

Textured Yarn Technology
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Lecture - 25
Air- jet texturing: effect of water application

So, we meet again. And, today we will be talking about Air-jet texturing of course, but the effect of application of water this is the main theme of today's lecture.

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A step back

Till now we have learnt

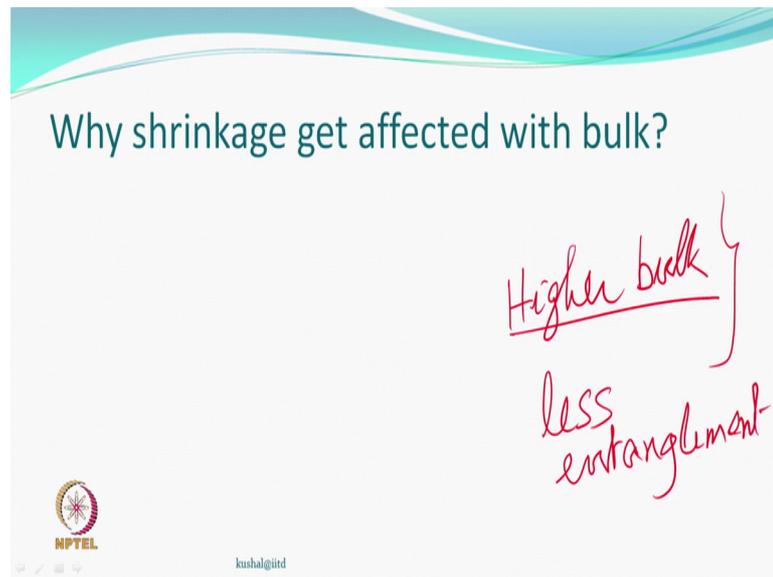
- Effect of overfeed on instability and bulk generated
- Effect of air pressure on instability and bulk generated
- How hot water shrinkage gets affected by bulk generated
- Effect of the above two parameters on tensile properties
- Effect of heat setting on properties of AJT yarns

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A step back till now we have learnt, the effect of overfeed on instability and bulk generated, effect of pressure on in stability and bulk generated. How the hot water shrinkage gets affected by the bulk generated. Effect of the above two parameters on tensile properties and also effect of heat setting on the properties of air jet textured yarns.

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Again, we recall as to why shrinkage gets affected by the bulk. As, we mentioned before higher bulk means less entanglement; that means, the fibers are not making so much of a contact with each other. And, if there is a fiber let us say a polyester in a hot water an individual fiber wants to shrink.

Then, the fiber next to it or the filament next to it may not follow the same path, it may shrink and its own, but it may not follow the same path, it would not force the other filaments to go along with it. And therefore, you may find that high bulk may not lead to high shrinkage, this shrinkage may be reduced, if the bulk increases then shrinkage can get reduced because the structure becomes loose.

So, for tighter construction is there single filament shrinkage would mean all the filaments must follow which are in contact with that fibers they of course, will shrink themselves as well. So, that is how the bulk affects the shrinkage in the case of synthetic fibers hot water shrinkage, because the fiber the filaments would not shrink.

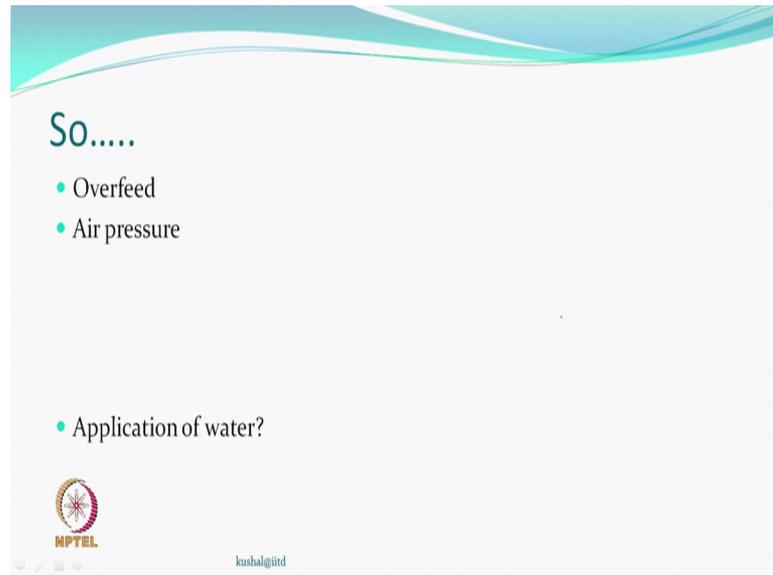
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The slide features a title 'Effect of heat setting' in a teal font. Below the title are two bullet points: '• Instability (%)?' and '• Bulk (%)?'. To the right of these points, the letters 'MS' are handwritten in red and underlined with two red lines. In the bottom left corner, there is a circular logo with a star and the text 'NPTEL' below it. In the bottom right corner, the email address 'kushal@iitd' is written in a small font.

Effect of heat setting that is you have done. Let us say the mechanical stretching; mechanical stretching has been done. So, certain amount of instability has been obtained, but if it is a thermoplastic fiber or a filament yarn then you can do the heat setting. So, what happens the heat setting to the instability? The instability will go down, it will go down, because the entanglements will become tighter as a result of shrinkage.

And, so, instability goes down, what will happen to the bulk? The bulk can also go down, because the loop size is going to decrease, also the number of loops also will decrease because some of them may get merged with the body of the yarn. Because of shrinkage due to heat setting this is; obviously, for the thorough plastic yarn.

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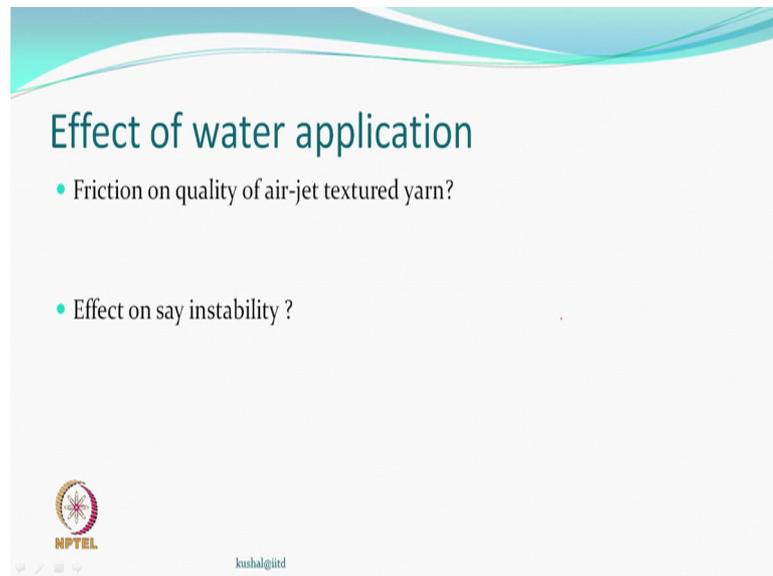
So, what we have learnt is that the overfeed is one of the major parameters, which affects properties and so we optimize that. And, air pressure is the second important parameter, which also effects all the property, of late the people started applying a certain amount of water, which a clumsy process I would say because normally a texturing is a you know dry process, and you want to add water to this, it cannot be a good process. Nevertheless, you would do such process only if it helps you. So, application of water is what we are going to be talking about today right.

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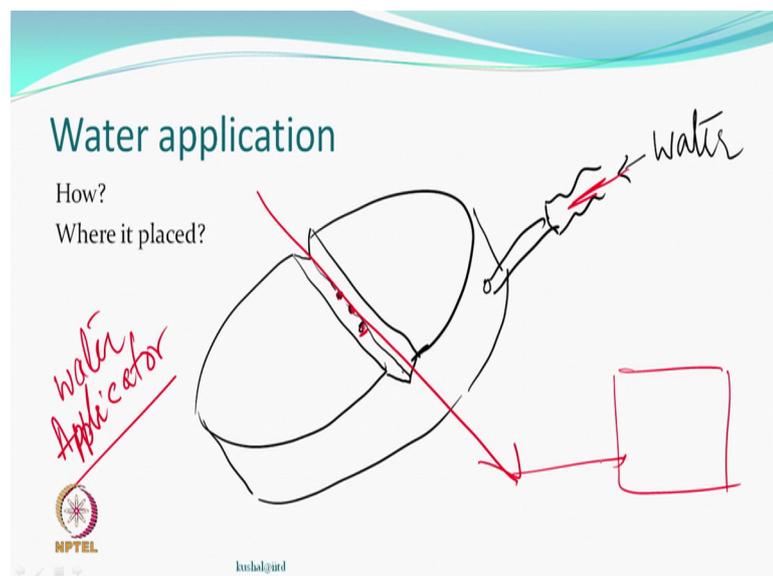
Effect of water application alright, how does it improve or affect the quality?

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So, as mentioned we will talk about two things, that is what is the effect of the quality of air jet textured yarns if we have a certain amount of water applied to the yarn or effect on instability. These are this is an instability for us is the most important parameters.

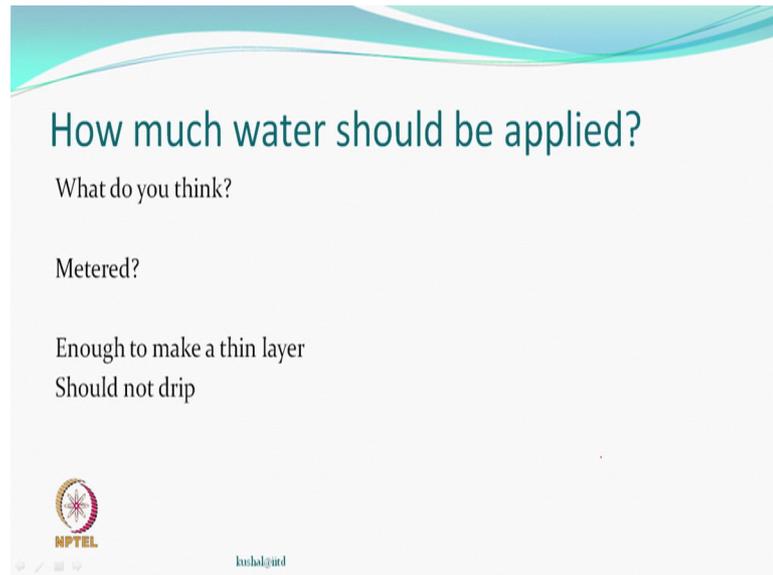
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So, what application? How do we do the water application? There is attachment we can call it a applicator or a water applicator. This is an attachment, which is placed before the actual jet. So, this applicator may look like this.

So, it is like a hollow, vessel which is sealed completely the water; obviously, is allowed to go through nozzle into a hollow chamber. And, this chamber has got some orifices through which the water will ooze out. The yarn would pass through like this and pick up water as it is passing through. And, so, will get wet and after that it will pass through the so called air jet. So, this is a pre wetting, which is allowed, which is used.

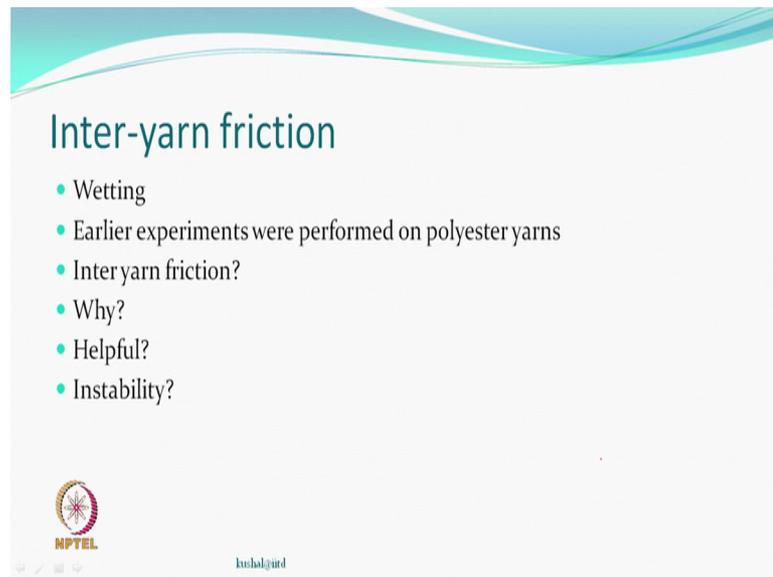
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The question that comes is there a control, do you want it to be controlled; how much water do you want to apply? What do you think? How much water would like to apply? It has to be very small amount therefore, it is metered that you exactly know, how much water is coming out based on the speed of the yarn, at which it is moving over the applicator.

So, it is a metered amount you have a control. So, you can apply more or less, but how much more? Just enough to make a thin layer on the surface of the filaments; you definitely do not want that the water be dripping. So, the quantity of water which will be required will be based on the surface finer filaments may require may be more, because they have more surface course filament require less because they have less surface, but; obviously, it should not be dripping.

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Inter-yarn friction

- Wetting
- Earlier experiments were performed on polyester yarns
- Inter yarn friction?
- Why?
- Helpful?
- Instability?

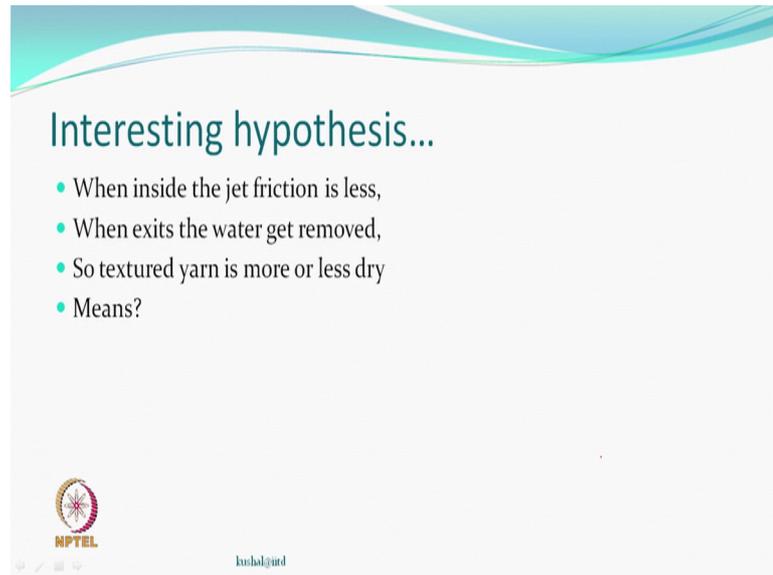
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Why all this thing came into picture? People wanted to see, what happens to inter yarn friction? When you let us say apply water. So, yarn gets wet it has a certain layer of water film. So, good number of researchers did some experiments all this work was done on polyester yarn, which was texturized air jet texturized and what did you observe they want they measured the inter yarn friction. So, there was some understanding as to inter yarn friction would play some role on wetting, why? Because, this layer will be something where there is a inter fiber layer, which between the two fibers there is a hydrodynamic layer, and where shear can be there between the two filaments.

And, so, it will be important that it can reduce the fiber or it can reduce the friction, which can reduce the friction will it be helpful. So, yes it was helpful what was helpful wetting? What happened to the instability? The instability reduced after wetting, and so it was assumed that the inter yarn friction is reduced, because of the thin film of water, between the filaments, and it was helpful because instability was reduced.

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Interesting hypothesis...

- When inside the jet friction is less,
- When exits the water get removed,
- So textured yarn is more or less dry
- Means?

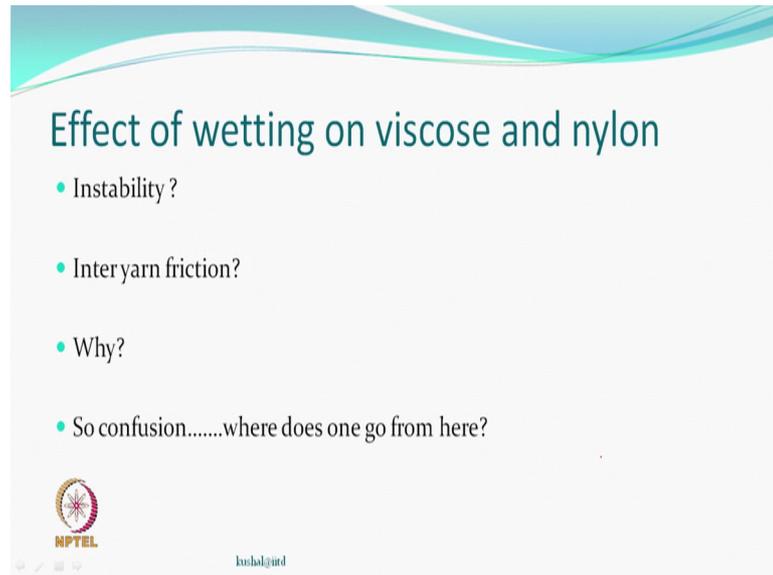
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An interesting hypothesis also was there, that when inside the jet the friction would be less. Because, yarn are touching, yarn may have to move relative to each other, and because there is a water film, the friction would be less. And, when it exits the jet the water will get removed from the surface and would get in a way sprayed, outside the jet which could be; obviously, there is collected and drained off.

So, there is a chamber in which wetting device is kept. And, so, the textured yarn is more or less dry. So, inside the jet you had less friction, outside that jet it is more or less dry. So, if the friction was the cause the friction would be more. Now, which is good for entanglement no slippages will take place of the loops and one can feel good that is what it means that is you can get less instability.

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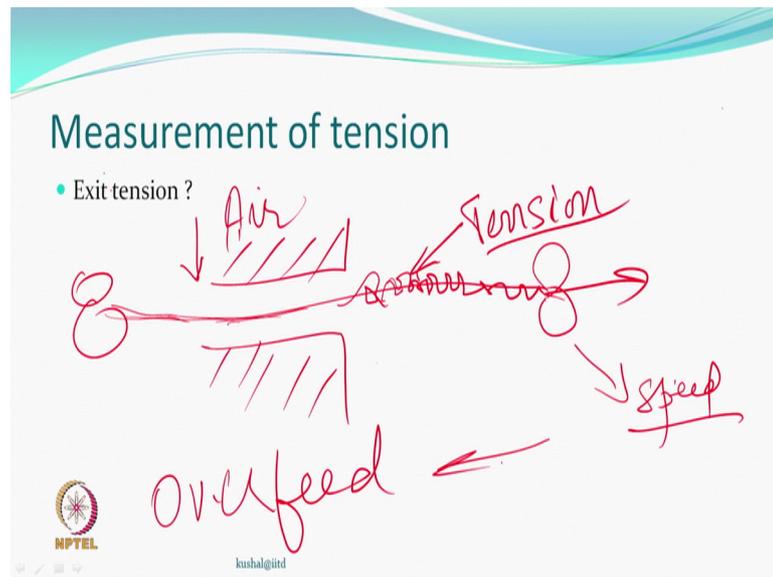


The slide features a title 'Effect of wetting on viscose and nylon' in a teal font. Below the title is a list of four bullet points, each starting with a teal dot. The first bullet point is 'Instability?', the second is 'Inter yarn friction?', the third is 'Why?', and the fourth is 'So confusion.....where does one go from here?'. At the bottom left of the slide is the NPTEL logo, and at the bottom center is the name 'kushalgird'.

Same experiments were then repeated on various other yarns like viscose and nylon. And, the hypothesis was that because the friction will be there reduced and so it will help, what did you see? They found instability of the textured yarn goes down. So, it is an advantage in these cases also, then they measured the inter yarn friction. So, when they measure the inter yarn friction, it was found that actually it was more, even on nylon filament yarns and the friction entered fiber friction inter yarn friction was much more, still more, in the case of viscose filament yarns.

Now, suddenly we have confusion, why did the friction inter yarn friction increase instead of decreasing? Because, these fibers this course definitely and nylon relatively is more hydrophilic, so it makes hydrogen bonds with the water molecules. And, so, the shear and the slip is reduced. So, confusion was; obviously, there as to whether what is the role of water them, the role of water they came interesting question.

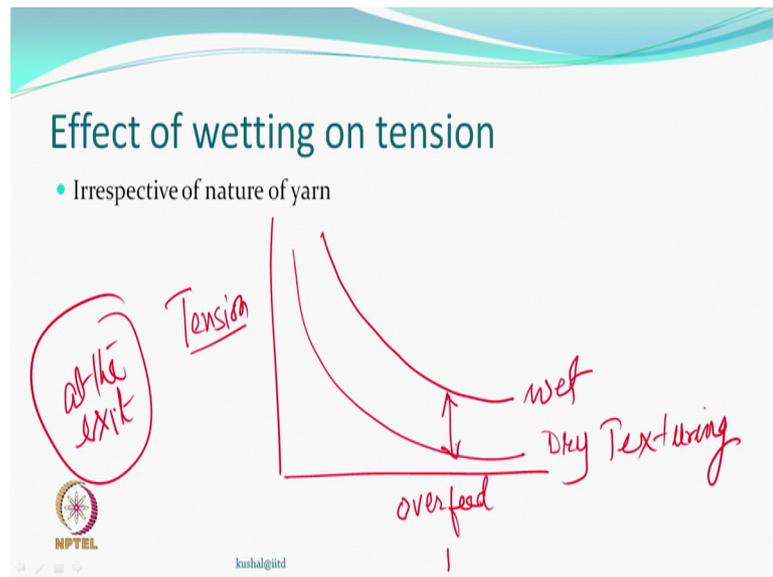
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While these experiments were going on people wanted to know is anything happening to the tension in the yarn which tension. We talking about let us say this is the jet, the yarn comes out, and there was an over feed, this over feed has been consumed, because of the interaction let us say with the air, or compressed air, and the air yarn which was a parallel bundle of multi filament yarn.

Now, is entangled textured yarn and goes out. So, you measure the tension here, will the tension be 0, because of the over feed no, because overfeed has been consumed. So, there is a tension. Now, this tension would depend on what is the air pressure what is the speed of the take up roll, which means overfeed and so there is tension. So, not having attention would mean that it is going to become loose that is not something which you would like.

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So, tension is there. So, you measure the tension. What was interesting was that irrespective of the nature of the yarn, polyester, viscose, nylon, or any other yarn that you may like to use, the tension increased on wetting. Let us say we plot versus tension; obviously, we are talking about the at the exit to plot this you get a curve like this, in the case of a dry texturing, when you wet and do the experiment people found you get a curve similar.

But, the tension was more there was a tension difference. So, irrespective of whether is the viscose polyester nylon the wet texturing resulted in higher tension at a given over freedom.

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Why is the tension high?

- Any response?
- Need more time?

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So, what do you think? Why is the tension high? You need more time to think your response ok.

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What about the humidity in the air?

- Will it increase or decrease?

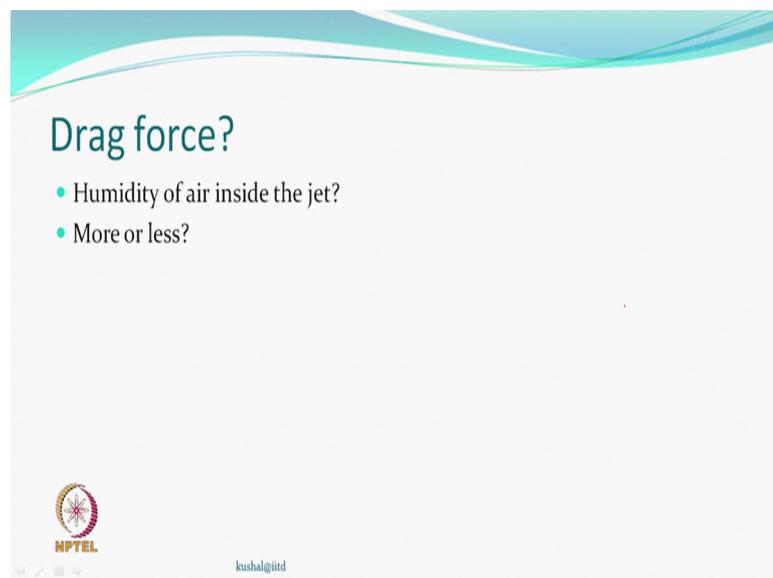
Compressed air
Wetting Device
Air Jet
Overfeed

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Let us ask this question will the humidity in the air increase or decrease what have we done? We have done, there is this air jet and then there is this wetting device. So, air first goes here, then goes there and then we hope the textured yarn comes out. So, we talking and of course, compressed air is coming from here. And, of course, in between these two we have given over feed to yarn is going to be pulled right.

So, it is wet only thing is now it is wet yarn. So, the humidity which is here in this area will it decrease or increase. Obviously, humidity of the air is likely to increase, because some of the water which is on the surface, may get sprayed into the air as it is moving, because the air is under pressure, velocity of the air will be quite high in the jet. And, so, this is what will happen and of course, we said at the end exit some air water may actually be sprayed out also. That means, there is some moisture is going to be added to the air which is being pushed inside.

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So, humidity would increase. If, the humidity increases humidity of the air inside the jet has increased as a result what would happen to the drag force up, you know which is being applied through the yarn which is moving through the jet. After, yarn is over fed and it is actually going to be moving, because something is pulling if nothing is pulling, then it will just get collected. So, something is pulling. So, that is the drag force because of the air pressure that we have and the motion of the air. Now, humidity is more, if the humidity is more will the drag force be high or less, the drag force will be high.

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What about the momentum of the yarn?

- It depends on?
- Increase or decrease?

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Now, then the yarn is also moving with some velocity. So, there is another term which we may like to talk about is the momentum of the yarn. So, momentum depends on the mass and the velocity right.

So, will the mass improve; the mass of the yarn which is moving, because of the flow of the air it will be more than that of the dry yarn, because some water is still going to be sticking around. And, velocity is whatever it may also increase more because the drag forces more and therefore, the momentum will be more. So, the momentum of the yarn would increase and not decrease.

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So?

- The drag force is high ✓
- Mass of the yarn is more and so the momentum is also high ✓
- Result?
- The tension in the yarn after exit is high ✓
- Why? ✓

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So, what happens? The drag force is high, the mass of the yarn and so the momentum is high, result, the tension in the yarn, at the exit will be high, why would the tension be high, why would the tension be high? It moving a momentum is high; why the tension is high? The tension is going to be high, because is being pulled faster with a higher momentum.

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What is happening at the exit?

limited amt of excess yarn

drag

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So, what is happening at the exit now? So, filaments are coming they are being pushed, because of the drag and because momentum is also high, there is only limited amount of

excess yarn, it is going to be pulled. And, if it is going to be pulled higher, the tension would be higher. Higher is the tension at the exit, it is like think about that we were saying that you put mechanical stabilization by pulling. So, there are loops which are going to be generated and the tension is high.

So, what will happen, the looks will become more tighter, the entanglements become more tighter and so instability would increase.

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Advantage

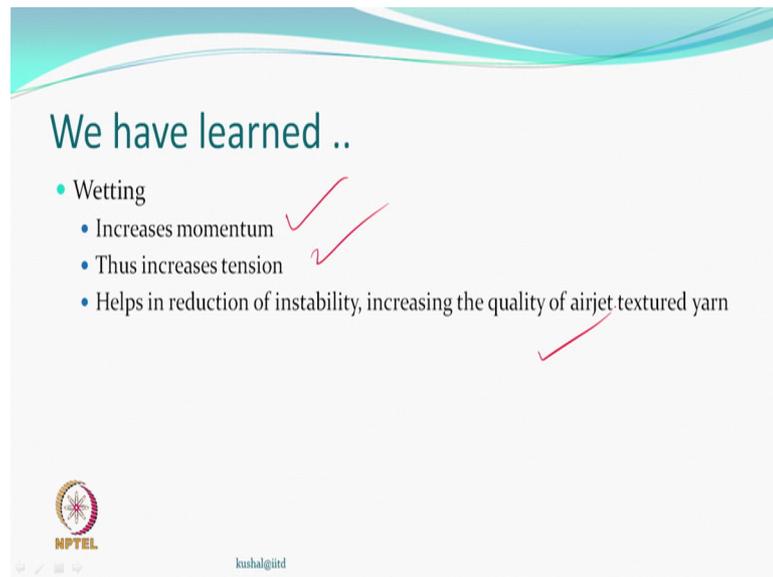
- Leading to tighter entanglement; meaning low instability
- Good for the product. Right?

Better quality of Product

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So, by adding some amount of water, we have achieved a tighter entanglement, low instability and so better product. So, the effect of wetting on friction is different, but the output is the same, it is because of higher momentum and increased tension all right.

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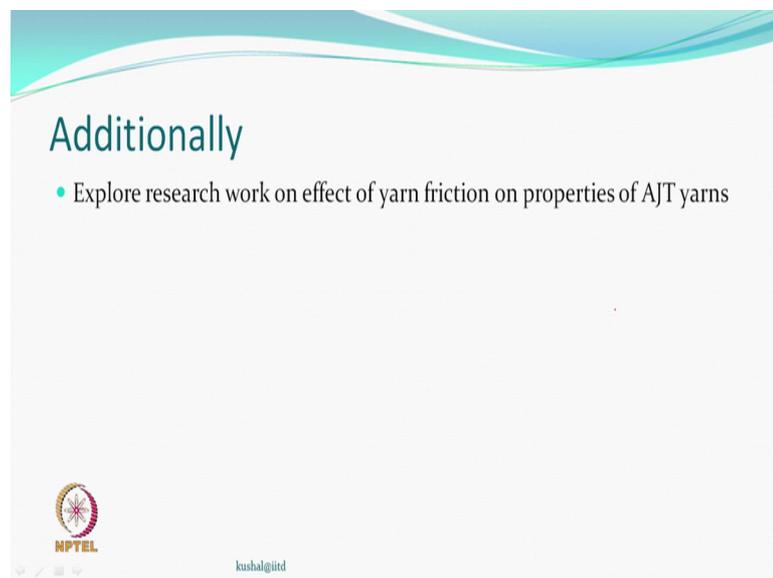
We have learned ..

- Wetting
 - Increases momentum ✓
 - Thus increases tension ✓
 - Helps in reduction of instability, increasing the quality of airjet textured yarn ✓

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And, that is how the quality of the textured yarn has been increased, less instability and better quality.

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Additionally

- Explore research work on effect of yarn friction on properties of AJT yarns

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So, a little bit of a confusion whatever it was on the friction, what it does to the air jet texture yarns, other than what we were looking at water maybe you can change the friction inter fiber inter yarn friction, filament friction, by adding different kind of spin finishes, different amounts of spin finishers. So, some research work has been done on

those things also, we may not cover in this lecture, but you can go through various research work done on various fibers and see what effects that they have.

Thank you.