New Spinning Technologies
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Lecture - 26
Spinning by Adhesive and Felting Process

So, today we are going to discuss Spinning by Adhesive and Felting Process.

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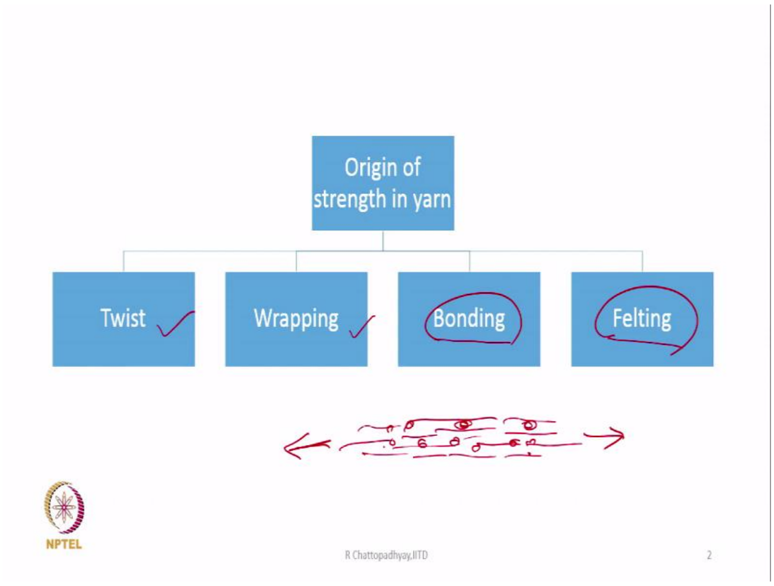

So far, we have seen that the spinning is done by either putting twist or by wrapping. Now, we will learn that there are other ways to hold the fibres together. So, that, the fibres as a bundle in the yarn form can really sustain some load; that is they are strong enough to take some load or they should have some strength.

Now, the very mechanism of strength development in a yarn is traditionally by twisting process. We know that, by twisting we force the fibres to follow a helical path and while doing so, fibres also keeps on migrating from core to the surface of the yarn and surface to core part of the yarn and it they follow it in a very periodic manner. And as a result, the yarn as a whole can really be strong.

Because, the fibres will not slip the helical configuration will allow the development of radial forces or transverse forces between the fibres. As a result, fibres will grip each other. And hence, they will not be able to slip easily. So, that is one mechanism which is traditionally followed and we do it on ring spinning, exactly this is what is done or on compact spinning also the technique is basically same.

Now, when it comes to wrap spinning, here, the bundle of fibres which are in the core they are actually wrapped and there are two different ways of wrapping that we have already learned; one is you wrap it by the same fibres, same constituent fibres and the other is that you wrap it by an external filament.

And this wrapping process, whether it is done by the same fibres or by the filament is actually going to again create some transverse force when the structure or this whole is extended and therefore, the frictional resistance develop between the fibres against slippage. And hence, the bundle of fibres which are there in the core they can resist slippage and therefore, they are strong enough to take some load.

So, these two techniques are very very popular and there are so many machines or so many technologies, which work on the principle of forcing the fibres to follow helical path or trying to wrap the core part of the yarn by either same fibres or by the external filament. Now, there could be another technique by which we can have some strength in the yarn.

Ultimately, any staple yarn is basically an array of discrete fibres. So, because it is an array of discrete fibres as I am drawing it here and is a parallel array. Since, the fibres are parallel; obviously, if I try to pull them, the fibres will simply slip. So, you have to somehow create a bond between the fibres and that bond is a mechanical bond which we create in the form of twisting or wrapping and that is a bond basically is a frictional bond.

Now, there could be another way or some other techniques to create these bonds. So, if we use some kind of glue in between the fibres and the glue holds the fibre together, then also, the entire you know the array of fibres will be able to sustain some load. So, that is what we are going to learn.

The other one is the Felting. Felting, I think many of you have already you know learned this particular word the felting and the fibre which is most prone to felting is wool fibre. And, what is the reason for felting? The felting is because, the wool fibres have scales. If we see the surface of wool fibres, which you might have studied in your textile fibres course, you will see that the surface of the wool fibres are not smooth there are a lot of scales on them.

And these scales can interlock when the fibres are in the form of a bunch and there could be some process in which we can make the fibres to interlock and this interlocking is because of the presence of scales on the surface of the wool fibres. So, we will see that, how felting takes place and we are actually many of you maybe you know already know that felting is very common when we try to wash a woollen you know sweater in the washing machine.

The dimensions of the sweater which is weight of 100% wool, they generally shrink and this shrinking is because of felting between the fibres. So, through this felting process also, there is a possibility of holding the fibres together; that is only possible because of the scales which are there. So, now, we are going to discuss the various the technologies which have been developed.

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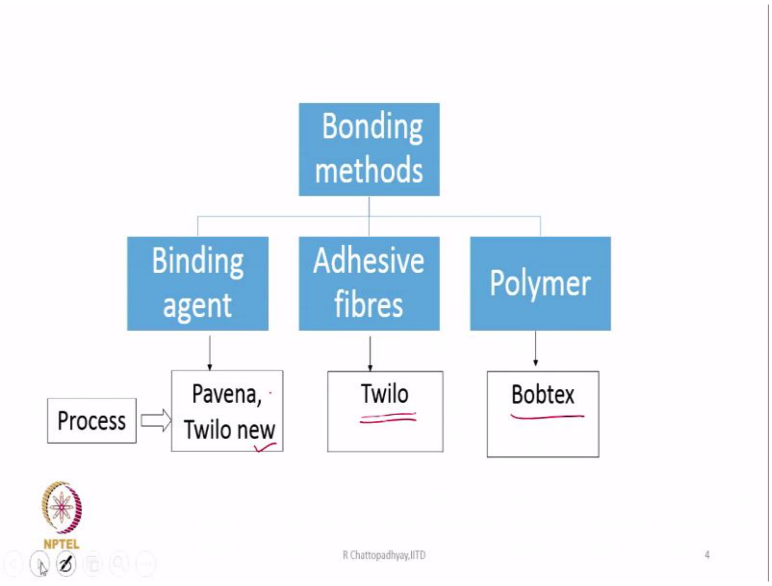

Now, we will first think that we will take is Bonding. So, bonding methods could be with the help of Binding agent or with the help of Adhesive fibres or with the help of some Polymers. So, bonding methods could be either by some binding agent or by some adhesive fibres or by some polymeric materials. Now, the processes which have been developed they are known as Pavena or Twilo new process; where binding agents are used to produce a yarn.

When we use adhesive fibres, the technique is also known as Twilo. The different companies have developed these techniques and when polymers are used, it is known as Bobtex. So, processes are known as Twilo process or Bobtex process. Now, we are going to discuss this processes one after the other.

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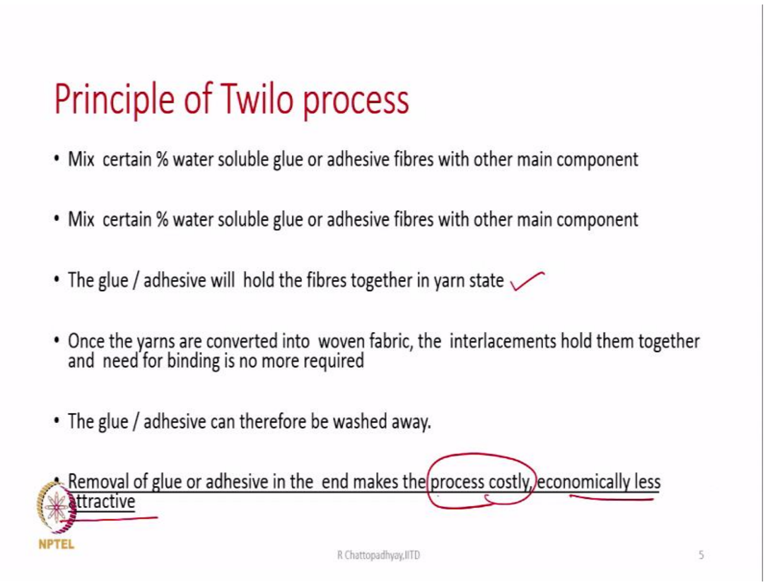

First of all, the principle of Twilo process; principle is that, since we have to have some kind of binding agent or adhesives, So make certain water soluble glue or adhesive fibres with the main components. We have to have some way to mix a glue, which is water soluble and some other adhesive fibres, which also could be water soluble.

Then the glue and the adhesive will hold the fibres together in the yarn state; that is the purpose of the glue that they will be able to hold the fibres which are there in the cross-section of the yarn together. And, the once the yarns are converted into a woven fabric, the interlacements will be able to hold the fibres together and therefore, once these yarns are converted into fabrics, we do not need the glue.

Because, the interlacements which are there, they are good enough to hold the fibres together. So, when we make the fabric using these yarns which has some kind of glue adhesives, we can now remove all these glues and adhesives. And, if we remove them, the glue and the adhesives is no more there and what we have left is a fabric where all the fibres are free from glue and free from twist.

But they are held in positions by the interlacements, every interlacement point is a source of pressure point and depending upon the frequency of interlacement, we can see that a fibre maybe you know held at 20 or 25 or 30 different points depending upon what is the end per inch and what is the picks per inch. At so many points, if a fibres are held by some pressure; obviously, the fabric as a whole will be stable enough.

That is how we you know, this kind sort of processes have been developed; because we know if the glue remains, then the yarns will be very very stiff. So, we have to get rid of the glue once the fabric is made. And therefore, you have a fabric made of 100% fibres, no glue and the fabric will be will have right handle so that they can be used on for different different purposes.

The only thing negative about this processes are that, the process is costly; because removal of the glue and adhesive makes the process costly and therefore, economically less attractive, that is the only thing. So, therefore, we have to think of that which kind of products for which kind of products we can use this kind of technology. Because, the products will be costly therefore, the yarn that you will make will be costly the fabric that we produce will be costly also.

And the cost is coming because, the additional process that we need to get rid of the glue or the adhesives.

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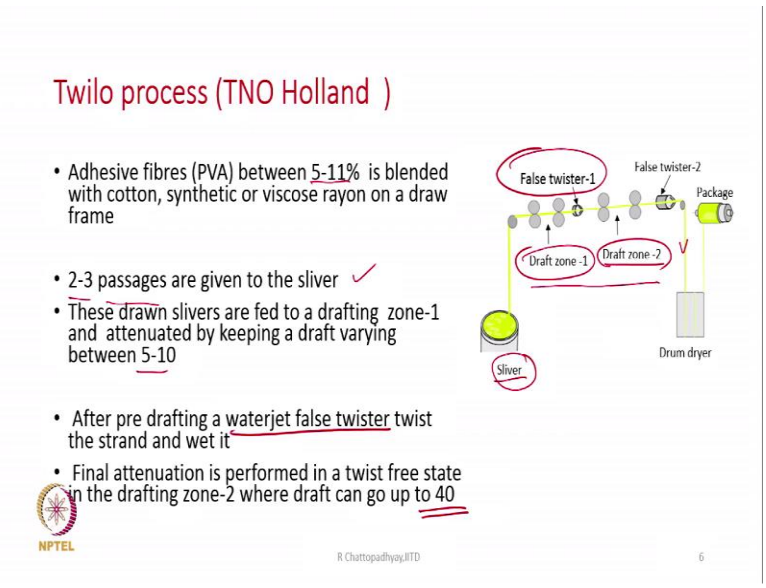

Now, the an outline of the process is shown here on the right hand side and what we see here is that, there is a source of sliver and this sliver has 5 to 11% of PVA, Polyvinyl alcohol it is a kind of adhesive fibres and they are available in filament form and they are also available in the form of staple fibres.

So, these fibres we have to mix with either cotton if we want a cotton yarn, we can mix with synthetics maybe polyester or we can mix with viscose rayon or we can mix with you know a combination of polyester/viscose blend or polyester/cotton blend. So, proportion of adhesive fibres could be between 5 to 11% or 10%.

And they can be mixed on a draw frame because we know in the draw frame we can easily maintain the blend percentage very well. Then, we have to give 2 to 3 passages, ok draw frame passages to the sliver, so that, the fibres get well dispersed within this sliver and the sliver becomes quite uniform as well. So, therefore, 2, 3 passages are basically very good.

Dispersion of the adhesive fibres will be better and the sliver also will be quite uniform, the fibres will be straight and parallel. So, that is the idea. Now, these drawn slivers becomes my feed material to the system. So, this is the sliver can and we feed the drawn sliver which is containing that you know 5 to 10% of PVA fibres.

So, they first pass through a Drafting zone-1, that it is written here is Drafting zone-1 consisting of two pair of rollers and we give attenuation which could be to the order of 5 to 10. So, some draft we give it maybe 5, 6, 7, 8, 9 that is the range is between 5 to 10. Some attenuation happens to the sliver. So, sliver becomes 5 times or 10 times thinner.

Then that is called pre drafting zone or pre-draft. So, we have given this much amount of draft, but this much amount of draft; obviously, it is not sufficient to make a yarn, from sliver to yarn the total requirement of draft to the to the order of 200, 300 in this range depending upon what is the count of yarn you want to produce.

Now, after drafting, what we do? We make the fibres to pass through a false twister, which is shown here. And, this is a water jet false twister. To twist the strand because we want to give it a round shape. So, you know if you the very quick way to transform a flat sheet of fibres into a round shape is by the method of twisting.

See, if we give some twist and we use a false twister here because we finally, do not need any twist at this stage. So, False twister-1, will be twisting the bundle of fibres which is moving out from the Draft zone-1. At the same time, because it is a water jet false twister it will wet the fibres. So, fibres will be in wet state because, we need to have some water, in order to make the PVA fibres we have to see fibres are there.

So, PVA fibres are soluble in water. So, if they get some water, if PVA fibre become quite tacky. And, they will be able to hold the fibres together now. And, once it moves out of the false twister, it go to the right hand side of the false twister, there will be no twist left there. So, twist will be present on the behind the false twister but, there will no twist present in front of the false twister.

Because, we know that false twisting basically means that the ‘S’ and ‘Z’ twist they cancel each other, which I have told in many times. And therefore, in front of the false twister there is no twist left, it is again a basically bundle of fibres with, PVA fibres dispersed within them and the PVA fibres have already sobbed a bit and they have become tacky.

Now, comes the 2nd drafting zone. In the 2nd drafting zone, the draft can go up to 40. So, there is a range in which we can keep the draft here; because, now after the 2nd drafting zone we have to reach to the stage of the yarn or dimension of the yarn. So, we can keep a draft of 30 or 35, 32 whatever we required accordingly we can keep the draft and we bring the bundle of fibres the dimensions of the yarn, whatever yarn count we want to produce.

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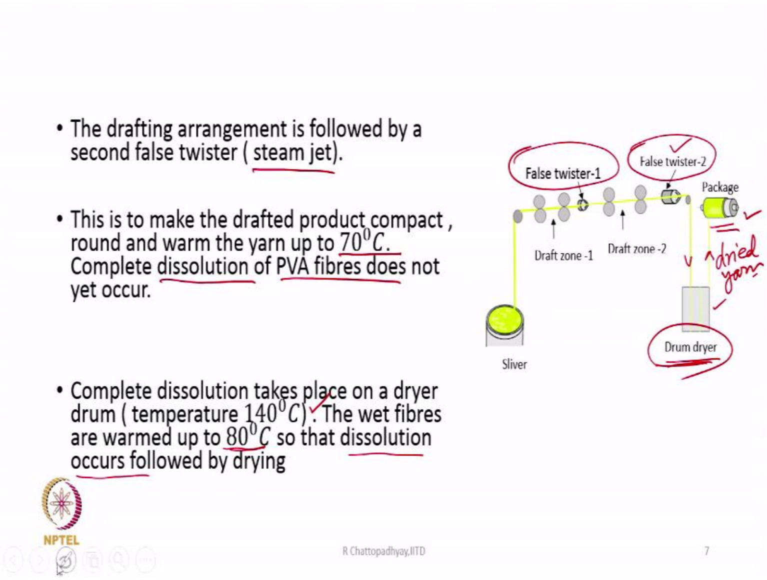

After this, we see another false twister, False twister number 2. This false twister what is the speciality in it? Now, this second false twister is basically a steam jet false twister; steam is there basically means there is a heating. So, this will again make the drafted products quite round and this will warm up to a temperature of 70 °C.

So, that complete dissolution of PVA fibres actually occur or at 70 °C, it may not occur probably depending upon what is the you know solution what is the temperature which it may not occur, but most of the fibres will dissolve and maybe complete dissolution may not have occurred at this stage.

So, complete dissolution can only takes place when it goes from here to the Drum dryer here. Here, we keep it the temperature to the level of 140 °C and when the yarn is passing through it can warm up to a temperature of 80 °C and at that temperature dissolution will be almost complete.

So, here partial dissolution occurs when it is passing through the False twister-2 temperature can go to the extent of 70 °C. After that, it goes to the dryer where the temperature of the dryer is 140 °C, but depending upon the whatever residence time is there, the temperature of this yarn can go up to 80 °C, So that all the PVA fibres are completely dissolved.

And after that, the dryer is already there the drying will also occur. So, simultaneously the drying also is going to happen and once the drying is over, we are going to form a package. So, by the time it is coming here it is a dried yarn. So, at this stage, it is a dried yarn containing PVA fibres, which have already dissolved and now they have dried.

So, all these you know that adhesive which is in dry state now is holding the fibres together; because it is a false twister, so there will be no twist in the fibres. So, fibres are held together by the PVA and this dried yarn is now going for package formations. So, the package is here. So, that is how the you know the actual machine is going to work.

We have 2 drafting zones and 2 false twisters; one false twister only using normal water, the other false twister is using steam. Next, we see the what kind of raw material we can use some data is giving here.

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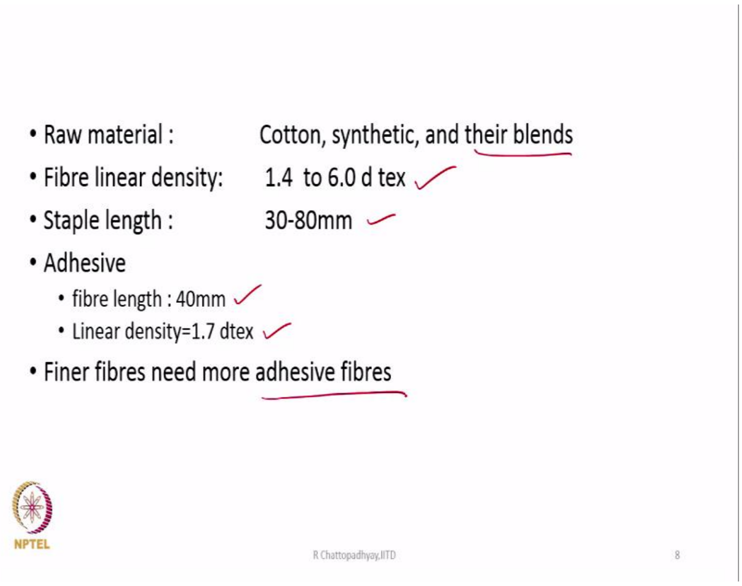

As I said we can have either synthetic fibres or cotton or their blends or whatever you know viscose rayon; we can use we can use lyocell fibre also; synthetics we can use polyester; we can use acrylic whatever fibres we require we can use it. The linear density of the fibres could be anywhere between 1.4 to 6 decitex, staple length could be 30 to 80 mm generally; that means, fibre should be long and the length of the adhesive fibre that is PVA is typically 40 mm and its linear density is very close to 1.7 decitex.

Finer the fibres we need more adhesive fibres.

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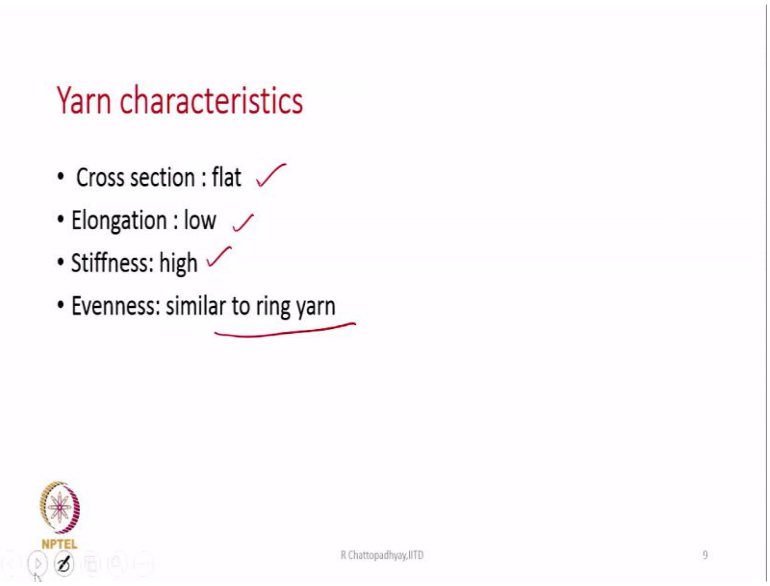

Now, the yarn that we make, how it will look like? This yarn you have remember that at this yarn stage they are still having lot of glue within them. The cross section will be little flat; though you expect to be expectedly perfectly round, but actually it is not round because when you try to wind the yarn also, there is some amount of pressure which will be there and that will make the shape of the yarn cross section little flat or more oval type of shape.

Elongation will be low, stiffness will be high, why? Because, there is no twist in the fibres. Since, twist is not there, the initial modulus is going to be quite high and because of the same reason, the elongation also going to be quite low. So, all these yarns will show higher stiffness and low elongations.

In comparison to the yarn made from the same fibres on other technologies, that is either on ring spinning or maybe on vortex spinning. Evenness is similar to ring yarn.

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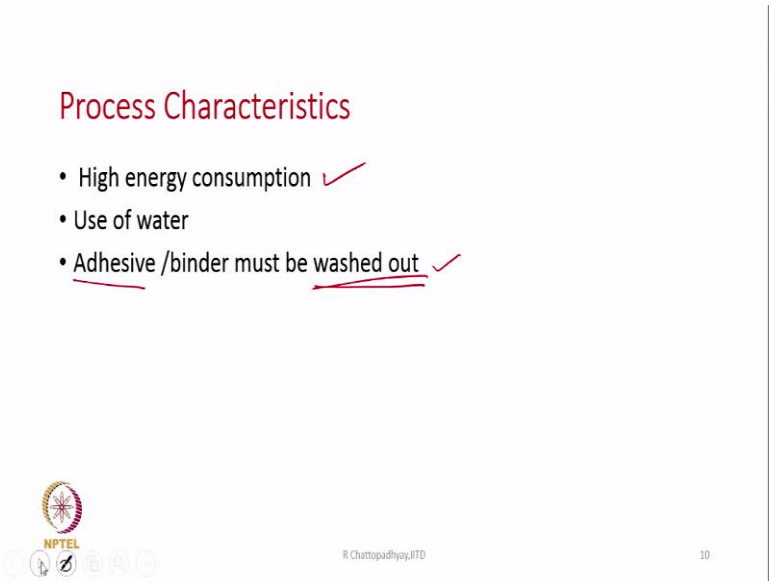

Process characteristics what is important is, high energy consumption; because you have to have steam, for the false twister that works with steam and we need a dryer also. So, over all the power consumption is high. We have to use water also. We do not need any water while you know spinning yarn or ring spinning technology or rotor spinning technology or jet spinning or vortex spinning there is no need of any water, but here, there is a requirement of water.

And other thing is important thing is adhesive or binder must be washed out completely. If it remains, the fabric will be stiff. So, washing out only happens after the fabric has been made.

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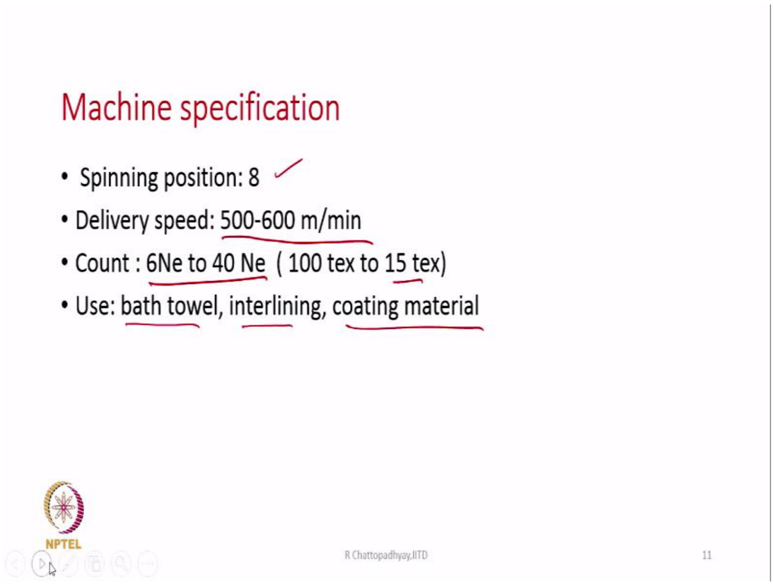

Machine specification that we have is spinning position is 8, what about commercial machine is available; delivery speed is very very high, 500 to 600 m/min. We have not seen the other technologies having similar to this kind of speed. Even vortex spinning also having a speed at the most 500 that is what the machine manufacturers claim.

Commercially it may run at 350 or 350 m/min or maybe 400 m/min. Delivery speed here is quite high. Count that can be spun varies from 6 Ne to 40 Ne or that is 100 tex to 15 tex on the finer side. And, it can be used in the bath towel, interlining, coating material some typical use are shown. So, bath towel may we can use it; that is we get rid of all the fibres, all the sorry all the binding agents and only fibres are left.

So, we can in the towel fabrics they can be used and in the case of interlining also this can be used and for coating material that if a fabric needs further coating and all, then this fabric can be used there also, then we coat it by some other material.

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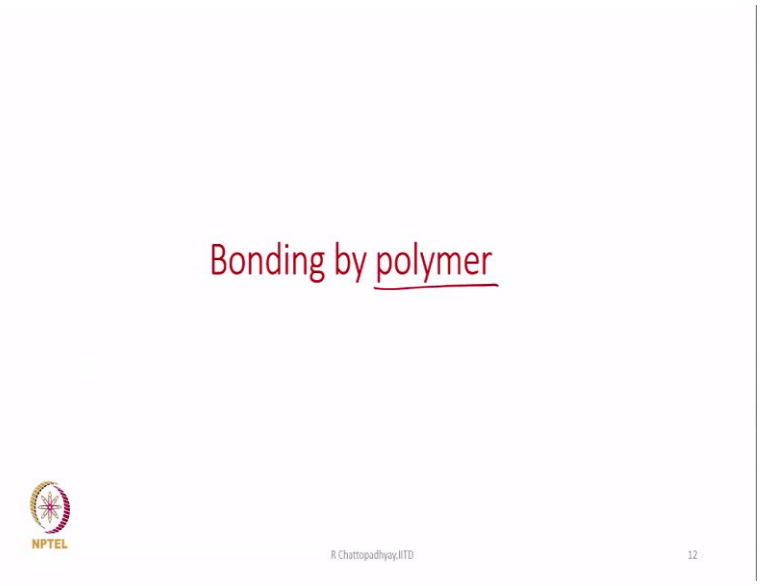

So, that is all about binding by some adhesive agent. Here, the PVA fibres act as a adhesive agent or as a binder. After this, the next technology that is comes to our mind is bonding by polymer.

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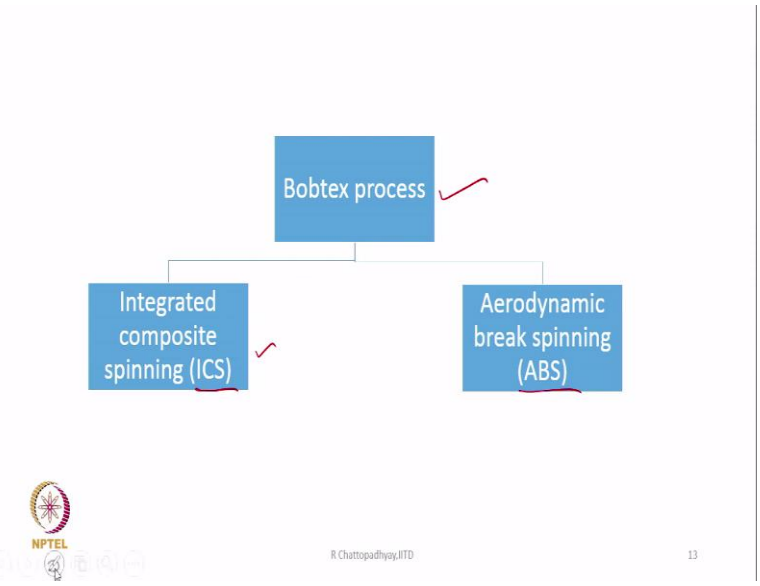

The process for this particular you know technique is known as Bobtex process, which was we will come to that where it was developed and within this there are two categories or two types; one is Integrated composite spinning known as ICS and the other is

Aerodynamic break spinning, short form is ABS. So, these are the two different processes which are there.

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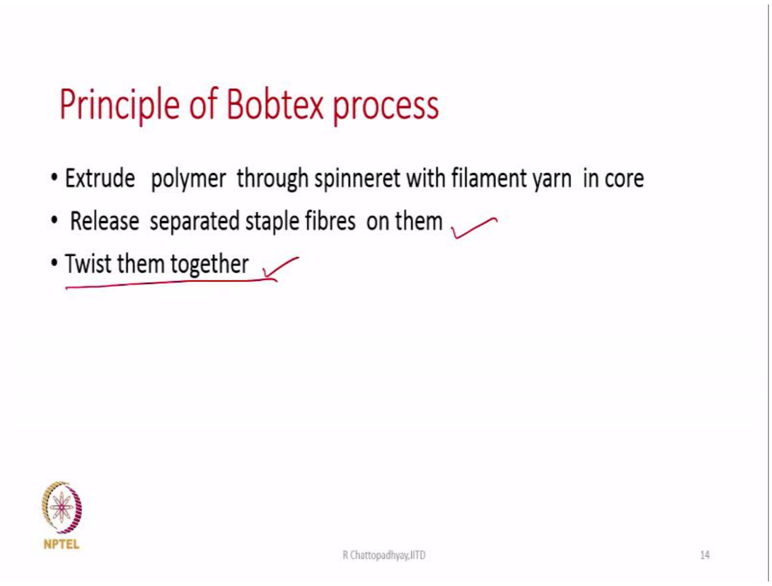

First, we will discuss about Bobtex process. In the Bobtex process, which was developed in Canada we extrude polymer through a spinneret with a filament yarn in the core. So, that has to be extruder and there has to be a method by which we can feed a filament in that particular extruder.

Then release separated staple fibres on them and twist them together. So, this is the main you know principle you can say basically. You are extruding a polymer along with a filament in core, then release some separated fibres staple fibres; whichever you want on the surface of that polymer.

So, in the core you have filament, on the filament surface there is a layer of polymer and now, this the surface of the polymer we will have staple fibres. So, we have to have a means to you know to introduce staple fibres and then this whole filament polymer, staple fibres they are twisted together and we get a round shape yarn. This is what is known as Bobtex yarn.

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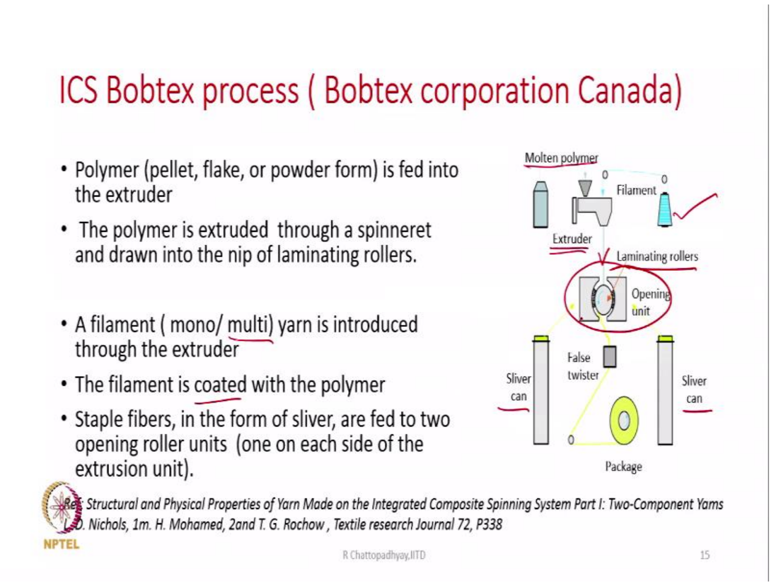

Now, if we want to show the sketch of the process, a schematic is given here, what you see here first of all that extruder is what we required. So, we have extruder and the molten polymer is introduced into this extruder. This is my molten polymer, so it goes inside the extruder and on the extruder, there is a filament which also go inside the extruder.

So, we have to have a mechanism by which we can feed the filament. So, polymer is fed in a molten state actually, they are fed into the extruder. And at the same time, and also feeding a filament. The polymer is extruded through the spinneret and then it is drawn see it is going down, towards a laminating rollers.

So, what we have here is a filament in core and that filament is also surrounded by a polymer matrix. And, the filament could be either monofilament or it could be also multi filament. So, the filament is coated with polymer because both of them are passing through the spinnerets. So, the filament remains in the center and it is surrounded by the polymer matrix, we say the filament is completely coated by the polymer.

After that, what we have to do is we have to now introduce staple fibres. So, then staple fibres gets an opportunity to get stuck to the polymer matrix. For that, what we have, that we have two sliver cans one on the right hand side and the other one on the left hand side. From both the cans this sliver is introduced. The sliver is moving towards this opening unit, this central opening unit it is going there.

And here, we have basically an opening roller, two opening rollers will be working for two feed sliver and the fibres will be opened out or separated from each other by these opening rollers. And these separated fibres will be landing on the laminating roller which is shown to the center and the fibres will be picked up by the polymer that is what is going to happen here.

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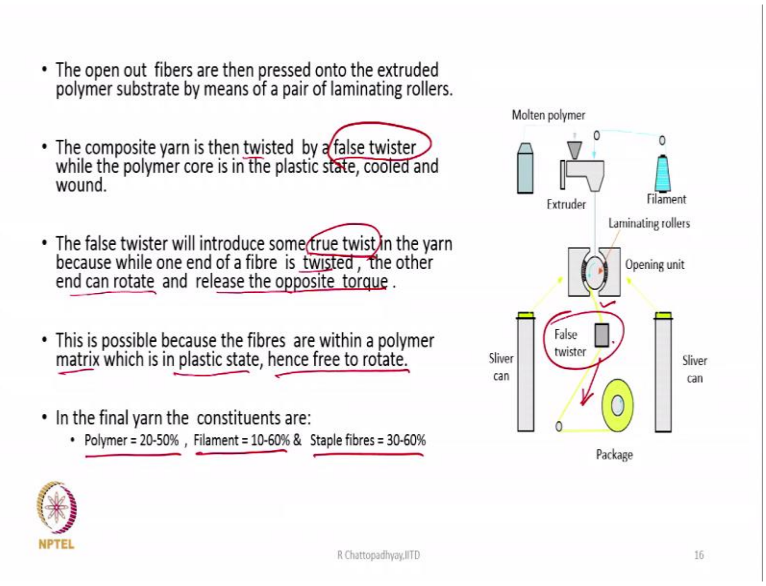

So, we will have a situation where, core contains the filament, we have a polymer matrix and polymer matrix picks up lot of staple fibres. We get a composite yarn because three types of material is there; filament, polymer and staple fibres, all of them are twisted together by a false twister, here is that false twister.

This false twister is here. False twister is going to twist them together. The false twister will introduce some twist in the yarn, because some true twist you see. Though false twister we mean that false twister should not you know leave any twist in the final yarn. Because, we feel as we have discussed earlier about the you know false twisting principle, that because the twist directions are different in the upstream and downstream stripes side.

Therefore, when the upstream part of the yarn flows to the downstream part, the twist in the upstream part and the downstream part they cancel each other and therefore, no twist is left in the downstream part where the upstream part always shows the presence of twist. See if the twister is here, this part will show may show some false twist, but the part below will not show any false twist that is what the false twister is going to do.

But some true twist is left in the yarn, because why? Because, one end of a fibre while one end of the fibre is twisted the other end can rotate and release the opposite torque that is the reason. When the other end cannot release the torque; that means, in that case, the torque present in the front part of the fibre and the back part of the fibre, this back part and front part is reference to the false twisting position, false twisting units position.

So, when the part in front of the false twister and the part in behind the false twister if both of them have exactly the same amount of torque, in that case, whenever the part behind the false twister moves downstream, they lose all the twist; because the torque will cancel each other because they have different senses. But, if the tail part of the fibres is allowed to rotate or they have some freedom of rotation, then twist present in the trailing part will be little less than the twist present in the downstream part.

And hence, though most of the twist will be cancelled some twist will be still left and that is why some true twist is seen in the fibres after the false twister. This is possible because as I have written it here, that the fibres within the polymer matrix which is a plastic state hence they are free to rotate.

So, there is the trailing end of the fibre bundle which is getting false twisted, this fibre bundle the trailing part is within the polymer matrix which is in a molten state and therefore, the fibre ends have some freedom to rotate because the torque is present there and hence some true twist will be same in the final yarn.

So, typically the final yarn constituents are polymers can vary to the percentage let us say 20 to 50% filament, percentage will be 10 to 60%. See remember, filament is going to give it the strength to the entire yarn and the filament if it is strong, the yarn is going to be strong.

Staple fibres can vary between 30 to 60%. So, these are the ranges in which the polymer filament staple fibres can be varied and we will be able to produce a yarn which is a yarn having a filament, polymer and staple fibres. So, staple fibres will be seen on the surface.

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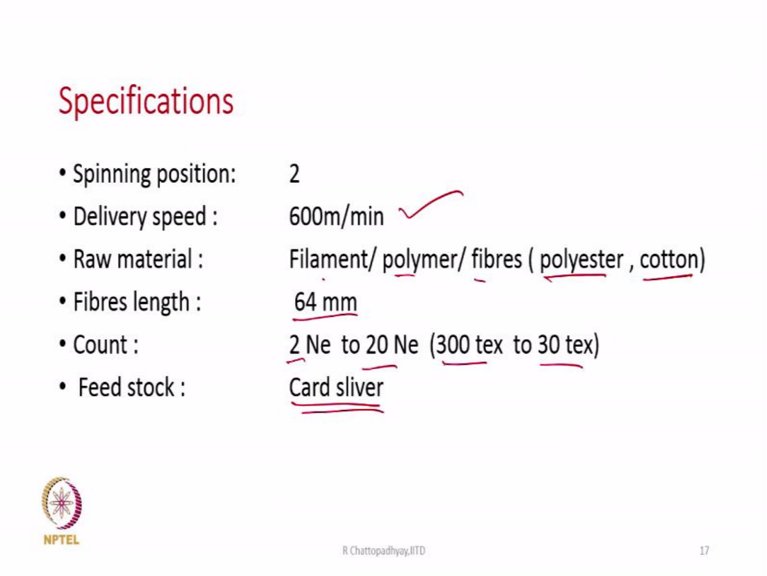

Specifications, spinning position 2 the machines which is available; Delivery speed can go up to 600 m/min; Raw material could be filament, polymer, fibre, fibre could be polyester cotton or some other fibre whatever we want; Fibre length is to the order of 64 mm long fibres; Count could be 2 Ne to 20 Ne that is 300 tex to 30 tex.

These are the typical yarn count that can be spun. Feed stock will should be Card sliver. So, that is our starting point, which take card sliver and then we carry on the process.

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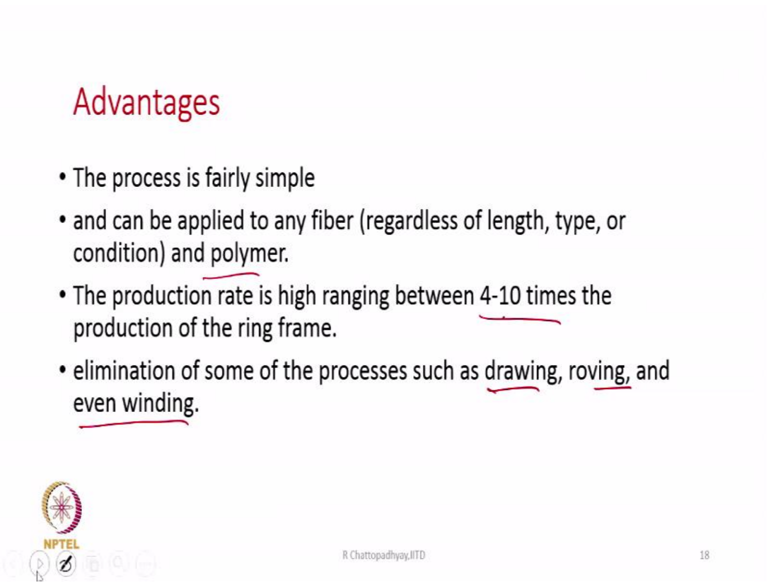

Advantages are, the process is fairly simple and can be applied to any fibre and polymer. The production rate is quite high ranging between 4 to 10 times the production of a ring frame, but it can go up to 600 m/min; whereas, the ring frame production rate could be 15 m/min.

So, very high and even it could be much you know more than 10 times, more than 10 times it could be. Elimination of some of the processes such as drawing, roving and even winding, that is the advantages that we get rid of certain processes.

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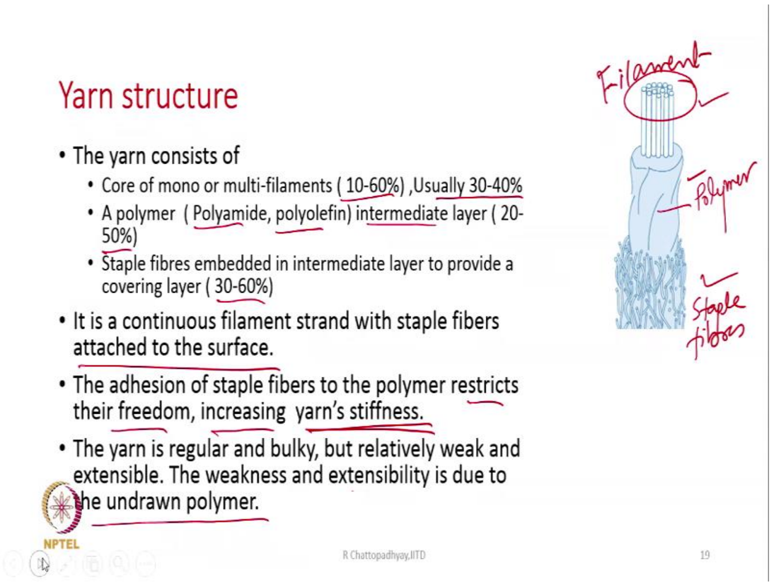

The yarn structure is shown here typically; you have filaments, then this is the polymer, and you have staple fibres. So, this is the typically you know, the structure, the you know it will look like this. The yarn consists of core of mono or multiple-filament 10 to 60%, but usually it is 30 to 40%.

A polymer which could be polyamide, polyolefin or intermediate layer 20 to 50% and staple fibres which could be between 30 to 60%. It is a continuous filament strand with staple fibres attached to the surface. So, surface will having show the present short staple fibres so that a typical spun loop probably will be visible.

The addition of the staple fibres to the polymer restricts their freedom increasing yarns stiffness. Stiffness is going to be high; because the filament inside is also straight and parallel, they are not following helical path. And the polymer is also there. So, the entire structure is going to be stiffer. The yarn is regular, bulky, but relatively weak and extensible. The weakness and extensibility is due to the undrawn polymer. So, whatever strength we get, because of the presence of the filament.

So, that is all about this particular yarn, that is called the process is known as Bobtex; where do we have filament, polymers, staple fibres all of them are present and we can produce some yarns as the diagram shows.

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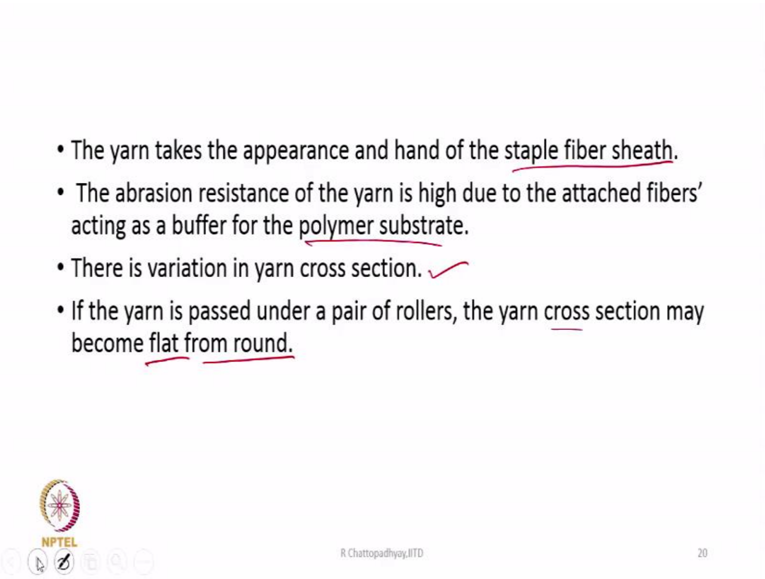

The next one, the other thing about the yarn is the yarn takes the appearance and hand of the staple fibres sheath; because on the sheath is containing the staple fibres and therefore, look wise or if we try to touch it, it will give the feel of a staple fibre yarn. And the abrasion resistance of the yarn is high due to attached fibres acting as a buffer to the polymer substrate.

Because the fibres which are there on the surface they can easily move now and they acts as a protecting layer and because they can they are flexible they can move. So, therefore, they can really you know reduce the abrasive stress. There is variation in the yarn cross section and if the yarn is passed under a pair of rollers, the yarn cross section may become flat from round.

Because polymeric material is there and therefore, if it is passing under a pair of rollers where the pressure is quite high that could be permanent deformation to the yarn and the yarn will become more and more flat depending upon how much pressure is acting on the rollers.

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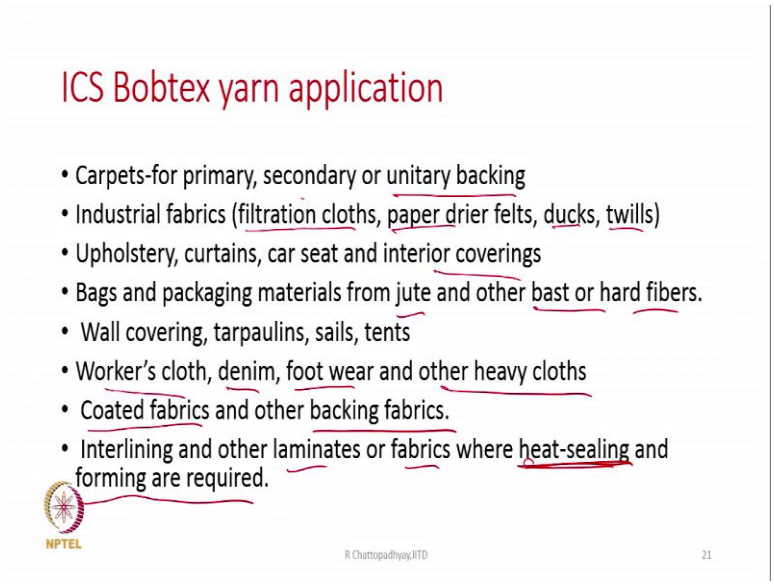

Applications of this yarns; one is Carpet - for primary, secondary and for unitary backing; Industrial fabrics - filter cloths, paper drier felts, ducks and twills; Upholstery, curtains, car seat and interior covering these are the possible applications, bags and packaging materials from jute other bast and hard fibres; wall covering, tarpaulins, sails, tent fabrics.

These are the type of material otherwise other than this we can have, worker's cloth, denim, footwear and other heavy cloths; Coated fabrics obviously, once you make it convert into fabric then we can coat it and other you know backing fabrics for different end users, also we can have fabrics which are used at the back like carpet is always having a backing fabric. So, these are the different applications of the yarn.

Interlining and other laminates or fabrics where heat-sealing and forming are required. If heat sealing is required, see the advantage is polymer is there. So, if we go for heat sealing, if it is required then we can heat seal it, because the polymer will little bit melt and it will easily seal. So, wherever heat sealing is required, the this kind of you know fabric made from these yarns can be used.

Or where we have to give a fabric a very you know, fabric has to take every difficult contour; then also this will be this fabric can be used, because we can go for heat setting of the fabric and we can easily give a different shape to the fabric, different 3D shape also can be given to the fabric, through the heating process.

So, these are the some advantages are there; because, it is made from you know polymer base material, major part of it basically is polymer and this polymer is what is actually can know they respond to the heat, that is they will be either they become soft when heat is applied and therefore, now they can be given different shapes. We will now discuss ABS process that is Aerodynamic Break Spinning process.

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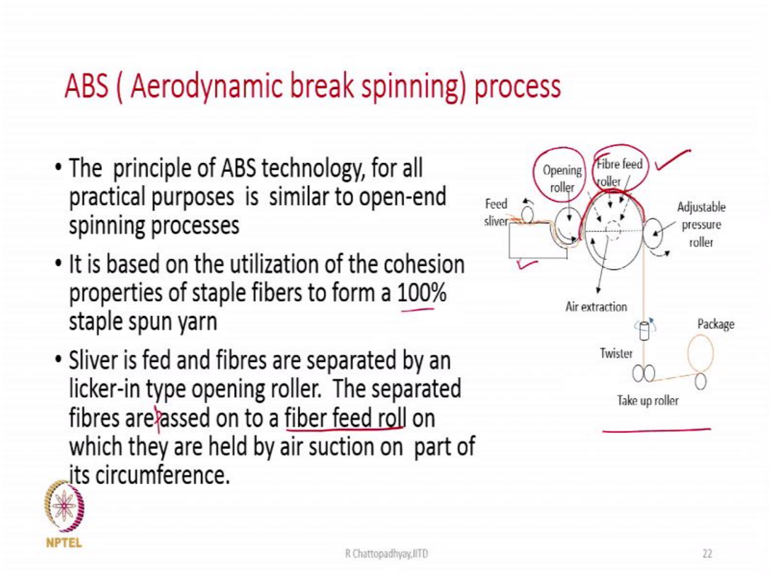

Here, on the right hand side, the and the sketch of this process is shown. The principle of ABS technology, for all practical purposes is similar to open-end spinning process. It is based on the utilization of cohesion properties of staple fibres to form a 100% staple spun yarn.

Now, here what we do, that a sliver is fed and fibres are separated by an licker-in type opening roller. So, here is the feed side. The sliver is feed here and there we have opening roller which is opening the fibres or separating the fibres from the sliver. After they are separated, now what happens? The fibres are passed on to the fibre feed roller.

See they are passed on to the fibre feed roller on which they are held by air suction. So, from licker-in or type of roller the fibres are going here. This is our fibre feed roller, because it is. So, there is some specialty about this roller; that is, one is this it is a perforated and there are internal suction. So, if I internally sucking the air and the air is entering through the perforations.

And if we feed fibres on the surface of this roller, we call it fibre feed roller, then all the fibres will remain stuck on the surface of this fibre feed roller.

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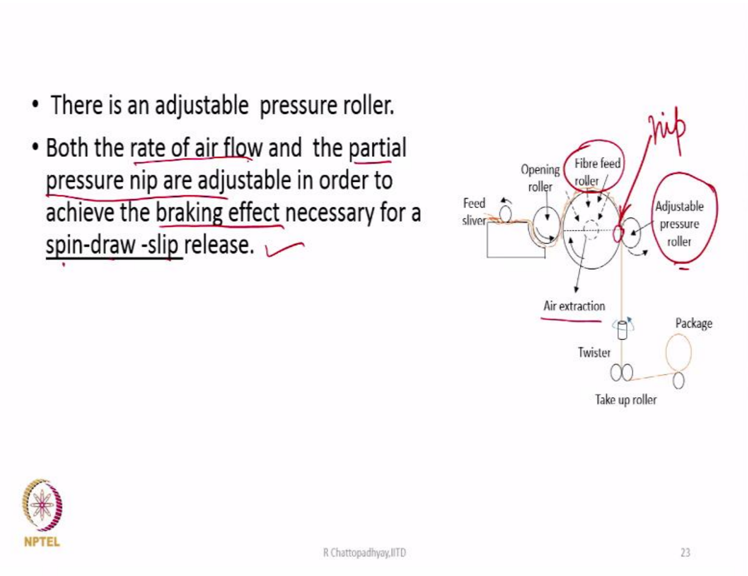

And then, the another interesting thing is, there is an adjustable pressure roll that is this particular roller. The roller is pressed against the fibre feed roller, but this pressure can be adjusted. The other thing that can be adjusted is the rate of air flow and through this fibre feed roller.

So, airflow also can be adjusted. And, the pressure given by the adjustable pressure roller can also be adjusted. So, two parameters can be adjusted; rate of airflow and the partial pressure nip that is at this point, at the nip point the pressure that is acting also can be adjusted. These two are adjustable in order.

Why they are adjustable? Especially this pressure here is adjustable because we want a breaking effect that is necessary for spin draw slip release of the fibres. That is why here we need adjustable pressure; the pressure should not be too high not should be too low.

So, there is a possibility of spinning, drawing and there is a possibility of slippage. It is not that the pressure is so high the fibres will not be allowed to slip from the nip.

Here is the nip, from this nip fibres should not be allowed to slip. It should be adjustable so that fibres can also slip, but at the same time there is some grip also on the fibres. This is called spin-draw-slip.

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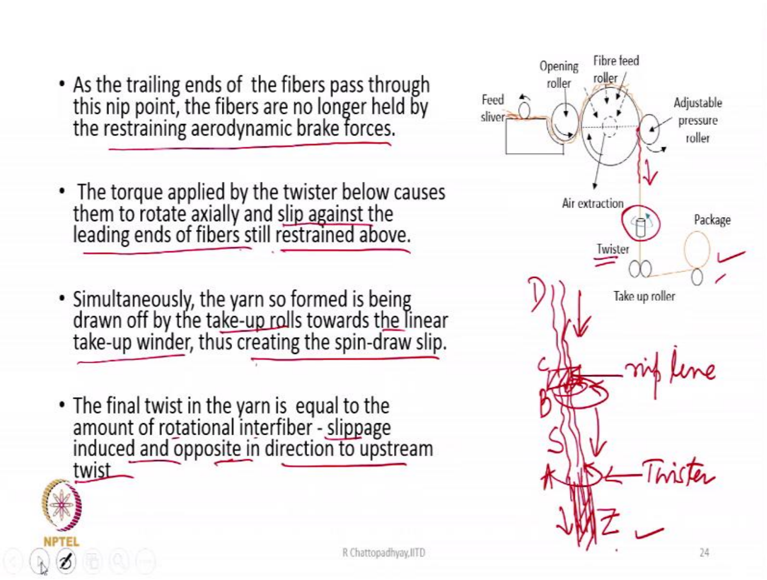

What happens, below that we have a twister which is here. So, as the trailing end of the fibres pass through the nip point, the nip point which is here between the fibre feed roller and the adjustable pressure roller, the nip is existing.

So, as the trailing end of the fibre pass through this nip point, fibres are no longer held by the restraining aerodynamic brake forces. See the aerodynamic force is acting on the upper part of the feed roller, fibre feed roller. So, only from here to there, upper circumference; that means, half of the circumference, the fibres are held because of this suction.

So, whenever the trailing end of a fibre is passing through this zone, there is the suppose the fibre trailing end is there and then fibre is there. As it is moving down, that fibre, the trailing end is at the nip, but really not really gripped because of this aerodynamic you know force or you know it may be pressure. Now, what about torque is applied to this fibre because of this false twister which is here?

It will cause the fibres to rotate axially and slip against the leading end of the fibres still restrained above. So, there are some fibres you see there are some fibres whose leading edge, suppose here is the let us say this is the nip line. There are some fibres which are here at the nip line. So, and some fibres with trailing ends are here and they are going down now.

This is the fibre flow. The nip is here. So, what it is saying, that when these fibres which are below the nip line for the trailing end is held at the nip and they are in contact with the leading end of the fibres which are behind them. Now, if these fibres ends rotate because of the twister which is here, what happens, that they will slip against the leading end of the fibre still restrained there.

That means, these fibre trailing end will be able to rotate here also, that is what it is. So, the twister is this point. So, the restrained that is here is not too strong and therefore, when the forward end of these fibres are under the influence of the twister, trailing end can rotate, they are not restrained. And therefore, the yarn will be formed and it will not have really you know your, it will not act like a false twister.

Because, the trailing end through the trailing end some torque will leak. So, the yarn so formed is being drawn off by the take-up roller towards the linear towards the linear take-up winder, thus creating a spin-draw slip. So, from here the take-up rollers are here, I am pulling the yarn out and it is going to the package.

So, the twister which is here, normally one would feel that the twister will be acting like a false twister. And if that happens, the final yarn will not have any twist. So, therefore, it will not have any strength, but why it is not happening is because, the trailing end of the same fibre; suppose this is the fibre ‘A’ and ‘B’ and the new fibre which they call let us say ‘C’ and ‘D’.

So, though ‘B’ and ‘C’ there is some overlap, but at the nip line, because the pressure is adjustable, we can adjust the pressure. When the ‘A’ end rotates, the ‘B’ does not rotate to the same extent, If both of them rotates same extent in that case, there will no twist over there and as it goes down, when this end is rotating the other end it can little bit free to rotate. So, when the lower end is getting twisted in one direction from the other.

Suppose this lower end of these fibres are getting twisted in let us say ‘Z’ direction. So, here we expect them to be ‘S’ twisted, normal circumstances that will be your first twist, but if the other end of the fibre that at the end ‘B’, there is some amount of leakage of twist then the ‘S’ twist will be little less than ‘Z’ twist and when the fibres will pass through this twisting point, the final yarn will show some amount of ‘Z’ twist in the yarn.

Because ‘S’ twist which has become less than ‘Z’ twist and hence, the yarn will show some twist and that twisted yarn will be then wound, this is what is known as ABS; aerodynamic brake spinning system, some similarity with the open end spinning system. The final twist in the yarn is equal to the amount of rotational interfibre-slippage induced and in opposite in direction to the upstream twist.

So, upstream twist is ‘S’ direction, downstream twist is ‘Z’ direction. So, finally, yarn will show some ‘Z’ twist. Even though the ‘S’ twisted part will flow to the ‘Z’ twisted part, but it will not be able to cancel the entire ‘Z’; because ‘S’ part is little less than ‘Z’. And why ‘S’ part is little less, ‘S’ twist is little less? Because, the end of these fibres are under the adjustable pressure roller where the pressure is such that the fibres can still rotate and some ‘S’ twist will leak continuously through the ends of these fibres.

The other technique is Felted yarn. So, we initially discussed about the felting process.

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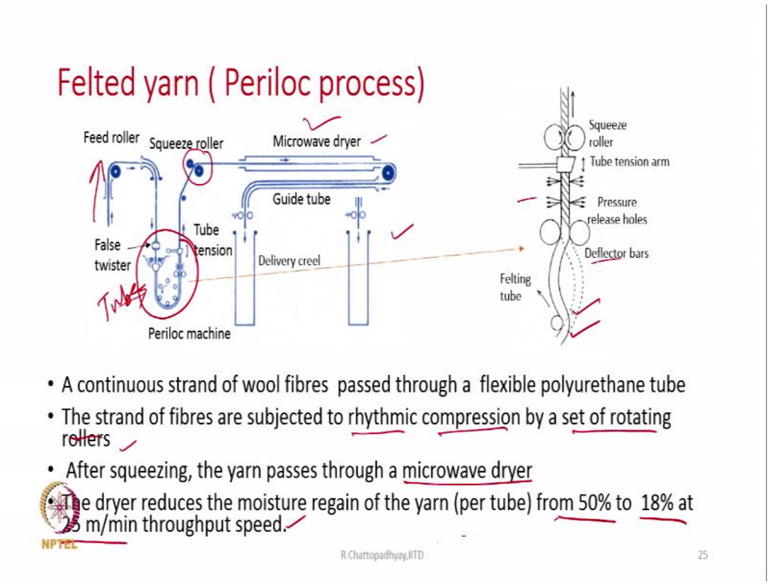

A schematic is shown here. First point is a continuous strand of wool fibre is passed through a flexible polyurethane tube. So, this is the yarn feeding directions and it is going and here we have this flexible tube. The strand of fibres are subjected to rhythmic compression by set of rotating rollers.

Here are the rotating rollers. This tube actually is agitated. After squeezing the yarn will pass through the microwave dryer which is here. The most important part is the tube; that is this region. It is passed through this tube; the strand of fibres and the fibres strand is continuously there is a rhythmatic or in a rhythmic compressions.

That is a mechanism by which this is done. This is something like this, the strand is following it is taking a bow shape is a wave. So, there is some compression and release compression release. So, that it takes a form like this and it is passing through this tube, then there are deflecting bars and it is reaching this point.

Whereas there is a pressure release holes are there and that is a very interesting way of you know, of actually creating some kind of agitations in the bundle of fibres within a constant space. The constant space is the tube, the fibres have to be agitated and when agitated means it has to agitated when it is little bit of wet. And, this relate this agitations some kind of shaking you can say, will lead to interlocking between the scales of the wool fibres.

This is process is only meant for wool fibres, other fibres cannot be really you know processed and cannot be converted into yarn following this technique. So, this Periloc process, which was developed by IWS, International Wool Secretariat at Australia; this was basically meant for wool fibres, there is no there is no twist here, it is there is no twist, it is all felting.

So, felting does not mean; obviously, it will not have any twisting, it should not have any twist. The original strand may be having some twist to start with, very little twist, but then when the time we felt it, the felting process the fibres will be basically interlocking the scales will go inside each other and they will lock themselves.

Now, this is pass through this squeezing roller; where the excess liquor is taken out and the wet material is passed through the microwave dryer, because we have to now dry it. So, the dryer is there and depending upon speed, time that you require and the capacity of, See all microwave dryer may have the drying time depends upon what is the count of yarn, how much water is there, how much time it takes to really to evaporate the water.

So, the purpose of the dryer is to remove the water. Then the dryer reduces the moisture from 50% to 18% at 25 m/min throughput speed, for a certain count of yarn. Some data has been given, the point is it all depends upon the as I said count of yarn and how much water is there, after squeezing how much water is still left over there.

And to dry it, we have to find out how much or time it gets when it passed through. So, time can be controlled by the speed with which the material is passing through the microwave oven and then we can also adjust the power of the microwave oven or microwave dryer, in order to make sure that in that time period that it gets, the it becomes you know it becomes quite dry. So, that not much moisture is left.

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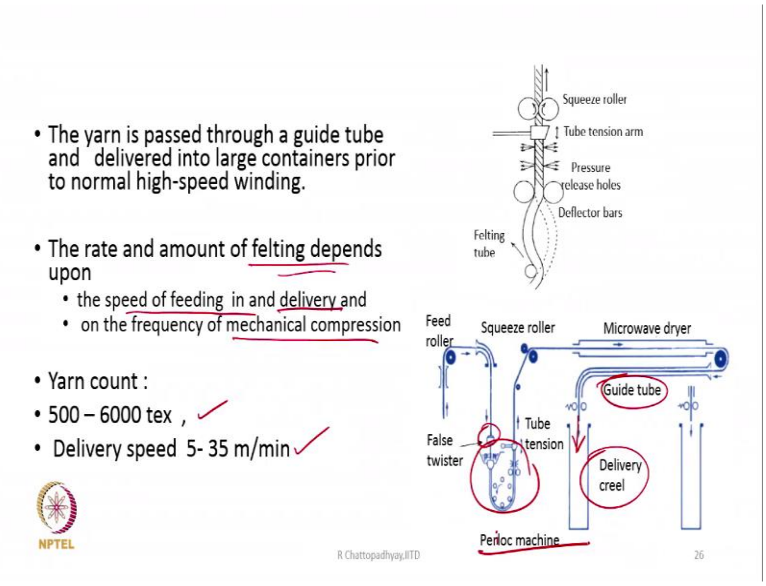

The yarn is passed through the guide tube and delivered into a large container. This is the guide tube and this is the container in which the yarn is ultimately flowing down. So, here is the main process which is happening over here, feeding a strand of wool fibres, they must be wet. There is a false twister over here.

See the purpose of the false twister to give it little bit of round shape; because, the tube is round. So, it has to pass through the tube and hence it has to be given little round shape, so false twister is there. False twister will be able to give it little bit round shape, but it will not have any twist left finally. Then it pass through this tube in wet state and the tube is agitated so that there is interlocking between the scales and a stable structure is formed.

The rate and amount of felting depends upon the speed of feeding in and delivery and on the frequency of the mechanical compressions that is air we as I say agitate or we go give a you know the compressive you know shocks or compressive waves are generated. So, frequency at feed is generated. What is the feed rate, what is the delivery rate, all of them will decide the amount of felting that will finally occur.

We have to have reasonable amount of felting so that the yarn is quite strong and it is processible. The count of yarn could be anywhere between 500 to 6000 tex. It is very very coarse count yarns which is it can be used in carpets. Can we use the delivery speed can vary in 5 to 35 m/min. And with that, we close this particular you know topic, that is this Periloc process is there, not so really very popular or not really taken up by the industry.

Probably some more you know work needs to be done in order to make it very very successful. But the felting process is otherwise common in the case of wool, many a times we make you know, the woollen blankets are made through the felting process. And, felting process can give you very beautiful you know interlocking between the fibres and quite strong interlocking.

And these felts are actually used many a times as only as blankets, but also it can be used in filter fabrics. So, if there is a way to bind the fibres together, other than twisting, then felting is a way by which will be able to really bind the fibres together and if we exploit that particular you know binding mechanism to make a yarn.

And then these yarns can be used, converted into fabric of you know certain thickness and it can be used for many different purposes, but generally by this process is you know coarse yarns are made and as of now at the time there are not really too many machines which are available, this is not perloc, but Periloc machines which are there.

And with this, we conclude today’s discussion on different types of techniques which are you know still which people have developed or at different countries at different times and some of them are relatively successful some of them are not so successful, some of them have potential to be developed further. With this we close.

Thanks.