Textures Yarn Technology
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Lecture – 24
Air-jet texturing: Effect of process parameters

So, we continue with our discussion on Air-jet texturing with some of the process parameters which may be affecting the properties, I will consider them.

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So, in the last discussion we had we did talk about various methods of characterizing air jet textured yarn, instability and physical bulk are the two more important properties, physical bulk is because we call it bulked yarn. So, that one something which must be measured, then other things like shrinkage, surface characteristics, tenacity, modulus. And, we did discuss something on the instability and bulk, the effect of overfeed.

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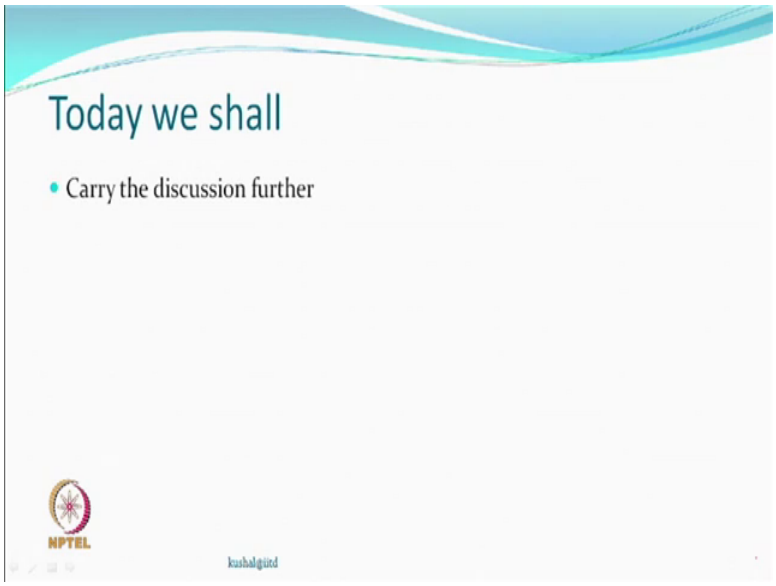

We carry on the discussion further on other process parameters, some variables not every one of them we discussing at the moment.

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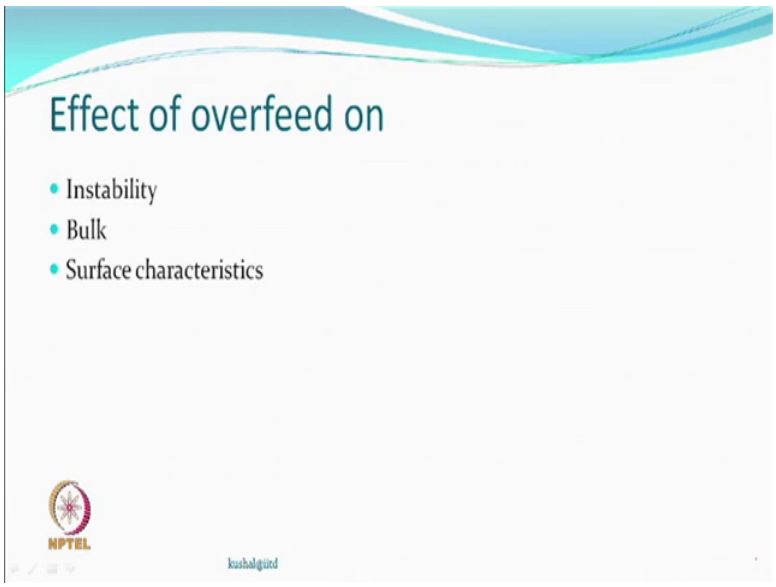

So, last time we talked about the effect of overfeed on instability, bulk and some of these surface characteristics. And, we found that from the point of view of surface characteristics the size of the loops, as well as the core diameter. And, the number of loops formed with the increase in overfeed has been seen and expected, and that would have a consequent effect on instability and bulk. So, they are in a way related.

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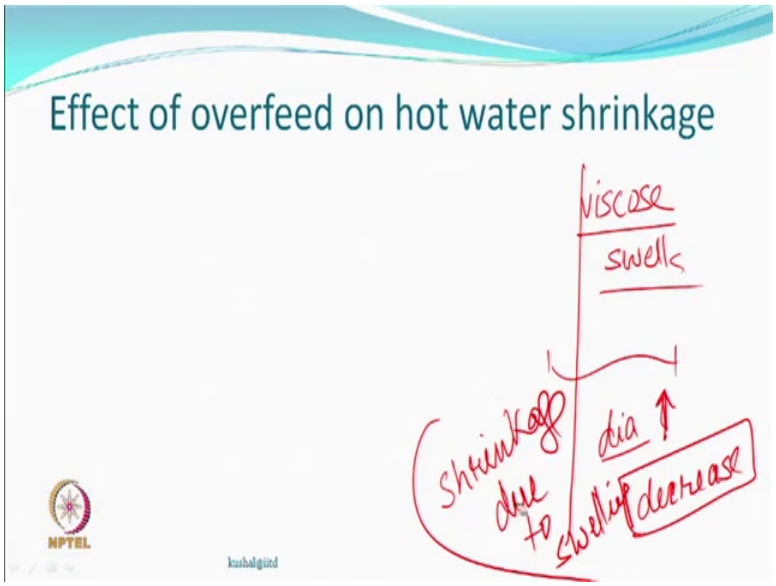

So, effect of overfeed on hot water shrinkage. So, let us assume that in hot water at the temperature that we are talking about, we expect some shrinkage to take place. Because, it is a let us say the thermoplastic yarn, but it is not a thermoplastic yarn the temperature may not affect the water may affect.

So, let us say if we look at just the shrinkage, because we said either is off because of relaxation and the molecules or because of swelling. Just to take the discussion little further, when let us say a hydrophilic fiber that is a viscous, swells. And, what happens to let us say this is a staple fiber, what happens to a dimensions, if you put it in water the dimensions of the fiber. Dimensions means, the diameter the length of the fiber viscous or a cotton what do we expect the diameter would.

Student: Increase.

Increase, diameter would increase and the length.

Student: Decrease, decrease.

Length decrease, how many of you have done any such experiment in lab? That you put a cotton fiber in water, measure its dimensions, before and after this swelling process; have you done any experiment have you observed or it was just a common sense that you are using, you observed what have you observed. That, the length shrinks, the fibre shrinks, diameter increases is that what you observed? Consider something like a balloon

where you have filling the water inside, what do you expect, diameter will increase the length will reduce.

Student: (Refer Time: 04:53).

So, this swelling process in hydrophilic fibers is not something, which is like a fixed volume stuff you can either you know the volume remains constant. If the situation is that the volume remains constant, then change of one dimension would change the other dimension. But, in this case when the water enters starts separating the molecules distance between the molecules start increasing it starts making iron bonds, separation increases and by doing so molecules and in all directions also.

One actually sees increase in diameter as well as the length, how much is a different story, but if you look at a fabric of a hydrophilic material or a yarn made from hydrophilic material. Then, what do you observe that can shrink. That is what we consider as shrinkage due to swelling. It happens despite the fact that the length of the fiber may have increased, the diameter has increased, but you still see a shrinkage of the assembly. What does it happen? What does it happen? Why do we say that the cotton fabrics shrink, so do a sanforization treatment or do any other kind of thing so that the fabric does not shrink in water.

Anyone, have you heard it for the first time or you think you have heard before and arguments, but you know cotton fabric shrink no doubt about that.

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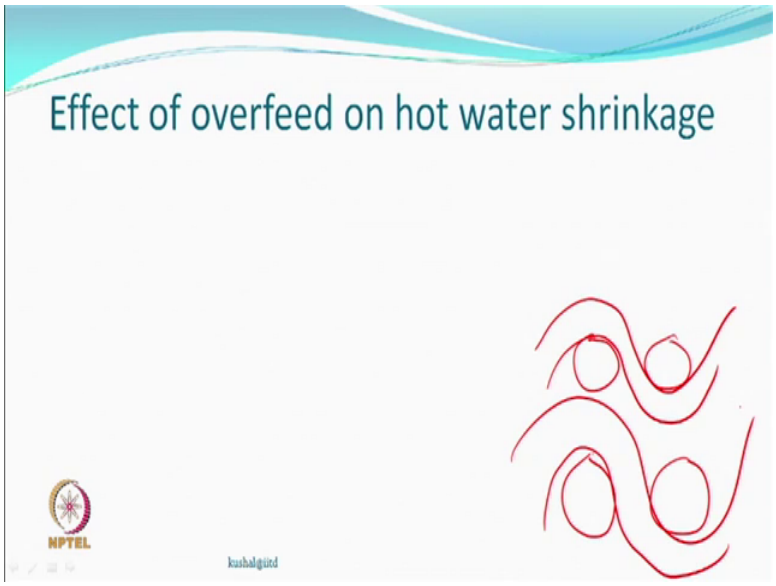

So, what is the shrink? Say, if this is the kind of your structure warp weft and if the diameter of this increases, then the other fiber has to traverse a longer path. From where will it get the extra length, from where see this shrink.

So, this is something related with shrinkage due to swelling. The shrinkage due to swelling is not such an issue in hydrophobic fibers, because they do not absorb moisture and they do not shrink. For these type of material the shrinkage due to relaxation of stresses, within the fiber or in the assembly of fiber that you make would make them relaxed and so, that may lead to shrinkage for example, thermal shrinkage.

So, the hot water shrinkage therefore, has more to do with the relaxation ok. That, if you take a polyester fiber put it in an oven it will shrink in length all right, if it shrinks then whatever happens. So, we have two situations where a fiber actually shrinks and in the case fiber may not shrink, but still shrinkage is seen.

So, in any case we have a hot water shrinkage layer you do an experiment with an air jet textured material and which have been prepared at different overfeeds, then what we would not know is what is likely to happen at all. Yeah.

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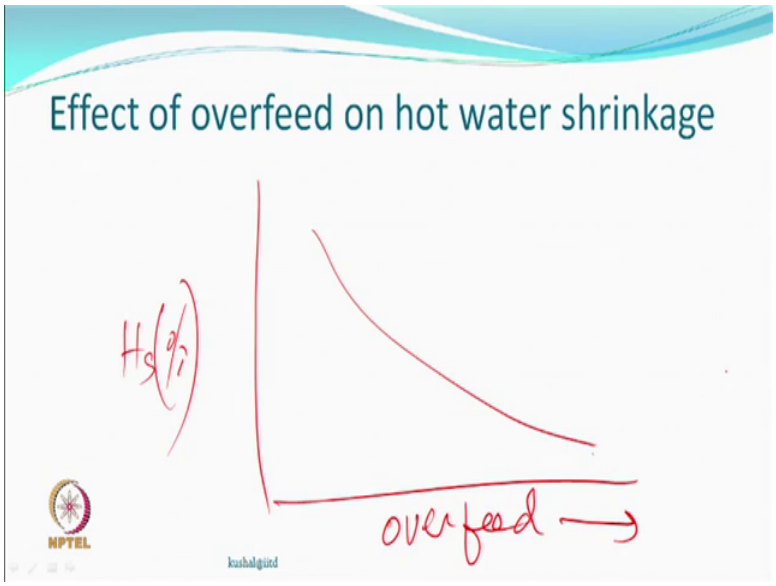

So, let us say I am looking at the possibility of working on the hot water shrinkage. So, before you answer this question; obviously, you know the property of the fiber let us say we are talking about polyester to begin with. So, we are justifying hot and water what is the shrinkage process. So, if this is a polyester air jet textured yarn, where different overfeeds have been used, do we expect anything to happen in this. Because of overfeed it is a thermoplastic fiber. So, hopefully fibers will shrink. The fiber shrinks by cause of it is property thermoplastic.

But, now, the same fiber or filaments have been prepared energy air textured machine different over feeds. We have seen, what happens to overfeed and instability, what is the relation between the bulk and the instability that kind of thing was one whole thing which you understand, now we will measure the same thing, the hot water shrinkage, you think it is going to happen it could make any difference. So, let us see we have whatever.

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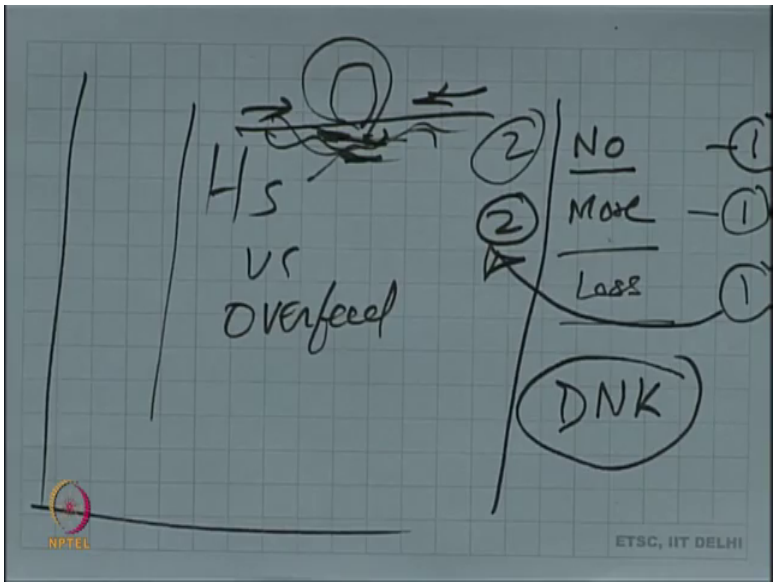

So, hot water shrinkage versus overfeed all right hot water shrinkage versus overfeed. So, answer effect overfeed no would shrink more, would shrink less, even if we forget about the trends and so on so forth. Fiber is same condition of test is also same.

So, how many people believe that there will be no change, because of over feed, not because of that putting the yarn in the hot water, yeah how many people believe they no change? Yeah. One person had dared to say something all right. How many people believe the shrinkage will be more? So, if you increase the over feed one more person thinks that the shrinkage will be more how many people believe the shrinkage will be less all right. So, there is one more.

So, basically in the class there are three people who have three different opinions, others probably do not know very interesting. So, so three possible answer which I have given, I mean if I had you had instigated other guys, maybe fourth fifth hours that could have come I do not know whatever. So, a divided opinion, but we must justify, the one who believes there is no change why do you believe that yeah.

Student: Less is stress in the yarn, because loop are bigger, because of overfeed.

Yes. So, there is no change ok.

Student: Stress is less.

Stress is less.

Student: So, there is no relaxation. So, there is no slippage.

So, no relaxation; that means, hot water is now we are going to play any role.

Student: Relaxation is there, but not because of overfeed.

Not because of overfeed ok. So, it is maybe something is happening, but it may happen to any of the yarn, but it is nothing to do with the overfeed right. So, because property is same, then the shrink; good so, the people who believe that will be more.

Student: Because, the in case of overfeed extra length will be there. So, more time will be there for subjecting the thermal shrinkage. So, it will lead to.

Time, we are not giving more time.

Student: Not more time, but length is extra, but extra length is there. So, shrinkage will be there more (Refer Time: 14:09).

Alright and who believe less.

Student: Due to extra yarn extra over feeding extra yarn is a extra yarn is (Refer Time: 14:21).

So, because there is an extra yarn therefore.

Student: Shrinkage.

Shrinkage will be less.

Student: Yes sir.

Shrinkage will be more or less.

Student: Less.

Less. So, anyone wants to you know argue with this argument these arguments. I mean now there is answer in their argument, whatever thing is good, you asked this question in the examination who sir feels like whatever they feel like a answer.

Student: [laughter].And, they are all justified right that is like a political statement, you see the only thing that is constant is let us say we said is the thermoplastic fiber and when your heat, if it has to shrink it will shrink because fiber is the same. So, fibers will shrink there should not be a doubt.

Fibers will shrink, that should not be doubt because fiber are supposed to shrink in high temperature, if they are shrink or did not do the same, we are now looking at assembly, we are not looking at a fiber, we are looking in assembly where one of the yarn has very less overfeed given and the other yarn has been given more over feed. So, let us say if want to answer this question again, by saying or recalling what happens to the instability of the yarn, when you increase the overfeed.

Student: Instability.

Instability.

Student: Increases.

Increases and increases sometimes exponentially and why does that happen, because there is there are loose.

Student: Connections.

Connections entanglements are not good and what it means is you can open, what it means is inter yarn friction should be less.

Student: (Refer Time: 16:25).

Otherwise, they will be compact, they will not open. So, the basic property is not a distance a chain between the thing. Now, in such situation where the overfeed is high structure is very open, put it in the hot water, fibers will tend to shrink. Now, the question was on yarn. So, would you like to consider your options now based on the old information recalled.

Student: (Refer Time: 17:08) So, no effect sir.

No effect.

Student: (Refer Time: 17:11).

So, let us say we take the pole again now we are more wise.

Student:

Now, more wise. So, how many people now believe no effect. So, the problem is only one vote, the person the earlier one was gone no there is one, two. And, the people who believe that there is going to be increasing ok, nothing has changed no there are one more.

Student: [laughter].

And, the less.

Student: Changed.

It is changed this guy's gone here all right. So, it is not helping, it is not helping. The answer has to come from the fact that when in a cotton fabric, despite the fact. The fiber were swelling length of the fiber may have increased, but the fabric was shrinking, the yarn was shrinking why, if in similar situation of fiber actually shrinks.

So, in a situation where they are closely held and if within the core there is a shrinkage of the fiber. And, because they are closed so into fiber friction would ensure, that the other which are nearby also follow the path. The ones which are in the loop, the one which are in the loop, part of a loop, loop can shrink, it is not going to change the length of the yarn, because loop is shrink so what?.

But, if it is tighter material here lot of entanglements and if this one wants to shrink the other cannot refuse. Versus the situation a sliver instead of a yarn, lying in some hot oven, every fiber wants to shrink, but the one which is shrinking cannot force the other one which is near somewhere too also the shrink. So, it shrinks is own ways.

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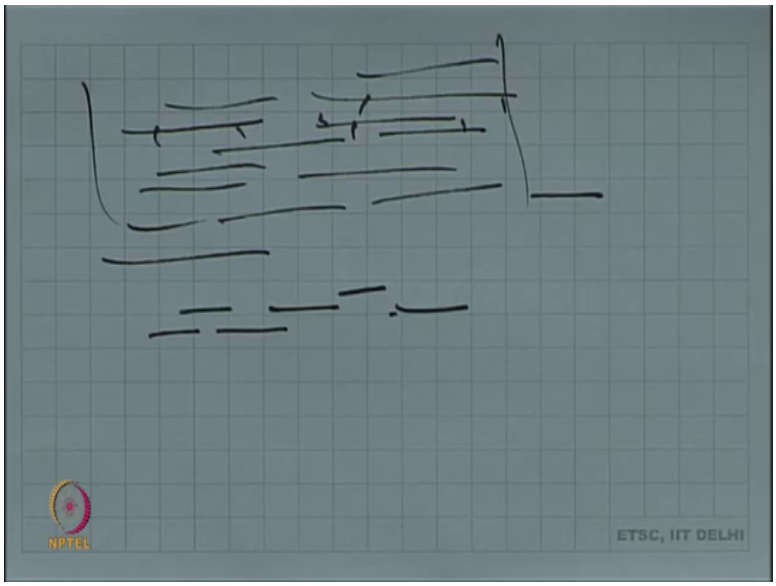

Let us say you have a situation, where there were fibers which were overlapping, fibers of some length, in a sliver all right all of them shrink. So, the lengths become smaller, they may over all this one becomes this one becomes slightly this, this one becomes slightly this, but the over length may not change at all, overall. When, they are free. So, they just do their job, they do not bother, they do not take the assembly along with it, but when they are tighter all of them must respond to any one change any one with changes.

Either, they do not allow it to shrink, I cannot shrink you do not shrink or less all shrink, because shrinkage means again lower energy. And, so, interestingly that if you increase the overfeed, the hot water shrinkage increases no sorry no what does happen decreases ok.

Interesting what is hot water shrinkage to do with the overfeed. And, you say oh my god there is a change; that means, whenever you are in an assembly form where each element is dependent on what happens to the element, because they were twisted together, they were brought in close together, one of them independently cannot move by itself.

And, so, the total effect therefore, is that all of them will get affected, if all of them are shrinking then; obviously, they keep shrinking, that is the best way to put them survive. So, this can actually happen and that is interesting good.

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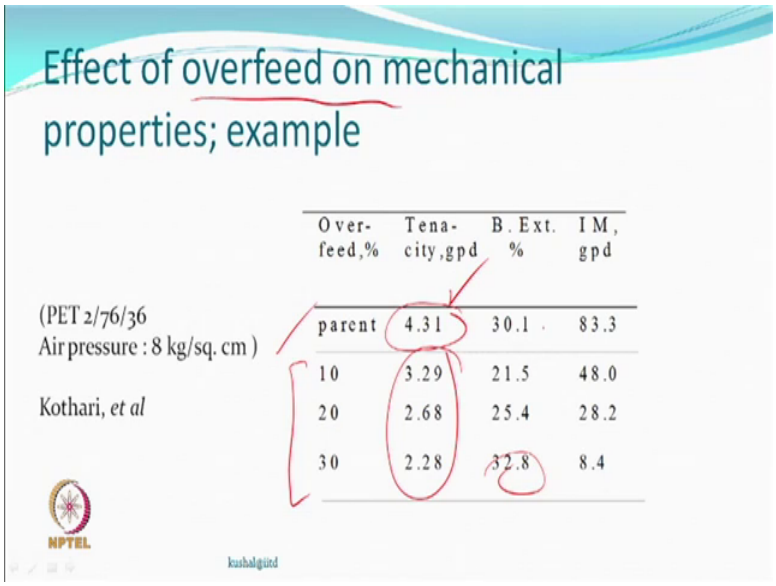

This is the some results some results from one of the papers Kothari, et al on mechanical properties of air jet textured yarn effect of overfeed. So, let us say they have increased the overfeed one is a parent yarn, there are three different conditions of overfeed and you try to work around. So, one thing which you can notice is the parent yarn has higher tenacity and the texture yarns have lower tenacity. So, textured yarn can actually be very bad you know, because most of the yarns are lying everywhere, they are not contributing.

So, they can happen and because they can open also maybe by the times there may be some little experimental stuff, but because of slippage you can have some amount of extension starting with the low extension and go to higher extension, but the modulus definitely goes down, because when you extend slippage or other things become more dominant. And, so, a parallel bundle of the same filament, resists more deformation, but very highly un oriented kind of thing is keep on increasing the overfeed, then they just may lead to more slippage. So, the initial thing will may appear that it just slipped very less resistance. So, modulus can go down.

So; that means, a process which actually has no effect on morphology can also affect tensile properties right, you will not damaged any fiber, but because fiber in their longitudinal direction or the direction of the axis are stronger than any other direction. And, so, this is an interesting type of this thing which we see on air jet texturing, which is supposed to be a simple mechanical process not doing anything to anything.

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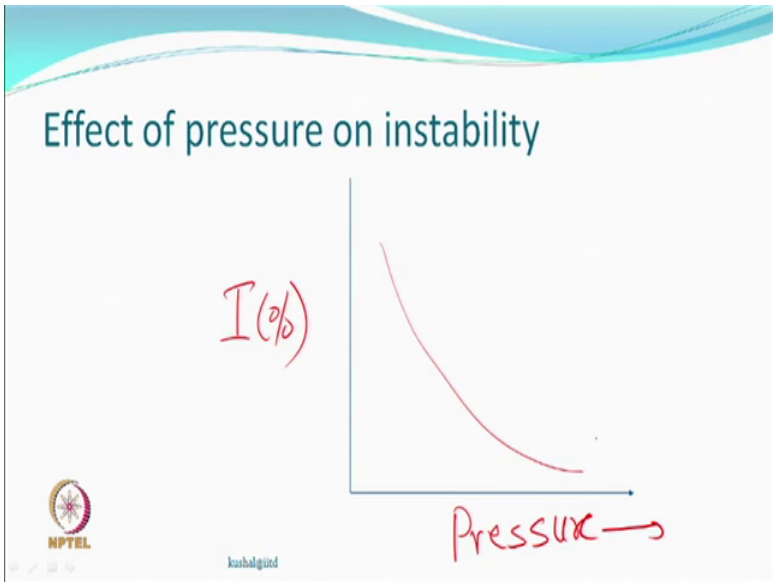

So, we look at the other important process control parameter, which is the pressure, which you can change; obviously, we expecting that the other parameter, let us say the overfeed is constant the machine speed is constant. So, we can increase the pressure at will let us forget about the cost.

So, what do we expect would happen in general very low pressure versus high pressure? If, we go and if you want to understand would it increase or decrease first let us settle that on.

Student: Decrease.

Instability will.

Student: Decrease.

Good. So, there should not be any confusion and it cannot keep decreasing when you almost have a chalk thing completely compact system and after that you keep increasing pressure may not matter difference right. So, it is opposite to the overfeed. So, in some sense you know key well if there is a problem, there I can increase the over pressure and so I can control instability in some way or the other right.

So, even if at the same overfeed keep; that means, if you have more overfeed, you want more larger loops to be created and never to the contents, more bulk to be created to

begin with, then you try to do something with the pressure also to balance right. So, pressure can do entanglements more and can give you a better thing of course, cost is increasing now.

In overfeed only the length of the yarn will keep shrinking you will 30 percent, overfeed length of that air jet textured yarn will less by 30 percent. That is of course, what you can charge maybe here also led to charge the cost will increase, because of the consumption, higher pressure, higher consumption also will be there no confusion here right.

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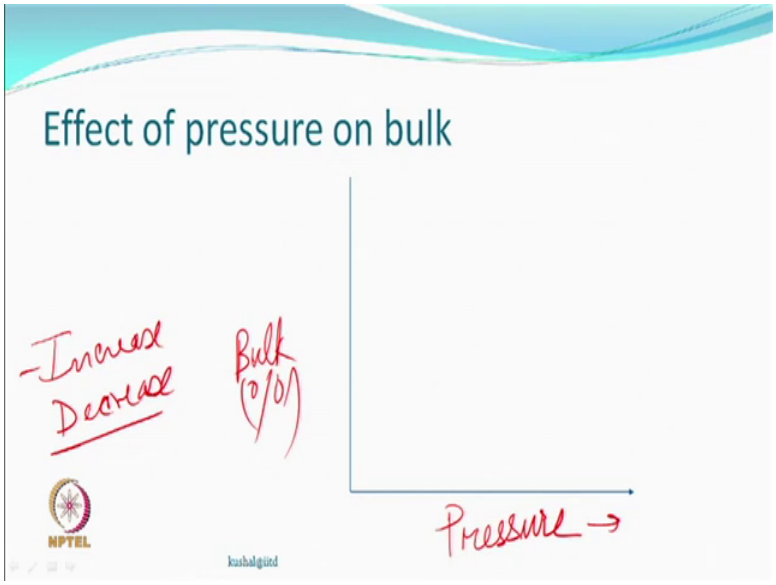

Effect of pressure on bulk right; general initial response; obviously, we are assuming overfeed is constant everything else is constant. So, increase or decrease.

Student: Decrease.

I am sure the third option called no change you not like to exercise good. So, there are only binary stuff either here or there. So, who said increase yes, why would you think that should increase?

Student: Sir, the bulk is defined as the density and in the pressure is more the loops just the loops are been takes some less area. So, that is way bulk are increases.

Area is less bulk is increasing this is some interesting thing a specific volume and not the density right the bulk ok. Yeah.

Student: With increases in pressure there are more entanglement the.

Right,

Student: More stable the stability is improved.

That is called the instability is reduced we agreed.

Student: Yes there.

Now, bulk.

Student: There are more amount of yeah a entangle, then we set over thinking.

Alright ok; other decrease anybody believes in decrease, nobody believes in decrease right. Very nice, before that before we have come to this some conclusion here let us go learn further.

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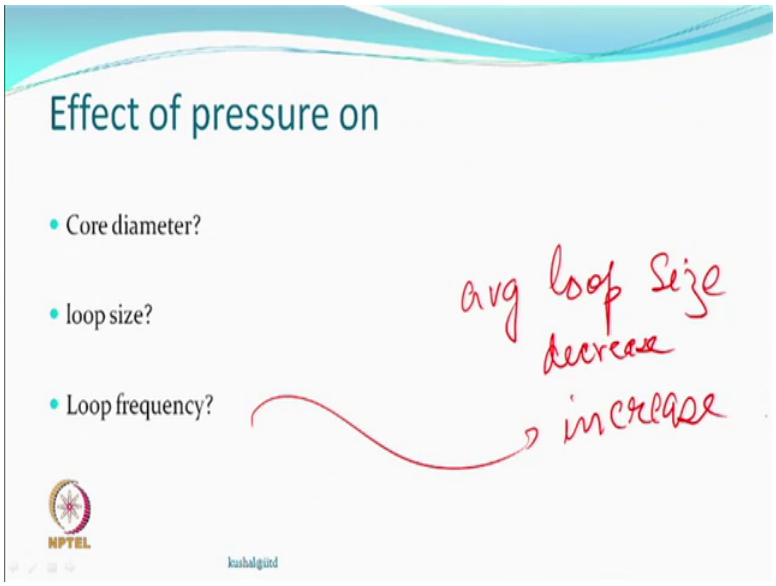

So, you can answer these questions only, if you have some information on this same overfeed loop size and loop frequency. Let us look at these things, what will happen to the loop size and what will happen to the loop frequency? When, you have more pressure, what would happen to the loop size average loop size. So, will it increase average loop size.

Student: Decrease.

It will decrease and the loop frequency will.

Student: Increases increase.

So, this is not going to follow the results of the overfeed, because here length is same. Excess length available for loop formation is same. So, if more loop size loops are formed, then the average loops sized have to go down. So, they are going opposite all right the core diameter can only either remain same or come down a little bit, because becoming more compact.

So, now what is the response on the bulk having some information on this? Now, we go back here.

Student: Yes.

Yes decrease increase.

Student: Decrease, decrease.

Decrease right.

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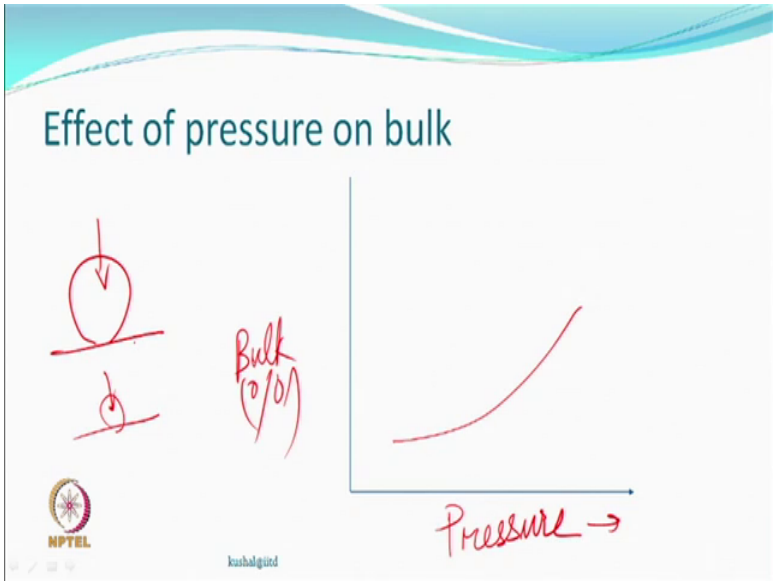

So, how soon we want to change our opinion it is a depends on who is discussing right. But, in this case also the bulk increases, the increase in the bulk is not to the same extent as the with the saw with the increase in overfeed. So, means so much of yarn is available to do that here the length of the yarn available is constant, but what happens is, if you form large number of smaller loops versus small number of larger loops.

In the same length, you can produce small number of larger loops, which can happen at low pressure. And, high pressure you may have smaller number of larger loop, larger number of smaller loops. Let me beat again, at high pressure larger number of smaller loops can be produce.

The response of a loop to any stress in this direction is different. The smaller loop resists deformation and how have you measured the bulk, you have warned it on a packet. So, if it is a larger loop they just become flat, they would not contribute except probably the thickness of the or the diameter of the yarn, but this when you compress would like to keep the thing away based on the tension on the yarn and on the package.

So, here you actually getting both the properties better by pressure ok. In the overfeed case bulk was increasing instability was decreasing, but in this case instability is decreasing, which is good for you and bulk is increasing which is; obviously, good for you, but you must remember this is not going to be the increase in bulk equivalent to what you will see in the case of increase in overfeed.

But, reason is different, there you have more length, more numbers, more everything, and therefore, you are giving here, the number versus the average loop size is related in opposite ways. So, this we have just discussed a few minutes before.

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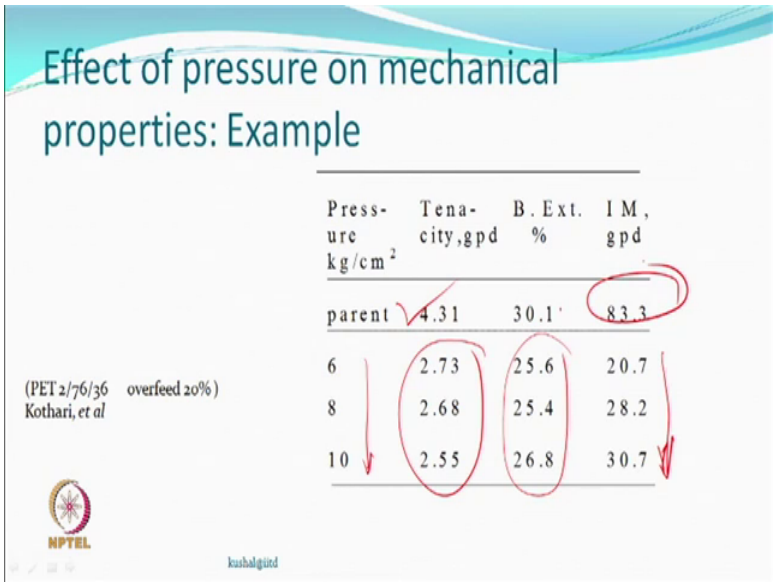

So, the tenacity again you see goes down compared to this, extension also is less, still because slippage also can be less. And, the modulus is following a different route, the more entangle, it is less would be slippage and with the increase in the pressure the modulus is increasing of course, still less than this right.

So, these two things and therefore, people would like to you know observe microscopic thing to just understand why something happens you know. If, everything follows the common sense nobody would do research. So, when you find that there is common sense not working, then we must improve our common sense and that is how we improve our common sense.

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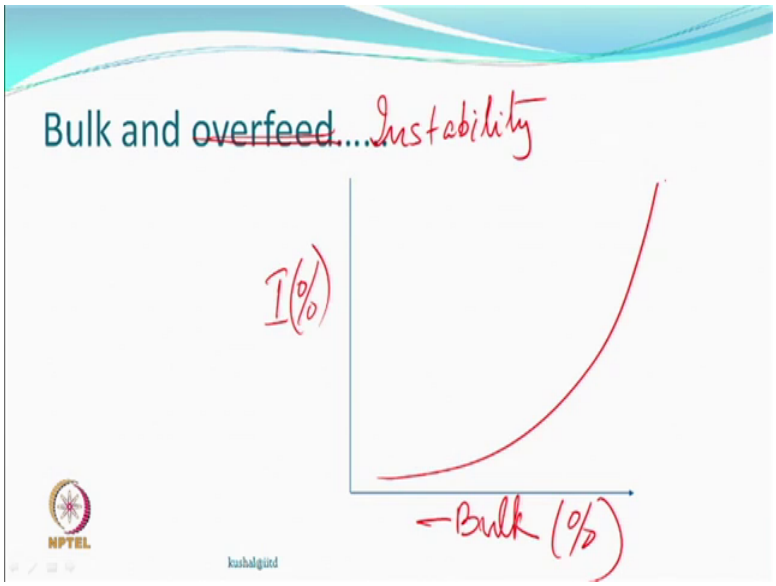

Suppose now we understand what is bulk? And, what is over feed? Somebody has done some experiment, somebody done has some other experiments increasing this increasing that and taken all the data. And, after that you say well here I am putting the value of bulk, and here just one sec, what I am doing now instability. This is what I want to plot a generalized curve, in respect to what I have done to the yarn, many yarns have been prepared see the bulk see the instability, see the bulk see the instability and then try and plot them. What do you think what happen quick guess the bulk increases right?

So, in general if you keep on increasing the bulk quite a lot, you will get a bad keep getting bad yarn. Of course, if you just keep increasing the pressure maybe you are in a different zone, but if you overall keep on increasing the bulk where I want a bulkier yarn and still more bulkier yarn. Then, you would find that instability will do after all what is happening you know. There has to be entanglement entanglement means something will come closer, sizes will come down and so on so forth will happen.

So, overall this is how if a general without Bhagwad, what have you increased, what have you decreased? How many things if it is the same kind of example. This is what we can expect to happen.

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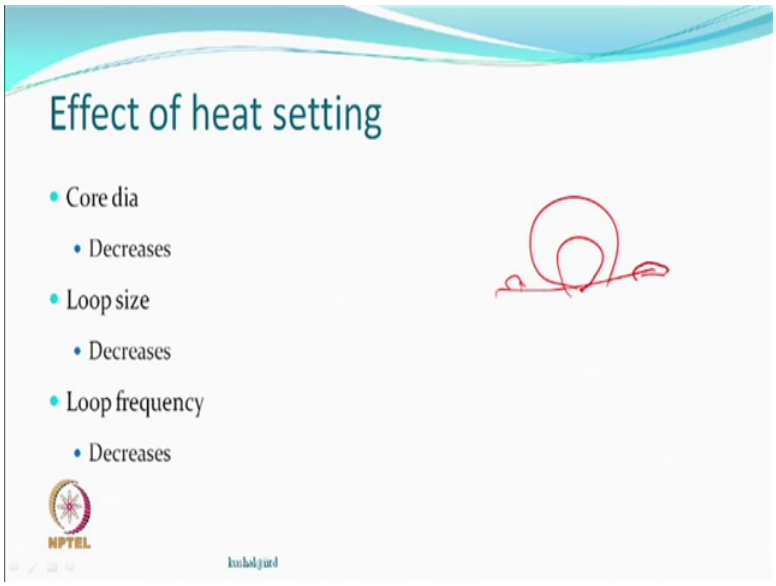

So, effect of heat setting. So, there is thermoplastic yarn and you know what we are talking about is the air jet texturing has taken place and now you are taking through a heater. So, in general we expect when you heat set a fiber, what would happen two things should happen; one length may shrink if you allow it to, crystallization and morphology can change, now because you are actually getting in thermal environment. So, if we agree and remember the old thing, that thermodynamically disorientation is possible, which means shrinkage. And, crystallization is also possible which means stability. Stability means, further change in dimension will not take place easily right ok.

So, if you do the heat setting, because of fibers wanting to shrink, core diameter may also shrink because anything which were wrapping around will also make it compact. And, so, you may see the core diameter may go down, you may like it you not like it. Loop size is decreases because the free loop, the free loop which was there can become this generally you expect that. The loop frequency, why would the loop frequency decreases only, if some of the very small loops were here, they may just get disappeared it is got into the structure itself some of them may go ok. So, this may happen.

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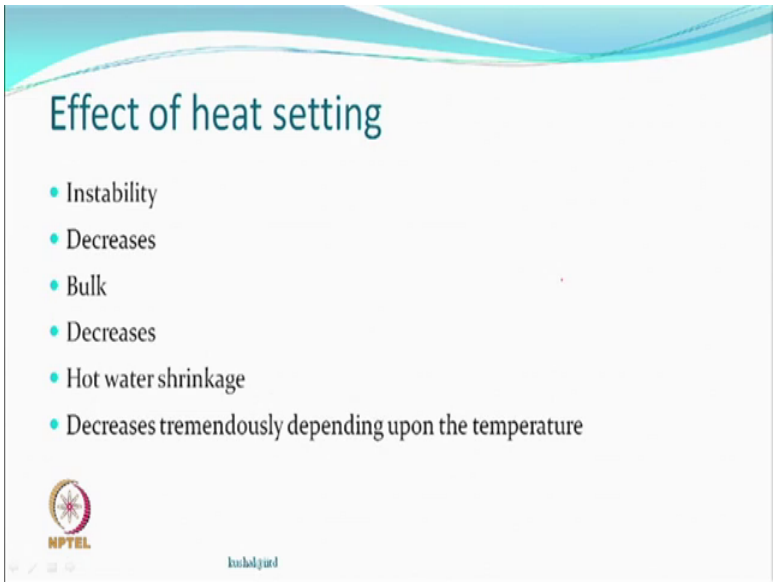

So, what would happen to instability as a result of this heat treatment yeah.

Student: Decrease.

Decrease no confusion that is why we doing it, otherwise spend money. The bulk compare to just before you know we are not saying whatever yarn we had.

Student: Decrease.

Bulk also decreases because some of the other loops which is a very small also contributed and gone vanished core diameter also shrunk, core diameter has also gone down and larger loops also become smaller loops also. They will contribute definitely, but some of them which were otherwise contributing and non-contributing anymore.

And, the hot water shrinkage; obviously, you are stabilizing the structure crystalline content may increase. So, you have a stable structure whatever happened happen. If, you allow shrinkage to take place during this heat shading process you have allowed, but now the final yarn which you get and test it is going to be more stable, because you have allowed all the shrinkage and relaxation during heating process all right.

So, finally, yarn is a stable yarn. A stable, because now it does not respond to hot water, what is the temperature hot water? 80 degrees and you would have done this at 180

degrees. So, there is no question of a smaller temperature doing large deformations in a fiber right.

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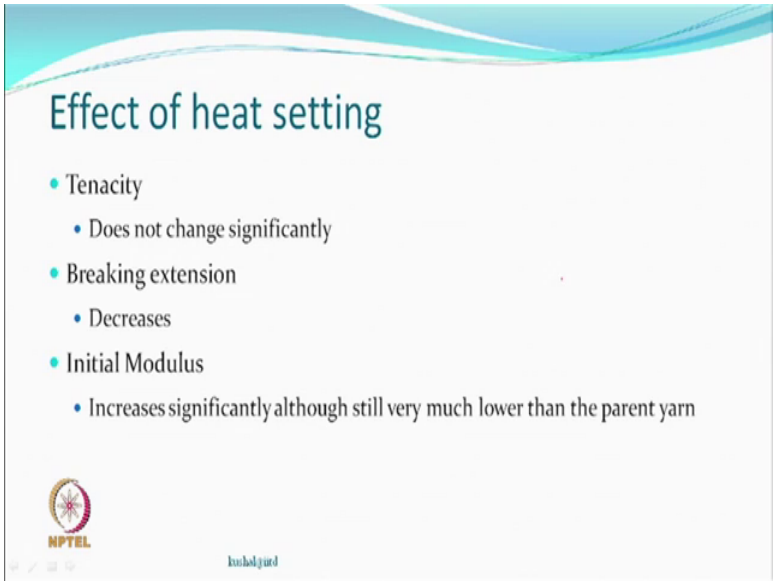

Tenacity may not change significantly; because the loops which were there have become smaller they were anyway not contributing to tenacity. The one which were in the core they were anyway tight and now they become more tight. So, if they were lying flat or they were parallel. So, they remain approximately flat or parallel or oblique.

And, so, may not change significantly. Some disorientation which may take place in the molecular configuration because of shrinkage gets overpowered with the so, much of a disorientation in the macro structure that we have done. The macro structure plays more important role in the micro structure, here because you have seen in the falsest texturing, because of the amount of loss in tenacity was not was there, but not so, much compared to an air jet texture yarn, which is no change in morphology and still you can change loads do.

You actually the other factors are playing much more important role also and therefore, dungeons equal. Braking extension can decrease because everything is in a different position tightly thing, the one which are being stressed in a transverse direction are weak. So, you can have decrease. Initial modulus can increase, because now slippage are going to be much less, but; obviously, it will still be lower than the parent yarn all right, interesting right.

So, theoretically a process which is supposed to be simple mechanical process other things you can actually see many kind of things happening at the end of the process. And, so, depends on how much stressed you are to optimize your properties, versus the need of the customer, you are on a different ground and you should be it is not easy for that matter like whatever you want I can give you.

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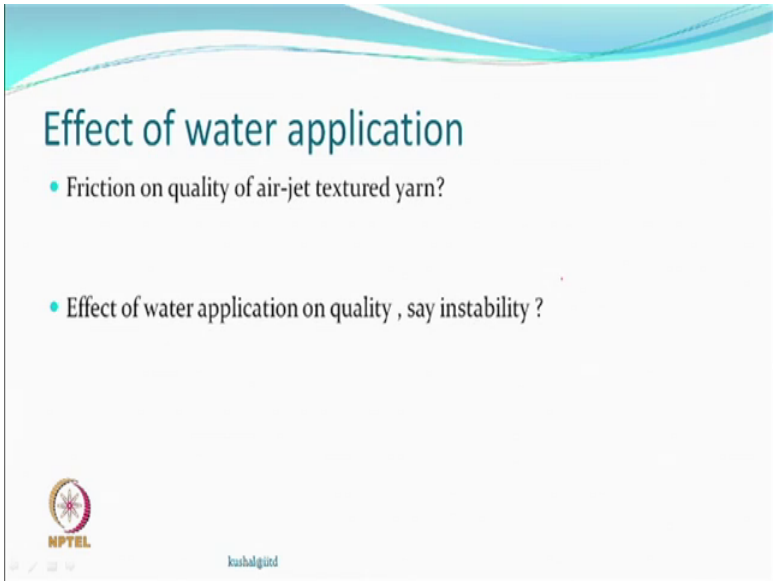

So, let us see in later part of the machine development people said that let us wet the fiber little bit. So, in this context why people thought was a lot of work being done on inter yarn friction on the air jet texturing process. It was a belief that, before any entanglement takes place, before any loop formation takes place, before one filament from one side goes to the other side entanglement wind this, starting on this side of the yarn during this process go to the other side of the yarn so, this intermixing entanglement etcetera.

Can be affected if the inter yarn friction is high. Somebody wants to go to that side, because the friction is not able to go and how much time do you have, how much time within that short period everything has to happen. And, if you can restrict that process by any means, then not happen a lot of papers were published, how much spin finished to be given which kind of spin finish to be given etcetera.

At that time some people thought keep suppose I have a polyester yarn, forget the spin finish I am waiting ok. So, they believed that the inter yarn friction could be less,

because a layer of water has been created between them, and they just can just slip right, slip.

Sometimes you slip you know and a wet floor more than a dry floor isn't it, how many people have fallen coming out of swimming pool right. So, on a wet floor you can a slip mode; that means, the friction would be less because there is a hydrodynamic layer which has been you know created between two surfaces and shear just happens. So, I said case suppose we do that, then maybe friction goes down and you can get a better yarn. Better means instability should be low that is one of the reasons why anybody wants to do anything on air jet textured yarn and what did define? You are just by applying water, they could get better instability.

And, so, like you kind of a stuff you know, oh my god we found reduce the friction, you will get something better well very interesting, you only surprise so many people wanted to publish so many paper on friction, everybody want to support the previous result all right. So now, another result interesting, they got better yarn, why we will answer maybe when we meet again.

Thank you.