New Spinning Technologies
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Lecture - 04
Twist Equation

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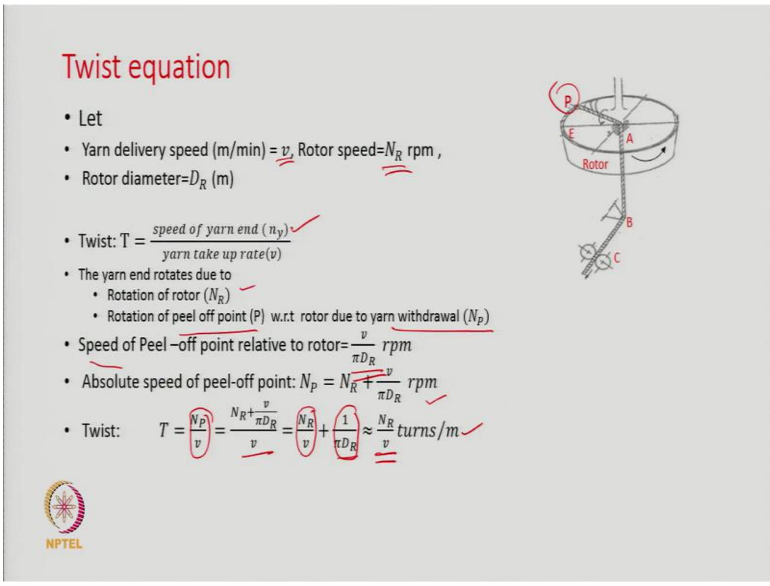

We will discuss now Twist Equations. Now the diagram what we see? A rotor is there and you can see the yarn path. So, let yarn delivery speed be ‘v’ in terms of m/min, rotor speed is ‘N_R’, rotor diameter is ‘D_R’. So, the twist ‘T’ we all know that is speed of the yarn end ‘n_y’ and yarn take up rate which is ‘v’. So, this is all known to us. So, the yarn end, we need to know what is the speed of the yarn end.

Yarn take up rate velocity this or take up rate this is given here is ‘v’, rotor speed is given, but the speed of the yarn arm ‘N’ is not given; that is the speed of the point ‘P’ is not given which we need to find out. We have already done it so, it is quite simple. The yarn end rotates due to rotation of the rotor and rotation of the peel-off point ‘P’ with respect to rotor due to yarn withdrawal.

Because I am pulling the yarn out therefore, the point ‘P’ gets an additional rotational motion ‘P’ is anyway sitting on the rotor. So, whatever the rotor speed, speed of ‘P’ will be that similar to rotor speed, but since I am pulling the yarn out an additional rotational speed it gains and therefore, the speed of ‘P’ is always more than the speed of the rotor.

So, what is that additional speed? Is actually ‘$v/\pi D_R$’ that is what is the yarn delivery speed or yarn take up speed whatever we can call it you may find different books write different things sometimes delivery speed sometimes take up speed meaning the same. So, peel-off point speed is going to be ‘$v/\pi D_R$’, the absolute speed of the peel-off point is therefore, going to be $[N_R+(v/\pi D_R)]$ that is going to be the speed of the peel-off point from there we can say how much is going to be the twist.

Twist is therefore, ‘N_P/v’ and ‘N_P’ is,

$$\frac{N_R + \frac{v}{\pi D_R}}{v}$$

divided by ‘v’ that it is,

$$\frac{N_R}{v} + \frac{1}{\pi D_R}$$

So, ‘N_R/v’ is the major component of twist generation; this part is very very negligible ‘$1/\pi D_R$’. So, for all practical purpose the twist is ‘N_R/v’. So, the speed of the peripheral point with respect to rotor is so little that for all practical purpose you can ignore it and we can still find the twist, which is reasonably accurate and for in the industry also we find out twist by taking the ratio of rotor speed by and the delivery rate.

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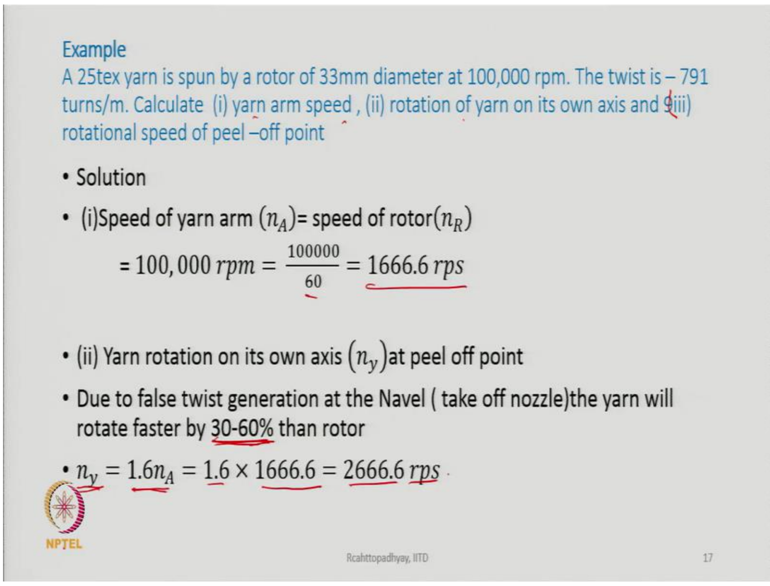

Now, we will solve another problem. The 25 tex yarn is spun by a rotor of 33 mm diameter, at 100000 rpm or 100000 rpm; 100000 revolution per minute. The twist is 791 turns/m. Calculate yarn arm speed, rotation of the yarn on its own axis, and the third is rotation speed of the peel-off point.

Solution, speed of the yarn arm is equal to speed of the rotor for all practical purposes they are almost same, but in the true if we go to very accurate then; obviously, the speed of the yarn arm is slightly more than speed of the rotor. So, it is '100000/60', this much revolution per second.

Yarn rotational speed at the peel-off point, now due false twist generation at the navel the yarn will rotate faster by 30 to 60% than rotor this is something, which will be given. Therefore, the speed of the yarn arm. So, the yarn is going to be '$1.6\times n_A$' that is '1.6 this much this is the rps' because I am generating false twist.

But we have not yet really discussed how false twist are generated we will just take it up just very now very soon within the rotor we generate false twist and how the false twist is generated is going to you are going to learn very soon. And the generation of false twist, how it is going to help us?

But as I as written here that the twist generation could be 30 to 60 %, the yarn will rotate 30 to 60 % faster than the rotor. So, actual speed of the yarn is going to be '$1.6\times n_A$'. So, that is why it is this is the speed in terms of rotational speed per second.

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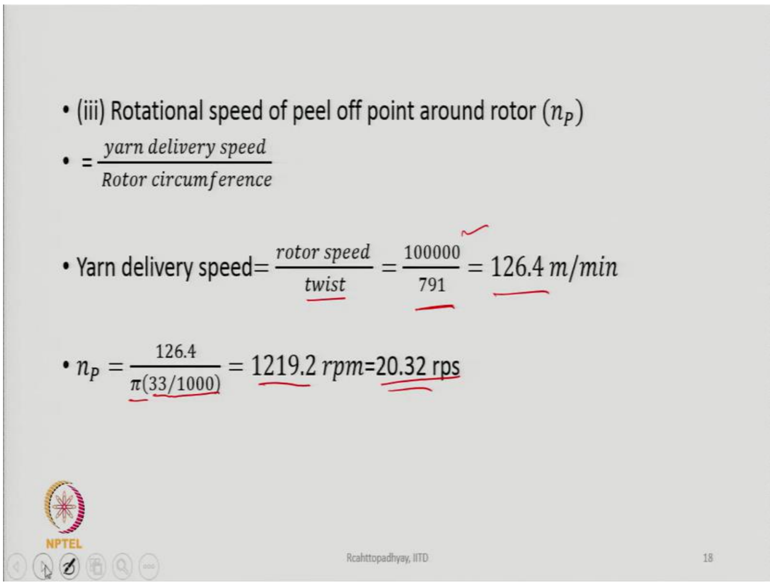

The rotational speed of the peel-off point around the rotor is the 'yarn delivery speed/ rotor circumference'. So, therefore, yarn delivery speed is going to be rotor speed by twist; '100000/791' is 126.4 m/min. 'n_p' therefore, is going to be '126.4/π×diameter in terms of meter, 33 mm converted into meter', we get the value 1219.2 rpm, or in revolution per second it is 20.3. So, that is how we can calculate some of these you know parameters.

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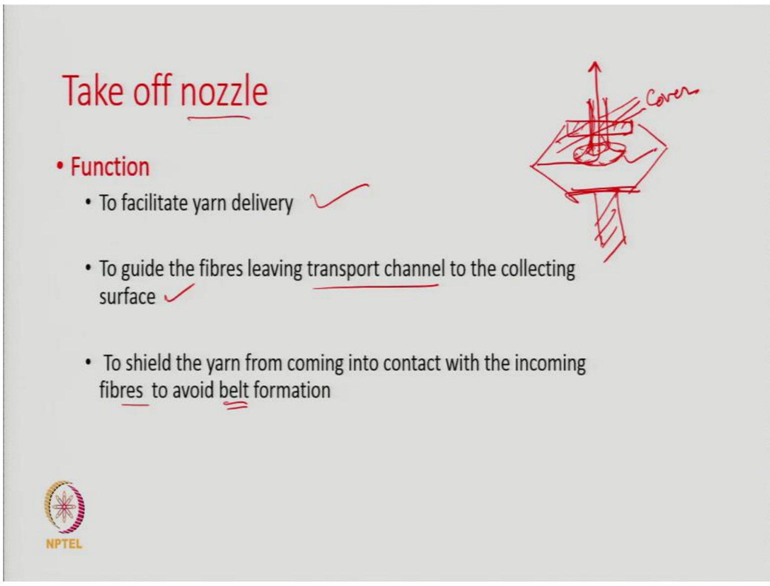

Now, we will discuss about the now false twist generation. Now for false twist generation what we have is that at the center point of the rotor; there is a rotor has a rotor cover, and at the covered center point there is a small tube through which the yarn is withdrawal. So, every rotor will have suppose this is the rotor simple diagram; that is a cover here; a cover is there and then through the cover, there is a tube which is there always. And the yarn goes like this through the tube and this is the cover this is my rotor.

Now, here at this edge as I said earlier that the bend is there and the bend is a source of friction point. Now here, the machine manufacturers what they have done that they have put a nozzle over here. So, the nozzle will see the diagram of a nozzle the purpose of the nozzle is to create or to generate false twist because the yarn will be rubbing against the nozzle surface.

So, whenever there is a rubbing action there is a possibility of torque getting generated or twist getting generated and actually twist also generates. Now the function of this nozzle is to facilitate yarn delivery because the yarn has to pass through this. So, it helps in delivering the yarn, then nozzle it looks like a funnel if I draw it here it looks like a funnel like this.

To guide the fibres leaving the transport channel to the collecting surface the here we have the feed tube. So, this covering part of the rotor also holding the feed tube. So, that way it is helps the it is guiding the fibres leaving the transport channel or the feed tube to the collecting surface. So, take off nozzle consists of a cover, a feed tube and also a nozzle; all put together and to shield the yarn from coming into contact with the incoming fibres to avoid belt formation.

Was this is a new term? we have not yet discussed belt formation part, we will discuss in some future lectures; that is to avoid this belt formation on the yarn or wrapper fibre formation on the yarn the nozzle here, which is placed at this place also acts as a shield. It does not allow many fibre, otherwise lot of fibres will be you know forming belts or forming wrapper fibres. So, to shield it also acts as a shield.

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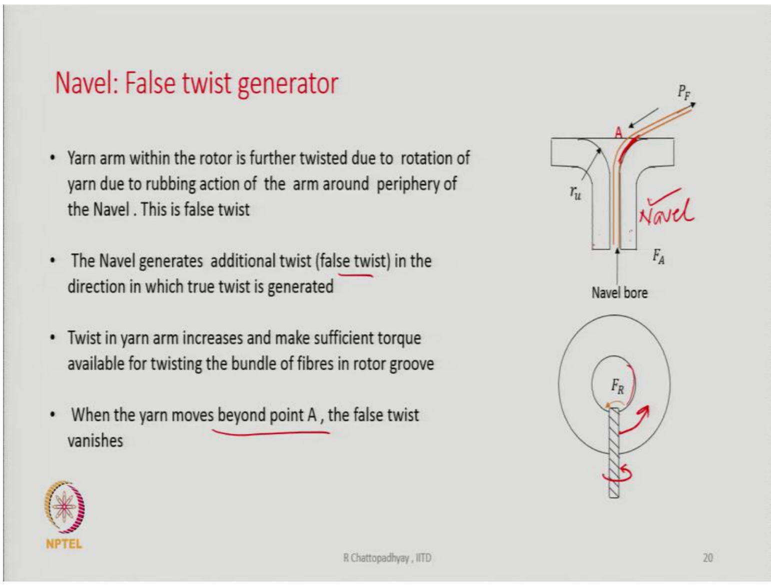

So, navel is a false twist generator this diagram looks better now; this is the kind of the actual you know diagram where we see here, this is the yarn and this is the navel bore. So, this is which is actually fixed with the rotor cover covering plate is there and this assembly that you see here we call it navel. So, this is our navel it is actually fixed on this and this is the direction in which yarn is going out.

So, yarn on within the rotor is further twisted due to rotation of the yarn due to rubbing action of the arm around the periphery of the navel. Now, you see, see if this is your navel bore and this is the yarn now this yarn is rotates like this it is rotating. So, this is abrasion at the contact point between the, this surface that you see here this surface and the yarn, it is continuously rotating.

As a result the there will be you know your rubbing action will be there or we can say friction will be there and that will cause the yarn to rotate on its own axis. So, additional twist is generated because of the rubbing action of the yarn in contact with the navel; that means, that if I can manipulate the extent of rubbing action I will be able to manipulate the level of false twist generation that is possible. Now this false twist generation is it beneficial or not that question will come, we will discuss that also.

So, navel generates false twist. In the direction in which the true twist is generated and therefore, it actually make available more twist into the yarn arm and by doing so, you strengthen the yarn within the rotor and what is the beneficial effect of that? That if I can strengthen the yarn within the rotor possibilities of end breakage will go down.

So, by generating additional twist temporarily, we gain in terms of strength of the yarn when it lies within the rotor, but as soon as the yarn leaves the rotor the false twist will vanish and whatever twist we decided into the yarn that twist will be left in the yarn because also the same time you have to remember that too much twist in a yarn will make the yarn very hard and its field is going to be negatively affected.

So, if we can have a arrangement where we can temporarily increase the twist within the rotor and therefore, avoid the breakage of the yarn end, then we gain. Since it is temporary in nature it is not going to affect the yarn quality especially in terms of its feel otherwise, if the yarn has high level of twist the yarn will. Now if you feel the yarn it will be very harsh it will be very hard also.

In general rotor yarns are little harsher than ring yarns because there are more twist is there; There are other reasons also we will come to that therefore, at the same time to avoid breakages we need to strengthen the yarn within the rotor and therefore, the false twist generation is going to be very very beneficial and that is why the navel and its design comes into the picture. So, as I said when the yarn moves beyond the point ‘A’ the twist will vanish it will not be there.

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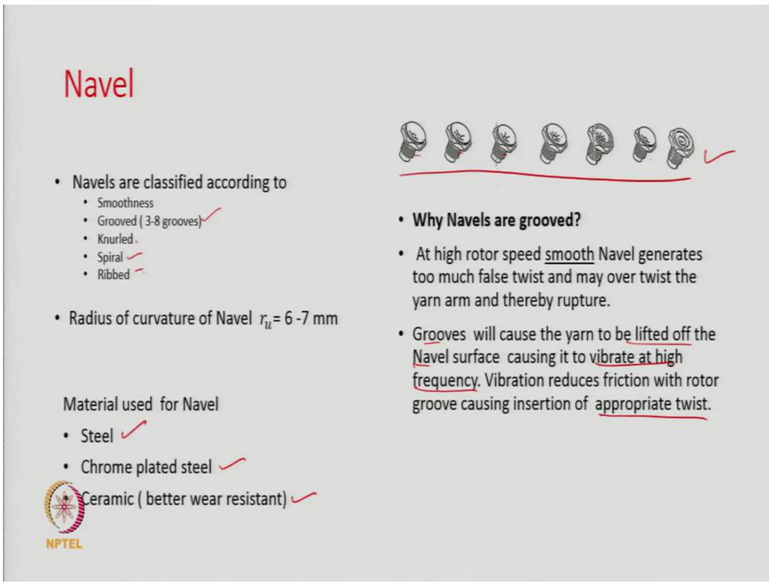

Now, the navel type some of the navel types are shown in this diagram. You see these are small pieces which can be fitted there these are the screws and the navels are these are the different types of navel designs are there to suit different types of yarn, different types of fibres. Navels are classified according to this smoothness or grooves how many grooves are there? Whether the surface is knurled or not? Whether we have a spiral groove then is called a spiral type of navel or ribbed type?

So, different types of navel geometry exist and the purpose of all of them is to influence the level of false twist that we can generate. Too much false twist also will be bad at the same time because then the yarn the as you have seen earlier I have shown that the peripheral twist extent that zone; that means, the twist that flows into the rotor groove that zone will extend too much and that has a negative effect.

If it extend too much we will see that that will cause more wrapper fibres to be generated into the yarn and yarn quality will suffer. So, that peripheral twist extent that is having no peripheral twist extent is equally bad, having too much peripheral twist extent is also bad. So, neither we need too short a peripheral twist extent neither we nor we need very large peripheral twist extent.

So, peripheral twist extents the length of it is decided by the twist that exist into the yarn arm and how much twist will actually into the yarn arm? That will be decided on how much true twist you want to keep first of all and what type of navel geometry we have used and therefore, there are so, many different types of navel geometry to suit as I said different counts, different type of nature of the yarn that we want to produce and different types of fibres that we want to process.

Material used for navel are either steel or chrome plated steel or ceramic different types of navels are there because the continuous abrasion the navels will have a life. And we need to then discard them after prolonged use the manufacturers will give you the life like travellers have to be replaced. Similarly, navel also need to be replaced after certain point of time.

Now, the navels are grooved why they are grooved? A at high rotor speed the navel generates too much of false twist and may over twist the yarn arm and thereby rupture. See we all know that too much of twist makes the yarn weak too lower twist also makes the yarn weak. So, if I generate too much of twist the yarn will be weaker and as a result yarn will break.

Now, when there is a large surface area of contact between the yarn and the navel then there will be too much of false twist generations because too much of twist will be generated why? Because friction will be more; contact surface area of contact is more and when it will be more when the navel is smooth. Smoother the navel, more is the contact area between the yarn and the navel; rougher the navel less is the contact area between the navel and the yarn.

So, if I how much contact area you want to establish between the yarn and the navel we can change it by having more number of grooves or less number of grooves or by having knurled surface or spiral type or one wants, different types of designs are there, basically trying to you know influence the extent of contact between the yarn and the and the navel and as a result of that to influence the level of false twist generations.

Now, what happens the another point is the grooves will cause the yarn to be lifted off the navel repeatedly on the navel surface causing it to vibrate at high frequency. So, this is also another point. Now too much of vibration is also bad the yarn will break, but at the same time if I allow it to vibrate; that means, at times it is losing contact with the navel surface and therefore, the extent of generation of the false twist will be less and it will help in you know generating appropriate amount of false twist.

So, one has to actually try by having different types of navel to see what suits in a given situation that is count of yarn, the speed of the you know rotor and the nature of the yarn that you want to produce based upon that we have to decide what type of level we have to choose. So, this is all about the navel which is a replaceable item.

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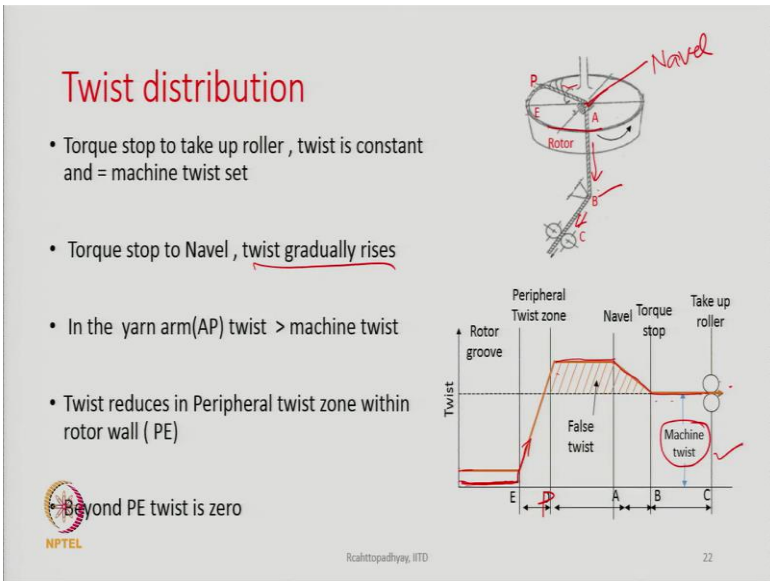

Now, we will come to the last part of this discussion that is the distribution of twist from the rotor groove to the take up roller from where the yarn is pull out. The orange line gives you the distribution of twist how the at different part of the yarn the twist levels are different. At the final part, torque stop to take up roller that is ‘BC’ region the twist is exactly equal to the machine twist.

What is machine twist? Machine twist is the twist, that we wanted to have in the yarn, which is the ratio of rotor speed by the delivery rate or take up speed that is called the nominal twist or also called as machine twist. Now torque stop two take up roller this is called the point ‘B’ is called torque stop.

See what happened? Here there is another bend this is the yarn path yarn is going out in this direction there is a raised portion over here and at the point ‘B’ and the yarn is deflected a bit this deflection is going to create a barrier to the flow of torque. So, what will happen? The torque in the region a b is going to increase.

So, at the point ‘B’ we are not generating any twist, it is simply not allowing twist to flow too much some barriers created. So, in the region in the region ‘A’ to ‘B’ more twist will be there and from the twist in the region AB is more. So, more twist will flow towards the point ‘P’. So, this is called torque stop in all the machines of today the torque stop is there this is ‘E’ and then the point this is point ‘P’ ok, this is ‘A’ point where the navel exist here and then the point ‘B’ is here torque stop.

So, here actually what we have? We have navel here yes, this point should be ‘P’. So, torque stop to navel twist gradually rises in the rotor groove the twist is very very low then from ‘E’ to ‘P’, this is the peripheral zone. So, beyond ‘P’ the twist is close to almost zero actually there are hardly any twist.

So, actually this point may be close to zero here, there is no twist there and then the twist start going up from ‘E’ to ‘P’ twist is rising, from ‘E’ to ‘P’ twist is gradually rising and then in the zone, that is ‘P’ to ‘A’ the twist is actually maximum here. Because we want to strengthen the yarn in this part always so, that the yarn is not going to break and it makes twist sufficient twist available to twist the yarn which is twist the fibres which is lying in the groove therefore, from in this zone false twist is also created by the navel and twist level is quite high.

And then from ‘A’ to ‘B’ from here to there again twist gradually goes down beyond point ‘B’ the twist is equal to the nominal twist or machine twist. And, beyond point ‘P’ twist is zero, then twist here is zero, in this zone the twist is zero. So, these are all zero twist zone. So, this is how we can show how the twist is changing along the path of the yarn.

Machine twist is zero here, gradually rising maximum here, then gradually falling and then it is stabilizing at a level that we wanted. So, that is the machine twist. This is the twist distribution within the in the yarn path starting from the rotor groove to the take up roller.

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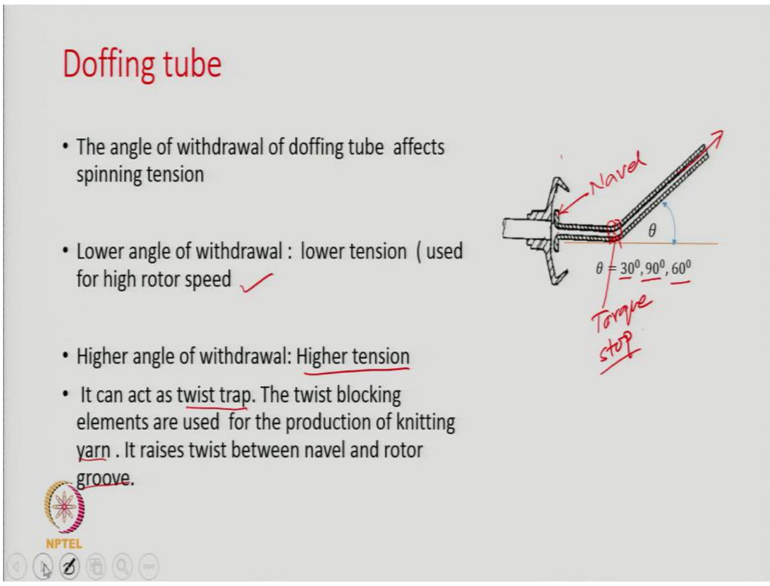

And the doffing tube when the yarn is taken out and made to pass through navel is here and this is basically a tube through which the yarn is going out and this whole thing is known as doffing tube. Doffing tube is bent. So, here is this bent where the torque stop is there, torque stop is here, then the this is bend. So, doffing tube yarn is doffed through this tube the angle of withdrawal the doffing tube affects the spinning tension. Lower angle of withdrawal, lower is the tension and that is what is used for high rotor speed.

We will discuss about the you know tension level in the yarn in some other lecture the too much of tension; obviously, will cause lot of end breakages and too low tension is also detrimental from the point of view of yarn quality. We will discuss about them in details and the higher angle of withdrawal is will lead to higher tension.

It can act as a twist trap the twist blocking element that is torque stop are used for the production of knitting yarn. It raises to twist level between navel and the rotor groove that is what is here that is twist trap or it could be torque stop different names are there the purpose is that part of the twist is not allowed to flow and going to accumulate here navel is the twist is more here that twist will flow this directions.

So, doffing tubes are available with angle 30°, 90° and also 60°. With this we close today's discussion. So, we have learnt about the how twist is generated the distribution of twist along the path of the yarn starting from the rotor groove to the take up roller, what is the twist equations and how many you know how many layers of fibres gets built up within the rotor groove. So, all these things we have discussed today and I hope if you listened it carefully you will be able to grasp it with this let me close.

Thank you.