Textured Yarn Technology
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Lecture - 29
Hi-bulk yarns

So, we are taking up another topic called the Hi-bulk yarn. We have learnt something about the bulk yarn. This is slightly different connotation and process also is slightly different.

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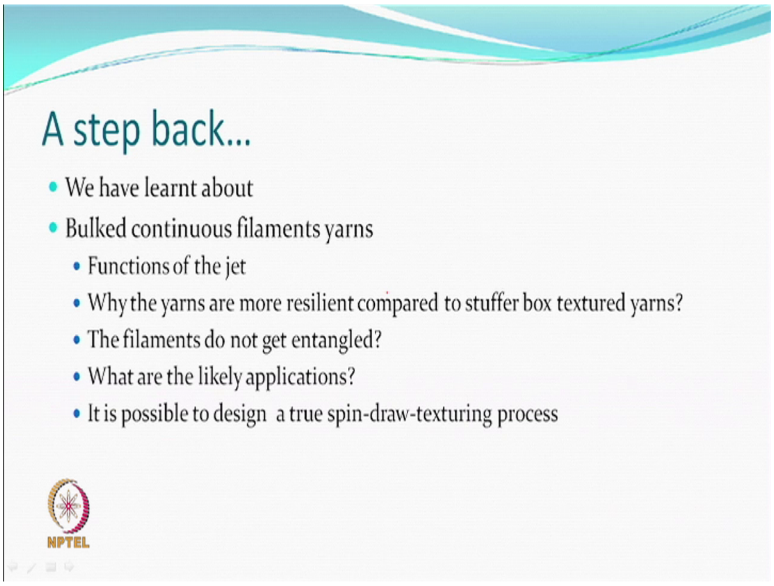

So, last time when we met we had talked about Bulked continuous filament yarn and the jet was there, the function of the jet, why the yarns; the bulk yarns; the BCF yarns are more resilient compared to stuffer box. Why the filaments do not get entangled? What are the likely applications such type of a material? And it is possible with this technology to do a true spin-draw-texturing process which no other texturing process can claim.

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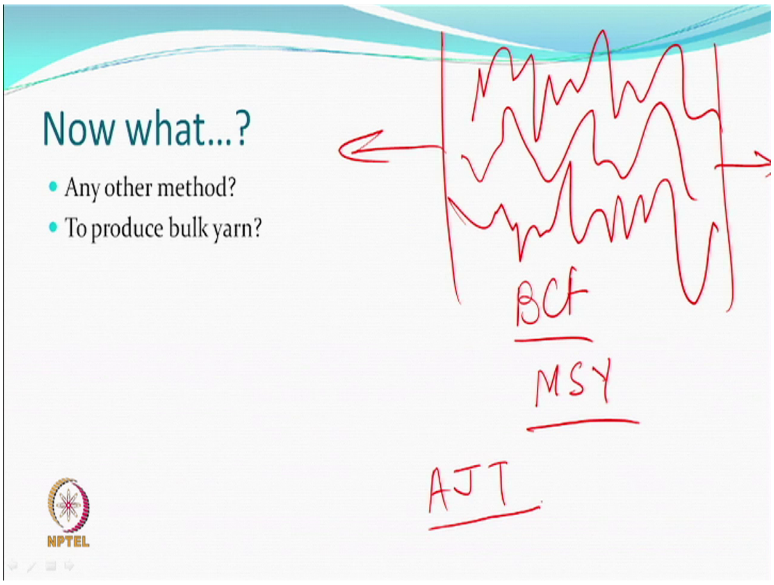

So, what next? The yarn which was the BCF yarn was it a bulked yarn or the bulked yarn. But it is not bulked yarn because it is close to Modified Stretch Yarn because what were you doing in BCF; you had individual filaments being crimped and then you could stretch, it will stretch and recover. So, although the name says Bulked Continuous Filament yarns. So, bulk has increased, but it is not a bulked yarn; your Air Jet Texturing or air jet textured yarn that was a bulked yarn.

So, what we are now looking at possibly another method with which we can actually produce a bulked yarn alright. So, that is what we call the Hi-bulk. So, bulk is high that is how the name is come. Certainly higher than if you look at percentage bulk terms would be generally higher than air jet also, but the name has stuck. This is Hi-bulk yarn.

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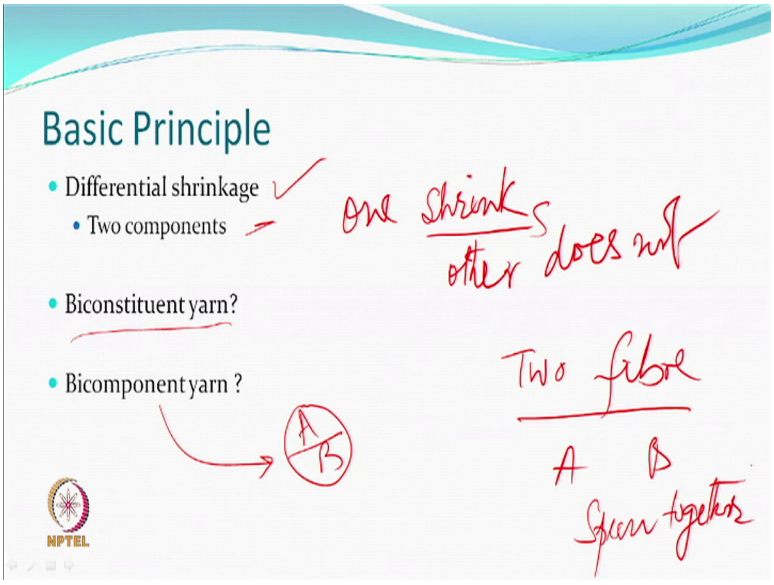

So, this yarn which will call the Hi-bulk yarn would have a typical stress-strain characteristics of this type, which means there is no stretch; that means it qualifies for bulked yarn. So, this is an important part. So, we are looking at another method of producing a bulked yarn

So, the principle that it uses to produce is called the differential shrinkage, that mean there are two components in the yarn; one shrinks, the other does not. One component shrinks and other does not. So, if this happens you get bulk; we will see. This type of a material do we call it biconstituent yarn or bicomponent yarn. So, there are two materials in this yarn; one shrinks the other does not shrink.

So, what do we call this yarn a bicomponent divided the term bicomponent which can also produce bulk in different ways, but that bicomponent and biconstituent have to be differentiated. A bicomponent yarn is a single yarn with two different polymers; extruded together then because of their differential properties response to a thermal or a hydrothermal or any other input that you have they may respond differently. And so a biconstituent yarn on the other hand have got two components which are individual. Let us say two fibres A and B spun together; component A component B blend them make a yarn. So, there are two individual components. So, this kind of a material you like to call as a biconstituent yarn as against bicomponent.

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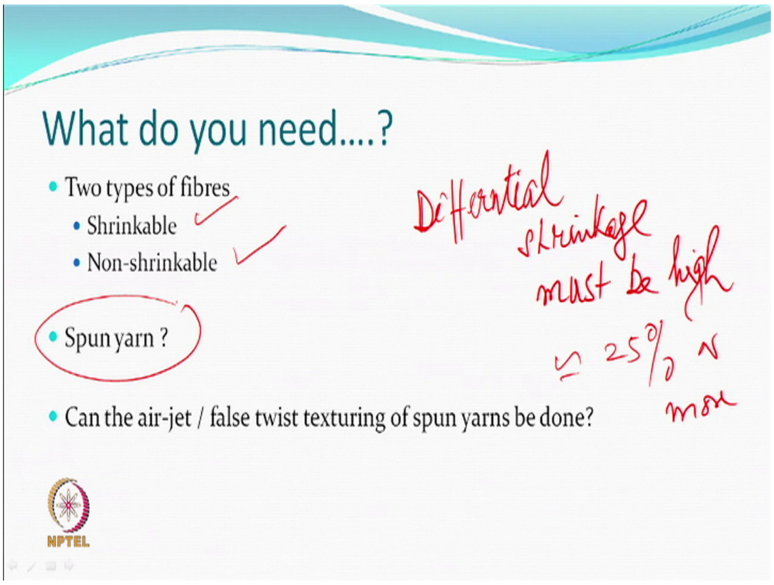

So, what do we need? We need a shrinkable component and a non-shrinkable component. When we say shrinkable you know all thermoplastic material shrink when you hit them and the simple test that you can perform take the fibre near the flame; not inside the flame and you can see the fibre shrinking away that the characteristic of a thermoplastic material.

So, in that sense every fibre would shrink, but that is what we do not mean. When you talk about shrinkable with some input, thermal or otherwise it will shrinks something like 25 to 30 percent of its length and when we talk about non shrinkable this may also shrink a bit, but that is 1 to 2 percent. So, there is a differential part of it. So, one component shrinks quite a lot, other shrinks less.

So, the differential must be high. So, theoretically somebody say non-shrinkable mean what is the non-shrinkable component, well the one which shrinks very less zero shrinkage or non word absolutely may not be the best word to use, but that is how people using it very very low shrinkage is what we call an non shrinkable component the one which shrinks quite high is the one and difference between the two should be high. And should be high means different should be close to 25 percent or more. If the difference is 3 percent 4 percent you will get some effect, but that is not going to do; that means, whatever is called shrinkable component is a special fibre in that sense that you have to work on this or selection; if you can do that then it is possible.

Now, there are two different types of fibres. So, how do we make a yarn? So, it is approximately clear; it is going to be a spun yarn. So, till now we had been handling filament yarn, where there is a false twist, BCF, air-jet, entanglement; we were talking about filament yarn. Now this particular thing is a spun yarn. So, you have staple fibres, two components, you mix them up make a spun yarn. So, this is different in that sense. Can the air-jet and false twist texturing of spun yarns to be done? Can the air-jet texturing of false twist type of a thing or with spun yarns can they be textured? We are saying yes or no.

Student: Yes.

Yes alright. So, they can be. Process will be different they can be done, but commercially of course, we are not doing so much of it, but it can be done, air-jet can be done, false twist also can be done. We will learn something maybe later.

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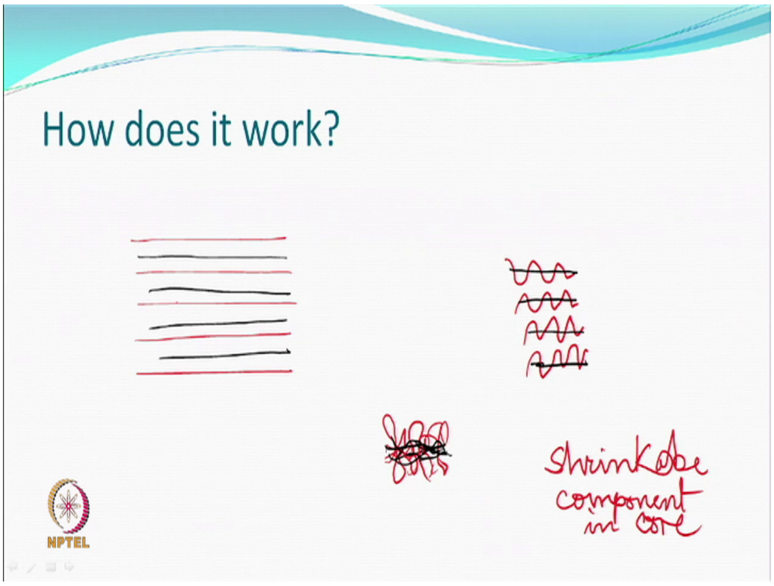

So, how does it work if you say is the spun yarn how does it work? So, let us say that two components; same staple length to begin with you mix them and after doing we expect something like this to happen, if there is interaction between the fibres afterall whenever we make a spun yarn; they will be inter fibre friction.

So, if one fibre does something the other has to follow is do something responded to it, if they are lying very separately then it may not respond.

So, if you give a stimulus so let us say the red yarn here fibre does not shrink; the black one shrinks in length. So, how will the non shrinkable-component respond, it will have to crimp it have to buckle that make some loops if you are intimate approximately. Then in the case of a spun yarn you might just see the yarn before the bulk generation looked a mix of black and red at the end of bulking process the yarn may appear more red because it is a non-shrinkable component it has made loops, it as the one which bending, it is come out and makes the sheath of the yarn while the shrinkable component shrinks and goes more or less to the core. So, this is your differential shrinkage. The shrinkable component goes into the core.

So, it is clear that you got to have shrinkable and non-shrinkable component. If you clearly look at the shrinkable component shrunk but does not really contribute must to the bulk. So, the combination is a bulked yarn, the bulk is being contributed by the non-shrinkable component, which wants to buckle, bend, make loops. So, that is one is a principle is concerned.

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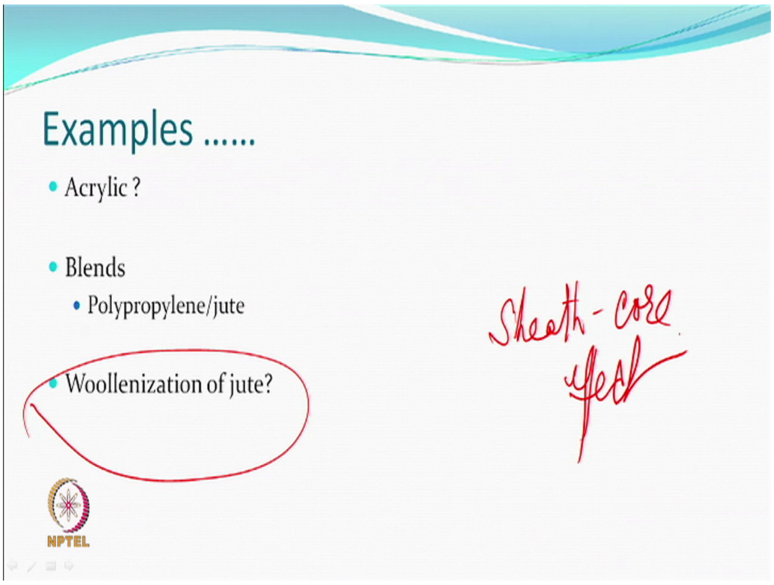

So, what kind of an example possible; so, there is a yarn which is available in the market which we call as the based on acrylic fibres, but you can have blends, polypropylene jute. Now you how does polypropylene and jute would work? Are we saying polypropylene will shrink and jute will not? That can also happen, but then polypropylene much shrink more. .

But now will polypropylene may not shrink that much, on the other hand what people of found is that if you threat wool in alkaline solutions of good strength they shrink and crimp and that process sometime is known as the woollenization of jute like wool is a crimped fibre. And normal jute fibre for example, is very straight and buy this alkaline treatment because of shrinkage of components in swirling somewhere not swirling somewhere it becomes a crimped kind of a thing and bulk generates, but that is not the one; that means, that this fellow can shrink in an alkaline solution but polypropylene will not.

So, one can always make systems where the one component which you wanted to go to the core; obviously, must shrink the one which you think abrasion resistance etcetera should be high may come on the surface. So, you can create sheath-core effect. Where the commercial situation is this the acrylic Hi-bulk yarns are available lot of research here in there if will do and very innovative work also have been done.

So, we concentrate on Hi-bulk acrylic yarn. So, this is a product which is commercially successful and so much so that as a knitting yarn is concerned hand dating particularly lye bulk wherever wool was there you have acrylic. So, this is so much popular that it is replace wool. Now obviously, people will love it if it give the same kind of characteristic and; obviously, cheaper than wool, relatively easier to handle, do not have to dry clean and, if you remember acrylic fibres are dyed with cationic dyes, the shades are bright and brilliant which invariably woollen are slightly duller very very bright woollen systems you do not get it.

You believe that it has to be handle differently the dyes also a slightly different you know; one is cationic the other is anionic and so overall is there, but wool is wool you do not say that we replace wool one should not be thinking about it, but it has actually commercially run it. Price is very low care does not have to be done too much.

So, Hi-bulk acrylic yarns are available anywhere you go in the market; the winter has started you can go and is see all Hi-bulk acrylic. Why is that the Hi-bulk acrylic is there and why not Hi-bulk polyester, polypropylene, nylon are available? Principle we understand.

So, what is so great about it? So, there is no product which is commercially available we called Hi-bulk polyester. Textured yarn is there, false twist is there, air-jet is there, BCF is there, but no Hi-bulk polyester etcetera commercially. These are not success. Once I know the principle I will try. It is like for example, you will not see a false twist acrylic filament yarn. So, we said will there is some problem with this you know; the problem was that if you heat it up, take it to a different state it gets yellow, degradation can start. So, you do not want to get in. So, let us keep that out, but this is one application which was as if meant only for acrylic fibres.

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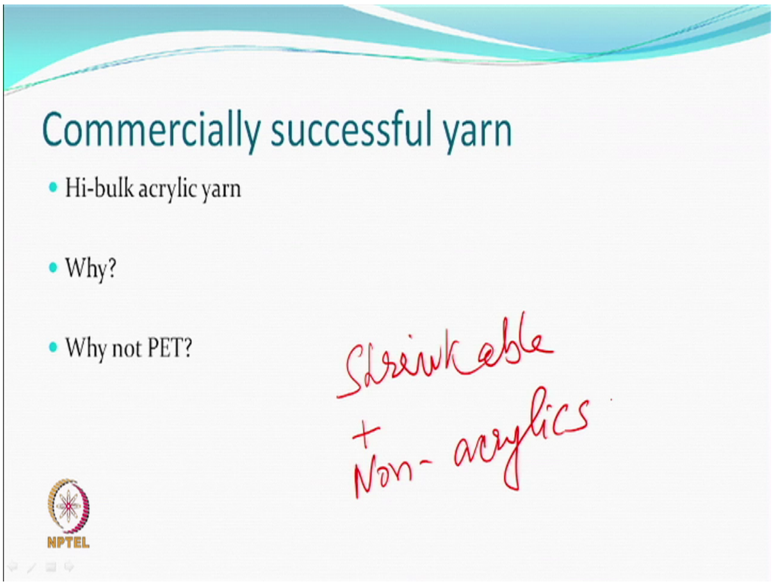

And the reason is you should be able to produce both shrinkable and non-shrinkable acrylics which you can do and we are not be able to do with polyester or nylon or polypropylene all though attempts have been done.

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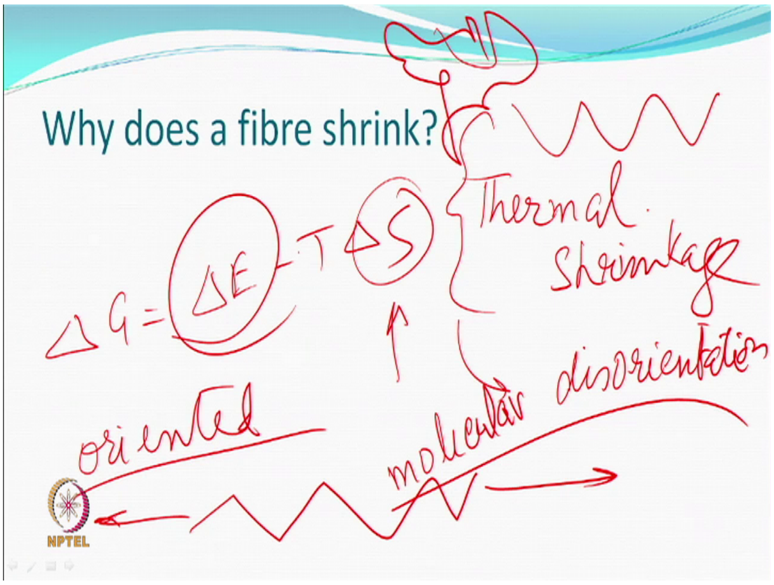

So, the question that remains is why you could not do it. So, you should be able to answer this question like this, why does a fibre shrink because you need something to shrink let us say at the moment just to simplify things we are looking at thermal stimulus the shrinkage can happen because of any other stimulus.

So, we looking at thermal shrinkage. Why does the fibre shrink? Clear? No. We agree that shrinks; why does shrink? Shrinkage means what; disorientation or let us say molecular disorientation. So, if any changes taking place, this general equation must be satisfied. So, what does happen during this so called shrinkage in this equation term, the molecules are disorienting which means delta s is increasing which is a natural process right. So, shrinkage will occur in a polymeric system like a fibre, but we have seen the same material can crystallize also, but now we talk about orientation, but if given a chance it would like to go into a spaghetti shape.

So, one of the reason of disorientation is it must have been oriented before. If you have oriented only that can something is already disoriented you cannot disoriented more. So, what you are saying is an oriented structure will disorient easily. So, you create a oriented structure. So, that is what we do all synthetic fibre after spinning a drawn. So, you are creating a oriented structure therefore, this material shrink; why the normal material does not shrink, shrink to the extent that you want? You see when you are stretching; molecule has been stretched let us say is a simple molecule also and you stretched it is not the crimped yarn I am talking about the molecule; carbon.

So, you have a bond angle which is in a natural state must be fixed, but if we do anything like a pull this angle may not be exactly same may not be. Otherwise how does the matter; whether this material is lying like this, it is satisfied or it is lying like this, how does the matter it matters because by pulling you are straightening and hopefully you have also stress the angles is like a spring which has been slightly extended want to give a chance it wants to come back, if you do not give this opportunity it cannot come back.

So, now we will like to say it shrinks because oriented. So, it can go to a disoriented state, but when you give any input like thermal input it should be enough to give freedom to this molecule to do what it wants to do. So, someone say so why polyester cannot do that orientated that is because of this. That is during this process of drawing heat setting etcetera. You are doing crystallization also you have seen crystallization. If crystallization occur that is also favourable; that means, also stable state.

So, if the materials which we talking about have a tendency to crystallize as well, then you are making may be oriented, but also stable structure oriented, stress induced crystallization, thermally induced crystallization, if all those things happen then you are making materials stable and stable to what dimension; stable means it is not good shrink. So, there are polyesters, polypropylenes, nylons, the moment you give these kind of inputs they crystallize also right. Polypropylene crystallizes while it is getting spun from melt to solid, nylons do at a certain rate and polyester maybe at a very slow rate, but they do crystallize. We were happy for that; you could do texturizing but and we happy there going to shrink further. So, that is good part of it.

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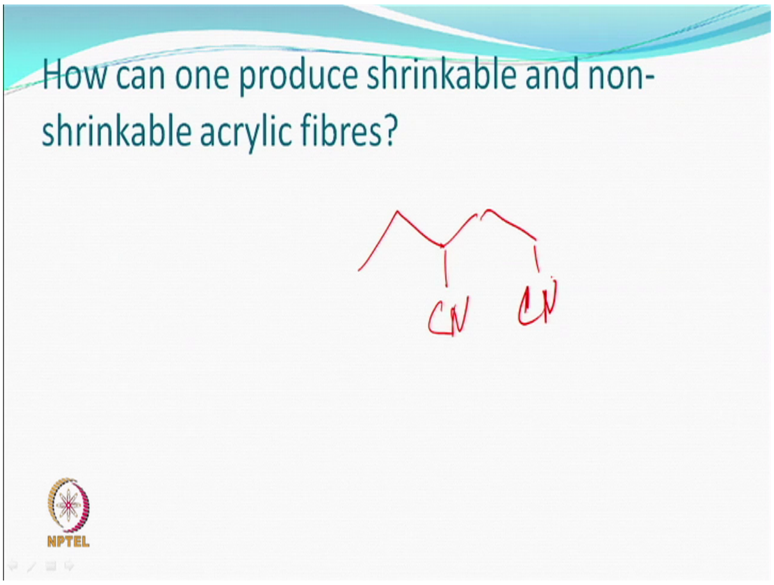

So, the acrylic fibres have not behaved exactly the same way as the other thermoplastic fibre that we talk about. It is possible to orient the fibre without it being crystallised. You seen the polypropylene the textile grade polypropylene right. If it is isotactic then you have a fibre; same molecular weight, with a tactic you have no fibre; that means, for crystallization also you need a certain facilitation. So, there is methyl group which was in polypropylene coming out, it is on this side, that side random or well governed. If it is well governed it is called the isotactic. Acrylic fibres also have a nitrile group which is the one something like that. Now I have drawn everything on the same side why should be on the same side.

So, tacticity of the polymer that has been synthesized would determine whether is going to crystallize very well or crystallize less. So, Ziegler-Natta etcetera were used catalyst to make polypropylene isotactic; something similar has not been done here. So, by addition polymerization of type you make things measure tacticity.

So, what does happened is that actually the acrylic does not crystallize the way other fibres are doing it is like a meta stable state, it gets to meta stable state slightly work very hard it would crystallize also, but not sharp crystals not various structures alpha beta gamma stuff. Because it does not happen, but what can happen is when you orient this material it may not have crystallize for crystal you have to come very close, but you can make various other kinds of Van der Waal interactions, polar interactions even if you are little far. Cyanide nitrile group is a very highly polar group and so because it is polar. So, polar polar interactions can take place and it is an abundance every second carbon you see this right, another molecule from the side is coming this is suddenly polar polar bond is created use done something. Let us say you have drawn, you have stretched. So, it have been stretched and doing this process molecule extended and you cooled, it is not crystallize, but still want to go back cannot go back, because these polar polar interactions take place and they do not allow the molecules do exactly what they want to do, but still not crystallize.

Now, crystallize is understand that you have molecules are come very close to a highly ordered structure; it gives the dimensional stability etcetera etcetera. So, it is possible in the case of acrylic fibre to orient without crystallization, while in the other case just you draw and they start crystalliation stress induced crystallization; that means, you can manipulate this now. So, that is what they did. So, did manipulation and this fibre responded well. So, you could produce a component which has been oriented not crystalline, a component which has been oriented and he treated little more so that crystallise. So, you can produced shrinkable, non shrinkable component.

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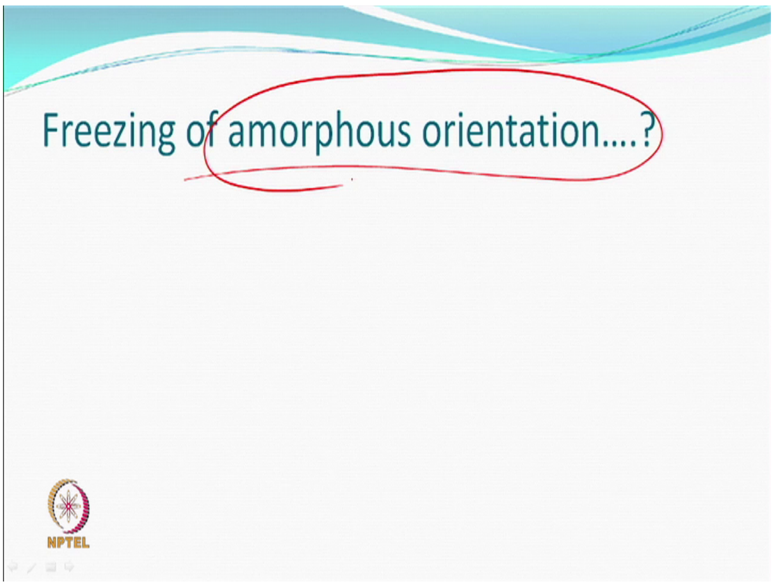

So, this is called Freezing of amorphous orientation. So, it is possible to freeze in amorphous orientation because it oriented therefore, when you give any stimulus it will like to shrink, disorientation state like to go. So, you have an amorphous orientation in other fibre it was not possible you have to do work very hard to reduce crystallization because naturally they want to crystallize.

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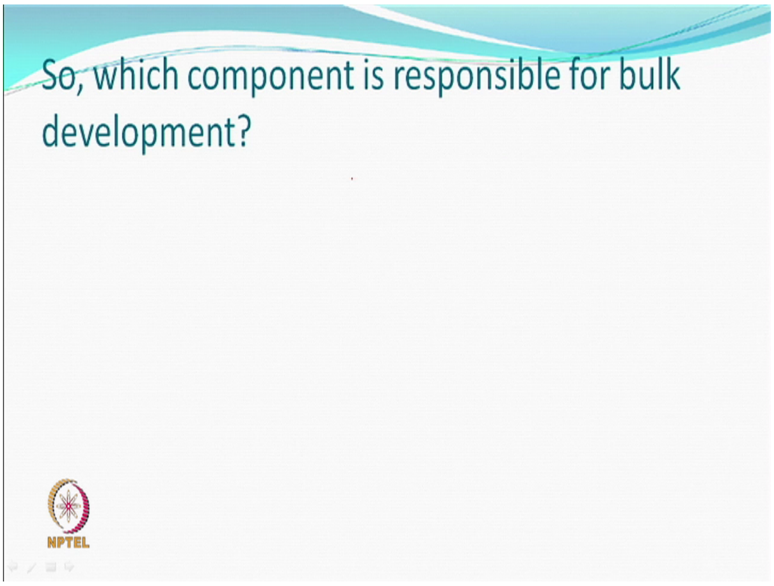

So, that is why you have in the market, commercially successful, acrylic Hi-bulk yarns, because you can produce a shrinkable acrylic fibre and a non shrinkable acrylic fibre and. So, we revise which component is responsible for work development.

Student: (Refer Time: 31:22).

It is a non shrinkable component. So, shall we let us say have only non-shrinkable component going to work? So, you got have both. So, figuratively speaking it is the non-shrinkable component which is developing bulk, but for doing so you still need a shrinkable component and the shrinkage difference must be high enough otherwise you will not see good results.

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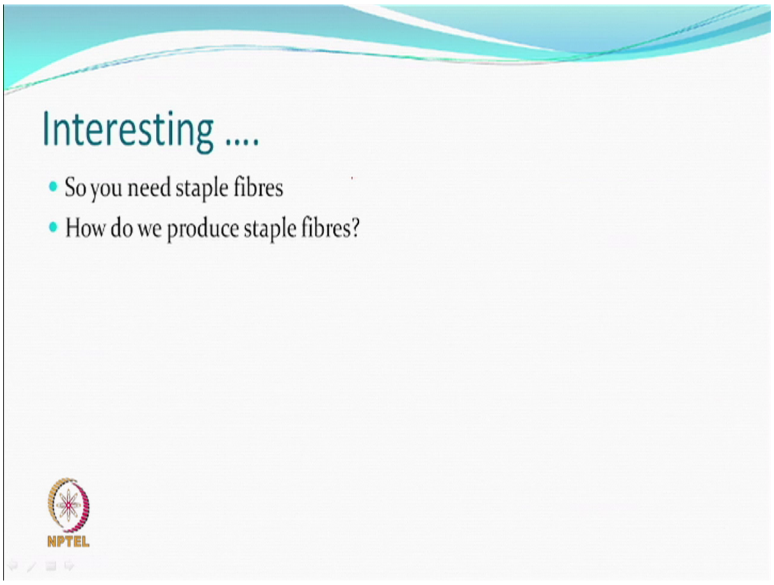

So, now this type of material is called a biconstituent yarn. So, you need staple fibres. So, it is not like you have a shrinkable filament yarn and a non-shrinkable filament yarn and you are saying look now come together it has not worked. So, you need branding and twisting and. So, is a staple fibre based thing alright. So, there is the process called tow-to-top conversion.

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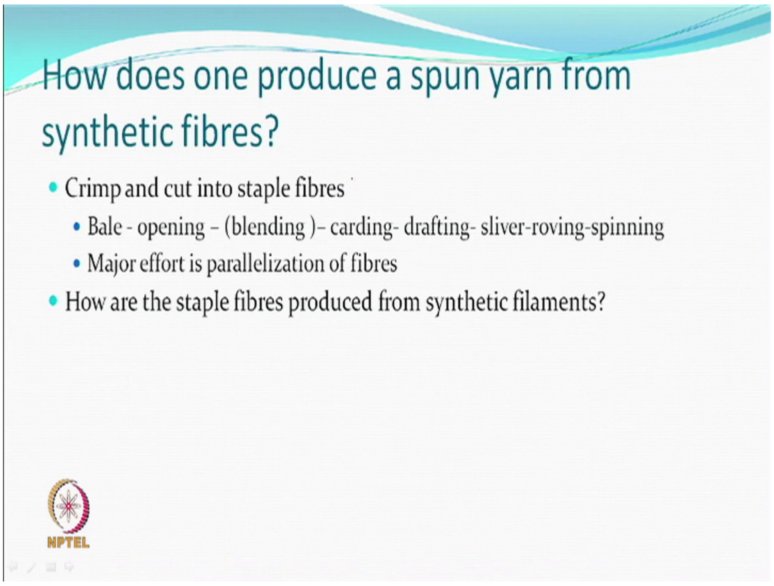

But before we do that you must know how do we normally produces spun yarn lets says polyester spun yarn, nylons, all other synthetic fibres. So, you have to crimp and crimp is done by stuffer box type of environment. You take a tow push into a stuffer box where some heating must take place may be steam, may be hot air, and then cut them into staple and from the staple what you do take a bale, you open the bale, you do the blending if it is required, carding, drafting, sliver, roving, spinning, normal process of making a yarn.

And a good amount of these processes are just trying to open fibres and then parallelize them along a desired access lot of work is done. So, one other thing which you do for this whole thing to do you know why people wanted to with this process; because you wanted to blend with polyester or you wanted to blend with cotton viscose. So, you needed in filament does not like to give you intimate blends right for everything to mix properly. So, get a fibre stage you mix them that is one. So, how do we produce a staple fibre from synthetic fibres?

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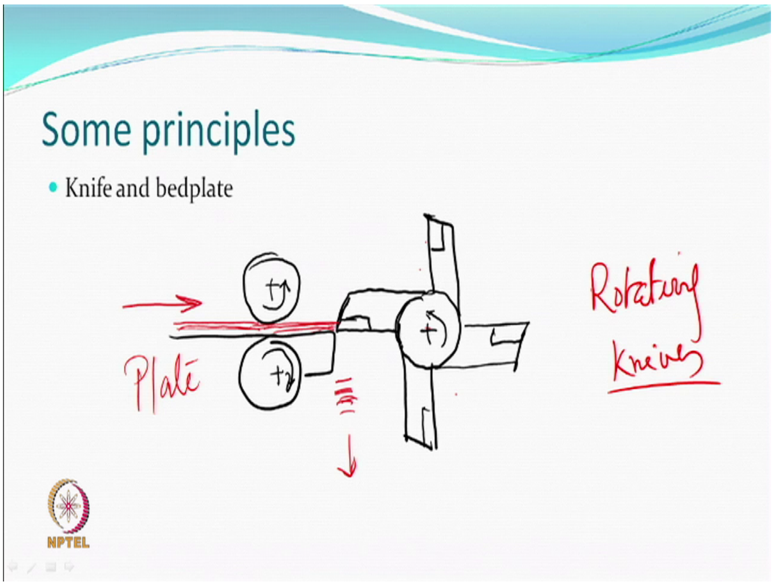

So, you have to cut them some of the principles of cutting call a knife and a bedplate. So, you have a bedplate here this is a plate over which there is a fibre tow is there may be spread over a plate it is being fed and then this is a system of four knife let us say very closely the come and cut for example, and the fibre will keep following.

So, a plate; rotating knives; so, you just keep cutting if you do the alignments properly in this can happen whatever happens is a cutting the other principle also.

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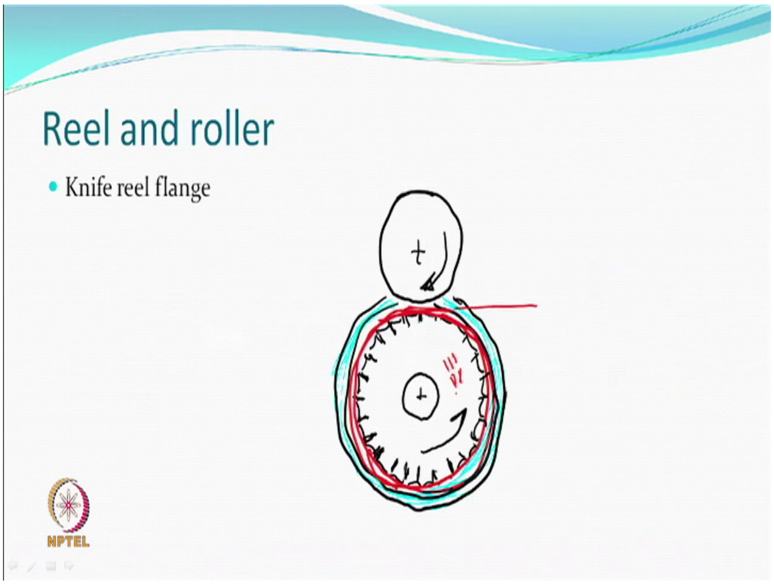

So, what you do is a knife reel flange. So, you have a drum type of thing with a blades like knifes are protruding out all over right. So, you can rotate this. So, these are knife; sharp knife on a flange arranged in this manner. So, there is the blade like going this you turn this, there is another blade, there is another blade, and there is a gap.

So, there is a roll and a flange and so blades and you have gaps and so the tow comes and the tow start wrapping on a knife reel make getting bound on a roller where there knifes are projecting out. Anyone who have seen a staple fibre industry fibre cutting?

So, this rot this so called reel which is got knives all over, over which you are making sure that the so called tow is coming and getting wrapped and you have putting pressure. So, wherever the pressure is high enough you will start getting fibres coming out. So, distance the staple length etcetera divide decided by this. So, called roll and this is a continuous process and you can suck the thing from inside and take it to the baling press is one of the most common type of cutting method is there which a large number of staple fibre industry will be using.

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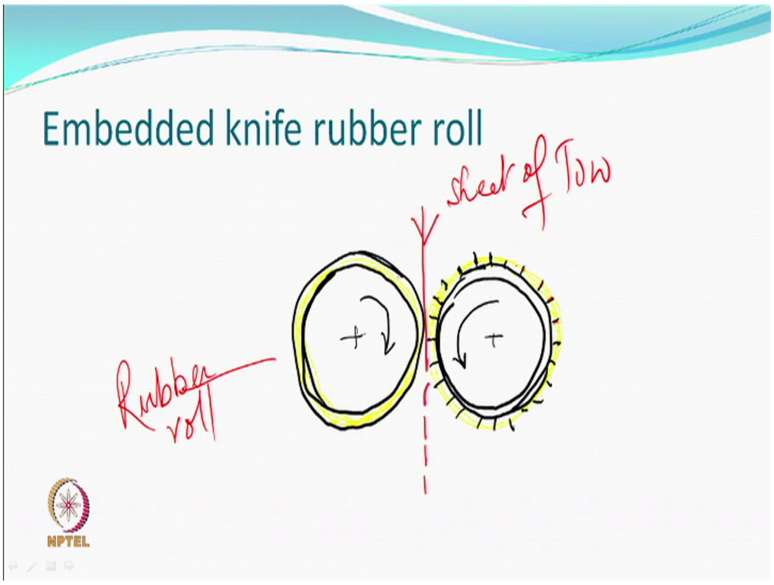

There are others also like an embedded knife, an embedded knife means this is a roll which is rubber roll this sheet of yarn or a tow is coming and then you have another rubber roll which has embedded knives. So, the yellow part is rubber you can understand yellow part is the rubber in which you have the blades just getting out. So, complete support is there of the matrix. So, when you compress it could compressor would more pressure then rubber will go blade will become prominent right this how we can carried also.

So, there are other methods also principles, but the one which we talked about this is one of the common ones does not require thing of course, whenever the blades go down we have to do the something about the blades, but it works very well. So, you produce a staple yarn and a bale, and then you go for your opening, carding, everything else. So, fibres collected and baled.

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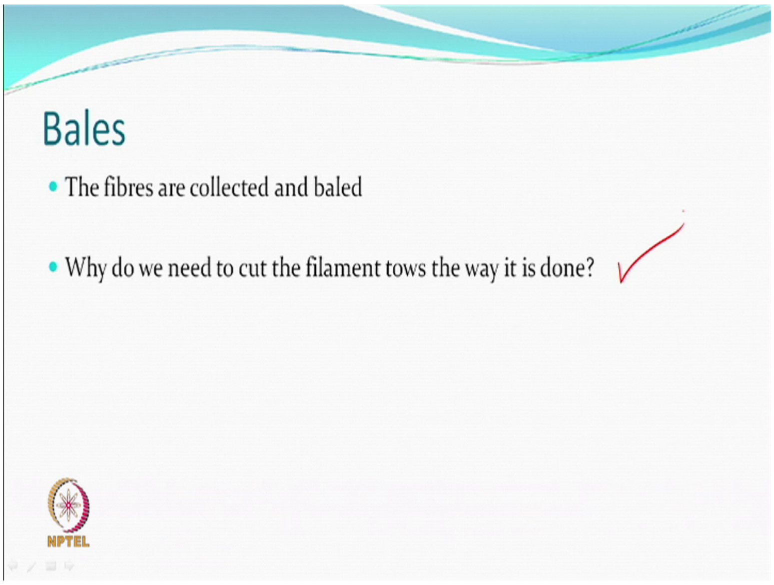

The question people then asked was why do we need to cut the filament tows the way it is done that was the question. Because filament tow the fibres are already parallel. So, you have first cutting then randomising them and then. So, like a let us parallelise them again. So, that was one of the question which was there the something which is already parallel say if a cotton wool, they are naturally grown they are hardly parallel. So, can do about we have to do everything, but why synthetic material which is anyway being made in a parallel manner, your first rank to d parallelize and then again opening and spending energy on that; that is why this tow to top conversion systems were designed.

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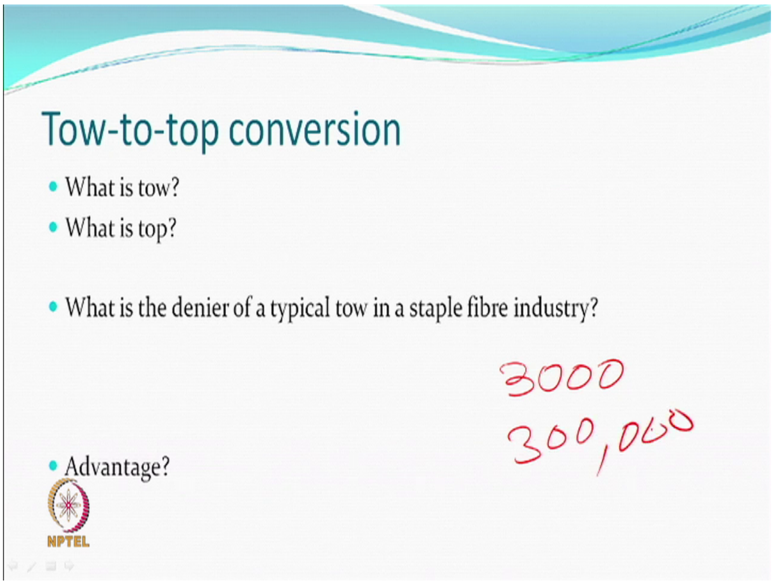

So, what is the tow? Tow is a.

Student: Bundle of filaments.

Bundle of filaments. So, bundle of filaments is tow and what is the top?

Student: After cutting the filament.

Yeah.

Student: The short staple fibre is called top.

So, fibres are there also; they were not called top.

Student: It is like sliver; It is like sliver (Refer Time: 40:22).

So, top is like a sliver. So, cotton people call the same material as sliver, the woollen people call the same thing a top that is one. Acrylic fibre normally follows the woollen system, you cut them in to staple length we generally higher we have is replacing wool is like wool it is like this thing. So, you going into the long staple systems also and because they use the terminology, the woollen people using wool industry. So, you have top. So, top is like a sliver.

So, what you doing is a tow which is parallel and then you have to make a top which is parallel in between you do not need carding, you do not need drafting, you do not need also kind of thing, nothing is required you have just do it. So, that is tow to top in the. So, called fibre industry, staple fibre industry the after spinning from different spinners, you keep collecting the yarns from different spinners keep collecting them and make a tow and then crimp and cut. What would be the approximate denier of such a tow; approximate denier of such a tow?

Student: (Refer Time: 41:53).

Yeah.

Student: 3000.

Some figures are coming like 3000 denier yeah.

Student: 2, 00,000.

200,000 yeah. So, it could be 300,000. So, that is the kind of a tow that you take because it is a very very cheap process right, you want to do mass cutting you take it around do whatever little stretching you want to do; when you are cutting, just cut them. So, very high denier therefore, becomes cheap. So, that is the kind of thing, but when you are going to convert a tow to top.

So, it is the sliver denier which will determine, what will be the tow denier right. You cannot be making a sliver of 3000 or 300,000 denier right. So, this is going to be different from the normal conventional staple fibre industry cutting systems. Advantage is very clear I believe, that you do not have to spend energy money in trying to parallelize and once you have a nice good sliver and then make a yarn, twist and make a yarn (Refer Time: 43:18). I think we stop here; we will pick up form here.