New Spinning Technologies
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Lecture - 22
Wrap Spinning

Today's discussion will be on Wrap Spinning. We will first try to understand what is the principle of wrap spinning. It is very simple.

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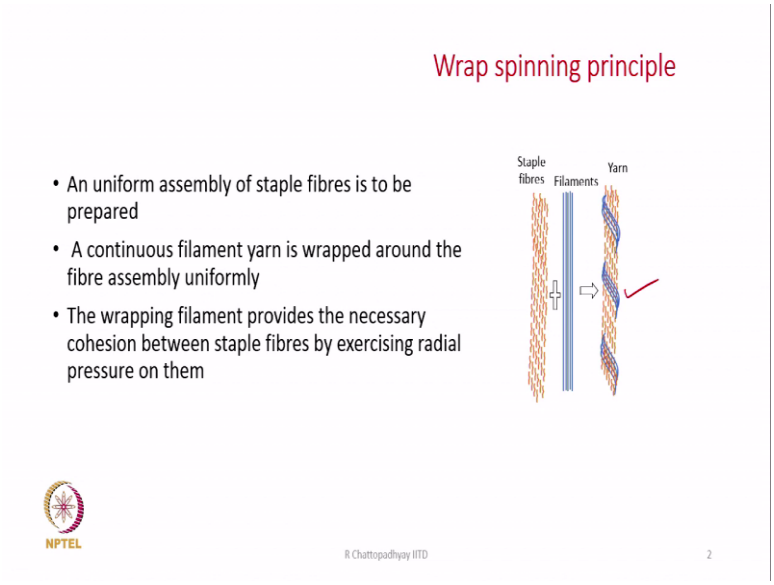

The diagram is shown on the right hand side. What we have is an array of staple fibres and there is a filament next to it. So, basically these two are two components, an array of staple fibres and filaments. Now, we have to basically wrap the array of staple fibres by this filament. And once we do it, the yarn that we produce is known as wrap spun yarn.

So, we have to have an uniform assembly of staple fibres that we have to prepare. And we know how to prepare an assembly of fibres. Right after carding, we produce a sliver. A sliver is basically an array of staple fibres. And then we want to improve the parallelization of the fibres. And we want to improve the configuration of the fibres, that we want to make them more straight and parallel.

And hence we have draftings. So, drafting operation was on draw frame, we improve this array. We want to make the array uniform as well as the fibres become straight and

parallel. And such an array is prerequisite. And then when we get the sliver, finally, we have to draft the sliver in order to come to the right dimensions of the yarn. A sliver dimension and the yarn dimensions are not same. Yarn is much thinner than a sliver.

So, our input is sliver, but then we have to further stretch the sliver or drop the sliver in order to bring it to the dimension of the yarn. So, whatever yarn count we want to produce. And when the sliver undergoes drafting, there is hardly any disturbance in the array. It still remains straight and parallel and also uniform.

And what we need also as I said earlier, a continuous filament yarn which is wrapped. So, that means, we need a procedure to wrap the filament around this array. The wrapping filament, the purpose of it is to provide the necessary cohesion between the staple fibres by exercising radial pressure on them. That is these helical wrapping of the filaments will actually exert transverse pressure on the fibres.

And therefore, all those staple fibres will be under tremendous transverse pressure. And hence they will not be able to slip away from each other whenever such a yarn is under tension. So, that is the purpose of the wrapping by filament. Though wrap spinning technique is there or in the case of air jet spinning also we wrap a bundle of core fibres.

Or in the case of vortex spinning also, we also wrap a bundle of fibres. But in those cases, wrapping is done by the constituent fibre themselves. There is no additional filament which is used to wrap. But in this particular case, the filament which is going to wrap it is different from the staple fiber.

The staple fibres could be cotton, they could be viscous yarn, they could be acrylic fiber, they could be wool fibres. And the wrapping filament could be anything, it could be viscous yarn, continuous filament, it could be nylon, it could be polyester, whatever suits a particular applications.

Accordingly, we can choose the filament. And therefore, we get a yarn where you can see from the principle itself that the fibres in the core are straight and parallel and the filament is wrapping it in a very very uniform manner.

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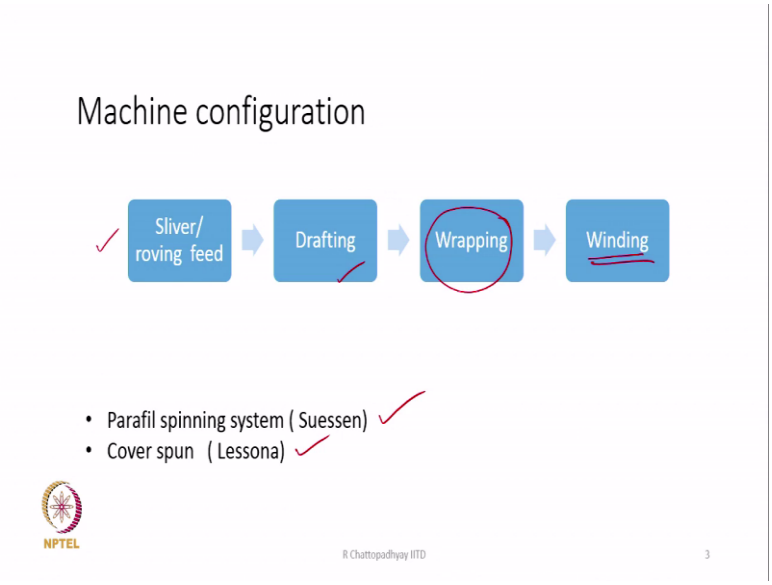

The machines which is used for spinning such a yarn will have typically a feed unit which could be sliver or roving. That means either we can feed a sliver or it can roving feed. Then there is a drafting unit followed by a wrapping procedure. And finally, there will be winding that is you can say package formations.

So, through winding we are actually trying to form a package. So, the entire machines can be divided into these four segments. And the machines which are available is known as parafil spinning machines developed by Suessen and the other one is cover spun developed by Lessona.

However, sliver is feed we all know that. The way the sliver is or roving is fed on air jet spinning machine or on vortex spinning machine. Exactly similar feed mechanism will be there to feed the sliver or the roving whatever the case may be.

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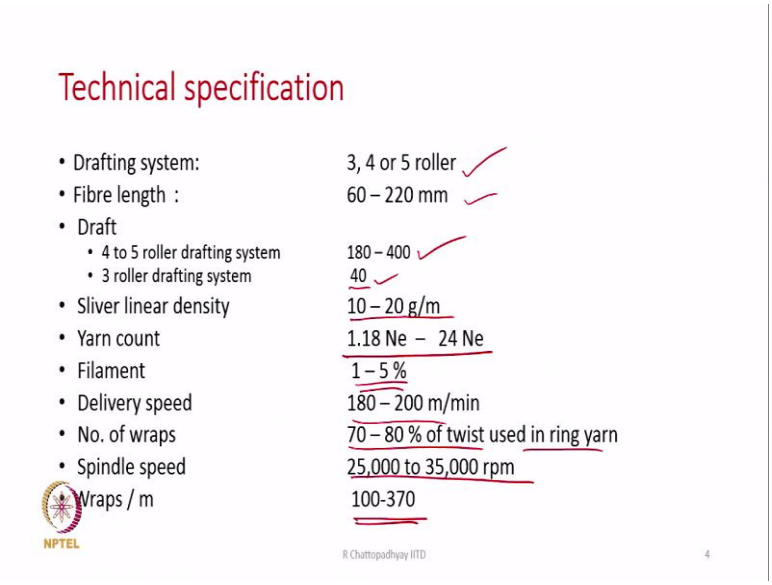

The drafting system could be 3, 4 or 5 rollers pair of rollers. And the fibre length that can be processed could be 60 to 220 mm. So, as a wide range of a normally longer fibres are actually used for processing on such kind of machines and to produce a yarn. Draft could be if it is 4 to 5 roller drafting system it can go up to 400, 180 to 400 we can use very high draft. And if it is 3 roller drafting system the draft is limited to maximum 40.

The linear density of the sliver can vary between 10 to 20 g/m, that could be the feed. So, we have a wide range very thick slivers can be fed and we can produce very thick yarn. This technology is very suitable for producing yarn for carpets which we need very coarse yarns, blankets something like that. Now, where coarse yarns are required this technology will suit them.

Then yarn count varying from 1.18 Ne to 24 Ne. So, on the finest side we can go around 20s only. So, 20s Ne is to equivalent to around 30 tex maximum that is the finest. Filament percentage in the yarn is between 1 to 5 percent, rest of it is basically the fibres which there which you know which is in the core. So, the wrapping filament is hardly 1 to 5 percent.

Delivery speed is quite high, 180 to 200 m/min. So, much much higher than what we generally observe for ring spinning. Number of wraps 70 to 80 percent of twist is used whatever twist is used in ring spun yarn, that kind of wrap or here we cannot call it twist,

we should call it wrapping density or is call it wraps per meter. Typically the price between 100 to 370 per meter. We can convert it to per inch also.

The spindle speed varies between 25000 to 35000. So, here also there is some kind of spindle is there and the spindle is responsible for producing the wraps, around the core around the yarn core. So, this is typically the technical specification of the machine. Now, the heart of the machine is basically the wrapping unit. So, we will discuss about them now.

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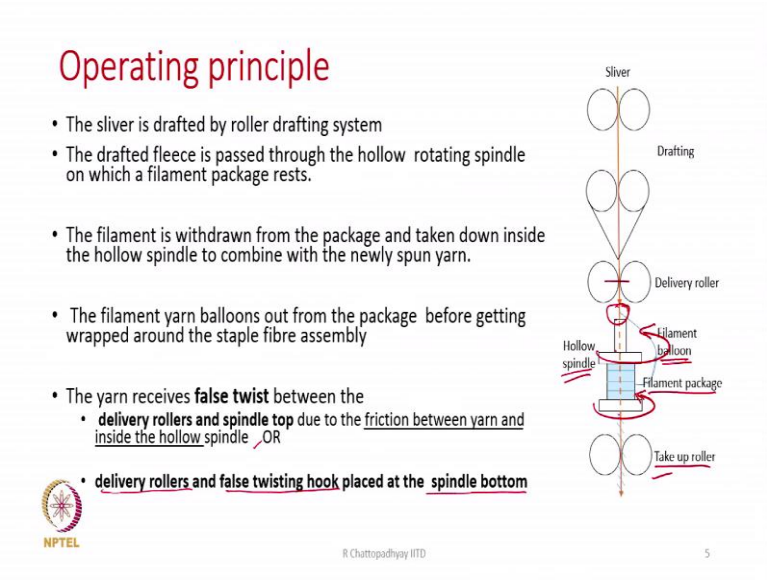

Let us look at the operating principle of the machine. A line diagram is shown on the right hand side. A drafting unit is shown with 3 pair of rollers. Then here there is a hollow spindle. And the spindle is hollow. And on the hollow spindle there is a filament package that rest. The and after that we have a pair of rollers called take up rollers which will pull the yarn out from the hollow spindle.

So, first of all we feed sliver maybe one sliver, two slivers whatever the case may be, we will also feed roving, if we want to produce finer yarns. The sliver is drafted by the roller drafting system. Then the drafted fleece is passed through the hollow rotating spindle on which the filament package is going to rest. So, the package is here.

Now, the filament is withdrawn from the package and taken down inside you see this filament path. This is the path filament is withdrawn, it goes over the spindle and then it

joins the incoming stream of fibres. And now from here this is the joining point. Actually from here both of them move together through the hollow spindle.

So, the filament balloons out from the package before getting wrapped around the staple fibre assembly. This is this balloon, the spindle is rotating like this, the balloon also rotates. The yarn receives false twist between the delivery rollers and the spindle top. So, the yarn path here we will show it in the some other slide that it receives false twist while it is passing through the hollow spindle.

As the spindle rotates it generates twist and that twist is basically false twist in nature. And therefore, what happens? The part of the yarn which is above the hollow spindle, they will get twisted in one directions and that is also what is desired. Because the yarn has to travel from the nip of the delivery rollers and it has to pass through the spindle.

So, the this stream of fibre must be twisted to have certain strength. If it is not twisted it will not have any strength, then the yarn cannot be spun at all. So, the false twisting is going to help in giving temporary strength to the yarn which is between the delivery roller and the point where false twist is getting formed.

I will see later on that there are two places where false twist can be generated. One is at the top of the spindle and one other could be at the bottom of the spindle also. So, we will we will come to that later on. So, the yarn receives false twist and it could be between the delivery rollers and the spindle top. Because of the friction between the yarn and the inside the hollow spindle.

How? That question must be coming to your mind and we will as we go through the slide it will be very clear to you. Because we will take it up in more details after only few minutes or few seconds. The other one is that the false twist could be between the delivery rollers and false twisting hook placed at the spindle bottom.

So, either from here to there or from here to there the yarn will be twisted. And that will be basically false twist. So, the filament yarn is going to join the false twisted part of the yarn and they will then go together.

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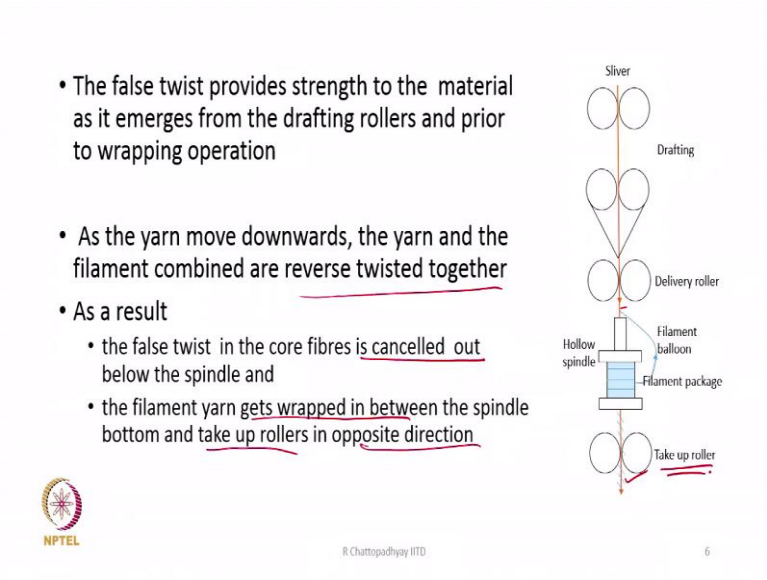

After this the false twist provides strength to the material as it emerges from the drafting rollers as I said that is what is required. In this point from here to there if it is dimension in the form of a assembly of fibres without twist it will not have any strength. So, we need to impart certain strength and that is only possible by having some twist.

As the yarn moves downwards the yarn and the filament combined are reverse twisted together. So, obviously, if there is a false twist, whatever false twist is generated the moment the yarn will cross that point all the false twist will be removed. We have already started the false twisting principle earlier we have shown it.

So, beyond the twist generation point as the yarn keeps moving all the twist which was there will be all removed because it will receive a reverse torque. Now, because of this reverse torque the filament will be wrapped around the yarn. So, as a result the false twist in the core fibres will be cancelled out, because both of them are reverse twisted.

So, result will be the core twist will lose all twist and they become straight and parallel fibres. The filament will yarn will get wrapped in between the spindle bottom and the take up rollers in opposite directions. That is how the wrapping is going to take place. And this wrapping is because at the twist generation point the you know the yarn as well as the filament both of them will get reverse twisted together.

As a result of that the filament will be wrapped, but the core twisted fibres they will be all losing twist. Because the twist in the upstream direction is in a direction which opposite to the twist which will be in the downstream directions. And hence these two twists will be cancelling each other completely. And the resultant will be a straight and parallel array of fibres after the twisting point. And these fibres by the same time will be wrapped by the filament and hence it will have strength.

So, as it is shown here it will be wrapped and then this is going to be taken out by the take up rollers. So, this is how the system actually works. Now, we will as I said we will now you know focus on the false twist generation part.

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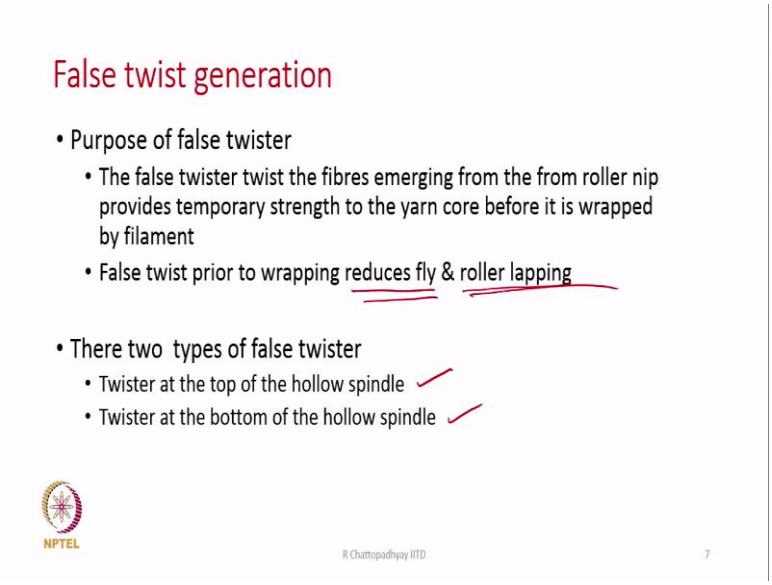

So, what is the purpose of false twister? Or then we should say that the false twister twist the fibres emerging from the from roller nip, why? Because we have to give them temporary strength so that they can flow through the spindle that is the purpose, that is to twist them in order to make them little strong. And the second purpose is the false twist prior to wrapping reduces fly and roller lapping.

See from the front roller nip as the fibres are coming out it is the form of a thin fleece of fibres. So, if the fibres remain in that form, it can easily you know lap. At the same time if the fibres are not bound together by some twist and the fibres can fly out also. Because it is running the drafting system is running at quite high speed. There is lot of air turbulence is there around the drafting rollers.

Similarly, the spindle is also running at high speed. There is also a air turbulence around it. So, there is always some turbulence of air in the spinning zone and if the fibres are not twisted there the fibres will simply fly away. So, that way it also helps to reduce the generation of fly and to avoid roller lapping. Now, there are two types of false twister. Twister, at the top of the hollow spindle and twister at the bottom of the hollow spindle. These are two different types of false twister.

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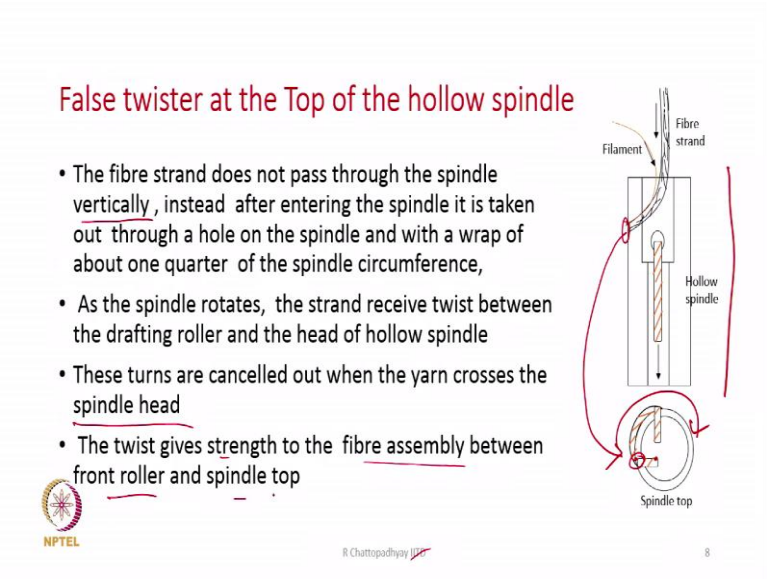

Twister at the top of the spindle we are going to discuss now. It is very similar to roving frame. The roving frame spindle you are all familiar with in the roving frame or we call it speed frame or fly frame and there is a flyer top on the roving spindle. So, the in the roving frame also the flyer top generates false twist. And the very purpose of the this flyer top is to generate more false twist. It is fairly similar in the situation here. That is we use the top of the hollow spindle to generate false twist through friction.

How? The fibres strand does not pass through the spindle vertically downwards though in the previous diagram I showed it is going straight like this. Actually, it is not like that. It is going down and there is a hole over here. It boots out like here is the hole. This hole is shown here and then it takes a round, wrap a bit around it and then enters the hollow part of the spindle again.

So, it wraps a bit and then enters the spindle again. By having this what happens that as the spindle will rotate the strand will also rotate. This will act as a arm and this is what is

going to rotate continuously. And as a result of that the part of the yarn from the front roller to the spindle top will get twisted and that will be false twist in nature.

These turns are then cancelled out when the yarn crosses the spindle head. So, if the spindle head if this is the place where the twist is generated then when the yarn is flowing as soon as it will cross that zone it will lose the twist. Because there is a twist in the reverse direction below that point, upstream it is twisted in one direction, downstream it is twisted in the opposite direction. But when is a dynamic situation when the yarn is also moving, we will not be able to see any twist in the downstream direction.

Because the twist has already been it has been lost. It has been cancelled out. So, the fibres there will be straight and parallel. But the upper part will always show us the twist. And this twist as we said earlier twist will give strength the fibre assembly between the front roller and the spindle top.

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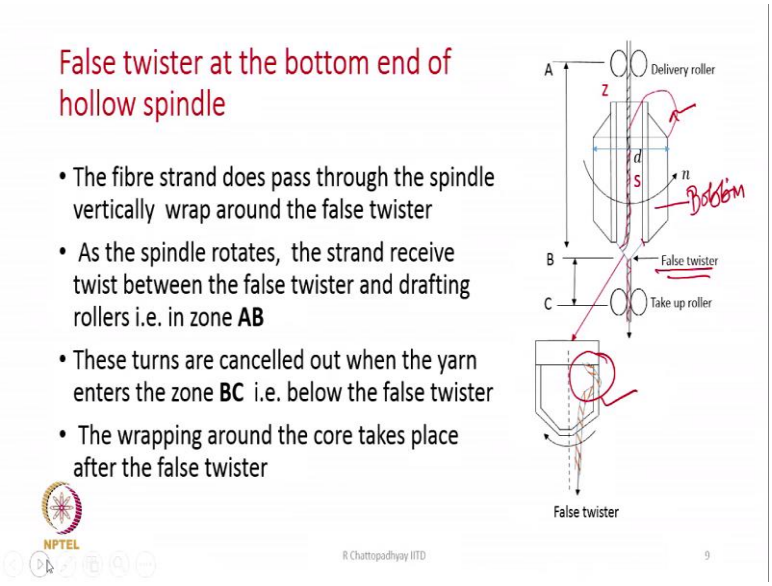

The other one is placing the false twist thing unit or you can say the there is a small hook or it can be also called loop which we place here. False twister is here in this case. At the bottom of the spindle, we place a small loop and the loop is shown here. This acts as a false twister. And you can see the how the yarn is passing through this false twister which is attached at the bottom of the spindle.

So, in this case the fibre strand will pass through the spindle vertically and then it wraps around the false twisting hook or loop whatever we say. This is the false twister or it we can call it as a false twisting hook or false twisting loop. So, its wrap around like this it is shown here.

As the spindle rotates the strand will receive twist between the false twister and the drafting rollers that is in the zone AB. So, we can say B is the location of the false twister. So, A between AB the part of the yarn will be twisted. The core of the yarn will be twisted and the yarn the filament yarn is joining as it is shown here. This is the filament bobbin.

This is the filament bobbin. From Here the filament is withdrawn and it is going in this directions and joining the thread. And because the filament is pulled out and the bobbin is rotating therefore, this balloon keeps on rotating also. So, whatever turns are generated in the zone AB all the turns are lost by the time the yarn is causing the zone BC or when is reaching BC everything is lost and the fibre becomes straight and parallel.

So, the wrapping around the core takes place after the false twister. So, we can say after the point B or in the zone BC all the twister getting removed from the core and the filament is simultaneously getting wrapped around the core. So, therefore, no possibility of the core to lose strength. And therefore, break at this point.

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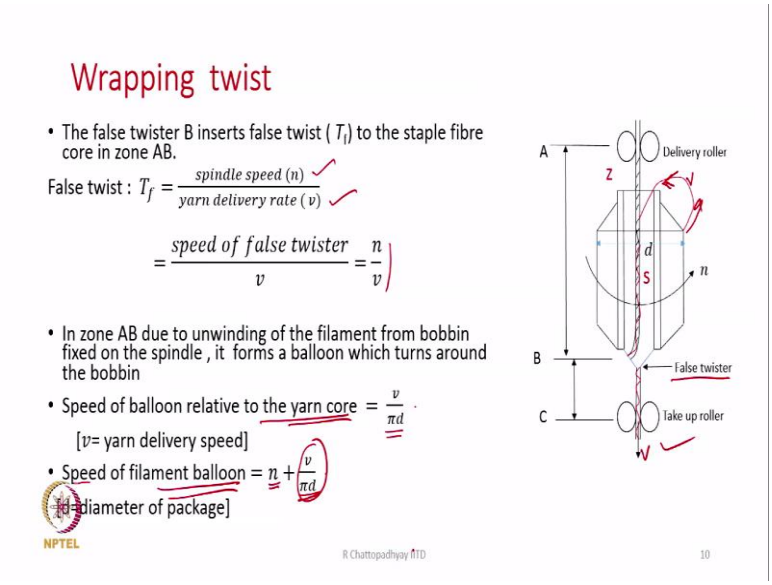

Now, we will try to understand do a little bit of analysis of the wrapping twist that will be generated. The sketch is you know shown here the exactly the same sketch which I have already shown in the previous slide. The false twister B inserts false twist to the stable fibres in the zone AB, ok. And this false twist will be how much? Twist we all know is the ratio of spindle speed by delivery speed. So, it is ratio of n spindle speed and n delivery rate which is v. So, it is basically n by v.

$$False\ twist:\ T_f = \frac{spindle\ speed\ (n)}{yarn\ delivery\ rate\ (v)}$$

$$= \frac{speed\ of\ false\ twistet)}{v} = \frac{n}{v}$$

So, spindle speed and speed of the false twisters are same. Because false twister is attached to this spindle, like speed of the spindle in the case of ring spinning and speed of the bobbin are same because bobbin is mounted on the spindle there. Similarly, here speed of the spindle and speed of the false twister will be same. So, first it will be speed of false twister/v which is will be n/v. Because speed of false twister and speed of spindle are exactly same.

In zone AB due to unwinding of the filament from the bobbin which is fixed on the spindle, it forms a balloon and which turns around the bobbin. So, this is the balloon the yarn going this direction, but it is also rotating because first of all the bobbin itself is rotating. And hence this point will rotate at the same time I am we are pulling the yarn out from the bobbin surface.

Therefore, the balloon will rotate relative to the core of the yarn. By how much? The relative speed difference is going to be v/πd where v is the speed with which the yarn is pulled out from the from the bobbin. And this is v is the delivery rate. So, let us say the take up rate is if this is v delivery, rollers speed also v though that is little very little difference between them.

$$Speed\ of\ balloon\ relative\ to\ the\ yarn\ core = \frac{v}{\pi d}$$

So, practically we can say the speed of delivery roller and speed of take up rollers are practically almost same. Though actually the speed of take up roller will be little more

little less than the speed of delivery roller. Depending upon how much tension we want to keep in this zone; that is called take up ratio.

Anyway so, because I am pulling the yarn out this yarn at a certain suppose this yarn is drawn out at this velocity v, then the balloon speed relative to the yarn core or relative to the spindle we can say is going to be v/πd. Now, the absolute speed of the filament balloon will be n, that is the speed of the bobbin itself plus the additional speed because the yarn is being pulled out.

$$Speed\ of\ filament\ balloon = n + \frac{v}{\pi d}$$

So, the actual absolute speed is going to be n+ v/πd. But the relative speed is going to be v/πd, where d is the diameter of this package, d is the diameter of this package. So, what happens? d keeps on changing because the bobbin becomes smaller and smaller, but v remains constant. So, the v/πd this part is going to gradually increase, because d is will be reducing, v is remaining constant. So, filament balloon speed will be little more than the speed of the bobbin.

Thank you.