New Spinning Technologies
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Lecture - 19
Yarn formation, structure and applications

So, now we are going to discuss the Yarn formation, the structure and applications of friction spun yarn. We have already discussed a bit about the yarn formation of Dref 2 yarn which is basically a kind of open end which is produced on the basis of open end principle.

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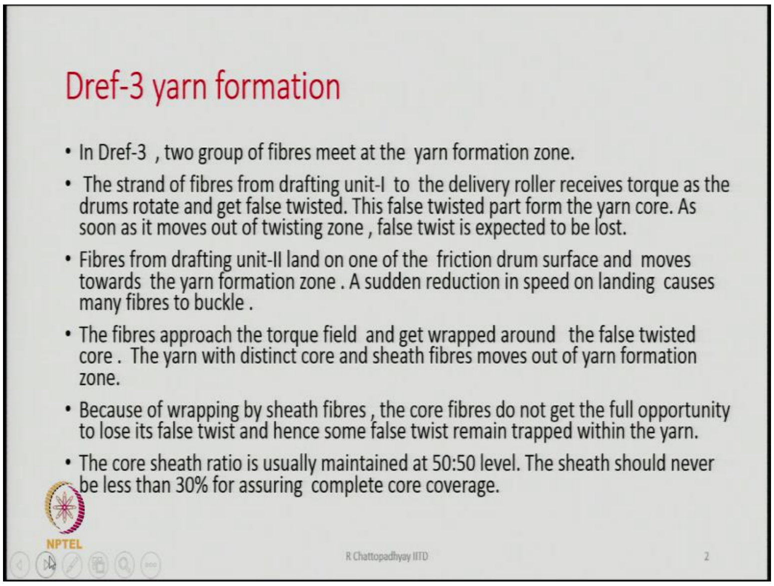

And we have discussed about them earlier. Now, in Dref-3 yarn formation, we all know that it is basically a core sheath type of structure and therefore, it is not really open end spinning, it is more close to basically wrapped spinning. Now, here two groups of fibres meet at the yarn formation zone.

One group is fed by the drafting unit-1 that is by the you know pair of roller drafting rollers and the other group is coming from the top that is basically open by the opening rollers and then they are actually landing on the surface of the friction drum and friction drums, a pair of drum is actually the twisting element of the spinning machine. So, the strand of fibre from the drafting unit-1, it flows and it reaches the nip of the friction drums and the friction drums are actually turning in the same directions.

So, that at the nip area the two surfaces of the drum rotates or moves in the opposite directions and the fibres which are coming from the drafting unit-1, these set of fibres initially get twisted by the two drums, the there are internal suction in the drum, the fibres get stuck on the drum surface and the as the surface moves the bundle of fibres which is resting on the drum surface will be twisted.

But as I said earlier also this twist is basically false twist. Now, so therefore, at any point of time what we will find that the fibre bundle coming from the drafting unit-1, they are they are basically twisted along the entire length of the drum. But once they move out from the drum the twist is going to be lost because basically it is a false twist.

Now, fibres from the drafting unit-2 that is coming from the top, they will be landing on the friction drum and the drum surface will carry them forward near the yarn formation zone where already the some fibres already exist that is the core fibres already there existing there in the form of it in a twisted state there existing there.

Now, the one you know issue that we should know that as the fibres land on the drum surface the fibres get buckled because they are approaching velocities much more than the velocity of the roller surface. So, most of the fibres which are ultimately going to form wraps they get deformed by the time they are landing on the surface of the friction drum, but that we cannot help though people are trying to somehow straighten the fibres by properly designing the transport channel.

But whatever we do ultimately fibres at a higher speed are actually landing on a slot speed surface. So, there is going to be some amount of buckling and loop formations or deformation on the fibres which will be finally, wrapped around the core. So, therefore, now these fibres are actually approaching a torque field it is a field because the entire drum surface is acting as a twist generating mechanism.

Therefore, over the entire length the bundle of fibres are getting twisted and also getting wrapped. So, wrapping is done basically on a false twisted core. Now, as soon as the fibres moves out both the core as well as the wrapped sheath fibres the core fibres will suddenly turn in the opposite direction because they have to release the twist the torque is there because the core is false twisted. And in doing so there will be lot of interaction between the two group of fibres.

Some of the false twist will be removed, but entire false twist which is there in the core fibres may not be removed because, they remain trapped by the sheath fibres. Sheath fibres are already existing on them and trying to grip these fibres the core fibres. Therefore, even though the core fibres is experiencing an untwisting torque it may not be able to you know still the entire torque may not get removed from it.

And therefore, sometimes we expect that the core fibres in the case of Dref-3 type of structure where there is a core and say some twist may be still left in the core. The core sheath ratio is usually maintained at the level of 50-50 it could be 60-40 or at least 30 percent sheath fibres as required in order to produce a yarn which will have you give you a reasonable strength and elongations.

So, usually it is 50-50 or 60-40 or 65-35 that is a typical core sheath ratio and maximum people go up to 70 percent core 30 percent sheath, but is never 80 percent core and 20 percent sheath. In that case the yarn is going to be very very weak. Now, we will discuss about the structure of both the yarns, Dref-2 and Dref-3.

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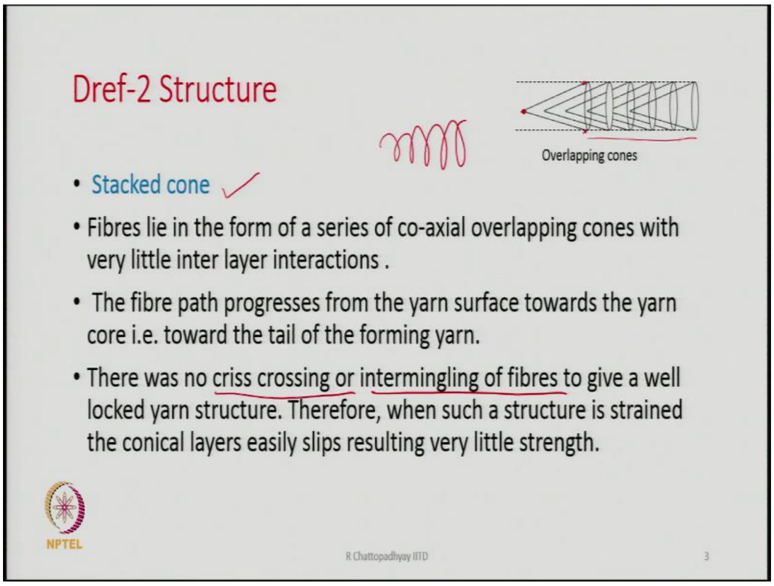

Dref-2 structure as I said earlier it is basically the principle of spinning is based on almost basically on the open end spinning principle because there is no core filament or core fibres were introducing. There is no drafting unit-1, there is only one drafting unit where fibres are opened out by the opening rollers and then they are released on the friction drum.

Now, here there is one concept that has been proposed that this is like a stacked cone that a fibres are actually getting wrapped and they are actually existing on the surface of a cone as if the fibre is forming a conical surface each an individual fibres and the yarn is a stack of series of cones; that means, fibre is existing at the center, the same fibre you also go at the surface.

So, automatically people may feel that there is some kind of migration like ring spinning that if the same fibre is existing in the core and again the other part of the fibre is existing at the surface of the yarn; that means, there is a migration. So, if there is a good migration one would expect good strength, but Dref-2 structure never gives you a strong yarn and it has been found that these yarns if you know put some load on it the yarn will fail and the failure is because of the slippage of fibres.

If the fibre slippage is the primary mode for yarn failure that basically means that is some absence of interlocking between the fibres. If the interlocking is not there, there cannot be gripping action between the fibres. Therefore, it has been seen also that we can propose that the crisscrossing or intermingling of the fibres does not exist.

The fibres are actually this is this in the form of the cone another fibre is also following a conical surface and if we have a stack of cones one after the other the yarn will look uniform, but if I pull them out the entire fibre will move out, because inter cone migration is not there. And hence these yarns are basically very very weak.

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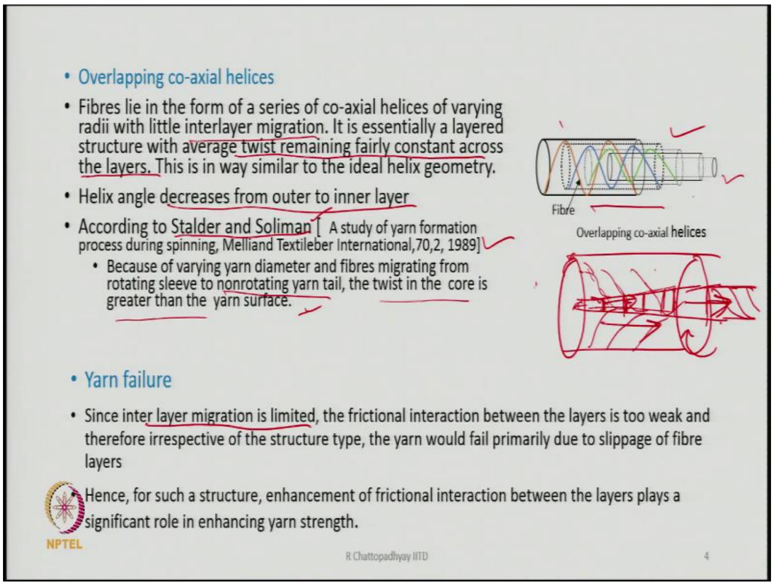

The other proposal is something like this that it is basically in the form of a coaxial helices of various or varying radii the little inter layer migrations. By studying the fibre configuration in the yarns using tracer fibre techniques. This is also has been found that the way the twist varies that it can also have a structure something like this.

That is as it is shown here you see that there is this quite a few coaxial cylinders are there and if a fibre is moving around the cylinder then and if the cylinders are there one after the other they are overlapping each other then there is still may not be any migration between the between the fibres that is the fibres are not really crisscrossing.

A fibre is following a helical path of uniform diameter. Fibre which is there on the yarn surface it is following the helical path of the yarn diameter, maximum diameter. A fibre that exists at inner layer it is following also following a you know uniform a helical path having uniform radii.

If the radii of the path does not change; that means, there is no migration from layer to layer migration will not be there and if it is not there then there is no gripping between the fibres and therefore, if I pull this bundle of fibre twisted fibres the yarn will fail. So, even though apparently it will look like lot of twist is there, but still the yarn will fail because of slippage of fibres.

So, that has been seen by some people after studying the way the you know studying the helix angle of the fibre using pressure fibres and it has been shown that helix angle decreases from outer layer to inner layer. The average twist remains fairly constants across the layers.

So, the twist remains constant the twist angle which is the helix angle will keep changing from outer to inner. There is another you know opinion by Stalder and Soliman where they are also proposing that because of the varying yarn diameter and fibre migrating from rotating slip to non rotating yarn tail.

See this I have not really discussed, but there is another theory or we can say you know an idea given by these two you know researcher that there exists a sleeve between the two drums and the sleeve rotates and there is a yarn tail which exists within the sleeve, but this yarn tail is stationary is not rotating at all and the fibres are actually moving from the inner surface of the sleeve to the non-rotating yarn tail.

The sleeve rotates as tail is stationary the fibre will be wrapped because what we need is relative motion. So, in this case the tail of the yarn which is existing within the sleeve is non-rotating it has only a translational motion that is it is can only move forward directions because we pull the yarn out, but the tail is not rotating.

It is the sleeve that exists between the drum which is larger in diameter and rotates at a speed depending upon the what is the diameter of this and what is the frictional contact it has with the drums and what is the drum speed. And from the sleeve rotating sleeve fibres are actually transferred to the non rotating yarn tail and hence the yarn tail is not uniform from the delivery end to the opposite.

See if this is the sleeve the tail exists like this. And fibres from the inner wall of the sleeve is passing over it and the sleeve is only rotating in something like this. So, this is the yarn tail is moving out it is stationary and from the inner wall of the sleeve the fibre. The sleeve is forming by the fibres which are fed from drafting unit-2.

There actually the fibres are landing on the drum and they are forming a kind of rotating cloud, rotating sleeve and the rotation of the sleeve actually is causing fibres. Somehow the sleeve is not very smooth; it is consisting of large number of fibres and therefore, the inner from the inner surface of the sleeve fibres coming into contact with the yarn tail.

Tail also has some projecting fibre. So, somehow they get cut by the fibres projecting out from the yarn tail and once they are cut they start getting wrapped that is how the twisting process is going on that is what has been proposed by these two researchers and that paper is also published as it is shown here. And what they say? If I am rotating the fibres around the yarn tail wherever the diameter is less rotation will be more wherever diameter is bigger rotation will be less and therefore, twist will be varying.

So, because of the varying yarn diameter and fibres migrating for rotating sleeve to non rotating yarn tail the twist in the core is greater than on the yarn surface. So, twist fibres which are getting wrapped over here that twist will be more. See this fibre will gradually move. So, at different point of time it is wrapped here, then this part is coming over here, then this part is coming over here, then this part is coming over here because it is continuously moving.

So, the fibre therefore, the yarn tail is tapered. On the delivery side it is coming to the dimension of the yarn, but at the other extreme end it is thinnest and the thin portion keeps on moving forward and it is receiving fibres continuously as it is travelling through the sleeve length or across the length of the friction drum.

That is how this kind of theory also has been proposed and based on that they are saying something about the way the yarn twist will vary. So, that are now different types of you know ideas have been proposed by different researchers and we need to know them the yarn failure.

Based on these two we if we see that whether it is this way whether it is a you know overlapping coaxial helix or it is basically overlapping of conical yarn or conical structures. If there is no inter layer migration there is no gripping between the fibres and therefore, there is hardly any strength that will get into the yarn. So, therefore, since inter layer migration is limited frictional interaction between the layer will be too weak and irrespective of the structure type the yarn would fail primarily due to slippage of fibre.

That is one of the greatest weakness of Dref-2 technology. So, in the case of Dref-2 technology, if we want to enhance the yarn strength the only way that is left with us is to introduce a strong filament in the core that is only way. So, if we want to produce certain yarns where the load bearing part of the yarn is filament that exists in the core. And we want to surround the filament we want to cover the filament by some other fibre due to some other reasons because maybe we want to have a good sensation of touch.

Therefore, the sheath fibres has to be maybe cotton or maybe viscose rayon or something, but the inner fibres could be that is filaments could be many other may be carbon fibre, may be copper fibres, may be very strong high tenacity polyester filament depending upon the need of the product we can have some strong filaments there and it is generally preferred to have multi filament yarn than monofilament.

Because of what will be the problem if we have a monofilament then wrapped by cotton or wrapped by polyester fibres, stable fibres or maybe polyester viscose staple fibres. What will be the what will be the you know the difficulty that will face after the yarn has been produced?

Student: Slippage.

There will be.

Student: Slippage.

There will be slippage yes the interfacial you know interaction between the filament and this staple fibres are not very good not very strong and therefore, usually we find there is a slippage of the sheath fibres or fibres which are wrapping the filament core this is a typical problem they can easily slip on the core and that may lead to some kind of difficulty during the formation of during winding of the yarn subsequently or during the formation of the you know fabric also. So, that difficulty could be there.

So, this is one of the you know problem of this particular technology, but there are different people have tried different ways to solve this problem also that is given the yarn the heat treatment and through that maybe some kind of some kind of bonding is created between the filament and the and the staple fibres in some situation it may work.

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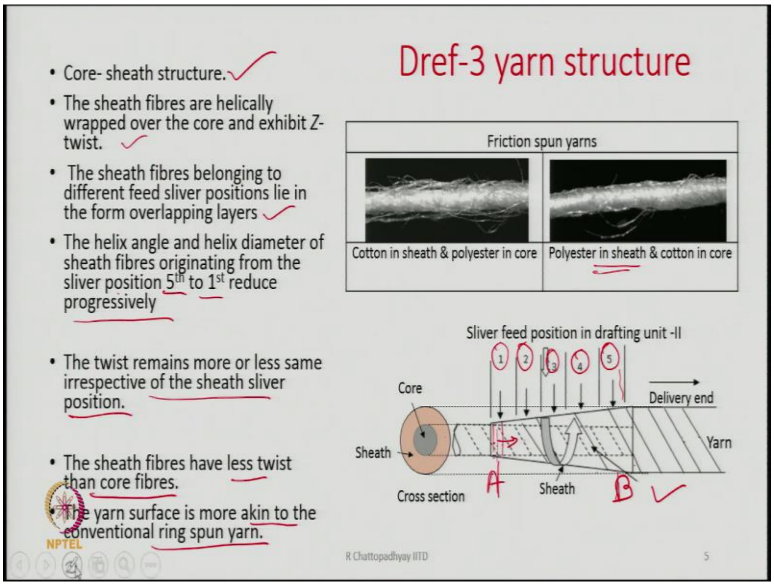

Then if we go to Dref-3 structure; Dref-3 structure it is a basically core sheath type of structure where there really exist a core the sheath fibres are helically wrapped over the core and exhibit generally Z-twist sheath fibres belonging to the different feed sliver positions lie in the form of overlapping layers.

So, that diagram is shown here see from this side from the upper side these are the 5 slivers; sliver 1, sliver 2, sliver 3, sliver 4, sliver 5 usually 4 to 6 slivers are placed and all the slivers are simultaneously they are opened out by the opening roller and the fibres belonging to these slivers will then move downwards and will land on the friction drum.

Therefore, the fibres coming from sliver 1 will be wrapped over the beginning part of the or at the entry level the entry part of this you know friction drum and then this you as this moves forward, it will go from position 1 to position 2 the same fibres. And now on the position 2 as it goes there fibres from the sliver coming from you know position 2 will be wrapped over the fibres which came from position 1.

Now, the fibres yarn containing fibres 1 and 2 will move to position 3 now. So, from whatever fibres are coming from position 3 they will be now going on the top of the fibre layer 1 and 2. So, like that the fibres will be deposit deposited on the top of each other that is quite called the overlapping of fibres overlapping layers will be there one after the other.

The helix angle and the helix diameter of the sheath fibres originating from sliver position 5th to 1st reduces progressively because by the time the fibres are coming over fibres are falling from position 5 it is actually going over a larger diameter of the yarn. And we can expect also that this diameter is rotating at a slower speed than the diameter here if this is A, this is B.

The friction drum short space speed is fixed constant. So, when it comes to diameter B diameter is larger so, rotational speed will be less where in diameter A potential speed will be more. So, fibres coming from position 5 will be wrapping that is wrapping rate will be little slower therefore, it twist we can expect to be different.

Helix diameter will be more because the yarn diameter is gradually increasing from A to B, at A the diameter is minimum at B the diameter is maximum because, layers are getting built up one on the top of the other. The twist remains more or less same irrespective of the sheath sliver positions this also has been found that this really does not make much of a difference in the final twist. The sheath fibres have less twist than the core fibres. Core fibres mean the fibres in the core part of the yarn.

So, the cross section part of the yarn is shown in the same diagram the orange part is the fibres belonging to the sheath and the grey part is the fibres which are forming the core. So, core fibres are actually coming from the drafting unit 1 that is roller drafting unit. So, they remain in the core and they all get false twisted sheath fibres have less twist than the core fibres.

So, this is also has been seen that as I said in some cases these twist may remain trapped though theoretically or ideally we would expect entire false twist to be removed, but practically it has been seen that some twist remains trapped and at some zones are there where the sheath fibres may show less twist than the core fibres.

See whatever is happening here is very complex because there is a possibility of slippage also which we have not yet I have not yet discussed because these fibres are not really positively gripped by the rollers. So, while they are rotating at a high speed and the only force that is acting and pushing the fibres towards the drum surface is a pneumatic force. Now, this pneumatic force may not be you know sufficient enough to avoid slippage.

Between the when the fibres the drum surface and the band of fibres which are there as every possibility of lot of slippage and the yarn as these rotates on the drum surface keeps on jumping also it is not that always it is in contact. Sometimes it loses contact because of lot of centrifugal force which is acting between them and lot of air turbulence also gets created there.

So, all of these basically means that there is a possibility of the yarn tail losing contact from the drum and therefore, there are lot of slippage. So, twist leakage is also there and hence many people also have shown that and this will be true also for Dref-2 because ultimately fibres are gripped. Now, not between the rollers like in the case of ring spinning we grip the fibres between the front roller of the drafting system and that grip is very powerful grip and the other end we are inserting twist.

So, there is no scope for the fibres to lose twist there in the case of ring spinning there is no scope because the other end of the fibres can never rotate they are so powerfully gripped the tail end of the fibres in the twist formation zone on the yarn formation zone not twist the yarn formation zone and here it is not.

So, the slippage possibility is always there. The yarn surface is more akin to the conventional ring spun yarn. The two diagrams are shown here you see the especially the chiffon polyester in sheath the surface look quite smooth like a ring spun yarn. The other one is cotton on the sheath.

So, the wrapping is not so good because cotton fibres are there are fibres of different lengths are there or polyester fibres are uniform length. So, if I wrap it with polyester the yarn surface will look much much more uniform and lustrous whereas, if I wrap it by cotton it may not be there is lot of hairiness also can be seen because of the nature of the cotton fibre.

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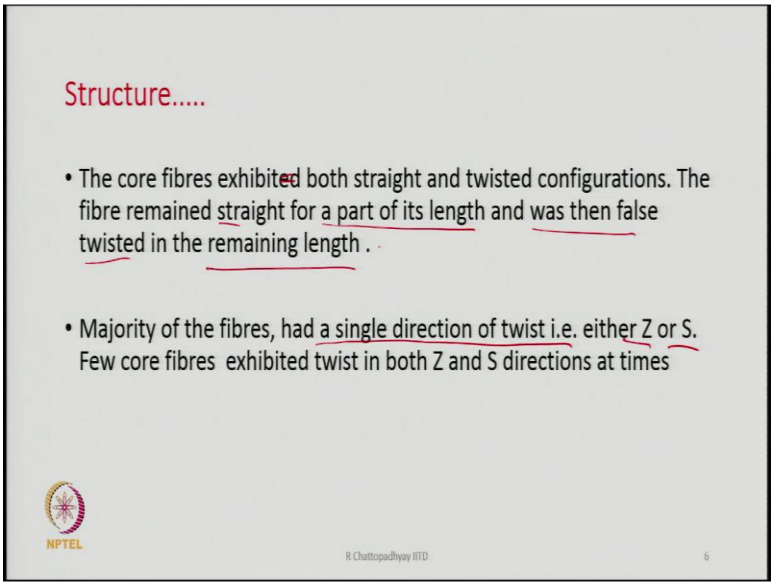

The other aspect of the structure is the core fibres exhibited both straight and twisted configurations core fibres exhibit both straight and twisted configurations that basically means the fibres remain straight for a part of its length and was then false twisted in the remaining length.

That means part of the fibre sometimes can be seen without having any twist a fibre is how long after suppose a fibre is 38 millimeter 48 millimeter. So, one can see some fibres in the core partly twisted and partly straight this all because while untwisting some twist has been removed some still has been left out there and hence this kind of fibres will be visible.

Majority of the fibres had a single direction of twist that is either Z or S. Now, the existence of Z and S direction twist automatically means that the entire false twist could not get nullified some of it remains trapped. So, Z and S twist therefore, can be seen in the core fibres and few core fibres also seen having both direction of twist Z and S. But there are few majority are basically either having Z or S twist.

So, ideally we expect the core to not have any twist, but in actual case some twist is still there. In a way this twist is going to in a way help also because it is going to give some amount of binding between the fibres. So, the yarn it will make the yarn stronger. So, Dref-3 yarns are much stronger than Dref-2 yarns.

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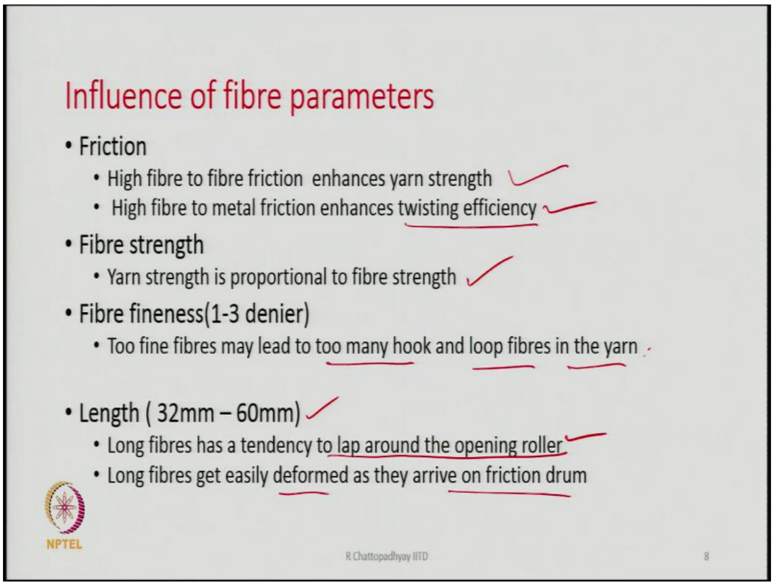

Influence of process parameters first of all we will discuss about friction generally high fibre to fibre friction enhances yarn strength especially this is true for Dref-2 yarn and Dref-3 yarn also it will happen. Because ultimately the it is basically a you know a structure where core is practically twist free we can say and it is wrapped.

So, ultimately any if we can increase the friction between the fibres it is going to resist the tensile deformations and therefore, there will be some strength enhancement. High fibre to metal friction enhances twist efficiency that slippage will be less if we can go for fibre to metal friction is more. Fibre strength will always increase the yarn strength it is true for any or any yarn technology yarn spinning technology.

Fibre fineness too fine fibres may lead to too many hook and loop fibres in the yarn that is in too many deformed fibres because finer fibres are basically having very little flexural rigidity. So, they can easily bend coarser side therefore, we go. But we have to also remember that friction spun yarn needs more fibres in the yarn cross section so that we can spin the yarn successful.

If we go for so, there is a critical minimum number of fibres that we need in the cross section to make sure that spinning is visible or spinning process is stable. So, that minimum numbers of fibres is much more. Suppose for ring spinning it is around 80 for rotor spinning it will be 120, 130 for friction spinning it will be still more maybe 160, 180.

So, we cannot go for too coarse fibres then number of fibre in the cross section will go down and therefore, the cohesion between the fibres will be low and will not be able to spin the yarn successfully. So, too coarse is not possible at the same time coarse fibres will not be able to we will not be able to wrap it because for wrapping also we need fibres to bend. So, if the fibres are too coarse especially sheath fibres, they will not be able to bend properly and they will not make tight wraps.

Length this is the range long fibre has a tendency to lap around the opening roller this is something one has to be careful and long fibres get easily deformed. So, too long fibres are not really beneficial at the same time too short fibres also will not be good. So, we have to have a critical fibres some range of fibre as given 32 to 60 mm within this range it is going to give you good quality yarn.

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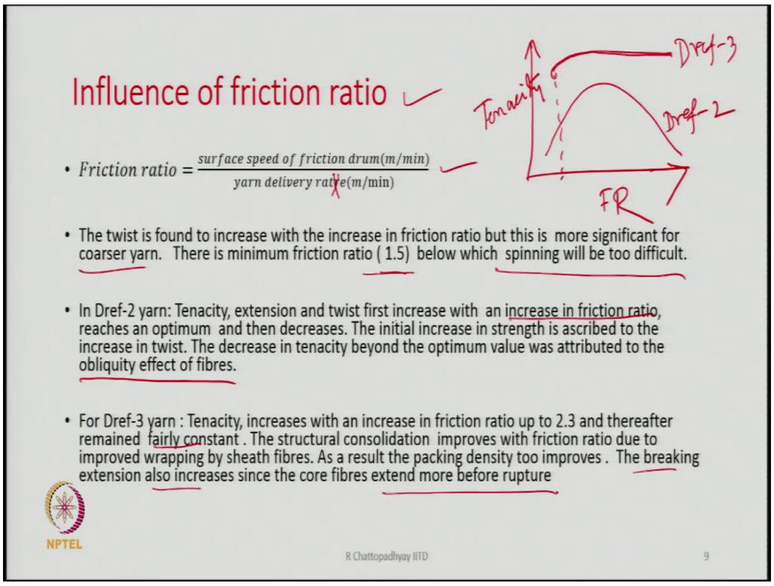

The other process parameters which are importance are one is friction ratio. Friction ratio is what? Is the ratio of surface speed of the friction drum divide by yarn delivery rate;

yarn delivery rate. So, ratio of these two is friction ratio. So, twist is found to increase with increase in friction ratio, but this is more significant for coarser yarn.

There is a minimum friction ratio 1.5 below which spinning will be difficult. So, some ratio typically 2 or 2.5 these are the typical ratio that we maintain in order to spin the yarn successfully. In Dref-2 tenacity extension twist first increases with increase in friction ratio reaches an optimum and then decreases.

That means, initially the with friction ratio twist will increase and twist increase a tenacity also will increase if tenacity increases extension of the yarn also going to increase. But when the friction ratio goes beyond the optimum then everything will fall down. Why? Because of typical that obliquity effect too much of friction ratio means too much of twist.

Too much of twist means too much inclined the fibres are with respect to the yarn axis and therefore, the strength will fall. In Dref-3 yarn tenacity increases with an increase in friction ratio up to 2.3, thereafter remain fairly constant. That means, if I plot typically friction ratio versus tenacity let us see for Dref-2 yarn we may get a curve something like this typical twist and curve. For Dref-3 yarn we will get a curve something like this.

So, this is for Dref-3, this is for Dref-2. That means, in the case of Dref-3 unless we have a certain friction ratio we will not be able to start spinning operation at all. And then there is a slight rise, but then fairly remains constant over a wide range of friction ratio it hardly changes. The tenacity does not change much it remains fairly constant.

The structural consolidation improves with friction ratio due to improved wrapping by the sheath fibres. As a result packing density will also improve the breaking extension also will increase. So, the core fibres extend more before rupture. See generally whatever we do most of the time we will find that if I change any process parameter and if due to that tenacity increases extension also will increase for any yarn whether you take any technology.

Any process parameter that will; that means, it improve the tensile property in general. So, tensile property means includes both extension and the breaking load. So, if I do something play with the process parameters and if I find that tenacity is going to increase you will also find the breaking elongation has increased. Both of them will go up together. If this structure become strong it will take more time to break. So, it will have more extension simultaneously that is what will generally happen in most of the cases.

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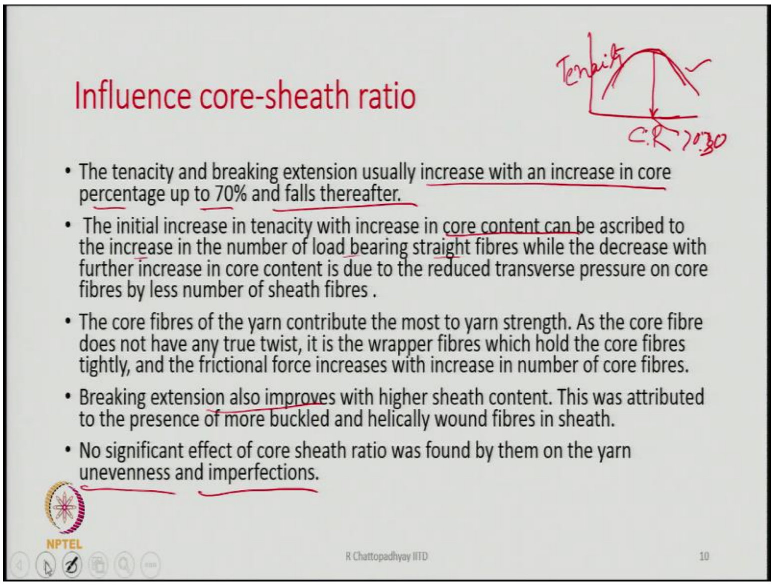

Influence of core sheath ratio here also there is a optimum. Tenacity and breaking extension usually increases with an increase in core percentage up to 70 percent and then falls thereafter. So, the point is that how a you know Dref-3 type of structure where core and sheath is there. How the fibres in such a structure is actually participating in sharing the load that what is important.

It is the core fibres which are practically straight are going to support the load because they are more or less straight. But it is the sheath fibres which are wrapping the core and these fibres are actually trying to develop or generate transverse pressure on the core and by that it is increasing the frictional resistance to slippage of the core fibres.

Now, if the core fibre percentage increases we can suppose we start from 40 percent, 50 percent, 60 percent if you go to keep on rise because am I load bearing fibre numbers is going up and up and therefore, strength will rise. So, initial rise in tenacity is because of increase in cores content and that is because increase in the number of load bearing straight fibres while the decreasing part is because the core content has gone beyond optimum.

Now, the sheath content is going down. So, there are less number of sheath fibres to generate sufficient transverse pressure and hence even though there are more core fibres are there they are actually slipping. That frictional resistance to slippage has gone down and therefore, the yarn as a whole is going to fail at a lesser load.

That means, we can also expect here like this if this is the core sheath ratio and this side is tenacity then also we can expect some a curve like this. It will increase first and then will start falling and this may be the optimum may be this is 70:30 beyond that it will fall.

So, why it is falling this side? Because core or sheath component has reduced too much and it is not in a position to generate sufficient transverse pressure on the core fibres. And therefore, core fibres as a whole are actually slipping when the load is given to the yarn. Breaking extension also will give you similar sort of behaviour. The core sheath ratio has got nothing to do much with the evenness and imperfections of the yarn.

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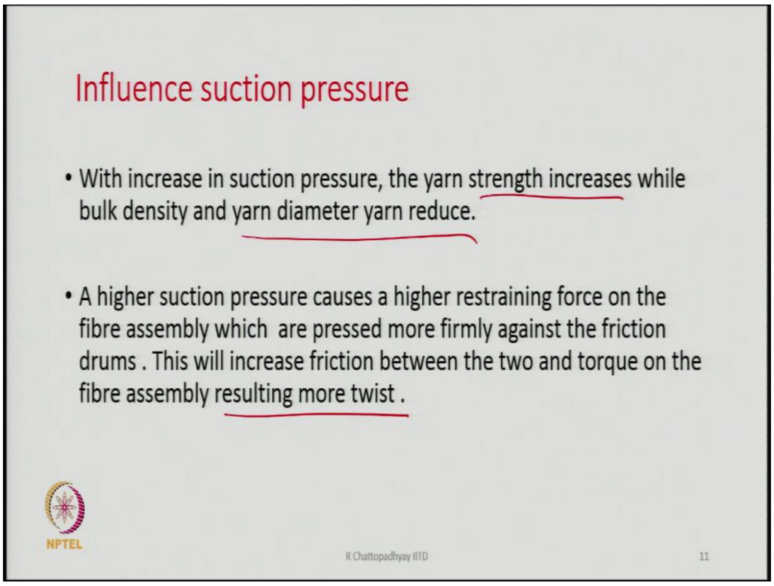

Next, another important parameter is suction pressure. The whole purpose of suction is to make sure that the fibres which are at the nip of the two friction drum they remain pressed against the friction drum. And now the friction drum can really the surfaces of the two drums can really generate frictional force on them and thereby torque frictional torque on the know the accumulated fibres which are there at the nip.

So, with increase in suction pressure yarn strength will likely to increase because we can expect more twist to be generated less slippage will be there. And at the same time we can see the yarn diameter to reduce. So, that is a indirect reflection that fibres are held together against the drum with higher force.

Therefore, there is better packing of fibres in the yarn and reflection of that one can see in the diameter of the yarn. So, it gives indirect indication that force must have been must have been more and that is why diameter has reduced. Is higher suction pressure causes a higher restraining force on the fibre assembly which are pressed more firmly against the friction drum.

This will increase friction between the two and the torque on the fibre assembly resulting more twist. And more twist basically means more strength. So, that is how this can work, but if I want to increase suction pressure; that means, I am actually consuming more energy also.

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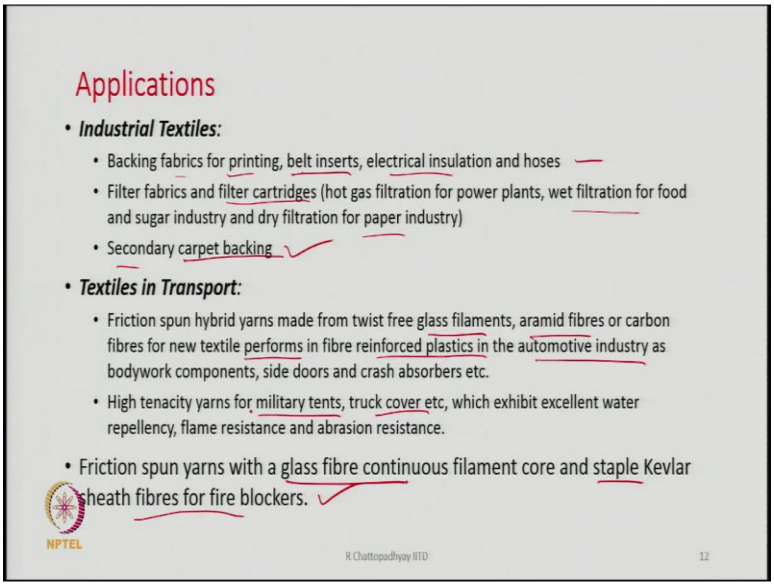

Now, comes the applications. There are varieties of applications of the yarn that we can produce on friction spinning 2 or 3 that is either open end type of friction spun yarn or a core sheath type of friction spun yarn. And this is possible because we can actually engineer the yarn in a better way that we can selectively place the fibres whatever you want. This possibility is less with other technology.

We can have a multiple component in the yarn cross section and can be rightly place them whatever you want to place the fibres. This opportunity is relatively less in the case of other technology. We can also spin core spun yarn or ring spinning technology that is possible.

Here also we can spin core spun or we can then wrap it better wrapping it by not just one type of fibre, but different types of fibres also we can wrap it. If we need that we need different fibres and different layers we can wrap it by different fibres different layers. Introducing a filament is much easier. We can introduce not just one filament we can multiple filament of two types also can be introduced simultaneously. So, flexibility is more and therefore, industrial applications are more.

The other reason of industrial application is that we will see that limitation of the technology and we will discuss about them. So, backing fabrics for printing, belt inserts, electrical insulation and hoses, filter fabrics, filter cartridges for dry filtration, wet filtration, a sugar industry, paper industry, secondary carpet backing yarns can be produced in the carpet backing yarn.

Most of the time what you use is jute yarns. So, it can be also we can use this technology and produce yarns and use them in the carpet because you basically need thicker yarns there. Friction spun hybrid yarns made from twist free glass filaments, aramid fibres, carbon fibres for new textile preform in fibre reinforced plastics in automotive industry.

These are high tenacity yarns for military tents, truck type as high tenacity because the filament that we can introduce could be a very high tenacity polyesters or high tenacity nylon can be given. Friction spun yarns with a glass fibre continuous filament core and staple Kevlar, sheath fibres can be used for fire blockers so, a combination of Kevlar and your which other one Kevlar and glass.

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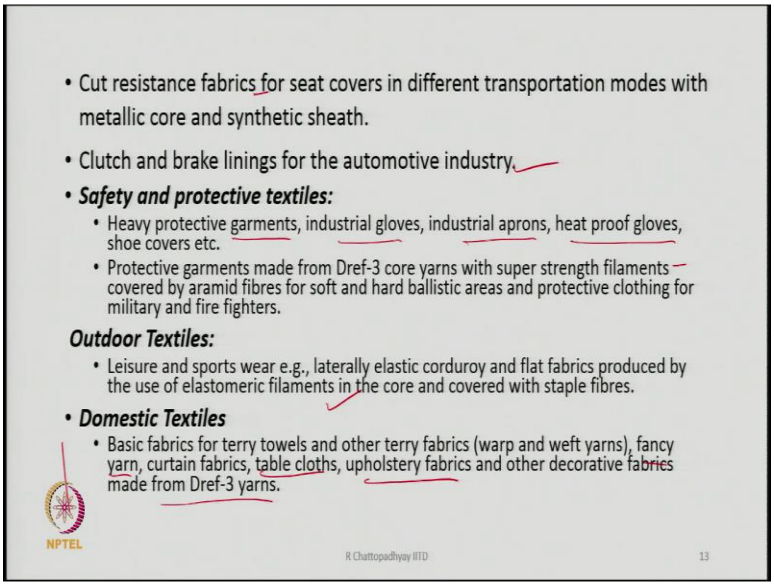

Cut resistance fabrics then clutch and brake linings for automotive industry. Safety point of view heavy protective garments, industrial gloves, industrial aprons, heat proof gloves, shoe covers etcetera. Protective garments made from Dref-3 core yarns with super strength filaments. So, outdoor textile leisure and sportswear, laterally elastic corduroy or flat fabrics produced by the use of elastomeric filaments.

So, there are lot of scope for the use of the yarns that we produce on these technologies. And most of them are basically you see whatever examples have been came in that all basically from technical textile point of view. The domestic textiles, table cloth, upholstery fabrics can be made, fancy yarns can be made also. Though technically it is possible we can make it, but in practical terms we do not produce those domestic textile using our friction spun yarns.

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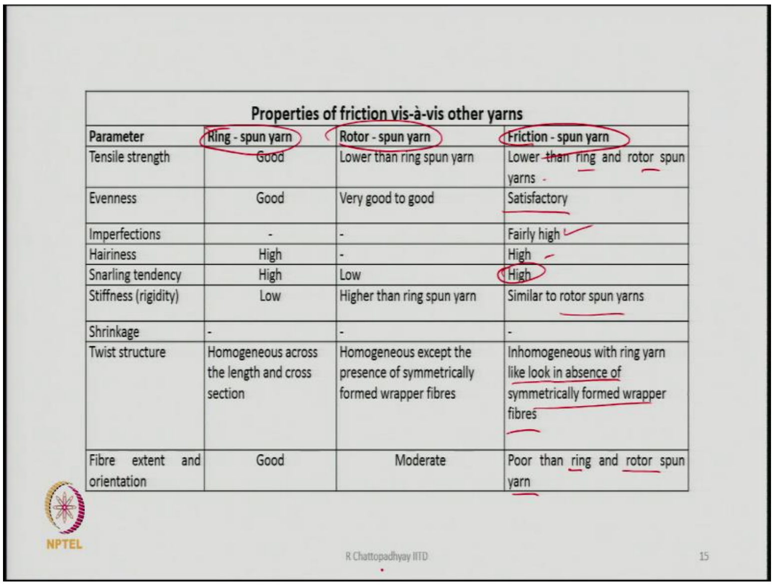

Properties of friction vis-à-vis other yarns

Parameter	Ring - spun yarn	Rotor - spun yarn	Friction - spun yarn
Tensile strength	Good	Lower than ring spun yarn	Lower than ring and rotor spun yarns
Evenness	Good	Very good to good	Satisfactory
Imperfections	-	-	Fairly high
Hairiness	High	-	High
Snarling tendency	High	Low	High
Stiffness (rigidity)	Low	Higher than ring spun yarn	Similar to rotor spun yarns
Shrinkage	-	-	-
Twist structure	Homogeneous across the length and cross section	Homogeneous except the presence of symmetrically formed wrapper fibres	Inhomogeneous with ring yarn like look in absence of symmetrically formed wrapper fibres
Fibre extent and orientation	Good	Moderate	Poor than ring and rotor spun yarn

We will see that why properties if we check in general terms we can say tensile strength, a comparison has been made with respect to ring spun yarn, rotor spun yarn and friction spun yarn. Tensile strength, lower than ring and rotor spun yarns, but if we go for introduce a filament then it can be stronger than rotor spun yarn also.

Even as good it is satisfactory over here imperfections are quite high with the if the twist formation zone the lot of disturbance are there, lot of air current, air vortex these things are gets created so, fairly high. Hairiness is also high, snarling tendency is very very high that is one of the negative points of friction spun yarn.

Stiffness similar to rotor spun yarns, twist structure inhomogeneous with ring yarn like look in absence of symmetrically formed wrapper fibres, it gives you look which looks like a ring yarn that is loop wise fibre extent and orientation, poor than ring and rotor spun yarns. On the surface especially for Dref-2 they will be poor because most of the fibres will be hooked and looped in Dref-3 also look at the surface fibres most of them will be hooked and looped because they are falling on a slower moving surface.

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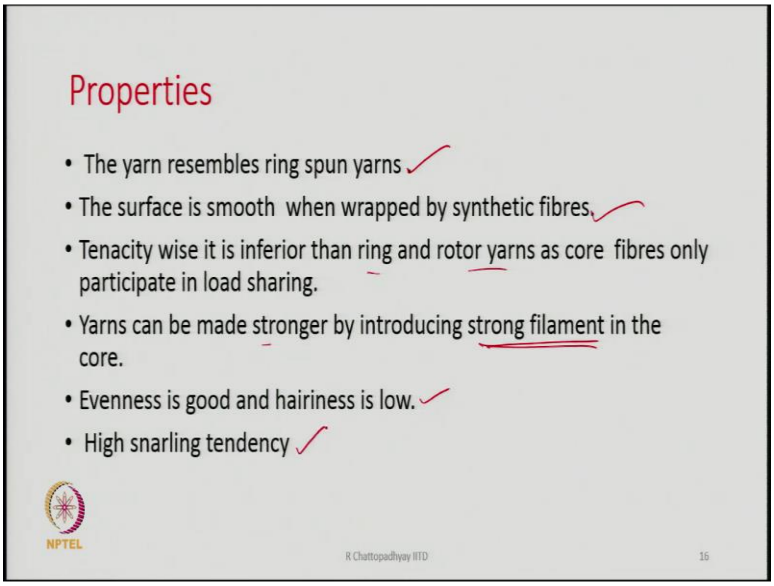

In general properties are yarn resembles ring spun yarn look wise, surface is smooth when wrapped by synthetic fibres. Tenacity wise inferior than ring and rotor yarns, yarn can be made stronger by introducing strong filament, we have to take the help of filament to make it strong.

Evenness is good and hairiness is little low provided we maintain the process parameter some combination of process parameter. If you optimize properly it can give you a good reasonably good quality yarn in terms of evenness and hairiness. And it has a high snarling tendency you could highly twist lively.

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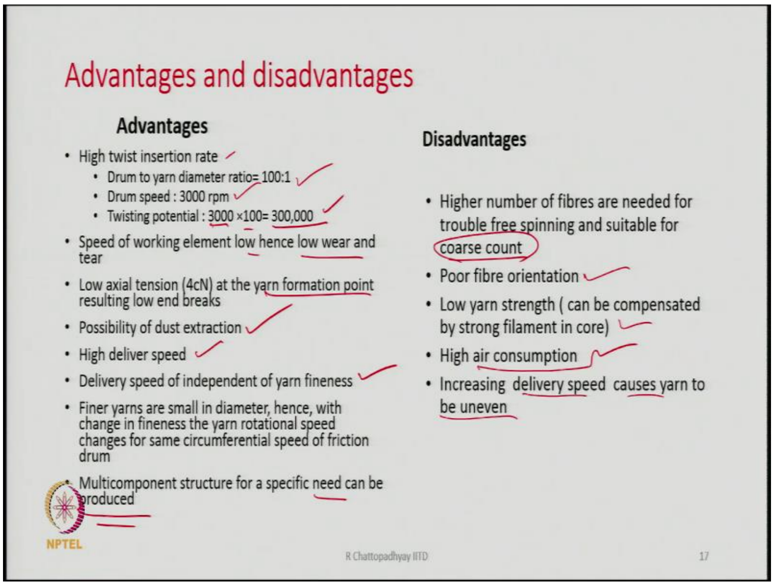

And the advantage and disadvantages. High twist insertion rate jump to yarn diameter ratio is 100 is to 1. So, if the drum speed is 3000 rpm typical speed is 3000, the twist potential is 3000 into 100 is 300,000 revolution of the yarn that is possible. How much revolution is there in the for the yarn for ring spinning? Hardly maximum 20000, 22000. The rotor spinning how much could be rotation of the yarn. So, the speed of the rotor?

Student: Around.

Around.

Student: Not 200,000s.

Not 200,000s.

Student: 1.2.

Maximum is 1.2, 1.1 that is the maximum. Here potential is 300,000s, but it has a potential, but actual is less because there is a slippage phenomena. Speed of the working element will be low, hence low wear and tear, low axial tension at the yarn formation point because there is no balloon. Within the rotor also there is a small the yarn arm actually forms a balloon, but here there is no balloon at all.

So, tension the spinning tension is very very low. Therefore, end breaks will be very low. Possibilities of dust extraction because suction is happening at the yarn formation point also. High delivery speed, delivery speed is independent of yarn fineness or yarn count because if the count becomes finer, the yarns the rotational speed of the yarn will increase automatically. And therefore, the twist will be maintained, you need not to adjust twist.

Finer yarns are smaller in diameter hence with change in fineness the yarn rotational speed changes for same circumferential speed of the friction drum. Otherwise, in the case of ring spinning if we want to go from coarser to finer count or then we have to we know that the twist is going to change and therefore, we have to again you know change the delivery speed in order to adjust the twist.

But this is something which is not required here. Multicomponent structure for specific need can be produced. Multicomponent that is additional advantage here. Disadvantages high number of fibres are needed for the trouble free spinning and suitable for coarse count only. So, this technology suitable for coarse count poor fibre orientation, low yarn strength, high air consumption and increasing delivery speed causes yarn to be uneven.

Delivery speed anyway is very high. So, one has to also find out what is the optimum combination of friction drum speed, delivery speed and suction pressure. These are the three main process parameters, which we have to find out what is the optimum combination of these three for a given yarn count and given fibre. Unnecessary, if you go for increasing delivery speed in order to increase the production rate the quality of the yarn may suffer, which is true for any technology?

For any technology there is always an optimum combination’s and beyond that if we try to go in terms of delivery speed then the quality of the yarn will suffer. It will be more uneven, more thick and thin base will be generated or more hairiness will be there or sort of problems will be there. So, there is always a upper limit of speed delivery speed for each and every technology.

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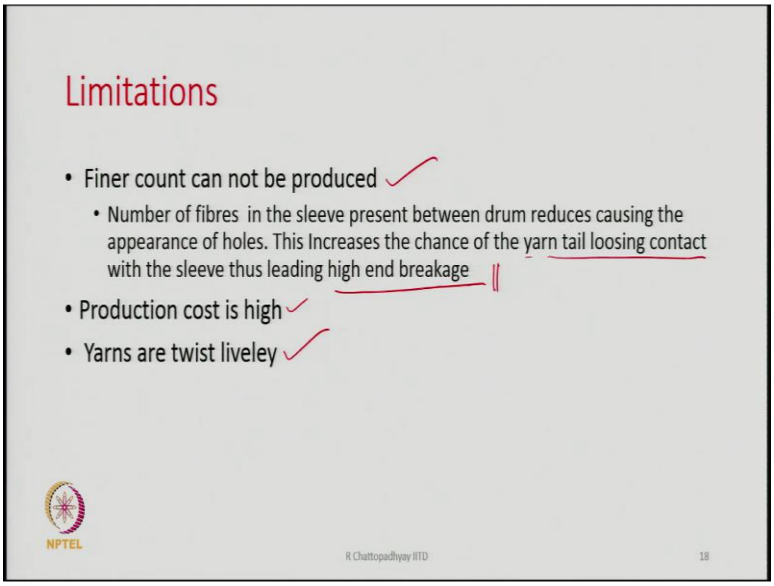

So, limitations final count cannot be produced. Number of fibres in the sleeve present between drum reduces causing the appearance of holes. These increases the chance of the yarn tail loosing contact with the sleeve thus leading to high end breakages. This is a reason that has been given by someone. Finer count typically maximum yarn count which is produced is up to 18 NA. Beyond that generally most of the counts are positive is 6 count, 8 count, 10 count, 4 count.

Production cost is high because the machine is very very costly and yarns are twist lively. Star linked tendency is quite high. So, either you have to go for then twist setting, which means additional cost you have to go for twist setting. So, these are the limitation it is not suitable for fine count. Not, cost is high and it is through sapling. And it cannot compete with the other established technologies in terms of cost.

And therefore, we cannot spend 30s count, 40s count on this technology. If we spend quality of the yarn will be much inferior comparison to ring spun yarns. So, alternative technologies are there they can produce a better yarn when you go above this. And therefore, these technologies are mostly suitable for industrial yarns where it is not very you know it is not very price sensitive product.

Whereas, if you want to penetrate the apparel market yarns meant for apparel use that market is very very price sensitive. A little increase in price people will refuse to buy. If we want to produce specialized yarn which we cannot produce in other technologies especially for industrial use then this is the technology you have.

Because in the products are such that price of the products are anyway very high in case of technical products. And therefore, this technology will suit there and you will be able to produce certain structures or certain fibre combinations which you will not be able to make in other technologies. That will be a vortex meaning technology. It is not suitable for course count at all.

So, you forget vortex count you forget air jet spinning. You cannot produce suppose I want to produce 4 count yarn for a technical applications where I need coarse strong coarse yarns. Now, what is the alternative we have? Air jet spinning no, vortex spinning no? Rotor spinning coarser, but very coarse is difficult also. And then introducing a filament in the you know in rotor spinning is also very difficult position.

Now, the whole alternative is ring spinning now. Ring spinning we can produce 6 count, 4 count also. But then this will be the yarn where if we want to mix different types of fibres, carbon, glass, Kevlar in the core surrounded by some FR viscose or FR polyester then this technology will be very suitable.

And you know the cost is high, but people will ready to pay this cost because these are basically meant for specialized products for you know technical products. And there therefore, these technologies are the yarns are going in such this you know this kind of you know applications it is going.

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And that is the end of this today's lesson. So, we have discussed about the structure part of the yarn the yarn formation mechanism, the applications as limitations. And we see the structure there are still sometime there is lot of know differences of opinion are there by the researchers.

And therefore, what is generally true that is what we need to grasp. Where there is a difference of opinion it could be there in the researcher because the researchers also study the subject or carry out experiments with different fibres and different may be produced on different types of machines the process parameters are different. And therefore, there could be some differences in the results that they get.

So, individually they may be correct in the assessment of the results and drawing conclusion out of it. But possibilities of know differences in the opinion or differences in the observation also could be there. Because many a times they are not going to study the entire spectra of the parameters change related to fibres related to processes. And therefore, the complete picture sometimes we do not get. With this we close today’s lesson.

Thank you.