New Spinning Technologies
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Lecture - 28
Comparative Analysis Between Spinning Technologies

So, today we will discuss about all the technologies that we have learned, an analysis that is a Comparative Analysis between them.

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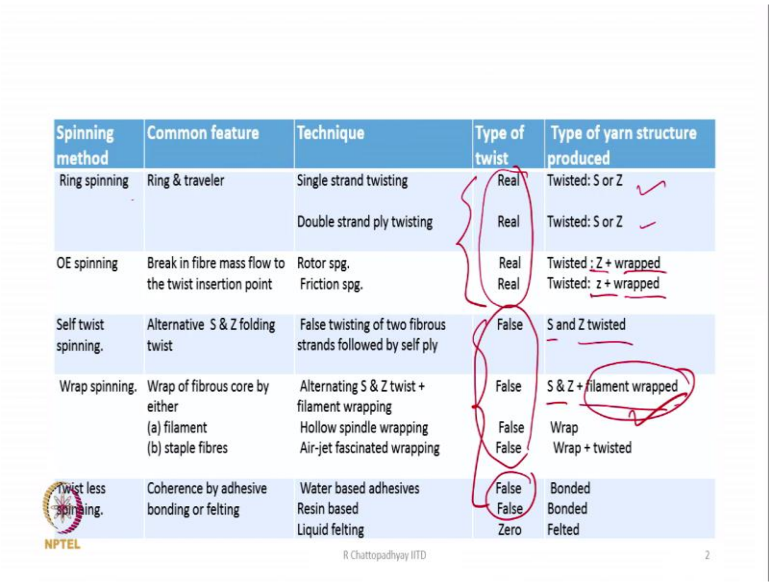

Spinning method	Common feature	Technique	Type of twist	Type of yarn structure produced
Ring spinning	Ring & traveler	Single strand twisting	Real	Twisted: S or Z
		Double strand ply twisting	Real	Twisted: S or Z
OE spinning	Break in fibre mass flow to the twist insertion point	Rotor spg.	Real	Twisted : Z + wrapped
		Friction spg.	Real	Twisted: z + wrapped
Self twist spinning.	Alternative S & Z folding twist	False twisting of two fibrous strands followed by self ply	False	S and Z twisted
Wrap spinning.	Wrap of fibrous core by either (a) filament (b) staple fibres	Alternating S & Z twist + filament wrapping	False	S & Z + filament wrapped
		Hollow spindle wrapping	False	Wrap
		Air-jet fascinated wrapping	False	Wrap + twisted
Twist less spinning.	Coherence by adhesive bonding or felting	Water based adhesives	False	Bonded
		Resin based	False	Bonded
		Liquid felting	Zero	Felted

Now, here you see a table and in this table, on the left hand side column the technologies are listed; ring spinning, open end spinning, self twist spinning, wrap spinning and twist less meaning. The common features are also given. The techniques are also stated here, the type of twist that we insert is also given, like ring spinning, open end spinning these are all real twist that we impart in the yarn.

Whereas, self twist spinning, wrap spinning there is also a these are all false twist, this is also false twist, twist less spinning and the liquid felting that is the felt yarn that we produce, there is no twist at all there this is zero twist. Because the mechanism of holding the fibres together is by the your the scales which are there on the surface of the wool fibres, they are actually interlocking.

So, that is that process is called felting process and in that process obviously there is no twist, there is no twister in between them. Whereas, in the other cases we use false twister from here to there and ring spinning and open end spinning we use true twisting elements.

The twist that we can impart and their detections are also stated in the last column; like, ring spinning we can give S or Z twist, whatever twist directional you want there is a provision to change the direction of twist. Similarly, in the case of open end spinning generally they are Z twisted, we will not be able to really change the direction of twist in the case of rotor spun yarn. We cannot produce S twist rotor spun yarn. The way the machines have been designed, that it can only give you Z twist directions, not S.

And also, we have some part of the fibres which are actually wrapping. Self twist spinning, we can have either S or Z twist, both are possible in self twisting because the yarn itself the strands which are twisted together, they will have S twist and Z twist along the length of the yarn.

And then, two of those strands when they are brought close to each other they wrap over each other, that is they are going to roll over each other and alternately S and Z twisted portions can be seen also in the final 2-ply yarn that the Z twist spinning process is going to produce.

In the wrap spinning, S and Z both are possible and that is a wrapping by the filament also. So, whatever you know principles and we have already discussed all of them, have been combined together and we have put them in the form of a table so that in a glance you can get an idea that which spinning system, what are their common features between the spinning systems and what techniques are used to produce the yarns, type of twist and the structure of the yarn in terms of the twist and their detections.

From there we go to the next slide.

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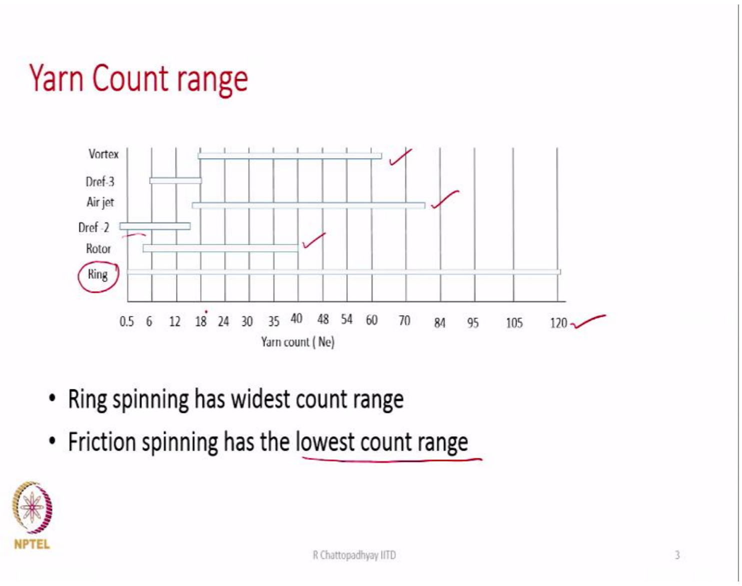

The yarn count range that can be produced, that is shown in this diagram. And, if you look at the most the bottom most which is the ring, you see there is a wide range starting from 0.5 Ne to 120 Ne. So, these bars are actually indicating the range of counts that can be produced. So, ring spinning has the widest count range.

So, that is the one of the very you know uniqueness of the ring spinning system. Though it is a slow in terms of production rate, but it is most versatile in its ability to produce a wide count range and its ability to handle many different types of fibres. Therefore, ring spinning is still so popular.

Rotor spinning, the count range is also stated here; somewhere it starts around close to 6 it can go up to 40, that is the range in which we produce this count. Friction spinning that is Dref-2 or Dref-3 the count range is lowest and mostly we produce coarse count yarn; whether it is Dref-2 spinning system or Dref-3 spinning systems.

Air jet, the count range is shown and the vortex also count range is shown. And we see very coarse count yarns cannot be produced on vortex and air jet. So, what we see that in the air jet and vortex very coarse count cannot be spun and we go up to generally 60s or 70s maximum and we start around 18, 20s count. So, the wide count range is there with ring spinning system and the lowest count range is with friction spinning system.

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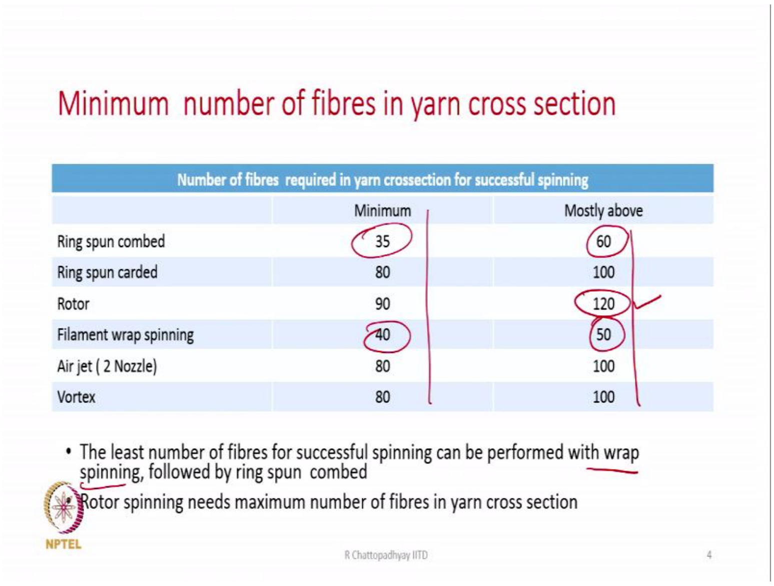

This particular table gives you an idea about the minimum number of fibres that you require to spin the yarn successfully; successfully basically means that, one would encounter the breaks, end breaks which is commercially viable. That is what is known as the successful spinning operations. There will be always some end breaks, but there is a minimum number of breaks which will be commercially viable on any spinning system.

And, to have a spinning system which will be running successfully, we need a minimum number of fibres in the cross section of the yarn and that minimum number of fibres stated here and if we look at this particular table what we find, that the least number of fibres for successful spinning can be performed with wrap spinning. And how many fibres are there? Around 40.

Similar also is there, with ring spun yarns close to 40 that is 35. So, they are and if we look at the others, they are much more. Though these are the bare minimum, most of the time for successful spinning operations, these are the numbers which are maintained; that is commercially we do not go below these values. We keep values more than this which is always beneficial, that if we keep the number of fibres in the cross section more than what is stated here in the last column, it is better.

But these are the minimum that we require to make sure that the quality of the yarn is what is demanded by the market. And, if you look at these values, we will find that filament wrap spinning has the minimum 50 and for combed yarn, ring spun combed yarn we need at least 65 as in the cross section.

Because other than the end breakage, we also need the uniformity of the yarn as well. So, there are multiple criteria based on which we decide whether the spinning process is going to be commercially successful or not. The yarn has to meet the requirement of the commercial requirements; that is the requirement in terms of the properties of the yarn.

It should meet the strength requirement, it should be able to meet the uniformity requirement, the requirement for false and their frequency, the hairiness there are many different criteria based on which a yarn is chosen for a specific operations or specific end use. And, what we see that rotor spun yarn, a rotor spinning needs more number of fibres in the cross section, 120.

So, why some spinning technology needs more fibres, some technology needs less fibre? Because, in rotor spinning the fibres are highly deformed. So, and they are not straight and parallel. When the fibres are actually transformed into a yarn, most of the fibres remain in a very deform state and therefore, you need more number of fibres in the cross section, which will able to sustain the spinning tension and will be able to spin the yarn successfully.

So, some cohesion is required between the fibres and this cohesion will be adequate when I have 120 fibres at least. If it is more, it is better, but it should not be less than this. This more number of fibre requirement is mainly because of most of the fibres in the yarn cross sections are not straight and parallel and there basically deform, they will be they will be hooked, they will be looped. So, many different configuration could be there and you need therefore more number of fibres.

And any technology which will be having straight and parallel fibres, we will need list. In the case of wrap spinning, when the straight bundle of fibres have wrapped by filament so you need minimum number of fibres, because all the fibres are basically straight and parallel.

In the whole spinning process, there is you know you cannot there is no way that the fibres will become hooked or looped or get deformed, that possibility is not there. Similar, same is the case in the case of ring spinning also. The way we draft the roving and we end up a ribbon of fibres which is transformed into a yarn, in that ribbon of fibres all the fibres remain straight and parallel.

Therefore, ring spinning also needs less number of fibres. So, a technology that does not disturb the arrangement of fibres, but that in terms of parallelization of the fibre, straightness of the fibres in those technologies, we will be able to spin the yarn with less number of fibres in the cross sections, otherwise you need more fibres in the cross section.

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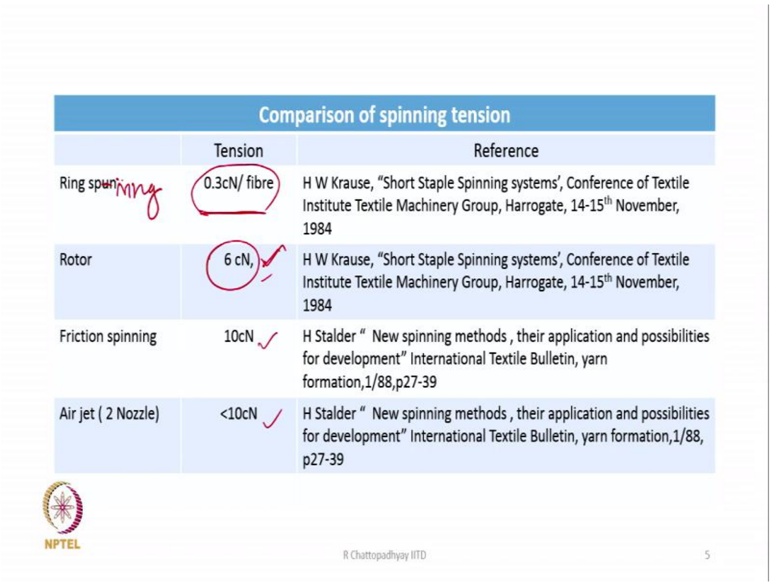

Comparison of spinning tension

	Tension	Reference
Ring spun	0.3cN/ fibre	H W Krause, "Short Staple Spinning systems', Conference of Textile Institute Textile Machinery Group, Harrogate, 14-15th November, 1984
Rotor	6 cN,	H W Krause, "Short Staple Spinning systems', Conference of Textile Institute Textile Machinery Group, Harrogate, 14-15th November, 1984
Friction spinning	10cN	H Stalder " New spinning methods , their application and possibilities for development" International Textile Bulletin, yarn formation,1/88,p27-39
Air jet (2 Nozzle)	<10cN	H Stalder " New spinning methods , their application and possibilities for development" International Textile Bulletin, yarn formation,1/88, p27-39

Here is a comparison of spinning tension. Spinning tension will be very high, in the case of ring spinning. So, I get a data where ring spun yarn or ring spinning process, the tension level was coated to be 0.3 cN/fibre. And, if there is a ring spun yarn we will be having at least 120 or 135 as depending upon the count, you can imagine even if we have 100 fibres, the spinning tension will go to 30 cN.

So, the maximum spinning tension lies in the case of ring spinning. And why it is so? Because in the ring spinning, the yarn has to carry the traveller, which is running on the ring and there is lot of friction between the ring and the traveller. Besides there is a big balloon also, so, rotation of the balloon also is there. So, overall tension in the ring spinning is maximum.

And because of this also there is advantage that the fibres as they move out of the you know front roller nip, the fibre remains in a straighten configuration because the tension level on each and every fibre is quite high. Therefore, in the ring spun yarns most of the fibres remains in straight line and parallel.

First of all, there is no disturbance while they are getting drafted. Their straightness remains as it is. Once they are released from the front roller needle, they are still sufficient tension on each and every fibre which will keep them in straighten configurations. And the rotor spinning, the tension level is 6 cN, friction spinning is around 10 cN, air jet spinning less than 10 cN.

These are typical values, because the exact tension will depend upon the speed of the operations and the count that we are going to produce. So, these are some typical values that has been you know stated by some of these researchers. So, generally what we can say that, ring spinning process develops maximum tension during spinning operations.

Whereas, a spinning system where traveller is not there, where balloon is absent will show minimum spinning tension. And hence, friction spinning, air jet spinning also gives much less tension. Rotor spinning there is a small balloon is there within the rotor. So, therefore, this tension is actually the tension 6 cN that has been given, it is the tension that is acting on the band of fibres within the rotor groove.

But by the time the yarn is withdrawn, that is near the take up rollers, the tension level will be quite high. So, this tension has been worked out and shown this is the tension level which will be near the groove; where fibres are about to be you know transformed into a yarn. So, as the fibres are lying in the rotor groove, there is some tension which is acting on them, that is the, that tension is 6 cN.

But, as the yarn is withdrawn, the yarn you know has to take the shape of a balloon within the rotor and then it takes a turn as it moves out, that is from the navel to the there could be doffing tube. So, there is a bend in the path of the yarn from rotor groove to the take up rollers. And we will see that, I think we have already you know in when we are discussing rotor spinning, I have already shown you that the tensional level can go quite high beyond the rotor.

So, these are the typical values and we can generally say that wherever big balloon is there and additional mass has to be rotated, tension is going to be high. The system where balloon is absent, there is no additional must to be dragged tension will automatically be much less. And less spinning tension means, we can go for higher and higher speed and we will encounter less and less end breaks during spinning operation.

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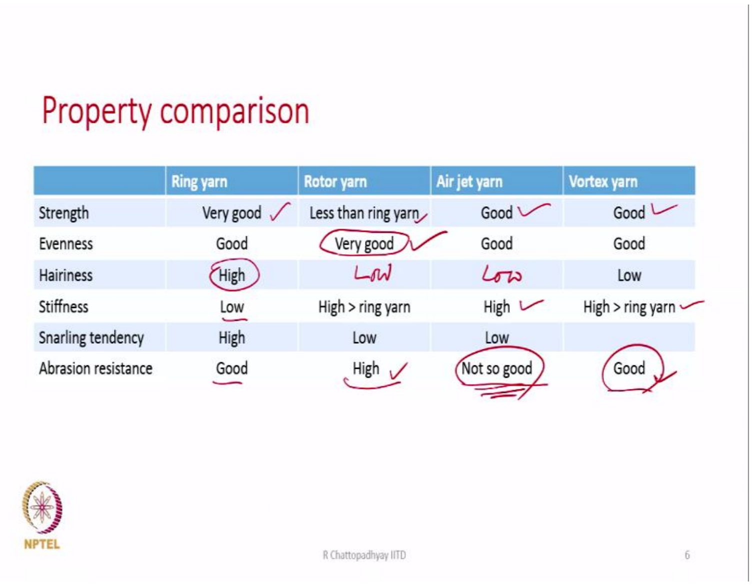

Few properties are compared here. Strength point of view you see that ring yarn is very good, rotor yarn is less than ring yarn, air jet yarn is also good, vortex yarn is also good. Rotor yarns are weaker because the fibres are not straight and parallel that is the reason why rotor yarns will be weaker. And some of the fibres are also forming wrappers. So, these wrapper fibres really do not contribute much towards the overall strength of the yarn.

If the 10 % fibres are forming wrappers these 10 % fibres actually not participating in load sharing when the yarn is extended and hence rotor yarn will be always weaker than an equivalent ring yarn or air jet yarn or vortex yarn if we compare. Evenness wise they are all quite good. Rotor yarn is still better than others.

And why rotor yarn will give us better evenness? Because within the rotor there is lot of doubling that is happening. This is something which is absent in ring spinning in air jet spinning in vortex spinning. In all those spinning system there is a drafting system and this drafting system is having basically roller drafting system we have.

And because the roller drafting system, every drafting system, there is a possibility of drafting wave getting generated. We will be we will try to minimize the wave generation by having a aprons by having right distribution of draft in the front and back zones. So, we try to minimize it, but even then, there will be some unevenness which will be generated because of the drafting process itself.

And there is no scope of doubling whereas, in the case of rotor spinning the drafting is happening not by the roller drafting system, but it is drafting is happening because of the opening rollers which is pulling out the fibres from the sliver and further drafting is happening in the transport channel where it is the air oscillating air which is also giving some draft to the fibres.

Finally, these fibres are actually going inside the rotor and there it is getting deposited in the form of layers after layers. So, there is lot of doubling of the fibre layers which is happening within the rotor and therefore, the evenness of the rotor yarn is better than the ring yarns or air jet yarn or vortex yarn. That is why it is written very good.

Hairiness is quite high in ring yarn. Other yarns it will be generally on the lower side. Why it will be low? Because there are wrapper fibres. So, wrapper fibres is going to bound the projecting hairs from the surface of the yarn. So, wherever you see all this technologies you know rotary yarn, air jet yarn, vortex yarn, all these cases there are some fibres which are forming wraps and these wrapping of these fibres are going to suppress the projected ends from the core part of the yarn.

And therefore, we find that on these yarns the hairiness is less comparison to ring yarn. Stiffness is low for ring yarn, but high in rotor yarns. It is also high in air jet yarn. It is also high in vortex yarn. High basically means in comparison to ring yarn they are more. The reason is again tight wraps. The presence of tight wraps on rotor yarn or air jet yarn or vortex yarn makes the yarn stiffer, stiffness with respect to bending, whereas, in the ring yarn there is no such wrapping fibres.

And therefore, ring yarn is relatively easy to bend in comparison to rotor yarn, air jet yarn, vortex yarn, which are little bit stiffer when we compare with ring yarns. Abrasion resistance is good with ring, but rotor is better. Air jet not so good. Vortex is good. So, this is in qualitative terms we are writing, exact values are not quoted.

Generally, we will feel that wherever wrappers are there is a possibility that the abrasion resistance is going to be better because some of these wrappers see wrappers are also different categories. So, we have I have already you know discussed the structure of these yarns.

And we have said that the wrapper fibres which are there they can be classified as tight wraps they can be classified as loose wraps and they are different angles. So, researchers have classified them into tight, lose or normal type of wrappings. Now, what is important the case of abrasion resistance is tight wraps and loose wraps.

Now, loose wraps will help to dissipate the abrasive energy because they can slide. They will be sliding over the yarn core and because of the sliding actions part of the abrasive energy will be dissipated. And therefore, rotor yarns or fabrics made for rotor yarns have been found to give high abrasion resistance.

Vortex yarns also good because vortex also has large amount of wrappers. In air jet yarns the wrappers are basically less in number. People have quoted different values. Generally, it may vary between 5 to 15 %, vortex yarn it can go 25-30 % because wraps are less. Therefore, the air jet yarns are not so good in terms of abrasion resistance. So, typically, this is the you know this is the comparison that we can make about their property.

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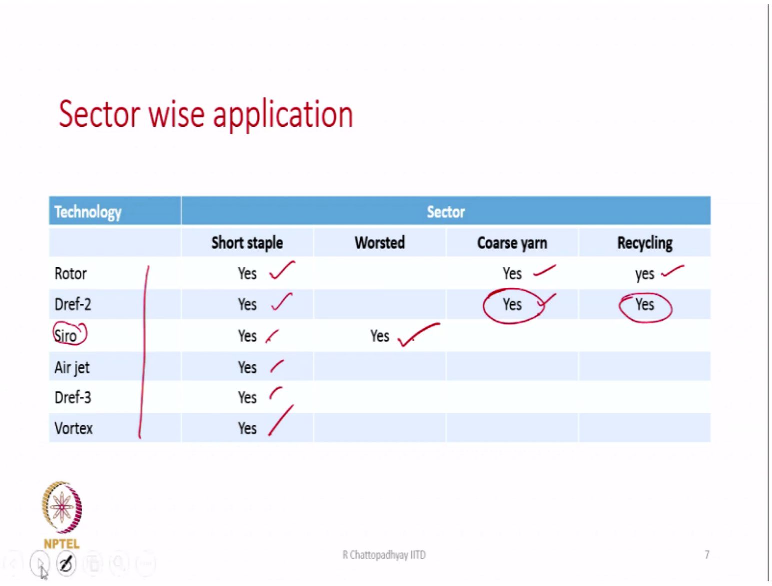

Technology	Sector			
	Short staple	Worsted	Coarse yarn	Recycling
Rotor	Yes		Yes	yes
Dref-2	Yes		Yes	Yes
Siro	Yes	Yes		
Air jet	Yes			
Dref-3	Yes			
Vortex	Yes			

Then we go to sector wise applications of these technologies. All these technology which are listed on the left hand side can be they are all applied for suitable for short staple, all of them. Then, Siro is suitable for worsted spinning system also. We have I have not shown it the another technology called self twist spinning. Self twist also will be suitable for worsted spinning system.

So, Siro suitable for short staple and also for long staple that is worsted system; system basically means is a long staple spinning system. What is especially if you come to the course, count wise if we go then rotor and Dref-2 both are suitable for coarse yarn category.

If you want to make coarse yarns then rotor and Dref-2 are very suitable technologies. They will be cheaper in terms of the production cost. So, whenever you know a industry is going for very coarse count they will prefer to go for rotor spinning process or Dref-2 spinning process.

Then if we want for recycling then also rotor and Dref-2 are quite good. Both of them are good for recycling of fibres. So, that is how we can compare. So that means, rotor can work in the short staple sector. It can also produce coarse yarn and it is also a good technology for recycling of fibres.

Same is the case with Dref-2 is also can produce coarse yarn and also good for recycling. Others have certain limitations. Some of them are suitable for long staple and short staple combined some of them are only suitable for short staple. Like air jet, vortex, they are not really suitable for very long staple fibres.

Though people are trying to you know spin even you know rotates yarn using wool fibres. There are attempts that people are trying to make use may not be 100 % wool maybe we can blend wool with some other fibres and try to process them and worsted spinning system. So, that these are the you know some possibilities are there.

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Comparison between different spinning technologies

	Open end spinning		SIRO	Self twist	Wrap / Parafil	False twist		Adhesive Twilo	Air Vortex
	Rotor	Dref-2				Air jet	Dref-3		
Feed stock type									
Sliver	√	√			√	√	√	√	√
Roving			√	√					
Form of feed stock									
Single	√				√	√	√	√	√
Double			√	√					
Multiple		√					√		
Attenuating									
Drafting roller			√	√	√	√	√	√	√
Opening roller	√	√					√		
Fibre guidance									
Guided			√	√	√	√	√	√	√
Free floating	√	√					√		

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15

Now, a comparison between different spinning technologies in terms of; if you look at these technologies feedstock wise sliver and roving, you know all these tick marks indicates in which technology, we can use sliver where we can use roving. So, open end spinning for rotor and Dref we use sliver as a feed material.

In wrap and parafil also the feed material is sliver. False twist is given in air jet. The false twist spinning system, air jet and Dref both will use sliver. Adhesive twilo we use sliver, air vortex also use sliver. So, sliver is the feed material for 1, 2, 3, 4, 5, 6, 7 different spinning systems. Whereas roving is a feed material for Siro and self twist spinning system.

The ring is not here because ring comes into the you know (Refer Time: 32:21) spinning system that is why we have not given the name ring here, but we all know for ring spring we need to feed roving. The next is form of feedstock that is do you feed one roving or one sliver or multiple sliver.

In rotor we feed only one sliver per spinning positions. In the wrap also one sliver, in air jet also one sliver, in Dref also one sliver, in adhesive twilo one sliver. So, one; then we speed sometime two, where two is there in the case of Siro and self twist spinning generally two rovings will be fed together not one and multiple slivers are fed in Dref-2 and Dref-3.

So, how many slivers or roving I am feeding attenuation per production positions that way comparison has been made here. Attenuation, that is drafting process; are you using drafting rollers or opening rollers? So, you see drafting rollers we use in the case of Siro, self twist spinning, wrap parafil spinning, air jet, Dref-3, twilo, air vortex. So, 1, 2, 3, 4, 5, 6, 7; for seven different spinning technologies, drafting roller is used with aprons.

An opening roller is used in the case of rotor, Dref-2 and Dref-3 also. Dref-3 has both. We have a roller drafting system also we have a opening roller system of drafting. So, Dref-3 is one spinning unique spinning system where both types of you know drafting systems are there, opening roller as well as drafting rollers.

Then comes fibre guidance; how the fibres are guided. One is there are there is a positive guiding device, the other one is free floating, there is no guiding device and guiding is done where Siro, self twist, wrap or parafil, false twist. Wherever we have a roller drafting system that basically means we have a complete guidance for the fibres to travel to the spinning zone.

There is a positive guidance for them and whatever this is not there; that means it has to be free floating. So, a rotor to the transport channel the fibres are simply travelling, there is no guidance. So, Dref-2 also similar things and Dref-3 has both, because we have one opening roller system of drafting. After the opening roller opens the fibres, they will travel to the spinning zone between the two friction drum only by air. So, in that journey there is no guidance.

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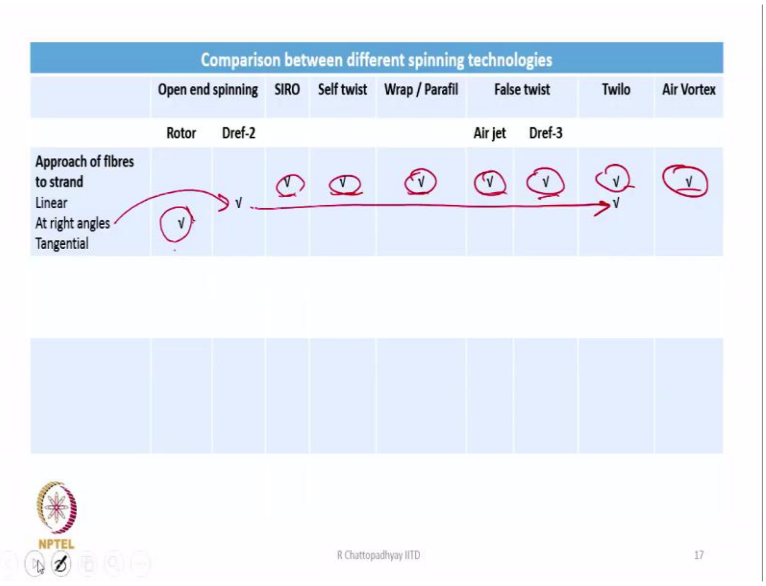

Approach of fibres to strand linear at right angles or tangential, so, these are basically linear, the next line is at right angles. So, right angles actually basically is this one that is Dref-2 and another right angle is there. This is end twilo that is there is a completely right 90 degree turn in the approach of fibres to the spinning or to the yarn formation position.

Others they go straight. There is no turn. And tangential is there in the case of rotor spinning. The fibre has the land on the rotor grove. The transport channel is also actually releasing the fibres on the rotor groove tangentially. So, depending upon whether the fibre is approaching the spinning zone linearly or taking turn or they approaching in a tangential manner we can have a comparison between the different spinning technologies.

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Comparison between different spinning technologies

	Open end spinning		SIRO	Self twist	Wrap / Parafil	False twist		Twilo	Air Vortex
	Rotor	Dref-2				Air jet	Dref-3		
Approach of fibres									
to strand			√	√	√	√	√	√	√
Linear		√						√	
At right angles	√								
Tangential									
Collecting assembly									
Not necessary			√	√	√	√		√	√
Rotor	√								
Drum		√					√		

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19

Then collecting assembly rotor whether we need it or we have a rotor type of assembly or we have drum. Collecting assembly is not required for most of the spinning system. Now, we need rotor in the case of rotor spinning system, no other spinning system needs a rotor. Rotor acts as a collecting device for the separated fibres and also acts at a twister.

So, rotor performs two functions. Its acts as a twister, its acts as a device which is collecting the fibres, forcing them to go towards the rotor grove that is they are accumulating there and then these accumulated fibres are transformed into a yarn. If we think about drum already the automatically what comes to our mind is wherever we have friction drum and therefore, Dref-2 and Dref-3 are the two spinning systems where drums are used, friction drums are used for collecting the fibres.

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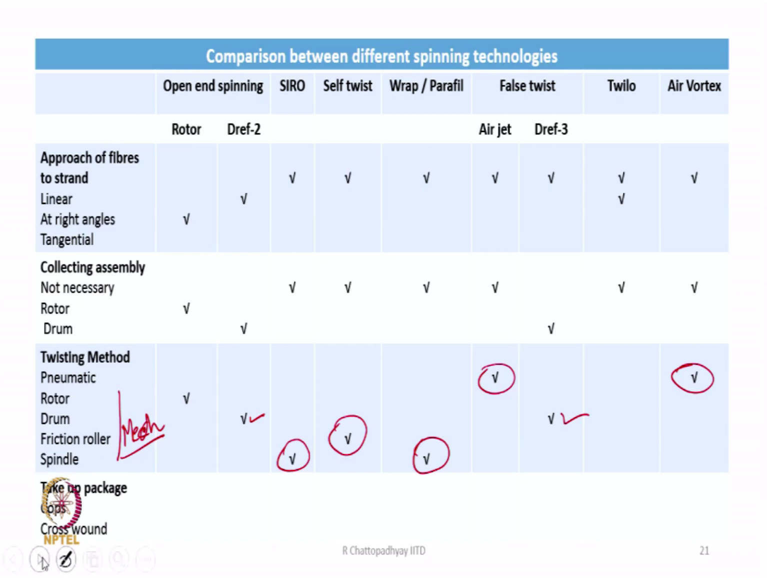

Comparison between different spinning technologies	Open end spinning		SIRO	Self twist	Wrap / Parafil	False twist		Twilo	Air Vortex
	Rotor	Dref-2				Air jet	Dref-3		
Approach of fibres to strand									
Linear			√	√	√	√	√	√	√
At right angles		√						√	
Tangential	√								
Collecting assembly									
Not necessary			√	√	√	√		√	√
Rotor	√								
Drum		√					√		
Twisting Method									
Pneumatic						√			√
Rotor	√								
Drum		√					√		
Friction roller				√					
Spindle			√		√				
Take up package									
Cops									
Cross wound									

Then twisting methods - see twisting methods we can have pneumatic system of twisting and we can have all the rest is basically mechanical system of twisting that is we have either have rotor drum friction roller spindle. There is a mechanical device which twist the fibres.

So, now if we try to find out pneumatic is only used in air jet and in air vortex. There is no other spinning technology where pneumatic means are used to twist the fibres. Then the mechanicals whatever mechanical we have. Rotor is used in only one case that is rotor spinning, drum is used in Dref-2 and also in Dref-3. Friction rollers are used in the case of self twist. Do not confuse between friction roller and friction drum.

So, friction drum is used only in the case of Dref-2 and Dref-3. Friction roller is used in the case of self twist spinning. There we actually twisting this strand with the help of friction roller. And then spindle is used we all know spindle basically means ring spinning. Other than ring spinning system spindles are used for Siro spinning also for wrap or parafil spinning. We will be using spindle. Take up package either in the form of cops or cross wound.

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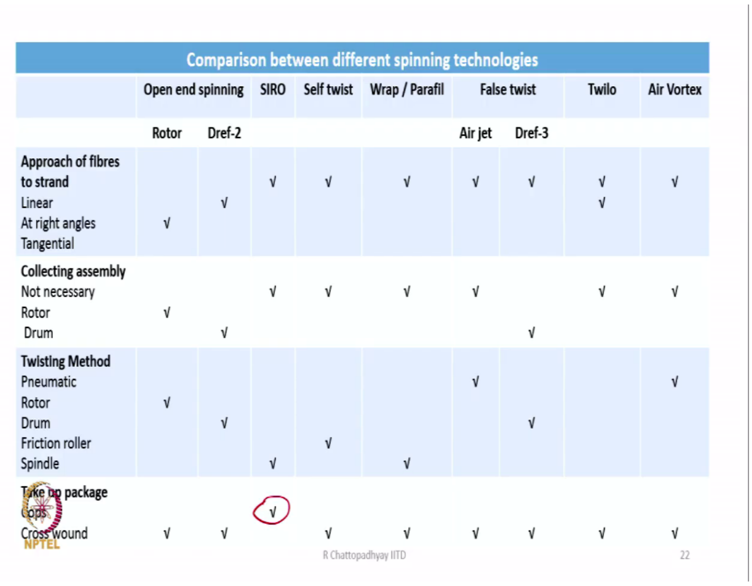

Comparison between different spinning technologies									
	Open end spinning		SIRO	Self twist	Wrap / Parafil	False twist		Twilo	Air Vortex
	Rotor	Dref-2				Air jet	Dref-3		
Approach of fibres to strand									
Linear			√	√	√	√	√	√	√
At right angles		√						√	
Tangential	√								
Collecting assembly									
Not necessary			√	√	√	√		√	√
Rotor	√								
Drum		√					√		
Twisting Method									
Pneumatic						√			√
Rotor	√								
Drum		√					√		
Friction roller				√					
Spindle			√		√				
Take up package									
Cops			√						
Cross wound	√	√		√	√	√	√	√	√

Mostly it is cross wound. The cop is there in the case of Siro. Siro is basically an extension of ring spinning. Compact ring spinning, compact spinning, Siro spinning are basically an extension of ring spinning system. So, cops are produced in Siro spun yarn also and cops you all know they are very small package whereas, cross wound cheese or cone are basically large dimension package.

So, most of the spinning system modern spinning system that we have they all produce big packages, because the production rate is very fast. So, we have to go for a very large package size. Otherwise, frequency of doffing is going to increase. So, we have to go for very large package which can hold 2 kilo of yarn or 2.5 kilo of yarns very large package.

So, the doffing frequency will be much less. With the cops package size is so small that they get filled up very quickly and we need to drop the full package and replace them by empty package. So, in that process lot of production time is wasted.

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And here is a diagram which gives you the strength of the yarn. Yarn strength comparison as a function of mean fibre length. So, if we try to you know process this type of length of fibres 8 millimeter basically from waste material, 20 mm carded, 20 mm combed, 30 mm combed, 33 mm polyester cotton blend and 33 mm polyester manmade fibre blend. And if we produce yarns then we will find that the rotor yarn shown by this blue line.

As you go for long fibres the relative yarn strength becomes less and less. See 100 % is basically this diagram here this one refers to ring yarn. So, with respect to ring yarn we are trying to compare them that is, if I use 8 millimeter fibres and produce rotor yarn and ring yarn, the rotor yarn will be little stronger. When the fibres are very short see it goes above 100, this is the point. It is going above 100.

So, for very short fibres rotor spun yarn will be stronger than ring spun yarn or ring spun can even weaker because very short fibres will generate lot of drafting wave, lot of you know thick and thin place because of this roller drafting system or apron drafting system. And therefore, when the yarn count is very coarse and it is made of very short fibres rotor yarn will be stronger than ring yarn.

But after that you see with respect to this line, this is for equivalent ring yarn. The blue line is goes down and down; that means, beyond that with respect to ring yarn the rotor yarn will be weaker and weaker. In the case of vortex yarn what we see? We start from a very low value 70 %, a relative yarn strength and then it goes up.

Same is the case similar with air jet shown by the yellow color line. So, for these two technologies as we go for longer fibres the gap between ring and the yarn made on these two technologies vortex or air jet this gap is gradually narrowing down. In the case of rotor yarn the gap is gradually widening. Here this gap if we compare with rotor so much, here the gap is much less.

So, as we go for longer fibres rotor yarns becomes more and more weaker with respect to equivalent ring yarn, whereas, vortex and air jet yarn the gap is narrowing down here the gap is from here to there, here the gap is much less that means, the yarn is becoming relatively stronger.

And this is because as we go for longer fibres the wrapping in both the cases vortex and air jet there is some fibres are forming wraps. The wrapping of fibres becomes more and more effective if the fibres are long. When the fibres are short fibres are relatively more stiff.

And because for wrapping we need the fibres to bend and then form sufficient number of wraps. When the fibres are short relatively, they will be stiffer and they will form less number of wraps, whereas, when the fibres are long sufficient length are available for the wraps to be formed.

So, the moment we go for 33 mm length of fibres the wrapping is much more much better in terms of uniformity of the wrapping and the length over which the fibres can wrap fibres. See if the fibre is short, so, this is the these are the fibres I have two wrap. If fibres are short, I can only have 1 or 2 or 3 wraps, but if I have long fibres, I can have more number of wraps.

So, longer fibre length will lead to more effective wrapping and therefore, the strength is going to increase and as a result the gap between ring yarn strength and air jet or vortex yarn strength is going to reduce. So, that was the last slide. With that we conclude this particular discussion, where we have compared the different new spinning technologies and we have you know we get an idea that in which way one technology is better than the other or what are their capabilities what are their weakness, ok.

Thank you.