New Spinning Technologies
Prof. R. Chattopadhyay
Department of Textile and Fibre Engineering
Indian Institute of Technology, Delhi

Lecture - 16
Material and Process Parameters

So, we are going to discuss Material and Process Parameters in the context of air jet spinning.

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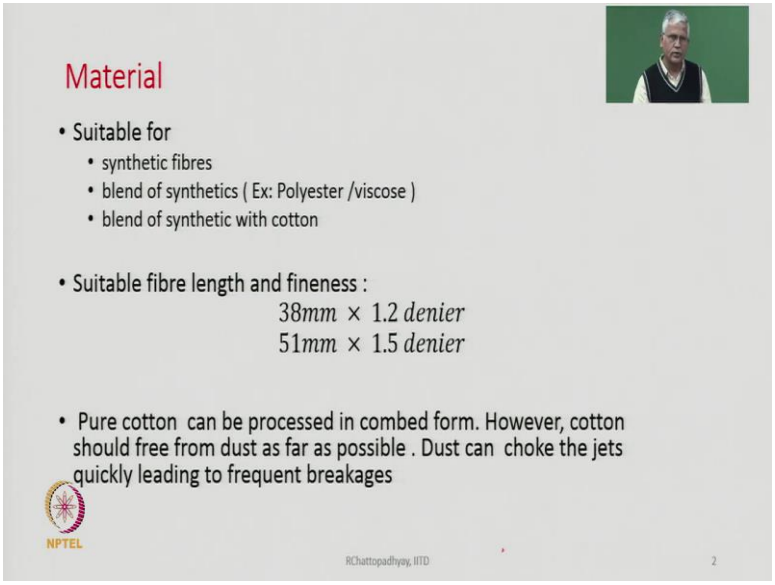

In the material for this particular technology, it is suitable for synthetic fibres primarily or blend of synthetics that is it could be as an example polyester and viscose rayon fibres or polyester with modal fibres or polyester with lyocell fibres something like this where both the blend partners are synthetics.

The other possibility is that we can also blend synthetics and cotton together. So, cotton synthetic blend also can be easily processed, but for 100 percent cotton it is not really. So, suitable though people have been trying to process 100 percent cotton fibre, but because we all know that cotton contains lot of dust particles.

And therefore, even though we try to remove the dust by processing fibres on blow room on carding machines and sucking out dust on draw frame also we try to remove some

dust and some trash particles by combing action also. But even then, whatever dust is still left can also create problem with the nozzles of the air jet spinning.

And therefore, 100 percent cotton is normally not processed, if we at all we want to process, we try to mix cotton with some synthetic fibres with the ratio of maybe 50/50 or 65/35, 70/30 and then we can process them together. The suitable fibre length and fineness typically is could be 38 mm fibres with 1.2 denier combinations or 51 mm fibres with 1.5 denier combinations and fibres of similar length and fineness in the case of cotton also.

Generally; that means, it is suitable for long and fine fibres. So, why long and fine fibres? Because ultimately the fibres would have sufficient length to wrap the yarn or the wrap the core part of the yarn. And it is not that the entire fibre length is used to really wrap the core part of the yarn, only part of the fibre length is used.

Therefore, if the fibres are long then even then if the 30 or 40 percent of the fibre length is used for wrapping still sufficient length is available to wrap the fibre wrap the yarn properly. So, that the yarn as a whole can really sustain some load and therefore, can really develop some strength.

And if the fibres are short wrapping is not going to be adequate. These things I have already told earlier and that is why short fibres presence in cotton is going to create lot of problems because they will not be able to wrap properly and the yarn will going to fail during the spinning time. Not only that the you know dust is going to create problem for cotton even the presence of short fibres can also create problem.

So, we try to eliminate short fibres through combing actions very purpose is combing is first of all to get rid of most of the short fibres because they are not going to help at all on the contrary, they are going to interrupt the spinning process.

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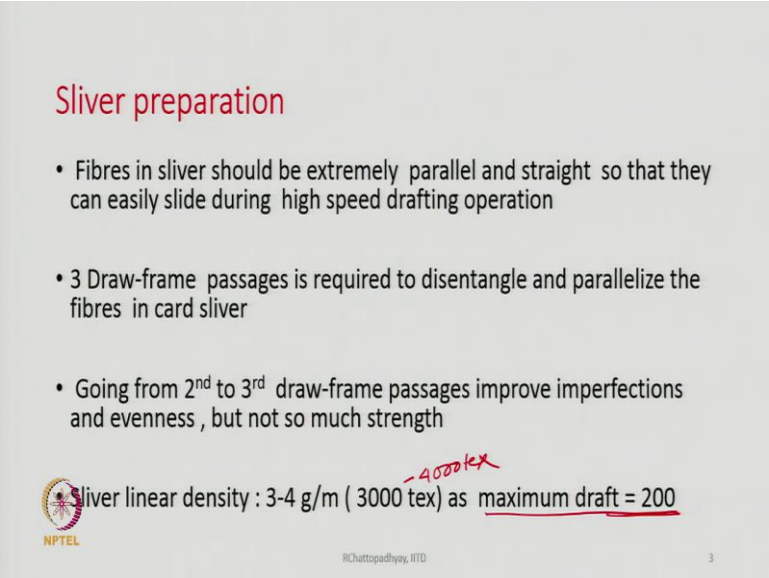

When it comes to the preparation of the sliver it is very obvious few things which are most important here, we can understand sliver has to be very very clean always because the dust should be minimum and even you should remember that even if you only try to process synthetic fibres, the spin finish can also accumulate within the jets and they can also choke the jets.

So, the spin finish that we use on synthetic fibres can also could be a source of problem, but it is not as problematic as the micro dust is in the case of cotton. Now, in the sliver the important points are that the fibres would be straight and parallel and why they should be straight and parallel? Because they have to undergo very high drafting not only in terms of the magnitude of the draft, but also the speed with which the drafting is going to take place.

It is almost 10 times you know faster than what we see in the case of ring spinning the typical drafting speed in the case of air jet spinning could be to the order of 180 meters per minute 220 meters per minute or the front roller I am saying. So, the fibres by the time they arrive in the front zone they are running at that speed. So, when if the fibre run at. So, much speed the sliding action has to be very very smooth and for that what we need we have to make the fibres perfectly straight and parallel as far as possible.

We all know that the card sliver in the card sliver the fibres are not at all parallel with respect to each other. Fibres are folded in different directions to different degrees. Fibres

also have lot of crimp still left in the card sliver. So, a card sliver is not really good to draft at a very very high speed. In order to improve the parallelization of fibres we all know that the draw frame is going to help us in this respect.

So, we if we go if we process the card sliver on draw frame then we make the fibres straight and parallel. We disentangle lot of fibres which are actually you know entangled with each other. So, generally three draw frame passages are given not just two. So, by the time we give three draw frame passages the fibres we can very straight and parallel at the same time the uniformity of the sliver also improves. The crimp level also goes down and therefore, the sliver is ready or the fibres in the slivers are ready to be drafted at very high speed.

That is why three draw frame passages are given and it has been found that going from second to third draw frame passages improve the imperfection level evenness though strength may not improve much. But in these respect because they are also going to spoil the yarn. See imperfection value and evenness value the neps take thin places all of them are going to downgrade the yarn.

So, in order to improve these aspects, the third draw frame passage is really very very helpful. Sliver linear density generally could be between 3 to 4 gram per meter; that means, 3000 to actually 4000 tex and the maximum draft that we give is to the order of 200 because we are going to produce a yarn directly from sliver. So, if I feed a 3000 tex sliver and give a draft of 200, the count of the yarn is going to be roughly 15 tex 3000 divided by 200.

So, that will give you value of around 15 tex. So, 200 draft and 3000 tex or 3 kilo tex sliver the yarn count going to be 15 tex and 15 tex is roughly close to roughly close to you can say 40s Ne yarn. So, depending upon the count that we want to produce we have to accordingly adjust the linear density of the sliver.

Now, if the modern adjust spinning machines if they if it is capable to give little bit more draft than 200 then accordingly, we can adjust the sliver tex. But what we generally can say that a thinner sliver is better than a very coarse sliver.

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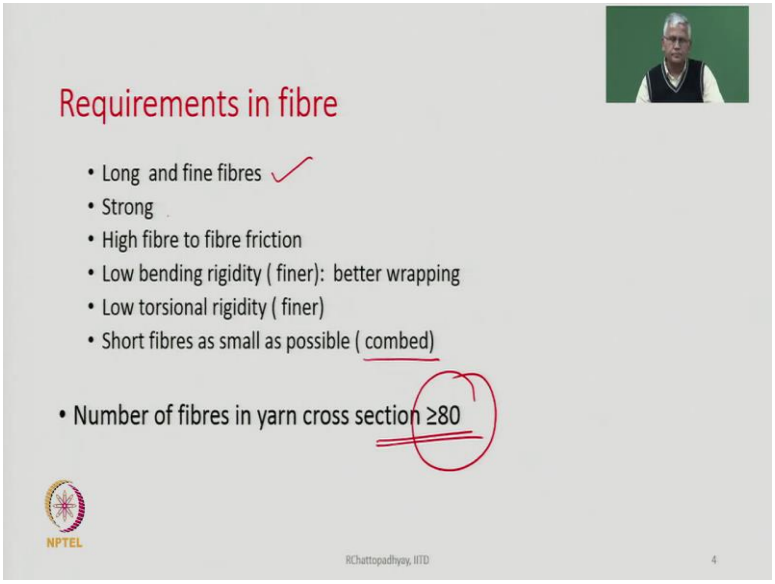

Next is requirement in fibres. So, the what are the you know parameters in the fibre which are really suitable? One is the fibre should be long and fine they should be preferred. The fibre should be strong there should be high fibre to fibre friction fibre should have low bending rigidity and low torsional rigidity.

Short fibre should be as small as possible in the case of combed sliver. So, these are the requirement in the sliver and sorry not sliver requirement in fibre. Because we have to fibres some of the fibres will be utilized to wrap the core therefore, a fine fibres are better because fine fibres will have less bending rigidity in comparison to a coarse fibre. Second thing is that if the fibre is long the friction is going to be more. So, many a times the yarn may break because of slippage between the fibres.

We have already studied that the structure of the yarn that if you look at the surface of the yarn there are many places why it is devoid of any wrapper fibres or some parts of the yarns are such that there is hardly any twist. So, in the yarn its stretched it may so, happen that the failure is not because of the breakage of fibres, but failure could be because of slippage of fibres.

If you have to restrict the slippage, then fibre friction is going to help us more is the friction more will be the resistance to slippage, longer the length more will be the resistance to slippage for the fibres and hence long fibres and fine fibres that way also will help because fine fibres will have larger surface area per unit mass.

So, if you have make a yarn with fine fibres the total surface area available for potential contact between the fibres is going to be more than if the same yarn count we make from coarser fibres. So, that is why there is advantage in having long and fine fibres. Next, we move to the other one another important information is how many fibres we require in the yarn cross section so, that the spinning can be continued successfully without encountering too many breaks and number of fibre that we need here is at least 80.

So, it should be greater than 80 that basically means that we should not allow the number of fibres to fall below 80. If it is yet more than 80 if it is 100, if it is 120 still better.

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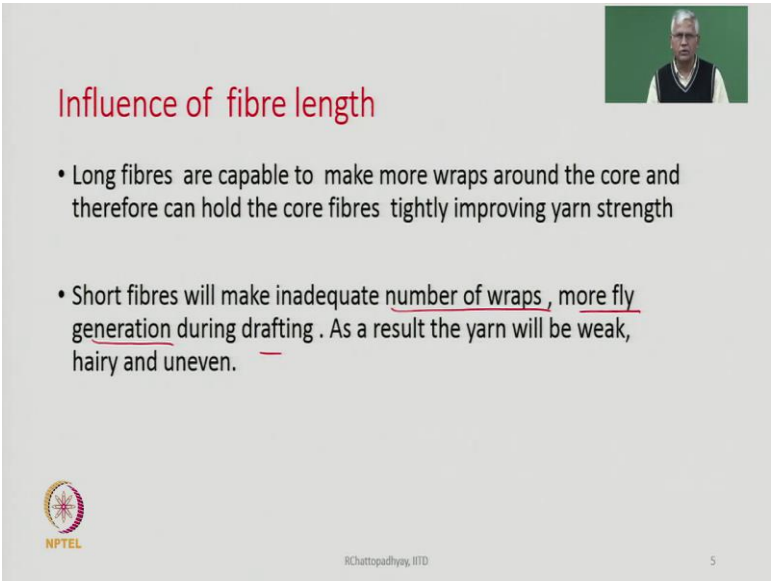

Next influence of fibre length I think I have already discussed a bit about it long fibres makes lot of wraps more wraps and short fibres will make inadequate number of wraps at the same time they will be creating more fly more fly we generated during drafting if we have lot of short fibres in the silver.

So, yarn will be weak short fibres makes there will be some kind of drafting disturbance. So, unevenness will be there in the yarn and they can also lead to lot of hairiness. Therefore, short fibres have to be avoided by all means.

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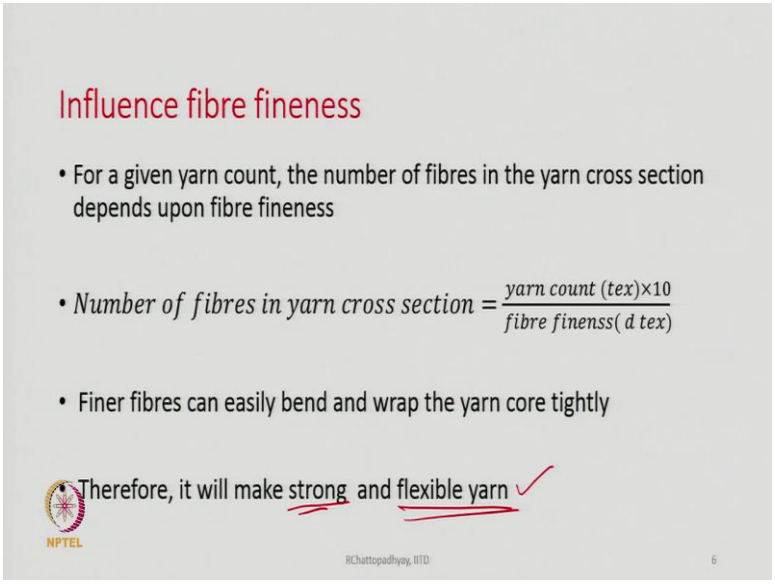

Fibre fineness. Fibre fineness will first of all decide the whether I am fulfilling the minimum fibre that you required in the cross section of the yarn or not. So, finer the fibres for a given yarn count, finer fibre means more number of fibres in the cross section. So, we will be able to meet the requirement of minimum number of fibres in the cross section if we go for fine fibres for a given count of the yarn.

The other thing is already told that fine fibres mean less bending rigidity there are easy to bend there are easy to you know torsional deformation also will be easier. So, they can easily be bent and therefore, they can easily wrap or they can be easily follow the curvature of the yarn. So, as a result the fine fibres will always make the yarn strong and flexible.

See one of the serious drawback of the air jet spun yarn is that they are stiff and why they are stiff? Then you have to look at the structure of the yarn. It is because of the lot of wrapper fibres which are wrapping the core so, tightly and they are also wrapping at an angle which is close to almost 90 degree to the yarn axis which are known as belts in the context of rotor spinning.

Similar type of wraps also can be seen in this case. As a result of these tight wraps the yarn becomes very very rigid with respect to bending deformations. So, these yarns are therefore, very rigid. So, they are not pretty flexible. So, one of the way because we will not be able to change the structure of the yarn too much because the as long as the

technology remain same. But if you want to make the yarn flexible one way is to use fine fibres and finer fibres will make the yarn flexible because individually fine fibres will have less bending rigidity.

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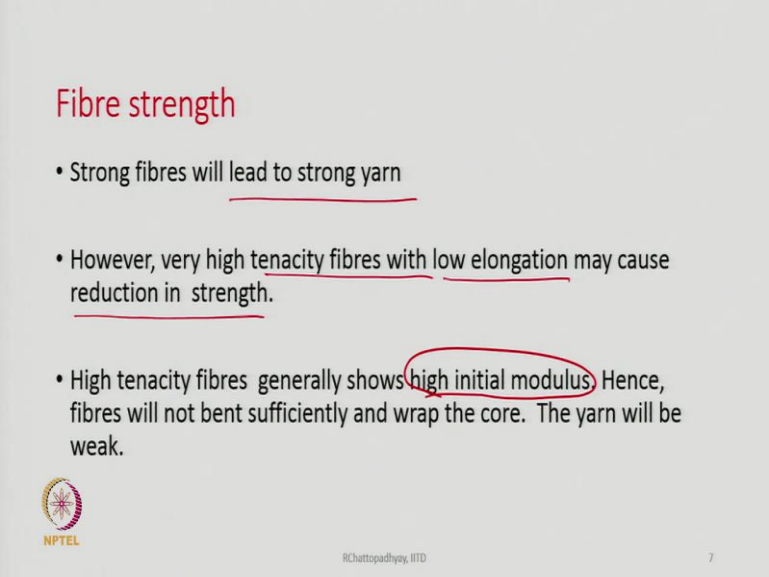

Fibre strength. Normally strong fibres will lead to strong yarns which is generally true for all systems of spinning. However, very high tenacity fibres with low elongations may cause reduction in strength. So, it may happen in this case especially very high tenacity fibre and low elongation combination. Generally, fibres which have high tenacity fibres I am talking fibres which are apparel you know use for apparels polyester fibres or viscose rayon fibres cannot have very high tenacity.

But polyester high tenacity polyester fibres are available and their modulus is high and their elongation is also less. Now, such kind of fibres will be beneficial to use them in air-jet spinning the answer is that no they are not beneficial. They will actually reduce strength because high tenacity fibre will have very high initial modulus and because of that their bending rigidity is going to be very very high.

So, these fibres will not be able to bend and therefore, wrap the main core and the wrapping is not proper that is wrappings are not tight enough then fibres will can easily slip whenever there is a tension on the yarn. And hence very high tenacity fibre is not going to give you very strong yarn.

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Fibre to fibre friction already discussed more friction will be more strength for a given value of coefficient of friction, the total frictional force acting on a fibre depends upon the fibre length longer the fibre. See, more force is required to withdraw the fibre from the cross section of the yarn because frictional resistance to slippage is going to be more that is the idea that these yarns can sometimes fail because of slippage.

If you want to avoid slippage mode of failure, we have to enhance the frictional resistance and the frictional resistance is a function of coefficient of friction between fibres the length of the fibres and also on the normal force that is generated because of the presence of wrapper fibres or in the case of ring spinning it will presence of twist because the fibres are following a helical path the moment we try to stretch the yarn.

Immediately the tension that develops on the fibres one component of the tension will be directed transversely towards the yarn core and this component is going to act like a normal force and that will actually lead to lot of frictional resistance to slippage of fibres.

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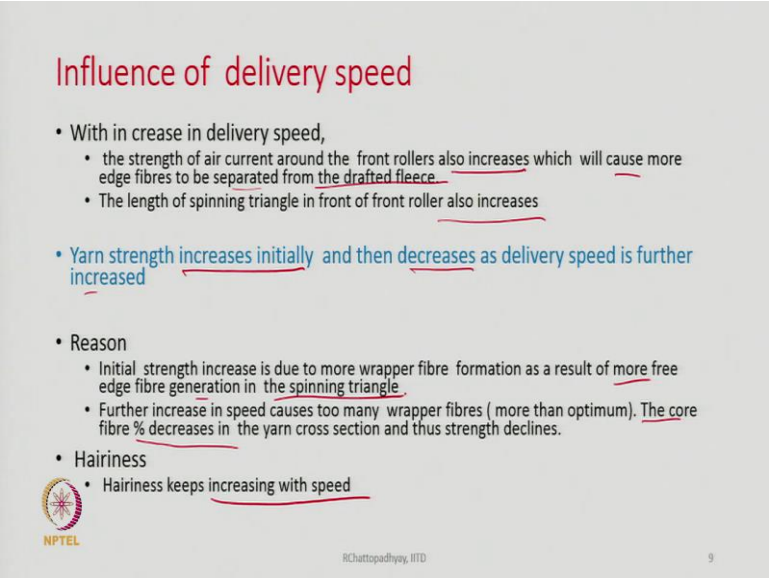

Delivery speed we all want very high delivery speed because more delivery means more production, but there is always a restriction in any technology that you choose there is a limit how much you can go as far as delivery speed is concerned.

But the productivity of the machine always depends upon the delivery rate. So, more delivery is always better, but more delivery basically means in many cases quality deterioration. Now, what happens here? With increase in delivery speed the strength of the air current around the front roller will also increase drafting rollers because the rollers are running at a very high speed which will cause more edge fibres to be separated from the drafted fleece.

The length of the spinning triangle in front of the front roller is also going to increase when we go for very high delivery speed delivery speed of the drafting system. Yarn strength will increase initially and then decreases and delivery speed is further increased; that means, it will pass through a optima that is what has been observed by many researchers.

Where initially there is slight increase in the strength of the yarn, but if we go further the actual strength of the yarn will go down and also in quality, we will also deteriorate in other respects especially with respect to faults. Reason is initial strength increases due to more wrapper fibre formations as a result of more free edge fibre generation in the spinning triangle.

See this initial rise in delivery speed means the air current around the drafting rollers is going to be more and more powerful and it is the air current behind the front drafting rollers which is going to disturb the flow of fibres in the main drafting zone and therefore, the width of the spinning triangle will be dependent on the speed of the drafting rollers especially the front drafting rollers.

It will also depend upon the draft that we use in the front zone. It will also depend whether I am using a condenser or not, but at the same time it will also depend upon the speed of the rotational speed of the front drafting rollers because the air turbulence which is created behind the roller that actually flows along the nip as I think we have already discussed these points earlier and that will increase the width of the spring triangle.

So, more fibres from the edges will be available or they will be escaping twisting actions and they will be part of the wrapper fibres ultimately. See wrapper fibres increases strength is going to increase initially, but this will not continue forever because a time will come when if the more or more fibres becomes wrappers at the same time you have to remember less and less fibres will become core because ultimately total number of fibre in the cross section is same when you are spinning a particular count.

So, if the wrapper fibre percentage increases, the core fibre percentage decreases also and if the core fibre percentage which actually determines the strength of the yarn and hence once we go beyond a certain limit of you know formation of wrapper fibres further increase wrapper fibres will actually result in reduced strength of the yarn because core fibre percentage has gone down.

Hairiness is going to increase with speed because the more and more delivery the turbulence which gets created also put the result in more Hairiness. More wrapper fibre does not mean the wrapper fibres will be able to wrap the yarn very nicely. We have seen that when the structure of the yarn is seen we see different kinds of wrappers.

People have categorized the wrapper fibres in different ways some wrappers are very nice some are little bit wild in nature some are they are very haphazardly placed in both S and Z directions some are loose some are tight. So, loose wrapper fibres is basically an indication that these ends of these wrapper fibres would likely to form projecting ends that is they will be forming hairs.

So, therefore, Hairiness is going to increase. So, you have to always find out what is the optimum delivery speed in a given situation. Generally, we have to find out the optimum combination of process parameters where delivery speed is one process parameter. The other process parameter is the pressures the jet pressures.

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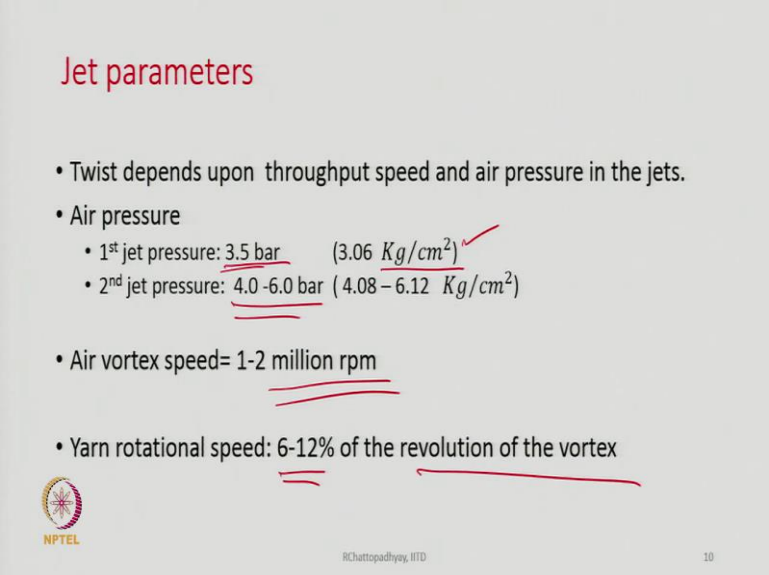

Now, the jets which are used there are generally two jets are used in the air jet spinning. The first jet pressure is typically 3.5 bar or close to that second jet pressure remains in this range 4 to 6 bar and bar 2 kg per centimeter square pressure this you know this is you know given here.

So, air vortex speed is typically to the order of 1 to 2 million rpm. I think I have already mentioned this earlier that the vortex speed has been measured and the vortex rotates at that speed all depends upon the pressure with which we inject the pressurized air in the nozzles.

So, 10 lakh to 20 lakh rpm is typically the speed of the air vortex, but the speed of the yarn is much less. Yarn rotational speed is typically 6 to 12 percent of the revolution of the vortex.

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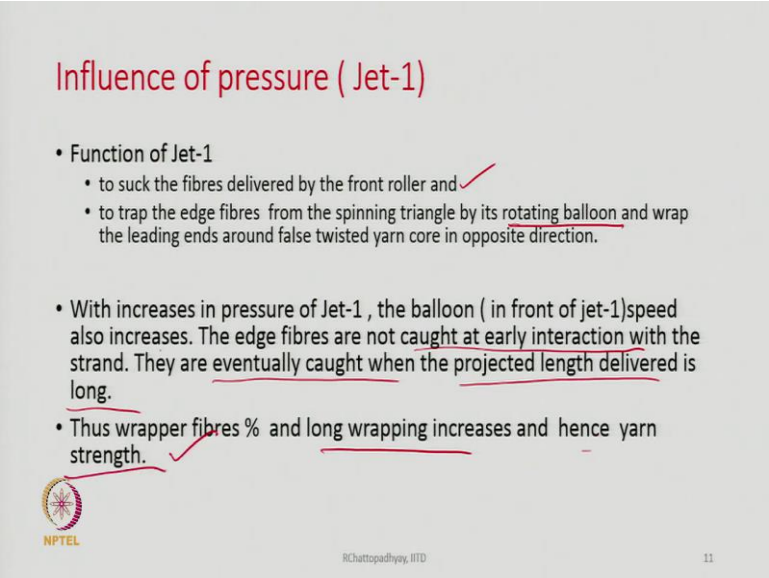

Now, influence of the pressure in Jet-1. So, you have to remember that there are two jets Jet-2 is more powerful than Jet-1 which one is Jet-1? Jet-1 which is close to the front roller front drafting rollers of the machine that is Jet-1 and Jet-2 which is the next jet.

So, function of the jet just to recall it back it we have already discussed earlier, it is function is to suck the fibre delivered from the front roller because compressed air is injected in Jet-1 if vortex is created and a component velocity of the vortex if we see it actually you know drives the air through the central channel.

And when the air is moving through the central channel at the very very high speed a kind of negative pressure is generated in the inlet of the jet and there negative pressure that is generated; that means, there is a fall in pressure near the entry of the jet and that fall in pressure or that negative pressure will pull the fibres from the nip of the front drafting rollers.

So, nip of the front nip of the front drafting rollers to the inlet of the jet the fibres are drawn and it is the suction that gets created because of the vortex which is flowing through the central part of the jet which will draw the air or draw the fibres and force them to enter the central channel where the vortex is existing and the vortex is going to turn this yarn this bundle of fibres.

Because as I said earlier Jet-2 is more powerful therefore, Jet-2 will generate false twist into the air fibres and that false twist will flow right up to the nip of the front roller whereas, the Jet-1 purpose is to create a balloon see the yarn inside the two jets is a flexible material ultimately yarn is a flexible material. If it is made to rotate at a certain speed; obviously, the yarn will be deflected because of the centrifugal force.

And it will create its balloon and therefore, there are two balloons the yarn path or the trajectory of the yarn between within the jet is not a straight path it is following a complex helical path with roughly two balloons which are there now the purpose of the Jet-1 is to pre-wrap the edge fibres which are escaping the twisting action and also the formation of a balloon.

So, to trap the edge fibres by the rotating balloon that is the purpose once they are trapped the trapping is a chance phenomena as the fibre is moving out from the front roller nip somehow they have accidentally if they are from the edges they are not from the central part.

So, they may escape twisting actually because there are some turbulence is there and they will then actually they will land on the balloon the; that means, they are landing on the balloon which is rotating at a very high speed also the balloon speed also to the could be to the order of l,50, 000 to 2,50,000 rpm.

So, at the fibre end lands on it may get caught right may not get caught. So, it may, but at some point of time it will be caught in the initial impact it may not get caught. So, the increase in pressure of the balloon speed also increases the edge fibres are not caught at early interactions with the balloon; that means, with the strand, but they will be eventually caught when the projected length delivered is quite long.

So, because the fibre is delivered at a certain speed has more and more fibre length is available is projecting out from the front roller nip they are going to be finally, caught by the balloon and if they are caught late that is better because they will form longer wraps on the yarn.

They cannot go inside the yarn because the yarn is already twisted that is the problem most of them they will not be able to go fully to the you know core part of the you know

core part of the yarn, but after wrapping part of it could be a could be a part of the normal yarn also.

Thus, wrapper fibres percentage and long wrapping increases and hence yarn strength is going to increase as you go for higher pressure for the Jet-1. We can roughly say that with increase in speed pressure; that means, more speed of the vortex. So, more speed of the balloon. So, wrappings are going to increase long wraps will be there and wrapping fibre percent is also is going to increase.

If wrapper fibres are basically, you know is the main cause for developing transverse force and therefore, hold the fibres together see if their percentage is more the strength is going to be more.

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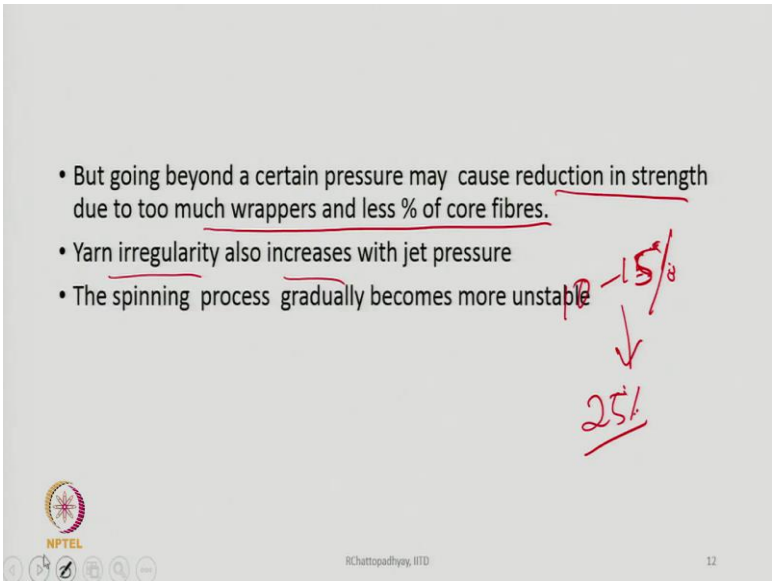

And Jet-2 the other thing is, but going beyond a certain pressure may cause reduction in strength due to too much wrapper fibres as already discussed whether if we keep generating generally typically the wrapper fibre percent is 10 to 15 percent.

This is the value of wrapper fibres it maybe 6 it maybe 8 also. Now if it goes very high if it is become 25 percent, then yarn strength is not going to increase on the contrary it is going to decrease because proportion of core fibres will be now much less. The other thing is the yarn irregularity also is going to increase that yarn will be more uneven that

possibility of this. So, there because of the disturbance and that will be created when the jet pressure is very very high.

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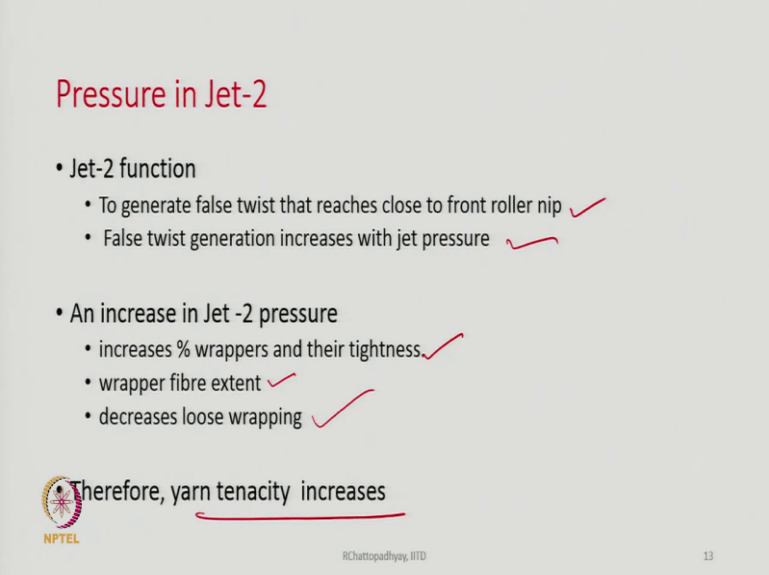

Pressure in Jet-2, Jet-2 function is to generate false twist that is the main purpose and the false twist should reach the close to the front roller nip. So, jet therefore, pressure in Jet-2 is always more than pressure in Jet-1 false twist generation increases with jet pressure.

An increase in Jet-2 pressure therefore, will increase percentage of wrappers and their tightness how tightly the wrappers are you know on the yarn body how tightly they are wrapping tightness of wrapping also depends upon the magnitude of false twist that is generated ultimately the wrappers the edge fibres which are forming wraps they will get additional wrapping when the false twist is removed by the time.

The yarn is moving out of the jet and therefore, the first twist is removed. So, now, all these wrapper fibres will get reversely they will be twisted. So, if the false twist is more the reverse twisting also will be more and you would expect more tight wraps to be formed that is what can be expected. So, decrease in the loose wrapping tight wrapping is going to increase and the wrapper fibre extent also has been found to increase all these will lead to increase in tenacity.

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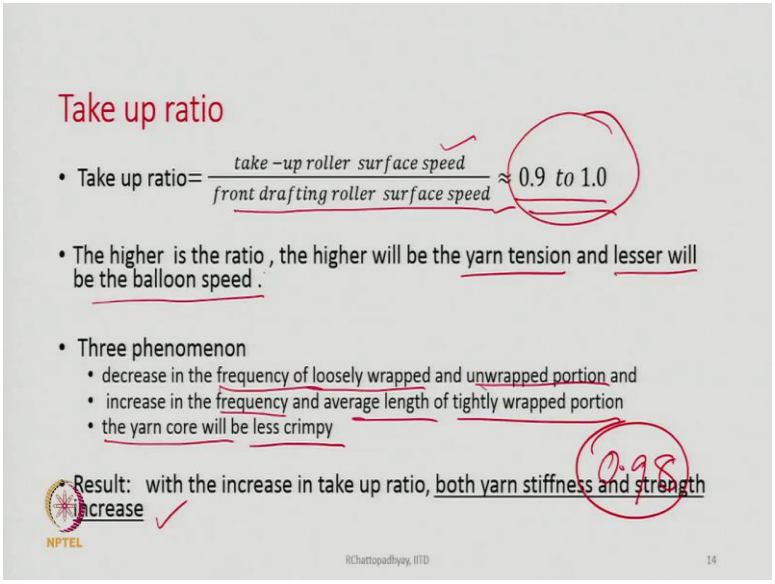

That is what general observation is, but everything depends upon what exactly is the pressure combinations of Jet-1 Jet-2 and at what speed we are spinning the yarn the next important parameter is take up ratio. Sometime it is also called as feed ratio take up ratio is take up roller surface speed divided by front drafting roller surface speed and this ratio is lies in this range 0.9 to 1.0.

$$Take\ up\ ratio = \frac{take - up\ roller\ surface\ speed}{front\ drafting\ roller\ surface\ speed} \approx 0.9\ to\ 1.0$$

The higher is the ratio the higher will be the yarn tension and lesser will be the balloon speed the yarn is very tight then the speed of the balloon is going to be reduce, the size of the balloon also is going to reduce because the yarn is under tension. Therefore, this is a parameter by which also the property of the yarn can also be affected three phenomena is important here when we go for higher ratio one is decrease in the frequency of loosely wrapped and unwrapped portion increase in the frequency and average length of tightly wrapped portion.

And the yarn core will be less crimpy we have seen earlier while discussing the structure of the yarn that sometimes the core of the yarn is wavy and crimpy if wavy part of the yarn is not going to really you know not every strong part of the yarn because when that part of the yarn will be stretched the wrapper fibres will take certain load.

And the crimpy core will take certain other load and therefore, the distribution of stress between these group of fibres will be so, different that overall, the load that these fibres are going to carry will be less. So, a crimpy type of core is something which is not good the second thing is if the crimpy regions are there in the yarn too much of this the yarn will be rough the fabric will be rough in terms of handle.

See wrapper fibre itself will make the fabric rough because the wrapper fibres are not oriented or not inclined the way the core fibres are inclined. And therefore, because they are wrapped at different types of angle the fabric is made out of it fabric will also feel bit rough.

Second thing if the if the crimpy core exist in the yarn and we convert them into fabric this will also give the fabric a very you know harsh feel. So, therefore, these are some of the drawbacks with these yarns. So, it is I mean a kind of combination of parameter that will reduce the crimpy core is always better. So, if the tension is high, we keep the ratio little high, but you see the ratio lies in this range only.

So, 0.9, 0.92, 0.94, 0.95, 0.98 this is the range in which it lies it is always little less than 1. But within this typically people keep a ratio of 0.98 and they have found that this ratio gives a good quality yarn. Sometimes, it could be maybe 0.96 also. So, the increase in take up ratio both yarn stiffness and strength increase.

So, 0.9 people go to 0.94 or 0.95 96 a little improvement, but no, but we should not go to beyond 1 also because that will make the yarn tension so, high that the thread may break during spinning itself. Whenever the yarns are twisted there is a contraction. If some of the fibres are wrapping there will be overall contraction of the yarn and the contraction itself is going to increase the tension.

So, if we go for very high tension keeping the take up ratio 1 or 1.1, then we will find that the yarn is going to break during the in this in the you know during spinning operation itself. So, some slackness we keep it by keeping a trap less than 1, but too much slackness is also not good. So, an optimum value is somehow maintained by choosing the right take up ratio. It will also depend whether I am processing 100 percent cotton whether it is polyester cotton blend or polyester viscose blend.

So, with all these typical whatever fibres we choose depending upon the fibre being processed and the count of yarn also we are going to produce these take up ratio values are actually adjusted, but it remains between 0.9 to 1.

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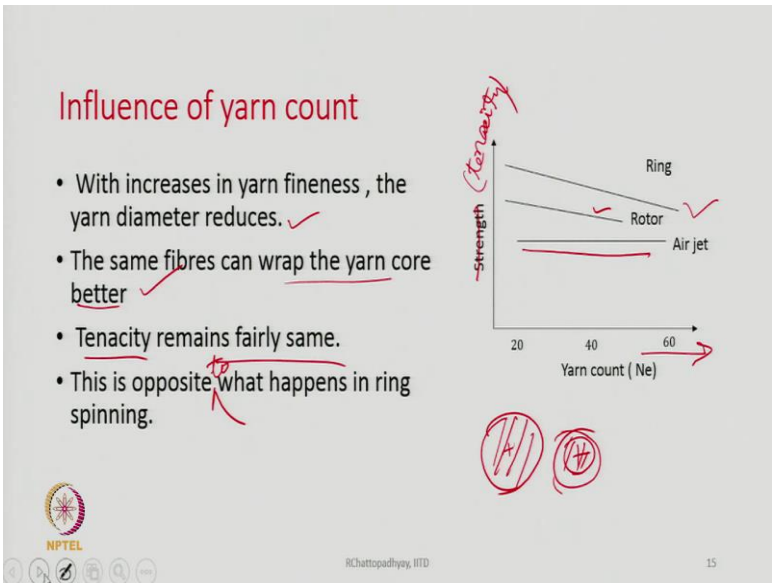

The one interesting part is that influence of yarn count on yarn tenacity. If you look at this diagram if the fibre is kept same and all other parameters are kept same if we go for finer count this tenacity is going to decline either the strength in terms of it is tenacity.

Strength is not be the correct word tenacity is better because strength of a finer yarn will always be less, but if we divide strength by count, we get a tenacity value. So, with tenacity the comparison is always better. So, if we compare this, ring yarn tenacity goes down as we reduce number of fibres in the cross section of the yarn that is I make the yarn finer and finer. The Rotor also there is a declining trend with air jet it is no change in tenacity.

So, this is something unique which is not there with others and why does it happen? With increase in yarn fineness the yarn diameter reduces the same fibres can wrap the yarn core better now. Earlier the yarn diameter was like this now the yarn diameter has become less. Same fibre we will be able to produce a better wrap around this. So, they will make complete wraps and because of this the tenacity remains fairly same it does not change much.

This is something different. So, the reason is that the same fibre length will be able to now wrap the yarn surface better and overall tenacity therefore, remains fairly constant. It does not change much as the count becomes finer if the fibres are kept same. This is opposite to what happens in ring spinning or rotor spinning also.

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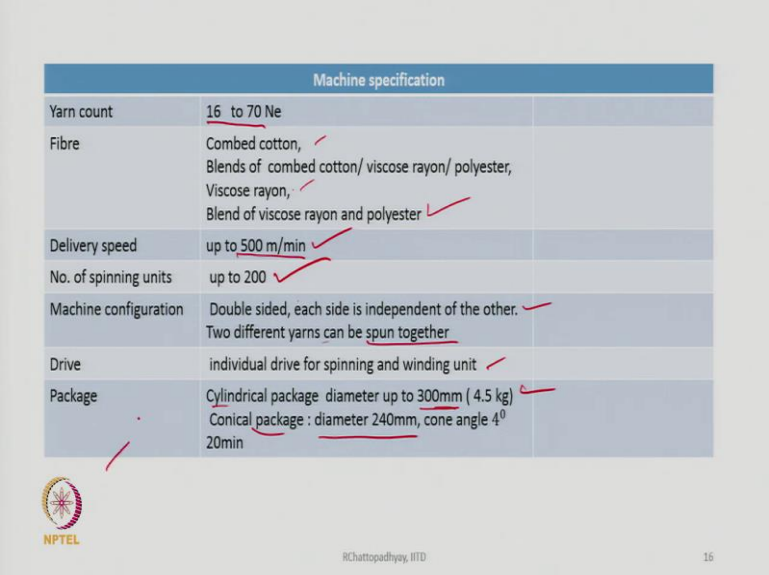

Now, this is the typically the machine specifications we will just discuss. Typically, these machines can spin yarn starting from 16 to 70s Ne. Fibres already stated combed cotton blends of combed cotton with viscose yarn polyester 100 percent viscose yarn or blend of viscose yarn and polyester all these fibres can be processed.

Delivery speed claimed by the machine manufacturer it can go to 500 meters per minute, but typically industrial speed is at 350, 380 by 400 around that. Number of spinning units 200 in a machine, machine configuration double sided and each side is independent of the other in terms of there you know flexibility that we have on the machine that is two different yarns can be spun simultaneously on two sides of the machines.

So, the parameters can be adjusted independent of each side. So, one side can run at a slower speed other side can run at different speed depending upon the fibre length we can adjust the setting of the rollers, or drafting rollers. So, air jet pressures can be also individually controlled. So, two sides are independent to each other and therefore, two yarns can be spun simultaneously.

Drive is individual drive for spinning and winding units. Package is cylindrical package diameter up to 300 millimeter or 4.5 kg big cheeses can be formed or conical packages also can be formed which can directly go to the knitting. So, these are the you know some typical machines which are there, but we will see that the air-jet spinning machines has already lost its popularity.

It is not pretty common nowadays and the vortex has taken over. So, our next discussion will be on vortex spinning machines. Air jet spinning machine has always a complaint that it cannot process 100 percent cotton fibres and therefore, people are forced to blend it with polyester or with maybe this viscose rayon. This was the you know issue with this. The second thing is that the yarns are bit stiff because tight wraps are there.

So, flexibility of the yarn also was the issue. So, whatever fabrics you make out of it that is to be little stiffer. So, you have to make you know if you want to get rid of the stiffness then you have to give some amount some kind of finishes to the fabric to make it little flexible.

So, these are the you know general complaints about this technology and therefore, nowadays the vortex has taken over and vortex spinning system has become very very popular and it is very much accepted in the industry. So, we will discuss about vortex spinning in the next class.

Thank you.