Textile Finishing
Prof. Kushal Sen
Department of Textile Technology
Indian Institute of Technology-Delhi

Lecture-01
Introduction to finishing

Welcome, to this course on textile finishing as we had mentioned in the introductory video also that we would definitely look into the chemistry. And then it's application particularly technological application which has led to many treatments and finishing processes.

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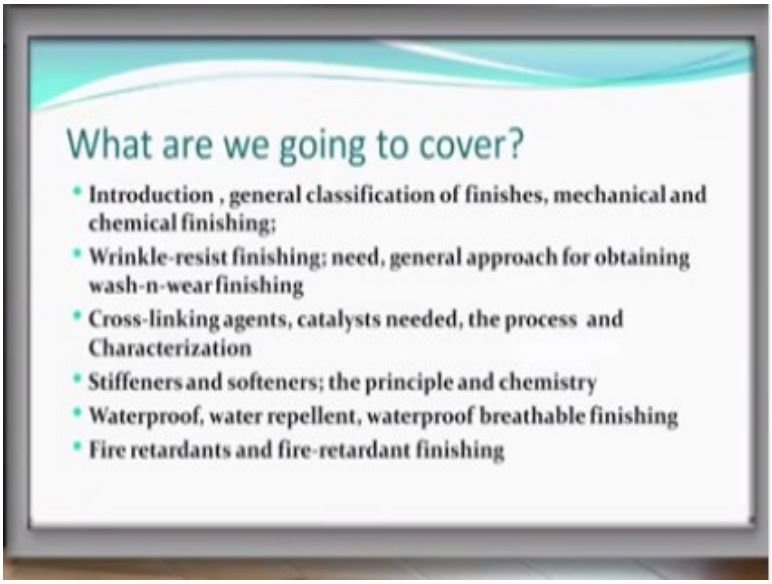

So broadly what are we going to cover I will just take a few minutes to just explain in this whole course some of the topics that we will be covering. Obviously, we will have some time we shall spent on introduction is to what the finishing is, generally how do we classify these finishes, in terms of mechanical and chemical finishes, this is what we going to be working on within the or specific finishes we will have a wrinkle resist finishes, what is the need.

The general approach for obtaining a wash and wear finishing, in within this topic we will try to see what kind of agents like crosslinking agent which are used for obtaining wrinkle resist finish. The catalyst that are needed to complete the reaction, the process and the characterization of a

finished fabric. Further, we will go and talk about stiffeners and softeners, their principle and the chemistry of these compounds, that will be interesting to see.

We will also talk about waterproof, water repellent and waterproof breathable finishes, how they are generally done, in brief we will be talking about it, some of the chemistry will also come into picture. Another important finish which we call as fire retardants or fire-retardant finishing. We will see how it is done what are the principles and a technology that is used.

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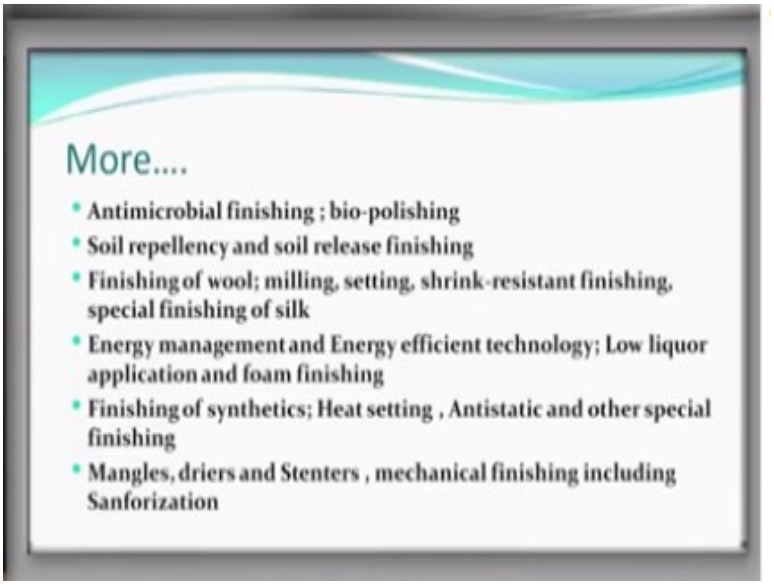

More topics. Antimicrobial finishing, bio-polishing. They are basically enzyme-based finishing, as the bio polishing is concerned and how bacterial degradation takes place and if you want to avoid growth of bacteria, what are we going to do about it. Soil repellency and soil release, this is an important topic of finish these days. So, we will spend some time here as well. Then the other material that we have wool. So, something specially related to wool, a milling, setting, shrink resistant finishing, some special finishing for silk as well we will cover.

We will also spend some time on topics related to energy management and technologies which are more energy efficient. Interesting in this will be low liquor application and foam finishing. Finishing of synthetic fabrics, some of the important things you call the heat setting, antistatic and other special finishing required for synthetics also will be covered in this course. And some

discussions on mangles, driers, stenters and some mechanical finishing processes including sanforization.

So, all these topics will be covered not exactly in the same order, you know. Sometimes some of the machines like mangles, maybe discussed before, so that it make sense. Some finishes maybe done at a later stage, so, but briefly this describes to what we are going to be covering in this course.

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So, we come to the first lecture what we are going to do today, giving an introduction to finishing is a general lecture. And therefore, would demand attention only to the extend the broadness of the topics that we were talking about.

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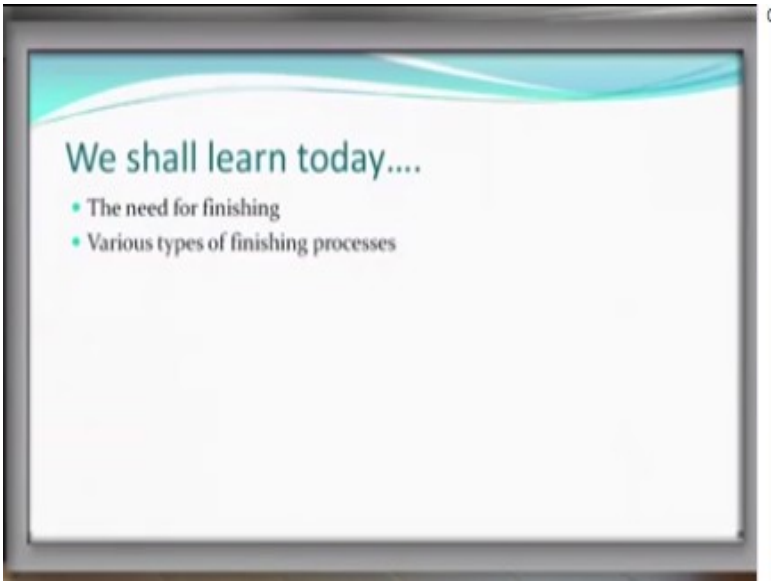

So, what we shall learn today is, the need for finishing and general types of finishing processes that are used in the industry today.

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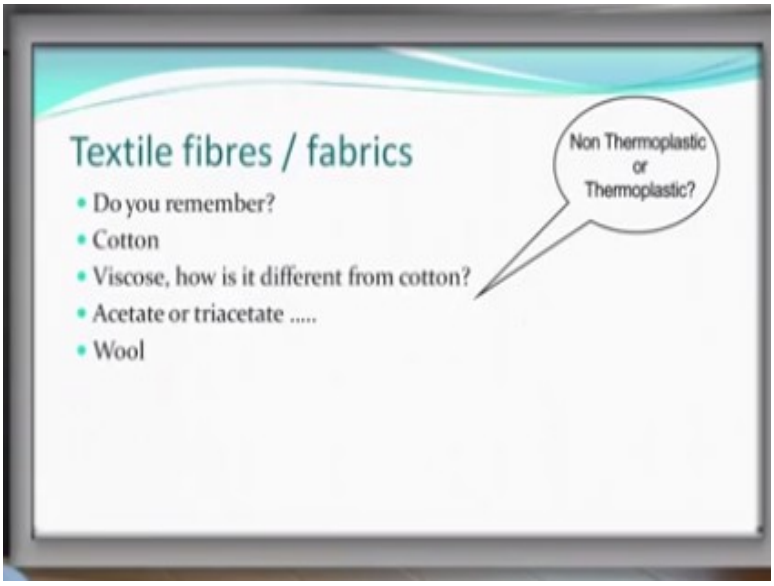

So, let us look at what we know about textile fibres and fabrics. As we mentioned in earlier little discussion that the chemistry of the fibres, will determine as to why a certain type of finish is required. So, let us say, we generally remember, recall from our earlier courses that you may have done, what are the important textile fibres, fabrics or fabrics made from them. Do you remember them? Can you recall some of the fibres and fabrics? yeah, Cotton.

Of course, cotton is one of the most important fibre, which is used in making all kinds of apparel and even industrial household textiles. So, it is an important fibre. Viscose is another fibre. What is the difference between these 2 fibres? So, one of them is called the manufactured fibre, which is called the viscose and the cotton is a natural fibre. And what is common in them? The common part is both are cellulosics.

Then you may have heard of fibres like acetate or triacetate. How are they made? What is the basic raw material, the polymer? Are they natural or manufactured? Yes, they are manufactured. But, how? The basic material is cellulose, the cellulose is modified, acetylated, so you make acetates or triacetate, where all the hydroxyl groups have been substituted. Then becomes triacetate, if you look at it, from the anhydroglucose unit.

Anhydroglucose unit should have 3 hydroxyl groups 1 primary and the 2 secondary hydroxyl groups. So, if you replace them completely by an acetate then you will have a triacetate. Is this triacetate a thermoplastic fibre or non thermoplastic fibre? Yeah, non thermoplastic or thermoplastic? Is it non thermoplastic? No.

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These are thermoplastic fibres, because the reason why cotton cellulose is non thermoplastic, that reason which is the intermolecular hydrogen bonding, that reason has been basically removed by substituting acetate groups. So, then you have wool, interesting natural fibre. Silk, another

interesting natural fibre. So, we are talked about natural which are wool, silk, cotton, manufactured fibres like viscose which is regenerated, acetate and triacetate which are modified.

Any one of them is synthetic among the fibres that we have listed here? What do you say? Anyone among these, is in the synthetic category? No.

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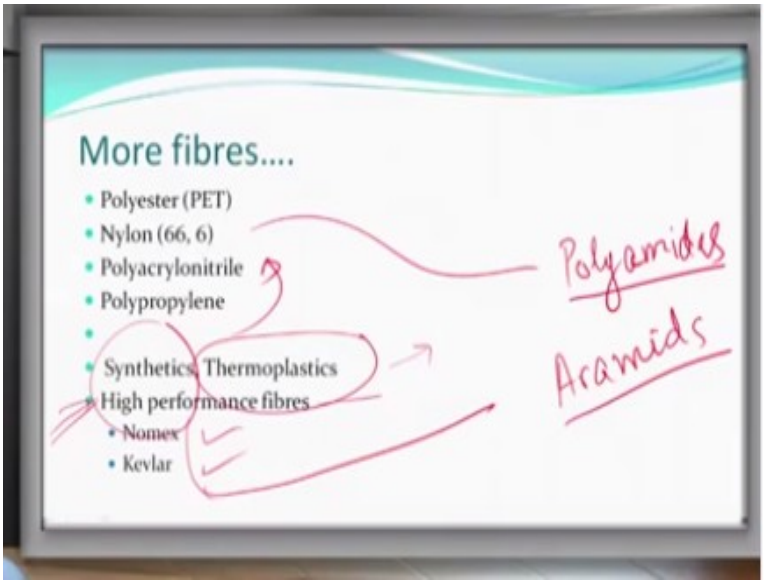

So, we have other fibres which are important, which are the polyester, which is the polyethylene terephthalate, because if we just talk about polyester that are many types of polyesters will be there. Then other commercially successful fibre is nylon, nylon 66 and nylon 6. So, these are 2 important commercial fibres. Otherwise there are many other nylons, that are also available.

Polyacrylonitrile, if you remember, this fibre has more or less been used as a substitute for wool. If you remember this, is good, otherwise try and find out, why polyacrylonitrile in apparel industry or apparel sector is considered as a substitute for wool? Polypropylene, another interesting fibre, which is less use for apparel, maybe for household more, industrial application is much more. All these fibres which are listed here are called synthetics, synthetic fibres. Why do we call them synthetic fibres?

Because, their backbone that is the polymer chain does not exist in nature and it has to be synthesized by using compounds called monomers. So, you have monomer which have to be

reacted to make them polymers and therefore, they are called synthetics. Invariably, they are all in the range of or in the class of thermoplastics. So, these are some of the important fibres which you will be coming across everyday.

While there other category of the fibre, which is called the high performance fibre, which are like Nomex, Kevlar. The difference between this, they are also known as polyamides, polyamides alright! And these are called aramids. They are aromatic amides, so, they have aromatic ring, in the thing and while these nylons do not have, so they are simply in the class of polyamide. These are called the aramids, they are high performance, invariably we may be using them only in special applications what not in the day to day applications.

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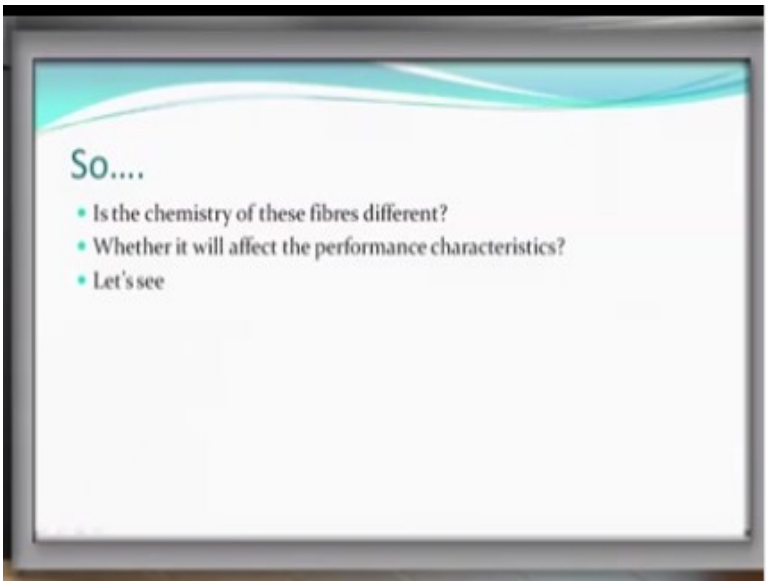

So, where do we stand? If somebody asks, is the chemistry of these fibres different? Is it different? Yes, of course it is different. Whether this difference and the chemistry is going to affect their performance characteristics? Like, some of them are thermoplastic, some of them are non thermoplastics, some of them may be biodegradable, some of them may not be biodegradable. Will it depend on this chemistry of these fibres? Yes, of course.

Let us see, some of these fibres and that difference probably is going to become a basis as to why a particular type of finishing process is required for some fibres and the other required for the other fibres.

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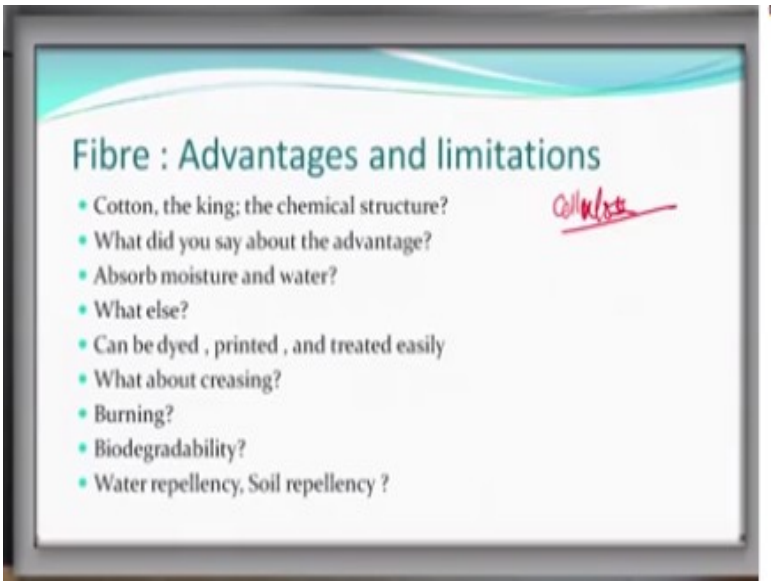

So, will we talk about requirements? Then we let us say we look at the advantages, limitations of these fibres and the fabrics made out of them also, not just the fibres. So, what does come to your mind? The most important fibre that comes to your mind is cotton, the king, which is called. And we just talked about its chemical structure. What is the chemical structure? Right, cellulose, so what is cellulose? I am sure, you will either remember or go back and check it out.

So, it is a cellulose based structure. So, what are the advantages of cotton? Yeah, you say that the advantage, what is the advantage? Well, it absorbs moisture, it is a hydrophilic fibre and water can be retained more, so a large number of people would have come to a conclusion, they did. That all materials, garments made from the cotton, should be next to the skin. So that, any moisture that is absorbed, which is secreted out, gets absorbed easily. Right!

That is why you like to have cotton near to your skin, but this may not really be an advantage today. Because if it absorbs more moisture, it dries also slowly. Say suppose, an athlete is running, these all cotton things he is wearing, or she is wearing. Then the perspiration will be there, it will be all wet and how do you think you will like a wet material clinging to your skin, and body, I do not know. Would you like to consider this as an advantage? What else?

Yeah, it can be dyed easily because normally we want to dye in aqueous medium, with water gets absorbed more and then the dye also goes, it can be printed relatively easily, can be chemically treated also easily. Yes, this advantage could be there or that is a process advantage. What about the advantage of the user? Is the user interested how did you dye? Is the user interested how did you print or finish? What user will be interested? What is the property that he or she is experiencing because of the textile, that he has or he has been wearing?

What about creasing? When you have any textile garment that you are wearing it creases. Right! It does crease. So, does the cotton-based fabric crease more? Or less? More or less? They crease more. Have you experienced it or not? They crease. Do you like the crease material or creased garment being worn? Some of you can. Most of people will like to have a garment which does not crease. So, this is a limitation. What about burning? Have you ever seen any cellulose, paper being burnt? Does it burn readily?

It does burn readily. The cotton also will burn very easily. So, all cotton garments, household material, if there is a fire that is the most dangerous thing that you can experience. So, this is a limitation. Biodegradability, if suppose you keep any cotton-based garment material, let us say in the soil or keep it unwashed for a long period, what would happen? You know, you will have fungus or rot growing on it, at the end will get degraded also.

Because, in nature we have an enzyme, called cellulase, so it can degrade cellulose and cotton is cellulose, so it gets degraded. So, is it an advantage or a limitation? For some obviously, it is a limitation. In modern world, somebody says it is an advantage also. Why? Because, at the end of the life of a product, you have to dispose this. And when you dispose any such product, then we expect that it will biodegrade itself, will not have to be incinerated or burnt out or do something.

So, from environmental point of view, it maybe an advantage from longevity point of view, it may not be that much of an advantage. So, all that is there, if it is the cotton. Water repellency, soil repellency, what do you think about it? It absorbs water, it cannot repel water, so they are against. So, in case you are interested in repellency of water then obviously you have to say that it is a limitation in that sense.

And same is, something related in soil repellency, who wants the fabric to be soiled but you have a water-based ink or any other soil it will get soiled. So, it is a limitation.

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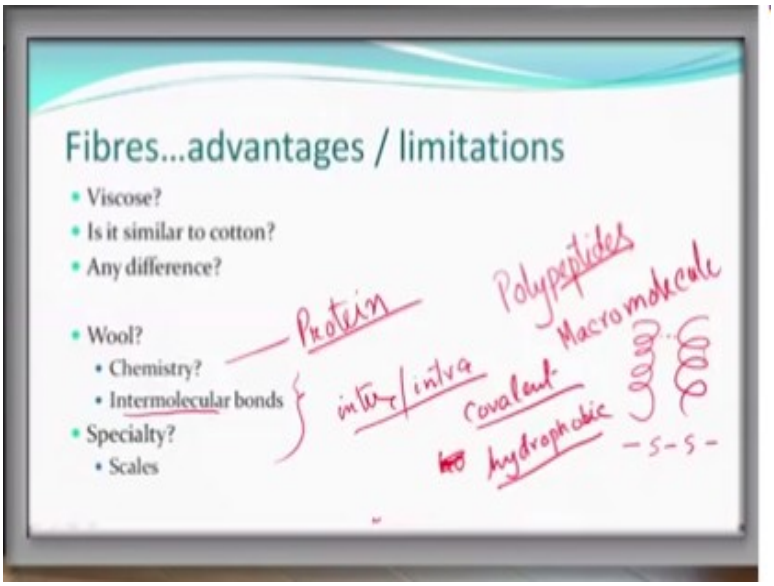

Viscose, what do you think about it? Is it similar to cotton? Yes, it is. In many senses, it is similar to cotton, because cellulose. So, all those finishes or the limitations that we have seen in the cotton, should be here as well, it will burn the way that burns, it will be hydrophilic, so, it absorbs, it would not repel water. One of the difference obviously, is a manmade or manufactured fibre, that is the difference, plus, the crystalline component in viscose would be expected to be less compare to what we see in cotton.

And therefore, the absorption capacity the moisture regain and other type of things will be seen to be different. The next important fibre that we have, you can talk about, let us say wool. What is the chemistry of wool? Basically, these are, these are protein based fibres. So, protein. Our hair also is similar to wool is called keratin, sometimes they are also called polypeptides. Is somebody ask this question, is wool, we understand it is protein or sometimes called polypeptide, is it a polymer?

We never ask this question to cellulose ok, cellulose has a repeat unit which is called cellobiose and it keeps repeating itself, based on how much time the fibre grew or what have you done to it.

So, there is a monomer or a repeat unit which is repeated every time. Can we call wool or in a way a protein a polymer? Can we call that a polymer?
Actually, strictly speaking, although a peptide link and the associated group is being repeated, but the amino acids in every such repeat is different and therefore strictly it is not a polymer, so what do we call it? You can call it a macromolecule, which has large molecular weight. So, it is a macromolecule. But what it has? It obviously, has peptide links and so with hydrophilic it makes various types of bonds. Let us see what kind of bonds wool fibre would make intermolecular bonds, what? Does it make hydrogen bonds? Yes. It does make hydrogen bonds.

Does it make Van der Waals forces? They will have intermolecular Van der Waals force? Of course, it will have intermolecular Van der Waals forces also. So, the hydrogen bonding will be there, you will have Van der Waal forces. But interestingly, wool would have intermolecular as well as intramolecular hydrogen bonds. So, if somebody may have taught you in a normal configuration, it can take a helical configuration, the molecule itself can taken helical consideration.

And, hydrogen bonds can be here and hydrogen bonds can be formed here. So, inter and intra, so you have Van der Waals forces which are possible, you have a inter and intra molecular hydrogen bonds, which are possible. They also have covalent bond. Which one? So, you have intramolecular disulfide linkage or cystine linkage. So, it is a covalent bonding, it has. I am not sure if you have heard about hydrophobic bonding, have you ever heard about anything called hydrophobic bond?

Well, hydrophobic bond also has been defined as reciprocal hydrophilic effect. If there is lot of water around the molecules of this protein, then the hydrophobic part, because they do not like water, they like to come together. So, in wool you can see hydrophobic bonds also, based on the environment, if it is hydrophilic. If it is not hydrophilic environment, they become redundant. But if there is lot hydrophilic environment, they have value.

Now all this, is a part of a chemistry and if the chemistry is there, so their properties, is also going to be working on them. Any specialty that we are looking at? Yeah, it has scales. Naturally

the wool is not a cylindrical smooth fibre but is got scales you remember. And because of scales there are certain properties which only wool will demonstrate and if you like them, it is fine, if you do not like them you have to work for a finish which will do reverse effect.

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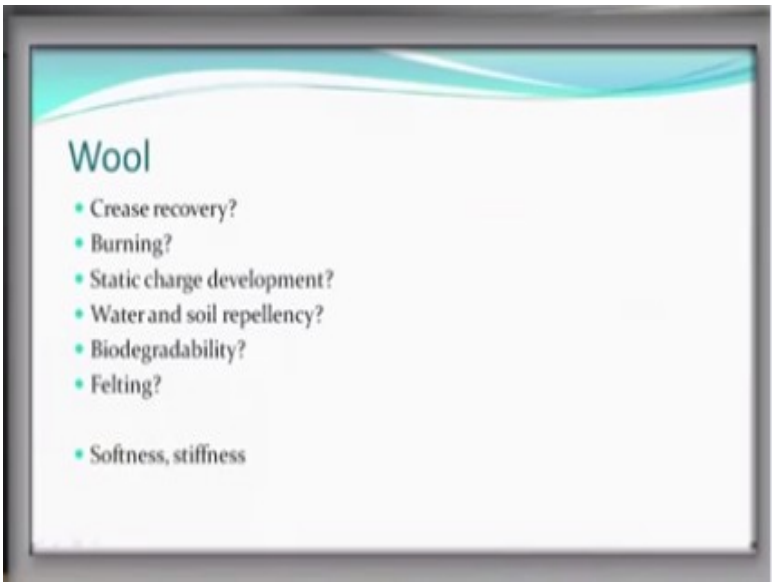

So, looking at the part of the chemistry that we said what do you think? The creased recovery of this, fabrics made from wool, are going to better than cotton or inferior to cotton? Yeah, they are better. Because of this intermolecular crosslinking which is the covalent crosslinking is very important, the recovery is better, even helical structure of the molecule is also better than you bend if the helical structure changes its shape, it likes to come back to its helical form also.

So, that way the recovery of this is better than let us say cotton, burning compare to cotton have you heard of somebody catches fire or something is burning people say, well, put some blanket on top of that. Well, the blanket normally is associated with wool, normally does not have to be, so why do that? Do not say go and surround or wrap with a cotton sheet, that may also work for some time, but wool.

So, in general wool is also naturally more flame-resistant, compared to cotton, it does not mean that it will not burn, it will burn but more resistant. Static charge development, do you think wool will have static development? Invariable no, but in very cold climates, cold conditions almost

every fibre can develop static charge. Static charge is, when you rub something or you come in contact, then the charge get station on the surface.

So that is a limitation. So, we had some advantage, some limitation. Water and soil repellency, it would require in case, because it is a hydrophilic material. Is it biodegradable? Is it biodegradable? Yes, of course it is. So, all the advantage, disadvantage you talking about are there, in fact, if you may have heard that, there something called a moth, an insect which can eat wool, say have to take special care. Right!

And so, insect proofing, biodegradability, all that if you look at it, some people say it is an advantage. For the person of the user it becomes limitation. Have we heard about something which we call as a felting**?** Felting? Felting is a phenomenon, where the woolen garments if you wash them, you might find there is an entanglement, the structure is not the way you want it. For example, if a woolen knitted sweater, if you wash in a washing machine, what you get at the end of the day? Does not look like the original sweater.

So, because the fibres get entangled so that, it is felting. If you like felting, it is good, if you do not like felting then it is bad. Of course, we will require soften, stiff finishes as well, based on what you want. Normally people like it to be softer generally, compared to 2 fibres obviously, because of scales and bit of rigidness and so and so forth may appear to be little harsher.

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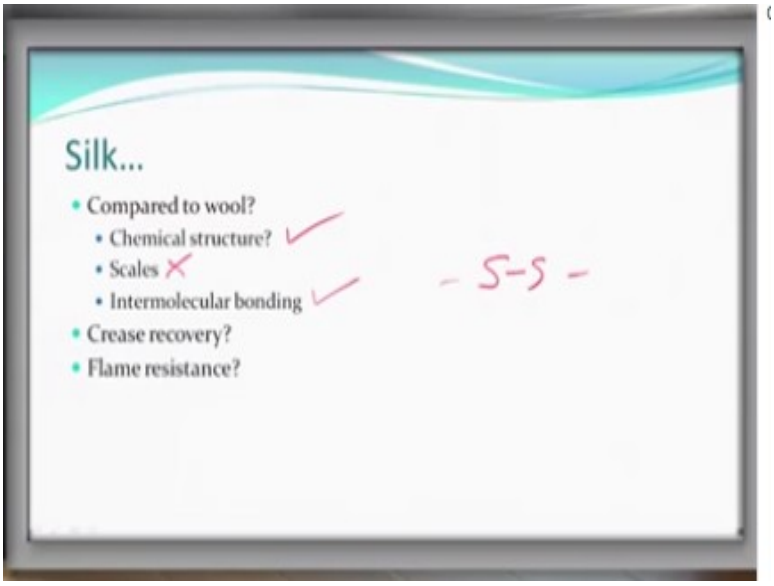

Silk. Compared to wool chemical structures is more or less same. What is the difference? What is the difference? You remember, this is also protein. But it does not have scale. It is a smoother material, in the intermolecular bonding also there is difference. One of the differences is there is no sulfur and therefore though no cystine intermolecular crosslinking. But it is a protein fibre of a different kind, it is not called keratin, it is called sericin and fibroin.

So, there are 2 types of proteins which naturally are extruded by the silkworm. One of them is more useful which you call the fibroin, which is also protein. Sericin which is called a gum, not useful as a fibre, it is removed, used for some other purposes but removed. So, there is difference between these and so if you look at the crease recovery of silk fabrics, is much inferior compared to a wool. Is that right?

Flame resistance also is less than wool, have you, did you expect it? Have you seen anything burning? You must have done some burning test on wool fibres? Some burning test? It is melt like burning beans, protein hair, burning hair, smell burning hair. Both of them will give similar smell, so you cannot identify but you have to do chemical test to say there is no sulfur there more or less, flame resistance is not as good also.

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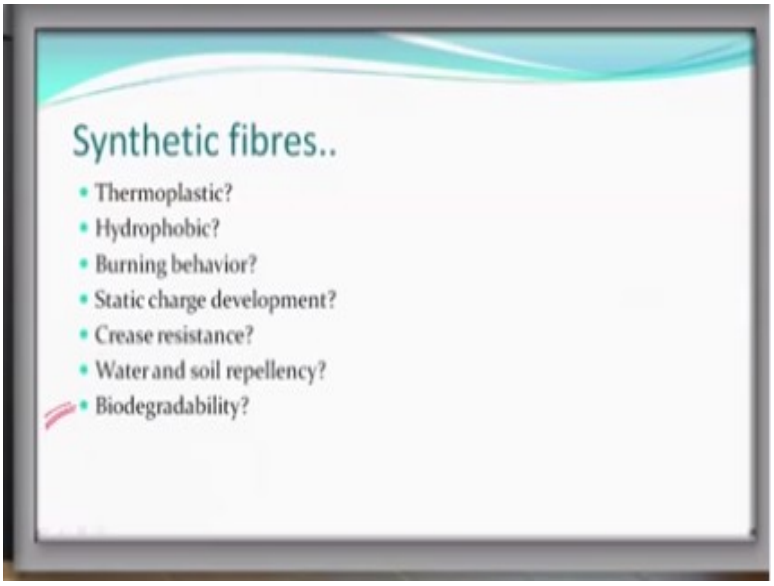

And look at synthetic fibres, most of synthetic fibres as we have mention before, all the 4 fibres that we talked about, they are thermoplastics. So, they can be handled by heating. You can do certain changes which can be permanent, semi-permanent by heat, which the other 3 fibres that we just talked about 4 fibres, they would not respond because they are non thermoplastics. Generally, all of them relatively more hydrophobic compared to the natural fibre that we talked about.

So, if hydrophobicity is an advantage, it is good. If it is a disadvantage, then you have to do something about it. Burning behavior, most of them burn pretty nicely, so if you are looking at a resistance to flaming, they are not the one fibres which can be used, you have to do something about that. Static charge, because most of them hydrophobic, most of them are prone to development of static charge, this is an important property by the way.

If you have a nylon carpet on your, any building, any you know, cinema hall, what have you, and lot of people keep walking around the same area, you might find it can develop a large amount charge, very high voltage, you can see sometimes spark so much and if electronic equipments all around, then obviously it can damage that as well. So, this is an interesting problem which is certainly with, seen with synthetic fibres.

Crease resistance, have you experienced? People are wearing polyester, polyester cotton versus the one who are wearing cotton, which one would crease more? As a user if you have experienced it, so obviously synthetic fibres have been seen to be more crease resistant. The product, final product, that is there. Water and soil repellency, well they do not like to they are hydrophobic, so they like the oily soil more.

But we will differentiate between repellency versus wetting, repellency versus absorption on moisture, 2 different things. Then obviously, because they are hydrophobic, their dyeing, finishing, and other processes will also be slightly more different. Biodegradability, this certainly is an interesting part in all of them, simple reason they were all synthesized, that the polymer did not exist in nature.

And therefore, we do not have biosystems, enzymes, which can degrade them easily. So, from stability point of view, it is an advantage, but from long term environment point of view it is an disadvantage, so people are working on these areas as well.

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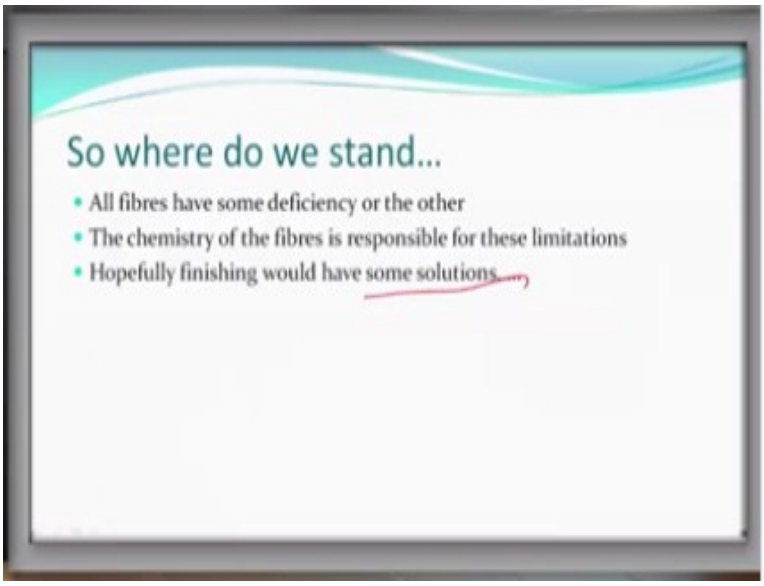

So briefly this is what we talked about and the where we stand, if somebody ask this question, so, all fibres have, will have some advantages, some disadvantages and if we closely look at the thing, their chemistry definitely going to play a role in determining what the property they will finally show us. And, property in terms of some advantages, some disadvantages also. So, what

we are looking at the finishing as a process, hopefully would have some solutions, solutions to do, obviously, any limitation which we can overcome.

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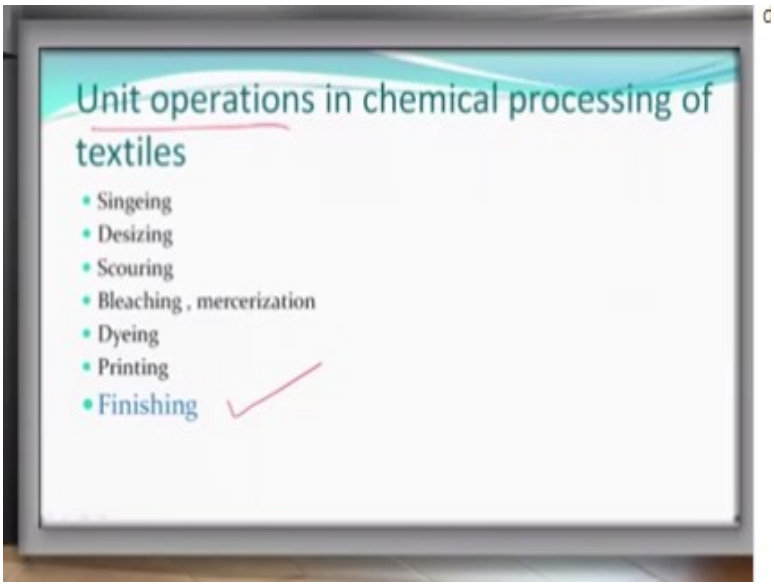

You must have heard this term called unit operations. So, unit operations in chemical processing, just recall them, recall. Singeing, you know what it is? Yeah. Desizing, a necessary evil to somebody, put size on a yarn, so that you can weave properly and so after weaving, you want to remove it. Scouring, in some fibres is required, not for all, but at least some fibres required, removing waxy material.

Bleaching, mercerization, bleaching for cotton and definitely would be required, you can bleach other fibres as well, but that depends on which fibre you are talking about. Mercerization term is only used for cotton, no other fibre mercerized, but they are unit operations. Of course, generally we have to dye all of them as another unit operation, you will have to, you may have to do some printing, to put colorful designs to increase aesthetics, so yes which is there.

And the final process is finishing. You cannot sell almost anything to a user without doing some finishing treatment, even if the simple finishing treatment you may have to do. And therefore, this is what is the most important chemical processing unit operation which we shall be talking in this course in little more detail.

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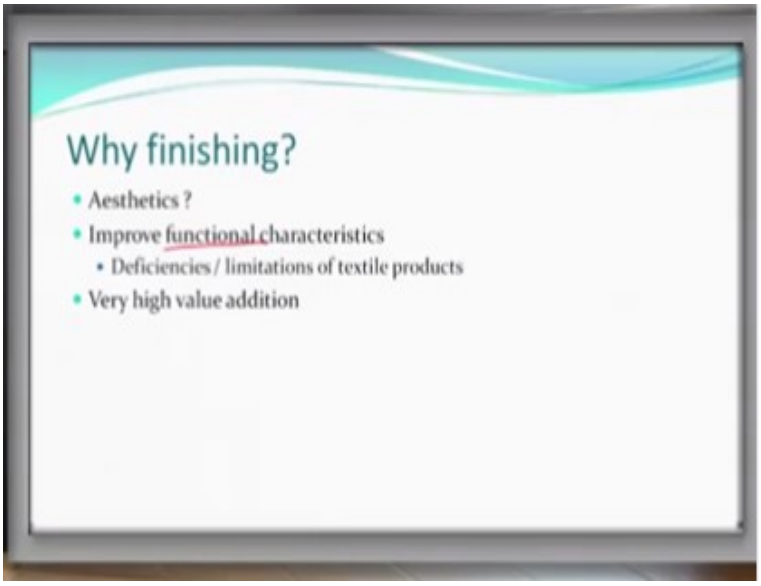

At this point maybe we can answer this question, why finishing? Some of it you already know, because the fibres and the fabrics made out of them or the garments made out of them, will have some limitation as a carryover, some limitation as a carryover of the properties of the fibre, that means which is obviously being governed by the chemistry.

So, one of the things could be aesthetics that it would look good, if you do some finishing. Yes, this could be one of the reasons why, for example after washing you like to iron, so that the surface become more smooth, smoother, right? So, aesthetics could be one of the reasons why you may like to do finishing. The finishing term means this is almost a last process, you have finished the thing and you have given it to the thing, end of the processing operation.

Other important thing is, why we would like to do any finishing treatment, is to improve functional characteristics, like we said it creases, so can we do something, so that, it does not crease? It burns rapidly, can we do something so it does not burn rapidly? Bacteria grows on it, can we do something, so that the bacteria do not grow on it? etc. So, the more important role the finishing would play, is to improve the functional characteristics of a textile. And depending upon what have we done, it is one process which adds quite a lot of value.

If somebody sanforizes a fabric, it is put there, it is sanforized. If you give an anti-shrink treatment, you write there, it is an anti-shrink treated fabric, value addition is very high.

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So, if you look at the classification, general classification, we can talk about it, basically 2 ways.

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One is the mechanical finishing, that use on some kind of machine, to do a certain improvement and which improve certain functions or aesthetics, that is mechanical, where you only use machines basically. Some of the examples, we will take it later. The other is chemical finishing, that means you are going to use certain amount of chemicals, which is going to alter the properties in one way or the other, obviously, in favorable to us.

Of course, there is no doubt that machines are going to be integral part of all finishing processes. You cannot apply a finish or do anything without a machine. So, even if you are doing chemical finishing some machines will be used, even to apply the chemical effectively.

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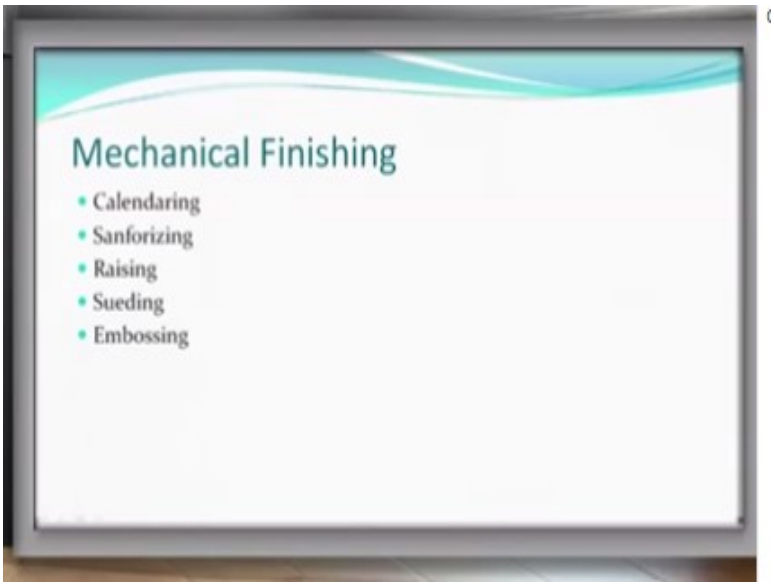

So, what are the mechanical finishers? We can look at it. Calendaring is one of them. We will now discuss all of them just now. We are just talking about calendaring, it is like ironing, removing creases. Sanforizing is very important finish, which reduces the shrinkage of a fabric after washing. Raising. In singeing we are removing the hairs, burning them. In raising by, we are actually doing the reverse after the final finish you want to raise the hair fibres from the surface, so that they look nice.

Something similar is called sueding, so sueds, you must have heard, it is a mechanical finish. Embossing, you may like to put a design, some kind of a design on the fabric by embossing.

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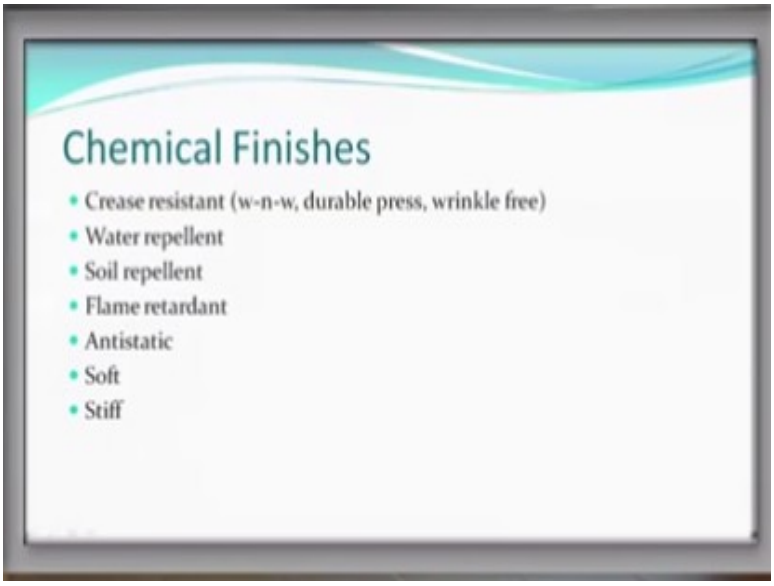

Then, there are chemical finishes where performance is going to be more important than the aesthetics. Crease resistant finish is one of them. Sometimes it is called wash and wear, sometimes also known as durable press, sometimes called wrinkle free. These are some of the term which are used, if you do a crease-resistant finish. All of such fibres which crease easily may be given a crease resistant finish.

Water repellents, depends if you are interested to repel water, what it means is that, if you just walk in through a light rain and shake your garment surface, will be dry. Soil repellent, obviously, everybody would want, almost every fibre would like to have a soil repellency treatment. Flame retardant, most of them all household and the apparel which we wear would require a flame-retardant treatment, they all burn.

Some other fibres which are not used in technical applications may not burn, but we are not talking about that, if they do not, they do not require. Antistatic, depends on what kind of a material that we are using. Soft, stiff finishing, if you want to give.

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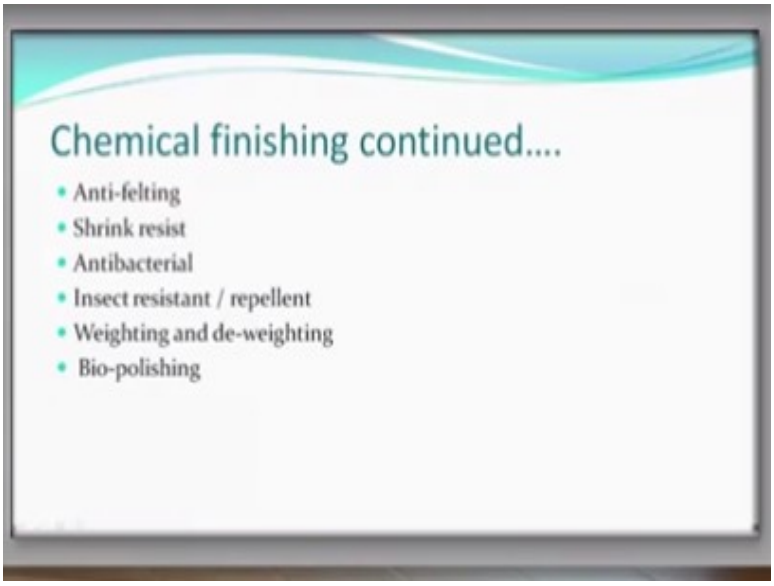

Anti-felting, the wool felts, we talked about, if you really require that shrink resist wool, so that does not shrink, it is a different kind of thing we will talk about it when we actually talk about wool. Antibacterial, this is again a chemical finish, because you have to use some chemical which will act against the bacteria. Insect repellent, as we talked about moth proof, moth proofing or treatment against a moth which is an insect.

Then, there are other finishing process where you remove polymer which is called de-weighting or you add polymer or add any other material which could be inorganic or organic, to increase the weight of the fabric. So weighting, de-weighting processes are also there, bio-polishing is just like singeing, but after is like a finishing process done by enzymes.

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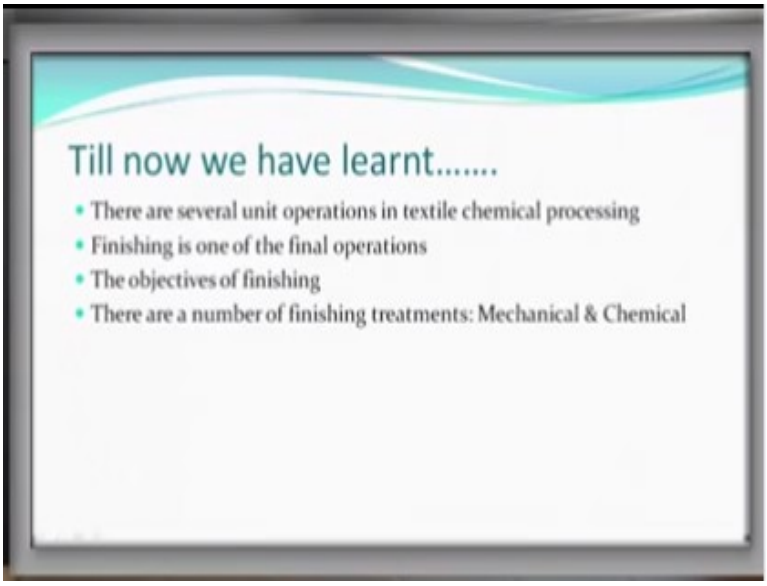

So, there we are. What have we learnt? That, there are several unit operations and finishing is one of the final unit operation before you actually sell the fabric. We have also learnt the general objectives of finishing processes and that there are a large number of finishing treatments, mechanical and chemical, which can be given or are given before we market or sell the material or a product, which you can see is a large enough space.

All of them are different, have different chemistry and all of them will require different attention, based on the chemistry of the fibre itself.

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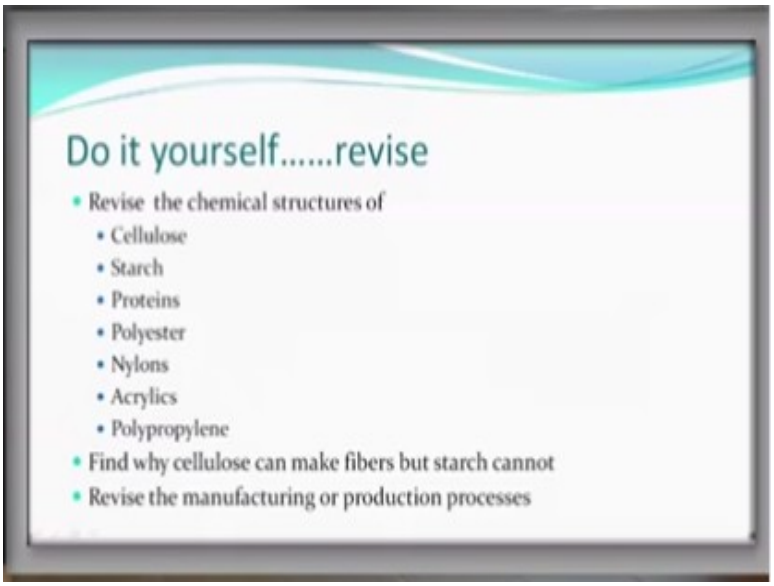

So, before we meet again, maybe you like to do few things yourself, revise from your old notes or go anywhere else look at it. The chemical structures of various fibres, note them down on your notebooks or whatever material that you remember. Starches, proteins, polyesters, nylons, polypropylene, maybe you like to answer as to why cellulose can be used to make fibres either naturally we have cotton or other manmade fibre, starch does not make fibres may like to know.

You may like to recall, remember, revisit the manufacturing or production processes of the some of the fibre which you will like to finish it in some stage, so that you know the chemistry, you recall that and so say well, yeah, of course this require or does not require.

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So, that is all we will do. We will meet in the next class and take up one of the finishing processes, thank you.