See; between the two drums there is little bit gap we maintain. The drums are not supposed to contact each other, you know they are metallic material.

We have to maintain certain distance. If the yarn is too fine it will pass through this gap. So, very fine count therefore, is not possible because when we find count yarns will be much less than a milli meter in terms of diameter. And excessive torque for lesser number of fibres in the finer yarn count results in instability during spinning. All these reasons we cannot really produce very fine count in this system.

And very coarse count accumulation of too much of fibres in the nip area may cause suction force to be ineffective on those fibres which are away from the suction slot. Consolidtion and wrapping or twisting action to be less efficient and requirement of a greater torque to twist a large mass of accumulated fibres by the friction drums.

So, these are the reasons to very coarse count we also cannot produce. So, there is a range of count in which a Dref-2 machine can work, but mostly we produce coarse count.

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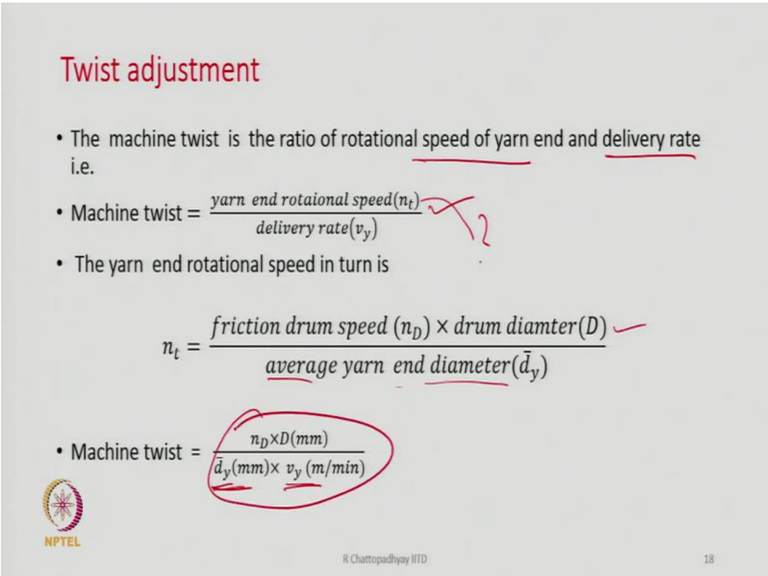

Adjustment of twist, the machine twist is the ratio of rotational speed of the yarn end and the delivery rate. So, machine twist is this yarn end rotational speed divided by delivery rate. Now, what is the yarn end rotational speed? What is this value? This is going to be the friction drum speed into drum diameter divided by average yarn end diameter.

$$Machine\ twist = \frac{yarn\ end\ rotational\ speed\ (n_t)}{delivery\ rate\ (v_y)}$$

So, machine twist is going to be therefore, n D into capital D by average diameter of the yarn and the delivery rate of the machine this is going to be the machine twist. This is the formula for machine twist.

$$n_t = \frac{friction\, drum\, speed(n_D) \times drum\, diameter(D)}{average\, yarn\, end\, diameter(\, d_y)}$$

$$Machine\, twist = \frac{n_D \times D(mm)}{d_y(mm) \times v_y(m/mm}$$

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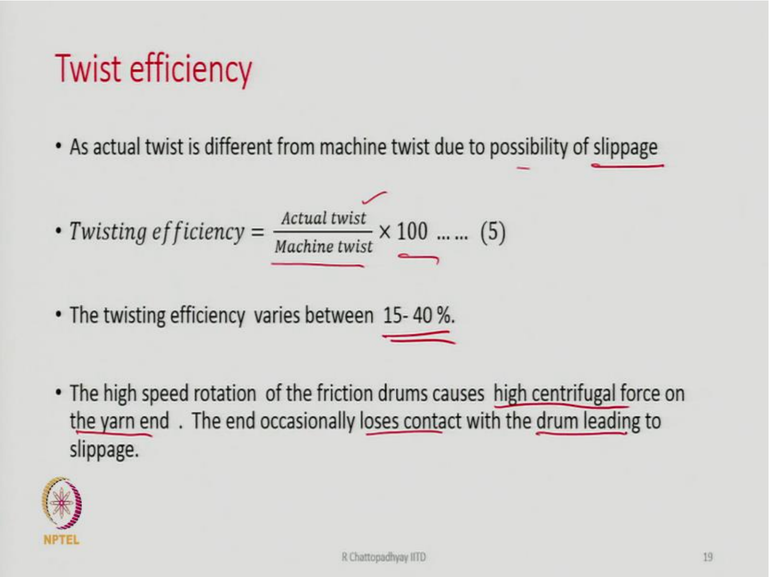

Twist efficiency is the what was the machine twist? What is the actual twist that we get? The actual twist is different from the machine twist due to possibility of slippage and therefore, twist efficiency is actual twist divided by machine twist into 100. That will give us what is the twist efficiency. Generally, twist efficiency is 15 to 40 percent. You know that means so much of slippage is there.

$$Twist\, efficiency = \frac{Actual\, twist}{Machine\, twist} \times 100$$

The high speed rotation of the friction drum causes high centrifugal force on the yarn end. The end occasionally loses contact with the drum leading to slippage. The yarn end will jump from the surface of the drum because of the very high centrifugal force which will be acting on them and therefore, they will lose contact with the drum and hence slippage will be more.

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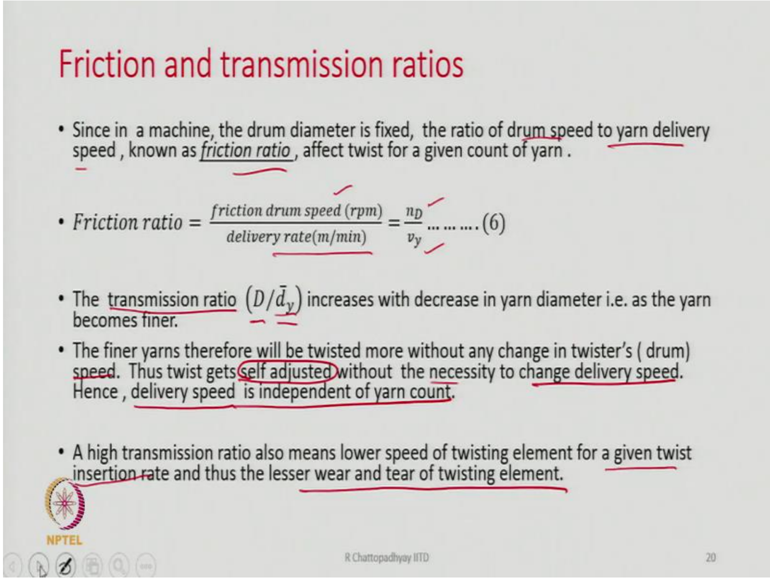

Friction and transmission ratios these are the you know we generally talk about friction ratio. Since in the machine, the drum diameter is fixed the ratio of drum speed to yarn delivery speed is known as friction ratio. So, friction ratio is friction drum speed and by delivery rate which is n D by v y that is called the friction ratio.

$$Friction\,ratio = \frac{friction\,drum\,speed\,(rpm)}{delivery\,rate\,(m/min)} = \frac{n_D}{v_y}$$

And the transmission ratio is capital D by d y average that is the yarn diameter average yarn diameter. Their ratio is called the transmission ratio. The finer yarn therefore, will be twisted more without any change in twister speed, because the moment the yarn becomes finer transmission ratio is going to increase because diameter of the yarn is going to reduce.

Thus, twist will get self-adjusted this term this is very important. Without the necessity to change the delivery speed in this machine you need not to change the delivery speed to adjust twist it will be automatically adjusted or you need not to bother about adjusting the twist in this machine. Therefore, delivery speed is independent of the yarn count.

A high transmission ratio also means lower speed of twisting element for a given twist insertion rate and thus lesser wear and tear of the twisting element. We have already you know discussed about this that I need to rotate the drum at a speed of 2000, 2500, 4000 rpm. But as we twist sorry, we rotate a twister like it is like a spindle in the case of ring spinning 15,000, 18,000 rpm or 20,000 rpm.

A twister rotor we run it at 100000 rpm or 80,000 rpm, 90,000 rpm there are very very high speed of the twisting element. Friction spinning twisting element is the friction drum. How much is the speed? Close to 3000 revolution per minute. At such a slow speed the wear and tear is going to be much much less.

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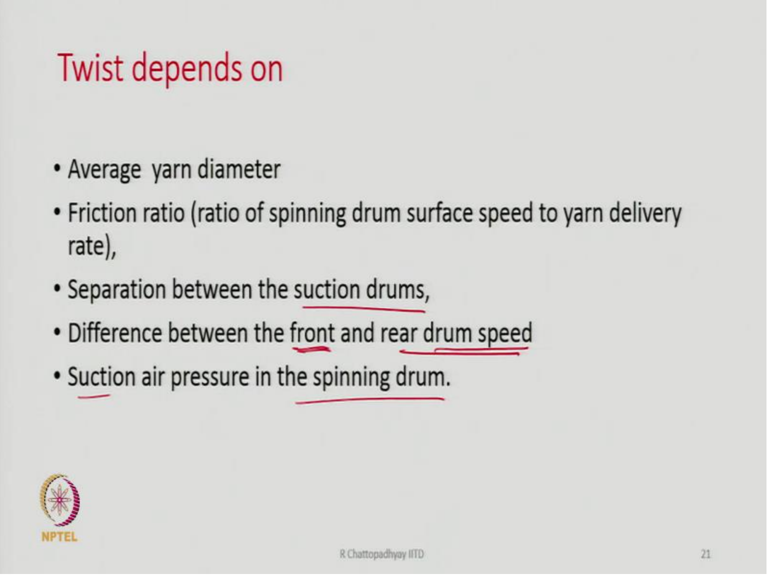

So, twist depends upon average yarn diameter, friction ratio. Separation between their suction drums. The difference between the front and the rear drum speeds is fine that these two speeds are not exactly same. We will discuss about more of them in the coming in some other lectures.

Suction, air pressure, is also another factor which can also decide the level of twist specifications of the machine.

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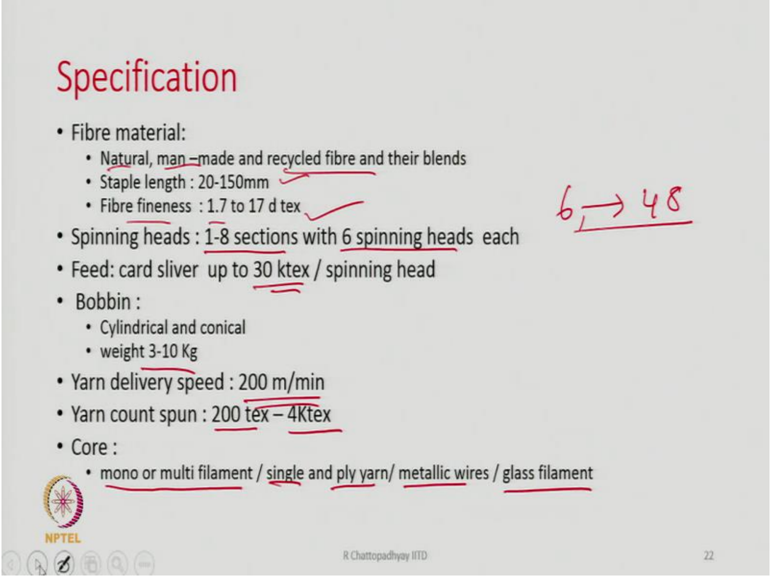

Fibre it can handle natural, manmade, recycled fibres and their blends. Staple length, 22, 150 mm, fibre fineness, 1.7 to 17 d tex. So, d tex and deniers are going close to each other. Spinning heads, 1 to 8 suction with each. Section having 6 spinning heads that means we can have a machine starting from 6 to 48 spinning heads so many spinning heads are possible.

Feed cuts, feed could be cut sliver up to 30 kilo-tex per head. Bobbin could be cylindrical or conical package can be made from weight could be 3 to 10 kg. Yarn delivery speed close to 200 meters per minute. Yarn count 200 tex to 4 kilo-tex use generally coarser count range of yarns will produce.

Core we can put mono multi filament yarns, single, ply yarns, metallic yarns, glassy filaments anything is possible we can put in the core.

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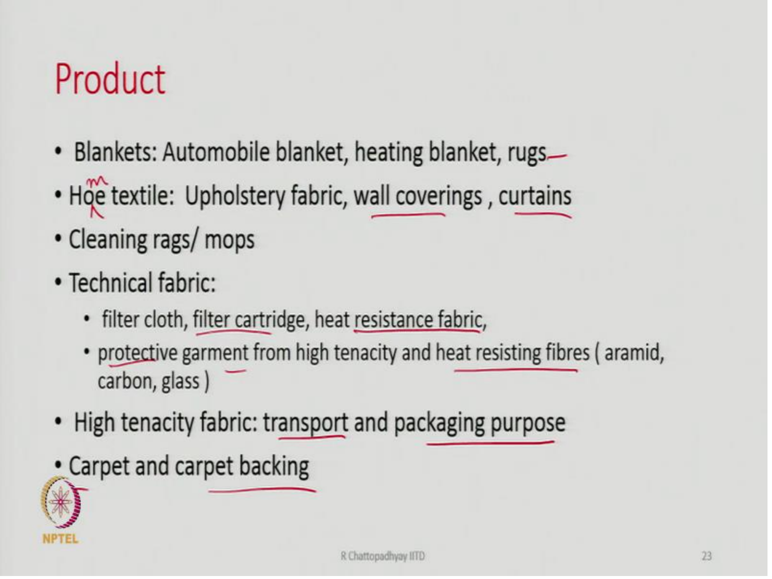

And the products which are made out of this technology are blankets for automobile blankets, heating blanket, rugs. This is home textiles, upholstery fabric, wall covering, curtains, cleaning rugs and cleaning rugs and mops. Technical fabric filter cloth, filter cartridges, heat resistance fabric, protective garments from high-tenacity heat-resisting fibres, high-tenacity fabric transport and packaging purpose.

Carpet and carpet packing basically, whatever, we can think of a product that needs coarser count yarn. Then you know friction-spinning technology may be suitable there. The second thing is that if we would requires composite yarns especially, then it will be very very suitable. So, coarse count yarns and also composite yarns, then this technology is going to be very, very helpful.

With this we close today's this particular lecture on friction-spinning. This is the we discussed about Dref-2 spinning system. Dref-3 is still left. We will discuss about them in the coming lectures. And Dref-2 technology is practiced especially for producing technical fabrics. However, we need very, you know two, three different fibres combinations and also coarse count yarns we have to, we and we really need. And this technology will be very, very suitable, ok. With this we close today's session.

Thank you.