New Spinning Technologies
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Lecture - 18
Dref-3 friction spinning

So, today's topic is Dref 3 friction spinning, Dref 2 we have already discussed and now we are going to discuss Dref 3 friction spinning.

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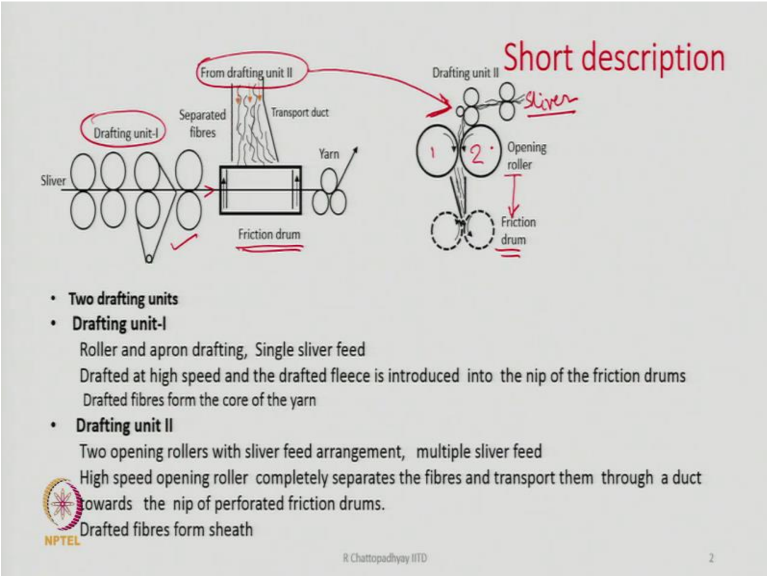

First we will give a very short or brief description of the technology. What you see here is a simple line sketch of the two important parts of the machines. What we see here that there are two drafting unit in this machine. You can see say that this is a basically constructional view of the you know the most important area of the machine not the entire machine as such is basically kind of simple line diagram.

So, there are two drafting units in the Dref 2 we have only one drafting unit. And In this case there is one drafting unit 1 which and there is another drafting unit drafting unit 2. This drafting unit is more clearly shown in the right hand side of the diagram. So, there are two drafting units and there is a friction drum. In Dref 2 also we have seen the friction drum is there.

In this case basically there is one additional drafting unit that has been attached to the machines that is drafting unit 1 that consists of basically a set of rollers. So, roller and apron drafting which is here and it is a single sliver feed that we feed only one sliver through it and then drafting is done at quite high speed and the drafted fleece is introduced here. In between the two friction drums.

So, there are two friction drums as it is shown here and the drafted fleece of fibres is introduced at the nip of these two friction drum and whatever is fed by drafting unit 1 that becomes the core part of the final yarn. So, it goes into the core and whatever is fed from drafting unit 2 that becomes the sheath part of the yarn.

It has a core sheath type of structure. So, material fed through drafting unit 1 becomes core and material fed through drafting unit 2 basically becomes your sheath. So, drafting unit 2 there are two opening rollers as you see it here opening roller 1 and opening roller 2 these are the two opening rollers. The opening rollers rotate at a very very high speed we will see at what speed they run and here we feed multiple slivers. So, this is the sliver feed here not just one we feed 5 6 slivers.

Whereas, through drafting unit 1 we feed only one single sliver and the once the fibres are acted by the teeth of the opening roller the fibres are sufficiently individualized and then these fibres are directed towards the friction drum. So, for fibres to travel from the opening rollers to the friction drum we need a support of air.

So, there is a transport channel through which or you can call it fibre feed duct through this duct the fibres from the opening roller surface will be moving and ultimately will be landing on the friction drum surface. They are directed in such a way they are the land very close to the nip area of the friction drums and the friction drum which is shown it here.

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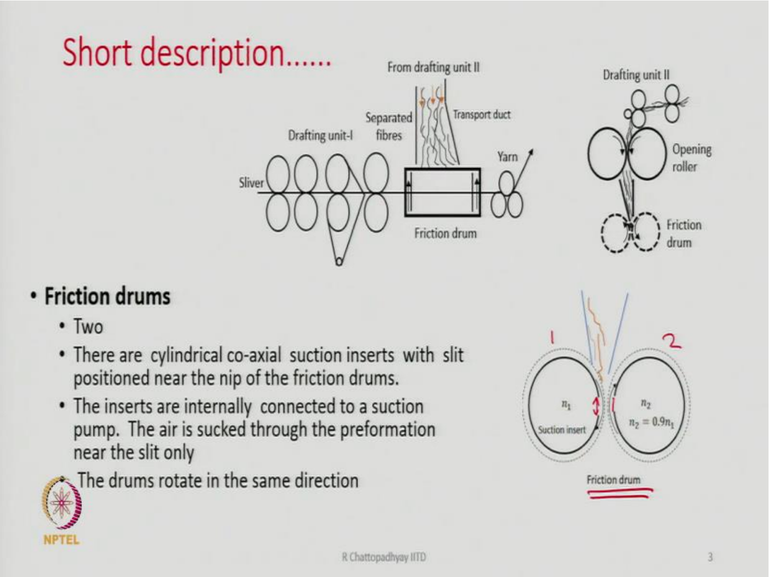

This side of the diagram there are two friction drums drum number 1 and drum number 2 the friction drum surface is perforated. So, there are lots of perforations on it and then there are two suction insert here this you know this circle that you see which is partially opened over here this is basically an insert inside the drum. So, on both side of the drum we have two suction insert and these inserts are connected to a suction pump.

So, we draw air and because openings are only here in this zone and in this zone so, here only the air can entry or the air can enter at the openings or where the slit actually exist. And therefore, this will cause the fibres to be directed at the nip of the two friction drums and the drums rotate in the same directions. So, that at the nip area the two surfaces of the drums will move opposite to each other, but if we otherwise the drum rotation rotational directions are exactly same.

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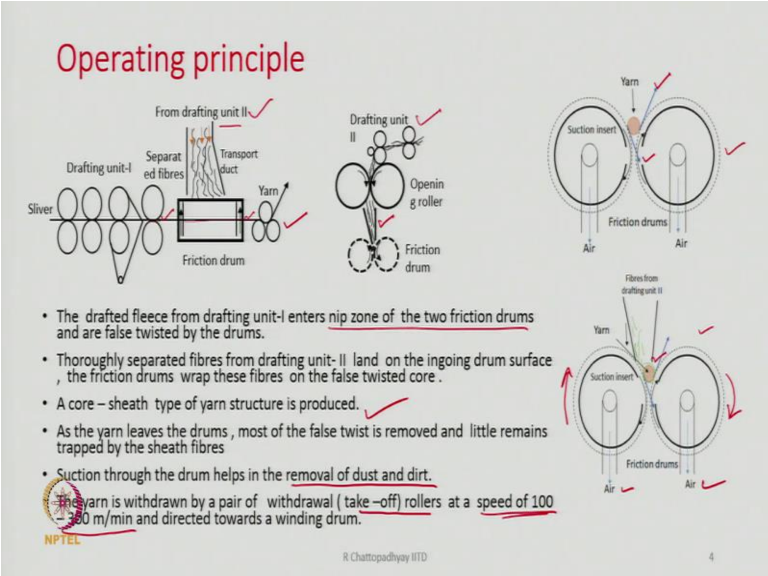

So, that is the direct basically description of the machine in simple terms and if we want to understand the how the machine works then as I said earlier the drafted fleece from the drafting unit 1 will enter the nip zone of the two friction drum. So, here it is shown that this is the nip zone and a bundle of fibres which is existing here shown by the orange colour this bundle of fibres is actually the set of fibres which are being fed through drafting unit 1.

And from drafting unit 2 thoroughly separated fibres separated by whom separated by the opening roller. Though, these separated fibres are made to move through the transport channel and they also will come and actually land on the friction drum. And here in this diagram this is shown the green lines that you see here these are the fibres coming from drafting unit 2 and the orange colour indicates the fibres coming from drafting unit 1.

So, two group of fibres are meeting they are meeting where they are meeting at the nip area of the friction drums. Now, as soon as the fibres from the drafting unit 1 that is these are arriving at the nip zone of the two friction drums two friction drum will act on that bundle of fibres the bundle of fibres are pressed against the friction drum because the suction is acting.

So, they are pressed and now because the roller surface is moving that is this roller is moving and this perforated drum friction drum is moving and this perforated drum is also moving. As a result, at the zone where they are in contact with the two surfaces the frictional force will work like she is shown here by this blue line or blue arrow.

So, both the surfaces of the friction drum will act on the group of fibres which are pressed against the drum surface and because of the friction the frictional force will act on them, which will generate torque and as a result this bundle of fibres will be twisted. Now, this twist will be basically false twist in nature because there is a continuity in the fibre supply from the phone roller nip to the end of the drum within the drum.

There is a continuous flow it is not like open end spinning the flow continuity exists there is overlapping between the fibre. So, if the drum generate twist on these fibres this twist is going to be false twist in nature. As soon as the fibre strand nip the drum surface or drum exit end the false twist will be removed.

Now, if the false twist is removed obviously then there is no strength in the bundle. So, before the false twist is removed therefore, we actually introduce fibres from drafting unit 2. These fibres will come land on the at the nip of the friction drums and they will start wrapping around it is shown here by the green lines they will start wrapping around the false twisted yarn that exists between the drums. So, they will keep wrapping.

So, now this entire structure consisting of the sheath fibres coming from drafting unit 2 and the fibres coming from drafting unit 1 all of them are going to move out from this twisting zone. And the sheath fibres which are wrapping the core they will remain in wrapped state and the core fibres which are false twisted part of the false twist might get removed, but some false twist remain trapped in between because the sheath fibres are actually wrapping over them.

So, because sheath fibres have already started wrapping over them even in the core are trying to untwist the entire twist which was present in the core entire twist may not get removed completely, but that does not matter. So, sometimes we see in the structure of the yarn that sometime the core part of the yarn has little bit of twist still left.

Though ideally we expect no twist with the work there because the core is getting false twisted, but in the practical cases some twist remains because of by the time they are about to be removed the sheath fibres are actually creating hindrance for the removal and therefore, some twist remains trapped that is what generally happens. Ultimately what we get a core sheath type of structure core surrounded by a lot of sheath fibres.

So, that is how the system is going to work and as I shown here the suction insert and they are connected to the suctions. Suction also helps in the removal of dust and dirt that is an additional advantage we get because we are sucking at the yarn formation zone. So, if you process cotton some dust particles are expected they will be sucked.

The yarn is withdrawn by a pair of rollers or withdrawal rollers sometimes called take-off rollers and the withdrawal speed varies between 100 to 300 meters per minute. So, the yarn is pulled out like it is shown here these are the withdrawal rollers or take-off rollers from there the yarn goes to the winding unit and you are all familiar with winding of yarn or cone or cheese.

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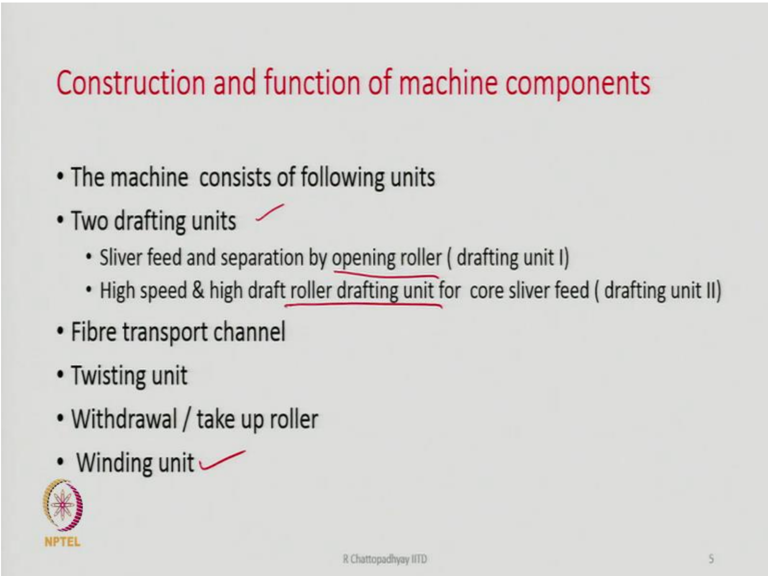

Construction and functions of machine components. So, we have already seen what are the main machine components one is the drafting units there are two drafting unit 1 of them is drafting by opening rollers and the other one is drafting by roller drafting units. Fibre transport channel twisting unit withdrawal or take-up rollers and then the winding unit. So, these are the basic you know components of the machine.

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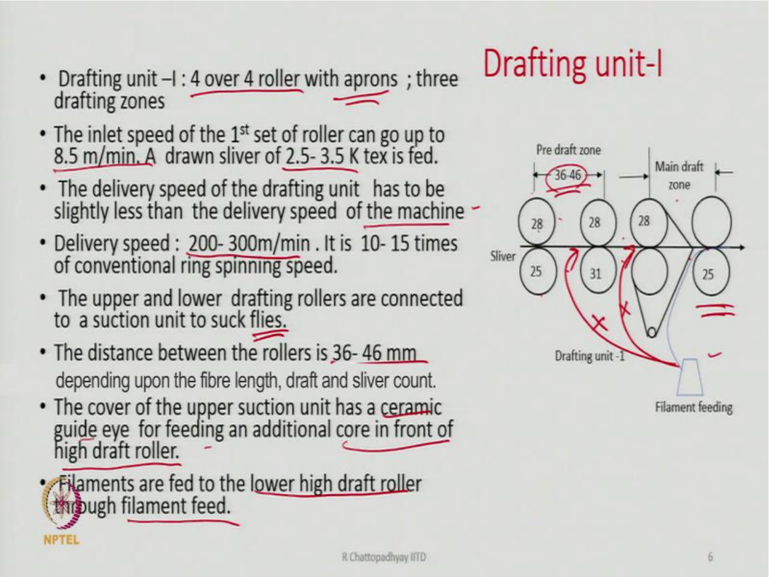

Now, drafting unit 1 if you look at you are already familiar with the drafting system we have studied drafting system on draw frame once roving frame or ring spinning machines and. So, many places roller drafting system most of you have already studied. So, here also we have basically a roller drafting system and we have four pair of rollers because we have to give very high draft.

Though we are not really spinning you know sliver to yarn in this case sliver is drafted we make it thinner and that becomes part of the core basically. So, drafting units is basically four over four rollers with aprons in the final zone we have apron because there the draft is more the inlet us speed of the first set of rollers can go up to 8.5 meters per minute that means, the surface speed of these rollers they can go up to 8.5 meters per minute.

And typically the sliver which is fed here usually it is little thinner in comparison to the sliver that will produce on carding machines or on draw frames generally 2.5 to 3.5 kilo tex slivers are used little finer slivers are used the delivery speed of the drafting unit has to be slightly less than the delivery speed of the machine.

So, this drafting this is basically a high draft high speed combinations delivery rates are quite high it can this delivery rate of the front rollers can go to the order of 150, 160, 200, 220 meters per minute. In comparison to ring spinning if you see what is the delivery rate in ring spinning hardly 15 or 18 meters per minute.

So, it is almost 10 times more. So, all the rollers have to run very very fast. So, the front rollers if we fix the delivery rate 150 meters per minute or 150-180 meters per minute so, its runs very fast. And actually it can go up to 200 to 300 meters per minute that is what is the claim by the machine manufacturers, but commercially generally people keep 180, 200, 250, 220 typically that is the speed. So, depending upon the kind of count we want to spin the type of sliver and fibres we are processing the right speed can be chosen.

The upper and lower drafting rollers are connected to a suction unit to suck flies that means, this part these upper part from here to there at the lower part actually there is a suction system. Why? Because if the rollers are at a very very high speed lot of dust if it is possessing cotton lot of dust will be generated and if not cotton also lot of fibre flies will be there because if every roller running at a very high speed they have their own air current.

And these air current may be there could be collision between the air currents of top and bottom rollers. At a result there will be some disturbance to the flow of fibres which leads to some kind some fibres to move away from the main flow and they become kind of fly and we have to suck the fly immediately otherwise these flies will be contaminate the surrounding atmosphere. So, therefore, we have to quickly suck them and hence we need to have actual suction system there.

Distance between the rollers a typical distance is shown here the distance will depend upon the fibre length that we are going to process and setting and draft combination these have been already told in some other you know in your some other you know classes. So, the setting parameters the exact draft distributions they all depend upon the type of fibre we are going to process.

So, typically here it could be 36 to 46 depending upon what fibre length we are going to process. So, this is the main draft zone and this is the pre draft or break draft zone we are also keep little bit of draft here just to keep the fibres under tension. The suctions you need may have ceramic guide for feeding and additional core in front of the high draft rollers that is here we can have a system of feeding the filament like in the diagram we are showing that if the filament directly going into the nip of the front pair of rollers.

See advantage here is that we can have one more component as a part of the core and that could be filament. So, for filament feeding that could be some separate arrangement, but it is actually very simple filament bobbin is placed here and the filament is removed and actually fed at the nip it has to finally, go to the nip through some kind of guide eye.

If I feed the filament here then filament will be under stretched. So, that is we cannot feed it here we cannot feed it. So, this is not permitted this is also not permitted filament will be under tension. So, we have to feed the filament here only. So, that it moves along with rest of the fibres and remain in this at the centre part of the yarn that is what is ideal. So, filaments are fed at the lower high draft rollers through filament feed arrangement.

So, there are arrangements for feeding filaments. So, we can feed polyester filaments we can feed nylon filaments we can feed mono filament we can feed multi filament we can feed Kevlar we can feed you know carbon fibre filaments. So, there are many options to feed different types of filaments and create a structure where you have filament staple fibres combinations.

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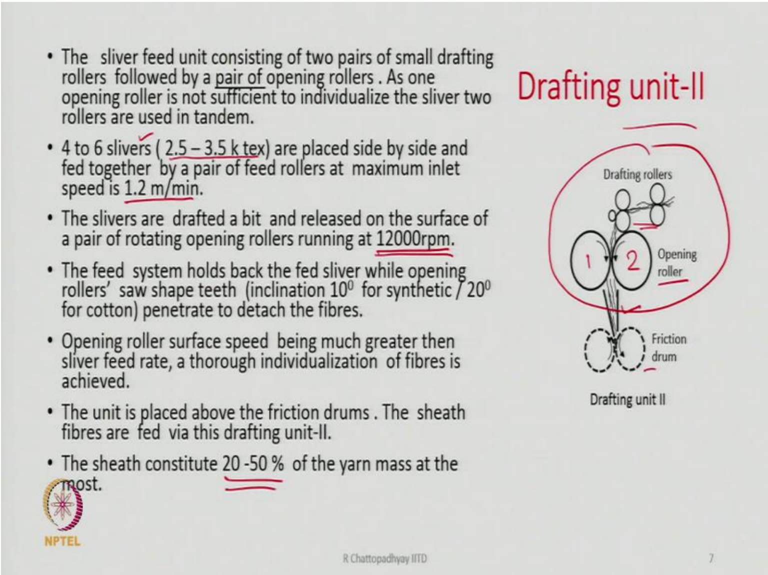

Drafting unit 2 is similar to what kind of drafting units we have in the case of rotor spinning machines where the fibres from the slivers are separated by one opening roller. Here we have two opening rollers 1 and 2 not just 1. The two rollers are required because of complete separation individualization we are actually feeding 5 to 6 slivers or 4 to 6 slivers are fed.

Slivers individually are not very thick they are 2.5 to 3.5 kilo tex and they are fed at a normally at a slow speed. The typical maximum speed is 1.2 meters per minute. So, comparison to the drafting unit 1 the sliver feed rate is much less and we are feeding 4, 5 or 6 slivers together and if we want to separate the fibres from the sliver. So, what we do first of all that is a pair of drafting rollers with little draft. So, fibres slivers are little drafted and then they are moving towards the opening rollers.

Opening rollers have their own teeth and the way a sliver is opened in the case of rotor spinning exactly same way it is done. The only difference is the one roller is not sufficient to individualize the fibres and therefore, we have two opening rollers and the opening roller speeds are very high at 12,000 rpm. So, as a result we get a very very high you know individualization of fibres from the sliver.

Now, the individualized fibres are made to pass through this transport channel. We will discuss about the transport channel. So, that means, we have to remove the fibres from the teeth of the opening roller. The opening roller teeth geometry can also vary depending upon which type of fibres we are trying to process here.

Whether we are processing viscous rayon or processing or polyester fibres or nylon fibres or acrylic fibre because you have lots of choices are there. So, depending upon the type of fibres and length of fibres, the denier of fibres, you want to process the proper opening roller teeth or tooth geometry can be chosen.

This unit is placed over the friction drum just above the friction drum. See the friction drums and the drafting unit 1 they are at the same plane, but the drafting unit 2 is placed above the two friction drums. If these are the friction drum, the unit is here, it is above. And the sheath fibres could be varied between 20 to 50 percents of the yarn mass. So, anything between 20 to 50 percent could be part of sheath, the rest is core. So, that kind of variation is possible.

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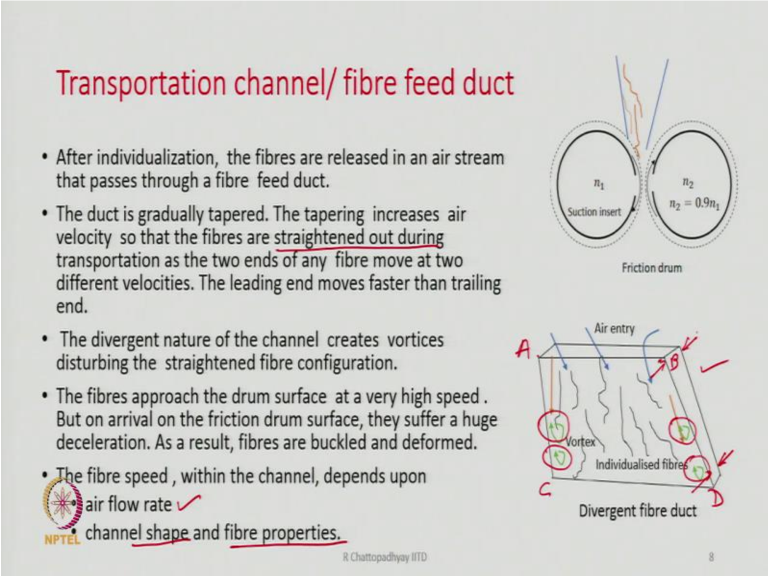

And transport or fibre channel is. So, we have discussed about transport channel also in the while discussing rotor spinning as well. So, here also so many there are more fibres have to be transported power unit time. So, transport channel is little larger and this is the typical you know design of the transport channel that it is divergent in nature. See if you look at the from here to here the distance, let us say I write A and B, if I write C and D. So, C D is larger than A B.

So, it is like that only. But if you look at this side and this it is narrowing down. So, channel is actually narrowing down from top to bottom. So, here whatever is the width, the width at the bottom is little less. So, that the air velocity keeps on increasing from top to the bottom part of the transport channel. And this is also we required the tapering of the transport channel is going to increase the velocity of the fibres which will help in straightening out the fibres.

Because the two end of the same fibres will move at two different velocities. Any fibre because fibres have a basically length dimensions and hence the leading end and the trailing end of the same fibre will be moving at two different velocities depending upon where exactly they are located. And this little difference in velocity is going to straighten them out. That is the advantage we get by having tapered transport channel.

But it has been also shown the divergent nature of the channel creates vortices shown by this vortex gets created also. And because of this some of the fibres actually lose their straightened configuration. They also can they can also get deformed because of the vortex which is generated. Now, the fibres are approaching through the transport channel it is they are moving or they are flying. Now, they are ultimately going to land on what they are going to land on the friction drum.

Now, friction drum surface speed is comparatively much less than the speed of the incoming fibres. So, the speed of incoming fibres are more than the surface speed of the friction drum. What is the result of that? Fibres after landing will be decelerated and they will get deformed.

That is the situation that we have that as a result of this fibres can get deformed and actually many fibres get deformed because of this reason. And the speed of the fibre depends upon the flow rate and the shape of the channel. That is geometry of the channel and the properties of the fibres.

So, ultimately it is the air drag which is you know carrying the fibres. So, drag is a function of the diameter of the fibre, the cross sectional shape of the fibre, the length of the fibre, the surface roughness of the fibre so many aspects of the fibre also come into the picture. How the fibre is going to move? How quickly they are going to get accelerated as soon as they are released into the transport channel. Then come the twisting units, twisting unit in our case or this case is basically friction drum.

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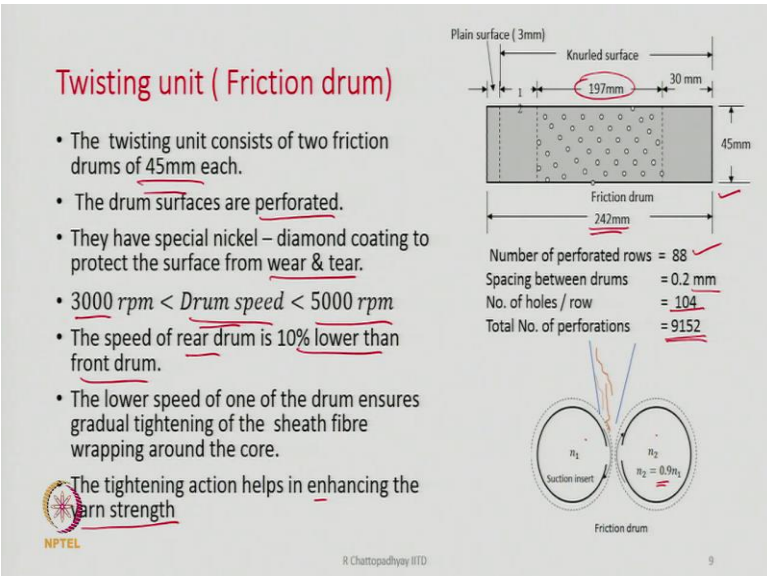

So, here is the simple sketch of the friction drum. Part of the drum surface, almost 197 millimetre in length is having lot of fine perforations. The total length is 242 mm. And the surface of the drum is also knurled. So, that there is a friction. You have to have good friction between the drum surface and the fibre.

So, surface of drum is not really smooth. Deliberately it has been made knurled surface that more friction can be there. Drum diameters are 45 mm. We have also shown here. Drum surface are perforated because through those perforations actually, the perforations are there. So, as they rotate and they reach the nip zone where the slit is there in the inserts and through those slit the air is drawn and therefore, the air will able to pass through the perforations of the of the friction drum.

So, therefore, the entire surface is having perforations. They have special nickel diamond coating in order to reduce the wear and tear. Drum speed varies between 3000 to 5000 rpm. That is the typical speed range of the friction drum. And the speed of the rear drum is 10 percent lower than the front drum.

The these two speeds are not exactly same. Suppose, n1 is the front drum then n2 speed is little less than it around 0.9 n1. And this is done why the lower speed of one of the drum ensures gradual tightening of the sheath fibres, wrapping around the core. That is the reason why there is little difference in the speed of the two drums. The wrapping fibre, the sheath fibres as they start getting wrapped, this wrapping action is going to be you know gradually they will be tightened.

If one drum moves slower than the other and the tightening will help in enhancing the yarn strength number of perforated rows around 88 spacing between the drums 0.2 mm or sometimes 0.1 mm also. The number of holes in a row per row is 104. Total number of perforations is 9152 on the entire surface of the drum. So, many perforations are there.

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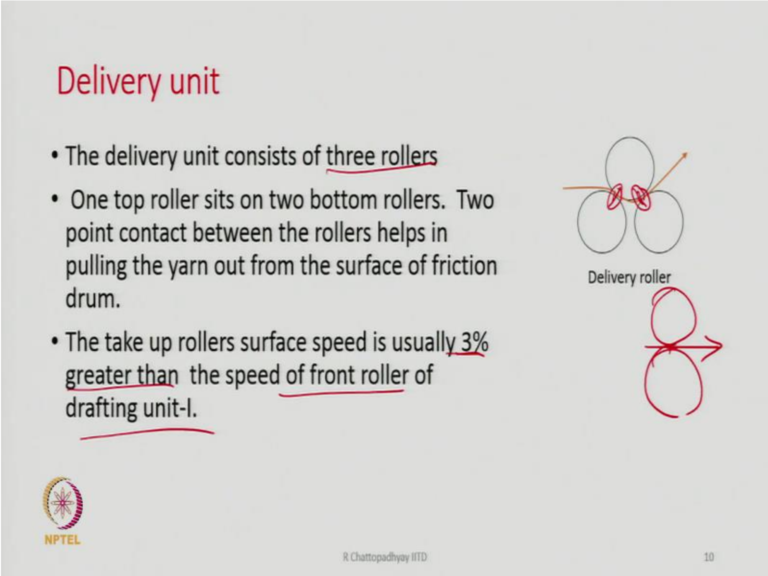

Delivery unit is consist of as it is shown here. Three rollers are there and there are 2 nip zone. This is going to help to pull the yarn at a very very. We have to pull the yarn at a very faster rate know, delivery rate is 180 or 200 or 250 meters per minute. So, just having 2 rollers grip on a yarn is not sufficient to pull the yarn at a very high speed. There is a possibility of slippage.

To avoid that, we will have a 3 rollers system where there are a nip zone over here another nip over here. The yarn is actually gripped at 2 points and then there they are pulled out. So, that to avoid the slippage and the take up roller surface speed is usually 3 percent greater than the speed of the front roller so, that the yarn remains under little tension.

So, surface speed is usually 3 percent. Sorry, take up roller speed is 3 percent greater. Yes, if it is more than the delivery roller of the drafting unit 1, then the yarn which is there and getting formed between the drums, it will be remaining under tension. We have to apply some tensions and hence, the little we can say there is a tension draft of 1.03.

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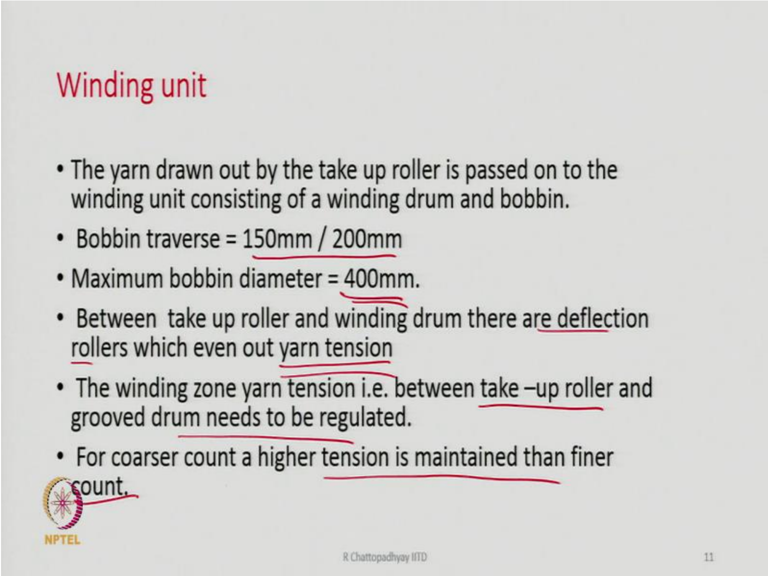

And the winding unit is a typical, it is actually exactly similar to the winding units that we have, we have already studied. The bobbin traverse could be 150, 200 millimetre, maximum bobbin diameter could be 400 millimetre. Between take up roller and winding drum, there are deflection rollers which even out yarn tensions. So, there are some deflecting yarn path which is created in order to you know even out the tension variation in the yarn, when the yarn is going to be wound on the winding drum.

And the winding zone yarn tensions also can be you know changed or can be regulated. That means, the take up roller speed and the drum surface speed, there is a difference between these two. Drum surface speed little bit more. So, that there is a tension in the yarn. And what about tension that tension can be controlled so, that we can get a package of right density.

Otherwise, the package may be very soft or may be very hard. So, we have some control on the tension in the yarn and the winding zone. And accordingly, we will be able to build a package of right density. For coarser count a higher tension is maintained than finer count.

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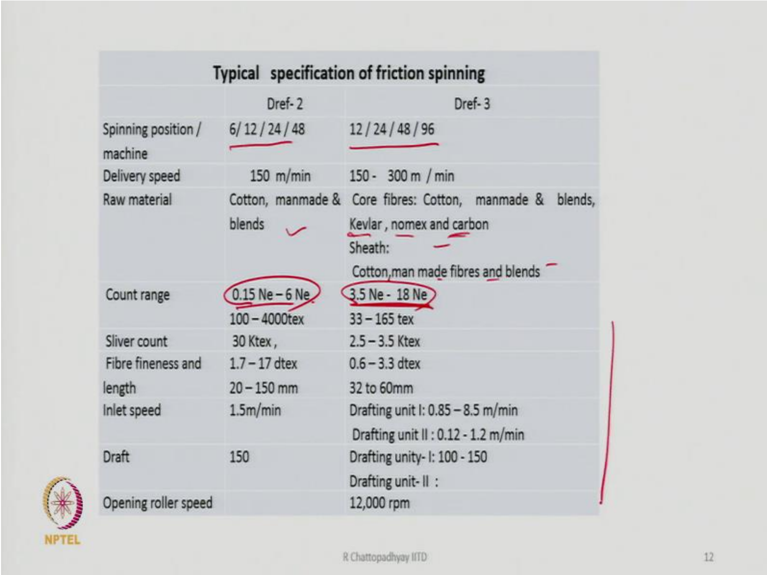

Typical specification of friction spinning		
	Dref- 2	Dref- 3
Spinning position / machine	6/ 12 / 24 / 48	12 / 24 / 48 / 96
Delivery speed	150 m/min	150 - 300 m / min
Raw material	Cotton, manmade & blends	Core fibres: Cotton, manmade & blends, Kevlar , nomex and carbon Sheath: Cotton,man made fibres and blends
Count range	0.15 Ne – 6 Ne 100 – 4000tex	3.5 Ne - 18 Ne 33 – 165 tex
Sliver count	30 Ktex ,	2.5 – 3.5 Ktex
Fibre fineness and length	1.7 – 17 dtex 20 – 150 mm	0.6 – 3.3 dtex 32 to 60mm
Inlet speed	1.5m/min	Drafting unit I: 0.85 – 8.5 m/min Drafting unit II : 0.12 - 1.2 m/min
Draft	150	Drafting unity- I: 100 - 150 Drafting unit- II :
Opening roller speed		12,000 rpm

Here is the specification of the friction spinning machine. Dref 2 and Dref 3, spinning positions could be like this. We can get a machine with 6 or 12 or 24 or 48 positions. For Dref 3, it can go up to 96 positions. Delivery rates are also stated here. The kind of fibres it can process. See here, we have fibres in the case of Dref 3, Kevlar, nomex, carbon. They can be there and they can be put into the core. Or sheath, we can have cotton manmade fibres or blends.

So, we can feed the slivers through drafting unit 2, which are going to form the sheath. So, here we can have a combination fibre and one, two slivers of cotton, three slivers of polyester or some other fibre. Whatever combination we want, we can have the slivers there or we can pre-blend the fibres and make slivers and then feed them also. So, we have many options to play with the structure of the yarn or play with the placement of fibres within the yarn cross sections.

That advantage we have in this kind of a spinning system. Therefore, this spinning system is very suitable for technical yarns. And generally, the count range if you look at it is very very coarse. So, Dref 2 yarn can never be used for apparels because it is suitable for only coarse count. Dref 3 yarns, we can go up to 18 Ne also. But generally, this is also used mostly for producing technical yarns. And other specifications are stated here.

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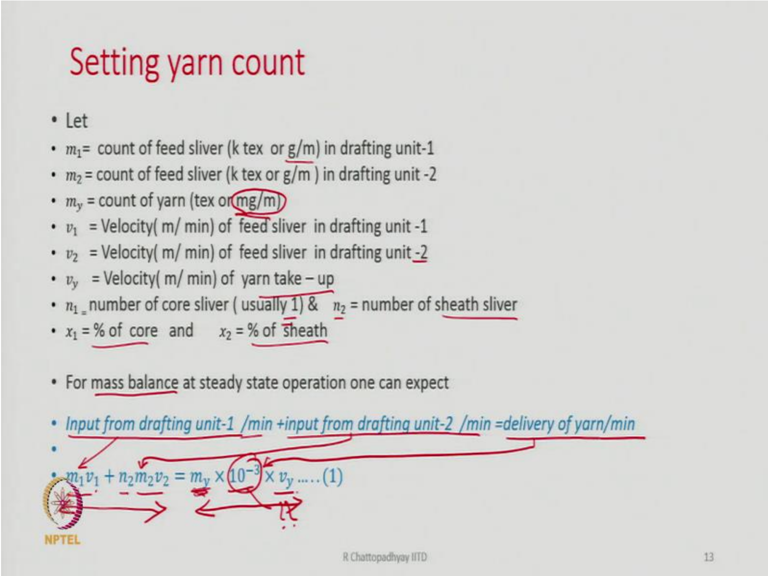

Now, we are going to discuss setting of yarn count. That is how to set a particular count of yarn that we want to produce. Let m1 is the count of feed slivers in drafting unit 1. So, there are two drafting units. So, from drafting unit 1, let us say the count of feed sliver is m1, m2 is the count of feed sliver in drafting unit 2, which is going to form sheath fibres. my is the count of yarn in tex. So, tex basically means milligram per meter. You have to remember, and clear tex means gram per meter.

v1 is the velocity of the feed sliver in drafting unit 1 and v2 is the velocity of feed sliver in drafting unit 2. vy is the velocity of yarn take up that is or yarn withdrawal. n1 is the number of core slivers. Usually it is 1 and n 2 is the number of sheath slivers. It could be 4, 5, 6 like that. x1 is the percentage core and x2 is the percentage of sheath. For mass balance at steady state operation, one can expect what whatever we feed the same amount should be delivered.

So, input from drafting unit 1 per minute plus input from drafting unit 2 per minute that because my total input that should be equal to delivery of the yarn per minute. So, here delivery basically means not in terms of how much length it has delivered, but how much weight of yarn it has delivered.

So, mass balance means basically you are discussing about the mass or the weight of fibre being fed and weight of fibre being delivered. So, there are two channels through which the fibres are being fed and there is only one channel through, which the fibres are taken out in the form of yarn.

$$m_1 v_1 + n_2 m_2 v_2 = m_y \times 10^{-3} \times v_y$$

So, therefore, we can write the simple equations. Input from drafting unit 1 per minute is going to be this. Input from drafting unit 2 is going to be this and the delivery of the yarn is going to be this. So, we write m1×v1 plus n2 m2×v2 equal to my 10 to the power minus 3×vy. Why 10 to the power minus 3? Why it is 10 to the power minus 3? That is because my is what is the tex value of the yarn.

So, tex value of the yarn basically means it is milligram per meter whereas, m 1 which is the kilo tex value of the sliver. So, it is gram per meter. So, it is gram per meter into velocity means so much of gram I am feeding. This is also gram per meter into delivery speed into so many slivers being fed. It is giving me total gram being fed per minute. So, I have to on the right hand side have to also have the same unit. So, you have to go for gram unit. So, milligram per meter should be converted to gram.

So, we have to divide it by 1000. That is why it is 10 to the power minus 3. So, my divided by 1000, we write it my into 10 to the power minus 3. It becomes gram per meter into v y that is the speed with which we are delivering. So, so much gram of fibre being delivered and so much gram of fibre from here to there, so much gram of fibre per minute I am feeding and from here to there is so much gram of fibre we are delivering.

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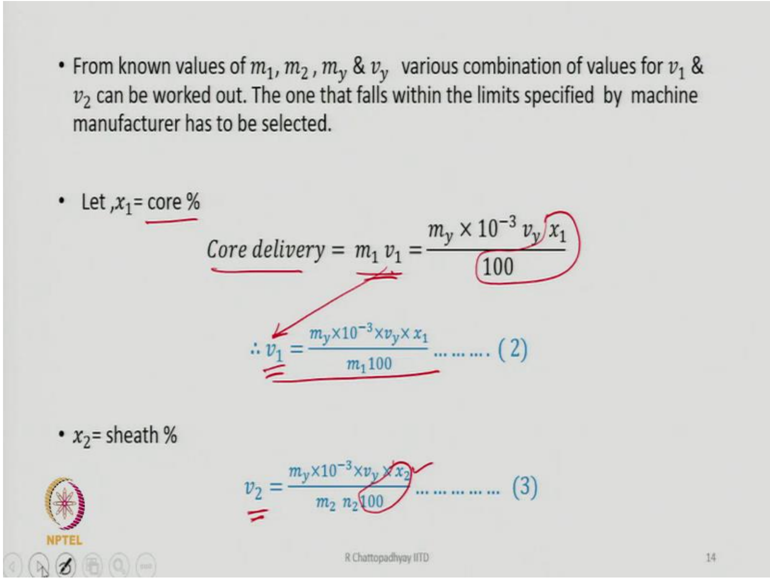

So, they are same with this. If let us say x1 is the percentage core then we can write the core delivery which is m1×v1 whatever is being fed from drafting unit 1 that is going to be basically my×10 to the power minus 3 ×vy × x1/100. This is the percentage of core which is present in the yarn.

$$Core\ delivery = m_1 v_1 = \frac{m_y 10^{-3} v_y x_1}{100}$$

$$v_1 = \frac{m_y 10^{-3} v_y x_1}{m_1 100}$$

So, this is the total is yarn mass. Out of that x1 percentage of the yarn is forming core. So, m1×v1 should be equal to this. So, from there we can write what should be my delivery rate that is v1. So, from here we find out what should be the v . So, straight way we come to v1, m1 goes on the right hand side. So, it will go at the denominator.

$$v_2 = \frac{m_y 10^{-3} v_y x_2}{m_2 n_2 100}$$

Similarly, we do it for the sheath percentage also and we can say that v2 is going to be exactly same way only x1 will be changed to x2 or x2 is the percentage of sheath. So, x1 by 100 it will be x2 by 100 and the equation remains fairly basically same. So, that way we can find out the feed rate at the drafting unit 1 and feed rate at drafting unit 2. So, when we want to set the machine then we have to actually most of the time we have to adjust the feed rate.

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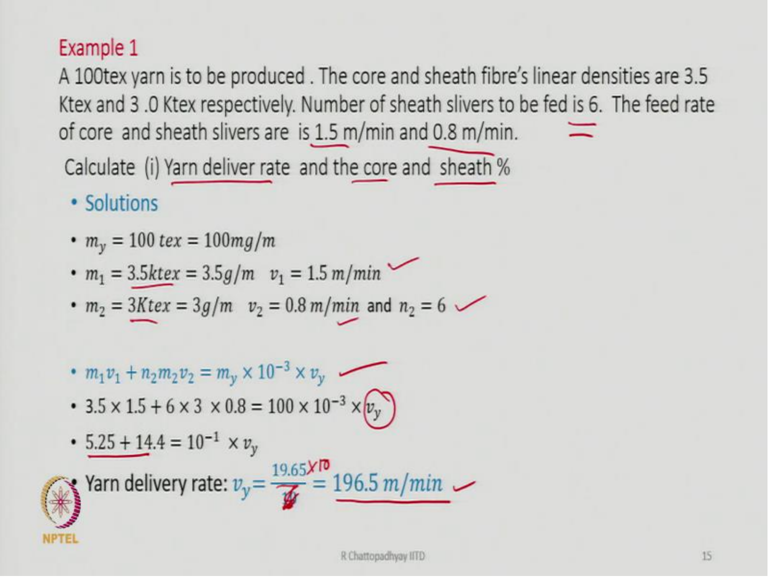

So, now we will solve a problem and that will make it clear problem number 1, or example 1. A 100 tex yarn is to be produced the core and sheath fibre linear densities are 3.5 and 3 kilo tex respectively. Number of sheath slivers to be fed is 6, the feed rate of core and sheath slivers are 1.5 and 1, 0.8 meters per minute. We have to calculate the yarn delivery rate and the core and sheath percentage in the yarn.

$$m_1v_1 + n_2m_2v_2 = m_y \times 10^{-3} \times v_y$$

So, how to go about? my this is the mass of yarn is 100 tex; that means, 100 milligram per meter. m1 is 3.5 kilo tex that is 3.5 gram per meter, m2 is 3 kilo tex 3 gram per meter, v1 is 1.5 meters per minute, v2 is also given 0.8 meters per minute, n2 is also given 6. So, first of all we write all those parameters whose values are given. Now, we have to make use basically of the mass balance equations. So, we know that m1 v1 + n2 m2 v2 equal to this we have seen it earlier. Here we simply substitute the values.

If we substitute the values what is missing here is actually in this equation v y, we need to find out the yarn delivery rate that is vy. So, straight way we will get the value of v y, yarn delivery rate will come 196.5 meters per minute. No, this is this will be multiplied by 10. And it will be 196.5, it is not divided it should be multiplied. So, 19.65 is this side multiplied by 10 will give you 196.5 meters per minute that is the delivery rate.

We need to calculate that in this situation what is going to be the core percentage and sheath percentage.

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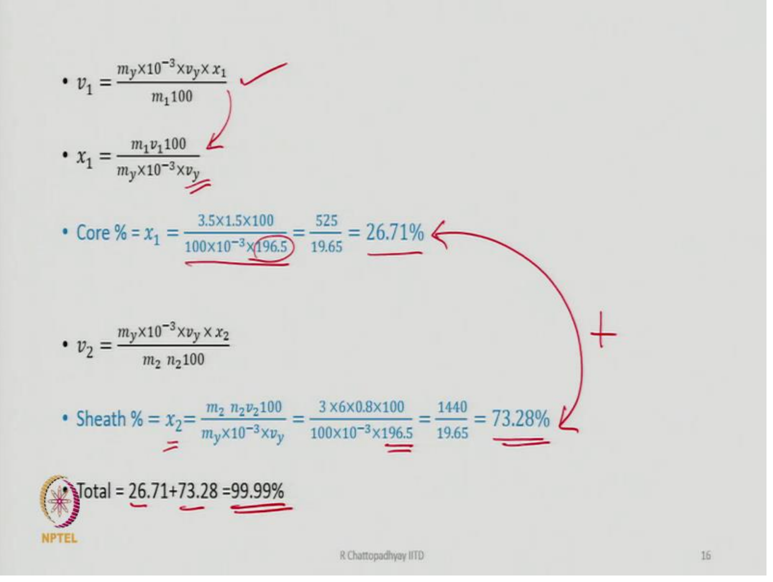

$$v_1 = \frac{m_y 10^{-3} v_y x_1}{m_1 100}$$

$$x_1 = \frac{m_1 v_1 100}{m_y v_y 10^{-3}}$$

So, if we know we know this equation v1 is this and therefore, from here we can write x1 will be m1 v1 into 100 divided by my 10 to the power minus 3 into vy. So, now is a question of basically substitution again because the values of the different parameters are already stated. What was earlier not known is vy. So, vy we have found out in the previous section and that vy value we are going to now place it here that is 196.5 and if we do it we get a figure 26.71.

$$v_2 = \frac{m_y 10^{-3} v_y x_2}{m_2 n_2 100}$$

$$x_2 = \frac{m_2 v_2 n_2 100}{m_y v_y 10^{-3}}$$

So, the core percentage is going to be 26.71 and exactly same way we will calculate the sheath percentage which is x2 and similarly we substitute the values. Only v1 vy values are not known earlier we whatever value of vy you have found out same values you are putting it that is 196.5 that is the delivery rate. And we get a figure now 73.28; that means, our core will be 26.7 percent and sheath will be roughly 73.3 percent let us say approximately.

And if I add these two this plus this there must be 100. So, if we add this and this figure in 99.99. So, it is almost close to 100. That means the answers are correct. So, this is how we can find out the core percentage and what deliver what you know under this condition what should be the what would be the core and sheath percentages and how much delivery rate we have to keep on the machine. So, that the machine keeps on producing that you know 100 takes yarn.

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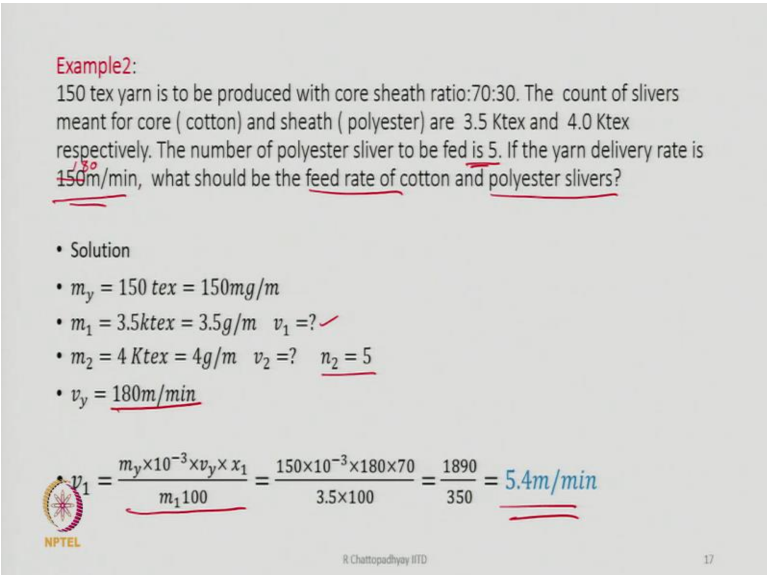

We will take another example what is this example now example number 2 read the example 150 tex yarn is to be produced with core sheath ratio 70 is to 30. The count of sliver meant for core that is cotton and sheath polyesters are 3.5 kilo tex and 4 kilo tex respectively.

$$v_1 = \frac{m_y 10^{-3} v_y x_1}{m_1 100}$$

So, the sliver that you are going to use for core and sheath their kilo tex values are given. The number of polyester slivers to be fed is 5 that is the decision we have taken that we feed 5 slivers. If the yarn delivery rate has to be 150 meters per minute what should be the feed rate of cotton and polyester slivers in this case. What should be the feed rate of cotton and polyester slivers?

Because accordingly we will adjust the feed rate and of both a cotton slivers and polyester sliver so, for a given core sheath ratio some parameters are already known we need to find out what should be the feed rate of the cotton and polyester slivers. Because once you want to work on the machine this is what you need to do.

First note down the values, which have been given already. So, 150 tex yarn means 150 milligram per meter. m1 is 3.5 kilo tex v1 is unknown. So, v1 there is a question mark. m2 is also given 4 kilo tex that is 4 gram per meter, but v2 is unknown we need to find out. n2 is given how many slivers will be feeding in drafting unit 2 that number is 5. And the yarn has delivery rate from commercial point of view has been decided to be 180 meters per minute.

So, if it is 180 meters per minute I think we have to make a correction here this would be 180 meters per minute. There could be some you know typing errors sometimes. So, you have to you know understand the typing errors. So, vy is 180 meters per minute; that means, delivery rate has to be 180 meters per minute. So, we can find out now v1, v1 formula has been given earlier if one can remember it is fine if you do not remember even then it is ok.

You have to go for you have to think the logic, logic is mass balance. How much quantity of fibre I am feeding that must be equal to the quantity of fibres I am delivering. So, you need not to think in terms of yarn or sliver just think there are 2 channels through which fibres are fed and there is one channel through which fibres are delivered. So, how much fibres I am feeding and how much fibres I am delivering there should be equal.

And if you remember this logic you can apply this and also can find out the value of v1 and v2, because with the same logic we have found out the formula for v1 and formula for v2. If v1 is this so, you just substitute the values you get a figure 5.4 meters per minute and v2 same similar formula you use the values here we get 0.405 meters per minute.

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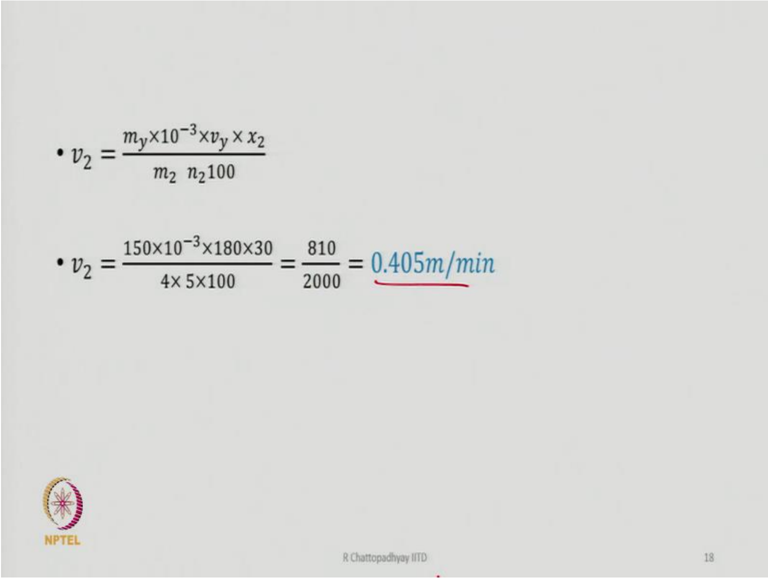

$$v_2 = \frac{m_y 10^{-3} v_y x_2}{m_2 n_2 100}$$

That means, the in this case the polyester slivers which are going to form the sheath is fed at a very slow rate because 5 of them are being fed. So, their feed rate is 0.405 meters per minute whereas, the cotton sliver which will go inside that is that go into the core that is fed relatively faster rate because I am feeding only one single sliver.

So, I have to feed it faster. So, v1 is therefore, always more than v2 and the machine manufacturers has given this profession. So, that v1 can be adjusted over a larger range in comparison to v2. Because the world you know designing the machines, designing the drive these aspects have to be kept in mind. Accordingly, the drive has to be designed.

Generally, you have to know what type of counts of yarns you are going to produce, what could be the possible you know coarse with ratios, extreme values you have to take and accordingly then you have to back calculate to find out what should be the feed rate in drafting unit 1, what should be the feed rate in drafting unit 2.

So, if these are the feed rates which we require, now one has to design the drive and keep this flexibility. So, that the feed rate of drafting unit 1 can be changed within this range or drafting unit 2 can be changed within this range. So, accordingly actually the designing is done.

So, before that actually all these calculations are done and then only the drive design actually starts, where one has to find out the gear train or if it is driven by motors then what should be the speed of the motors, how the speed of the motors can be controlled and in which range we should control it.

So, with this this part of this you know lecture is over now and next we will go to the, I think we will have one or two more lectures on the friction spinning. We will study the yarn formation mechanism, we will study the structure part of the yarns and some process parameters, how they affect the yarn quality or processing efficiency and what could be the you know applications of such yarns. So, these are the things we are still left we will cover in the coming lectures.

Thank you.