Textile Finishing
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Module - 6
Lecture - 13
Water Proofing and Water Repellency

Welcome back to the course on textile finishing. So, let us first see what have we done till now.

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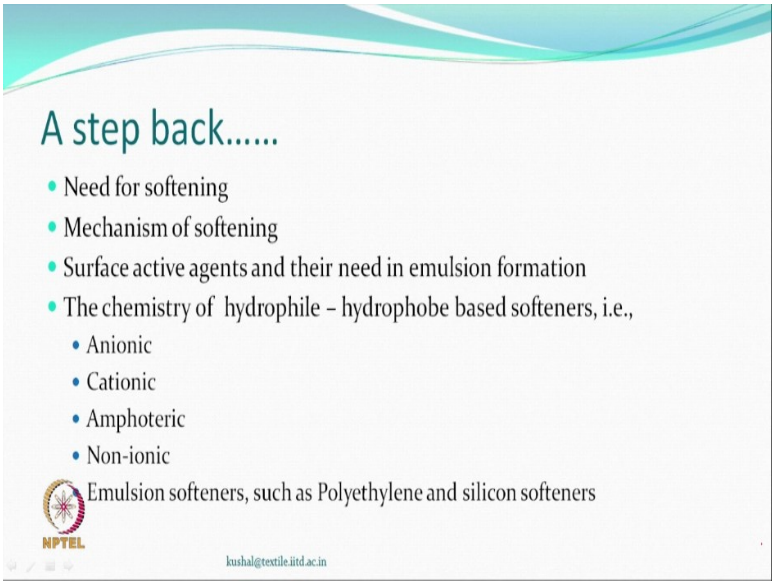

So, we were talking about softening and soft finishes. We did talk about the need for having a soft finish, the mechanism which in general meant reducing surface friction between the fibers, between the yarns. And we understood that softening is basically, primarily a process which is a surface process, surface treatment process; not a bulk process. We also understood that some of the software which are not going to be water soluble, because they do not have hydrophile.

They will have to be emulsified. And they can be applied as emulsion. And the classifications based on hydrophile, hydrophobe are anionic, cationic, amphoteric, non-ionic; and other than that you have emulsion based softeners like polyethylene or silicon softeners.

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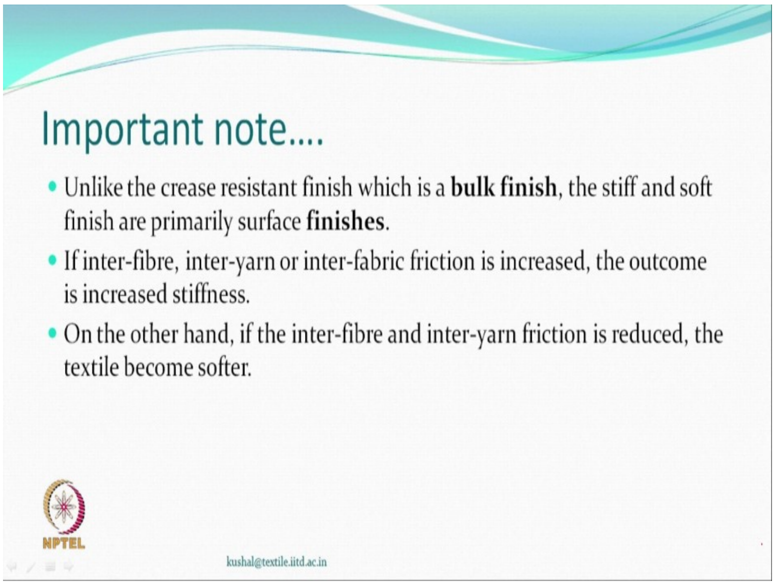

So, just to remind again that unlike crease resistant finish which is the bulk finish, the stiff and soft finish primarily are surface finishes. Is that okay? Right. What else? It reduces inter-fiber, inter-yarn, inter-fabric friction. If it is reduced, then it is soft. If you increase, then it becomes a stiff material. Alright. So, when you reduce it, it becomes softer. If you increase it, it becomes stiffer. Right.

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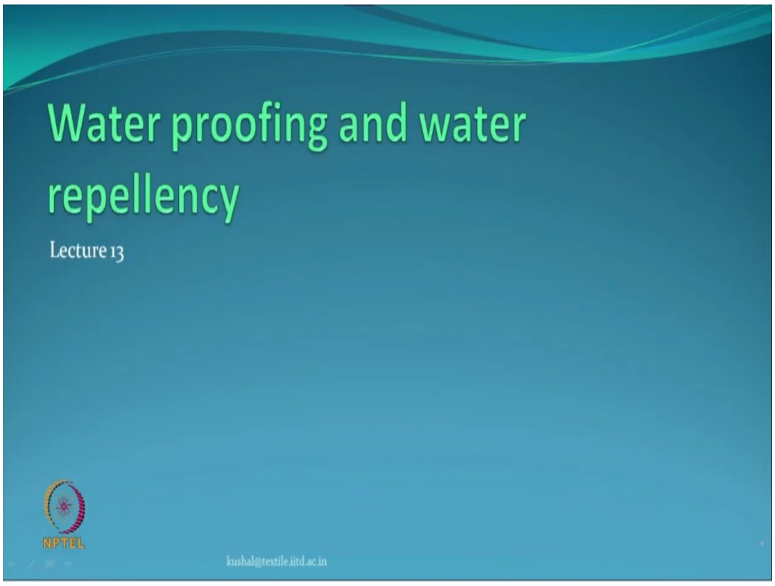

So today, we shall spend some time on waterproofing and water repellency. In fact, in next few lectures, we will talk about repellency and proofing;

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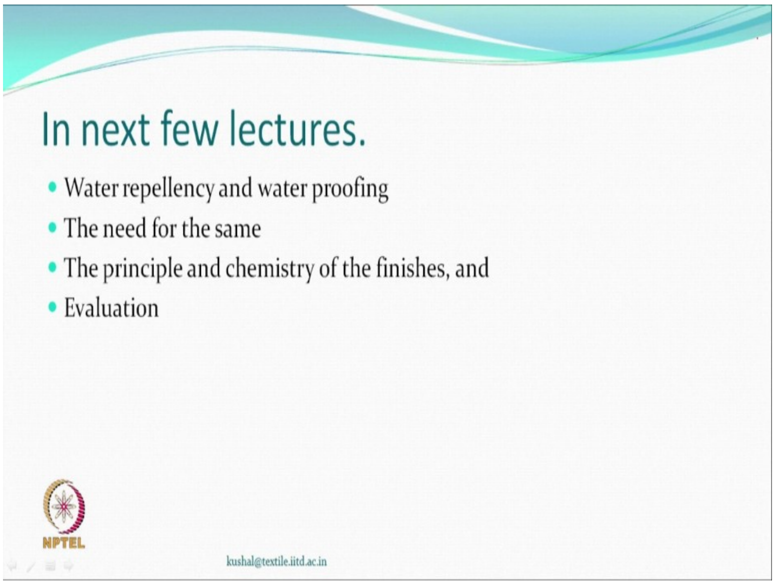

The need for these; and general principles involved; and the chemistry of the finishes. And of course, we will try to see how such finished material fabrics are in some sense evaluated. Right.

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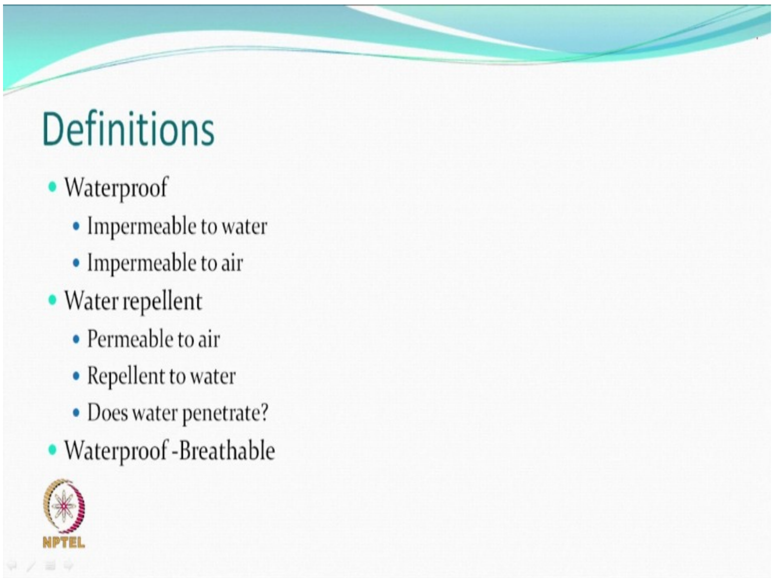

So, let us look at some of the definitions. So, before we try to see the finish finally, let us talk about some of definitions. Waterproof is a type of finish where we expect that this will be water impermeable. Water should not be able to penetrate. But it so happens, during this process, it becomes impermeable to air as well. So, such type of fabrics which are going to be impermeable to water and impermeable to air will be called waterproof. Alright.

We will try to understand whatever it means in a later discussion. Then they are finishes which you will call as a water repellent finishes. Here, they will obviously be repelling water, because they are called water repellent. So, they are repellent to water. But they are permeable to air. Now, this is important. If somebody asks a question, does the water penetrate well. It will penetrate if you apply some pressure. Alright.

So generally, when water falls, we expect it would not wet the surface and would just drop off. The another interesting offshoot of these type of fabrics is these days, what we call them waterproof breathable. So, the change that we are looking here is that they will be impermeable to water, but they can still breathe. What it means is, the air can pass through, the water vapor can be transmitted through. So, they are the other kind of material. So, we will talk about all these little bit as we move on.

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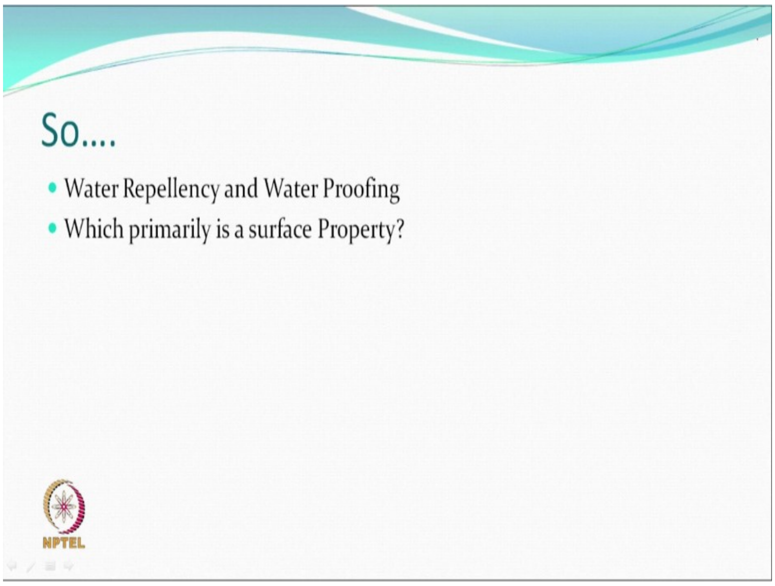

So, if someone asks this questions, that water repellency or waterproofing, these are 2 types of fabrics that we just talked about. Which one will be a surface treatment? Waterproofing, does it require a surface treatment or water repellency which is a surface finish. It is interesting to note that as far as water proofing is concerned, whatever surfaces that you may create, they may repel, they may not repel water.

They can be wet. But a waterproof material will not allow the water to penetrate, but it can get wet. It may appear as wet. So, although, whatever treatment we have given, is doing its job for waterproofing, but may not be water repellent. Of course, you can make it water repellent. When you say water repellency, that means, the surface of the textile has been made, changed, modified into one which repels water. That is interesting. So, one of them is definitely a surface property, change of surface property, which means the water repellency.

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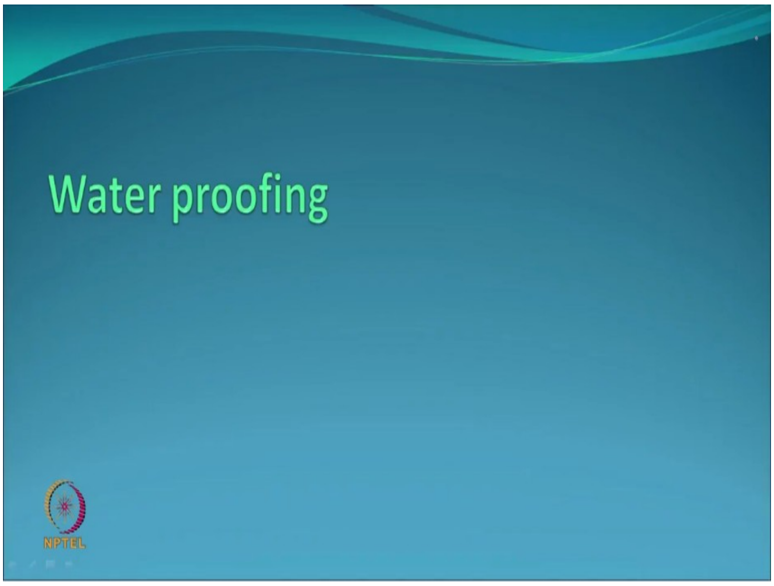

So, the first discussion that we will have is on waterproofing. So, let us see what it meant? What do you expect? Where do we need? You see, you have tents, you have raincoats. You do not want water to penetrate at all. Tentages, you do not want water to go through the tent. They are all textiles. So, these days, you have large structures also being made from there. And so, you would have, that you have the need where you do not want water to penetrate at all. That means, waterproofing is required. So, that is the need. And what do you expect?

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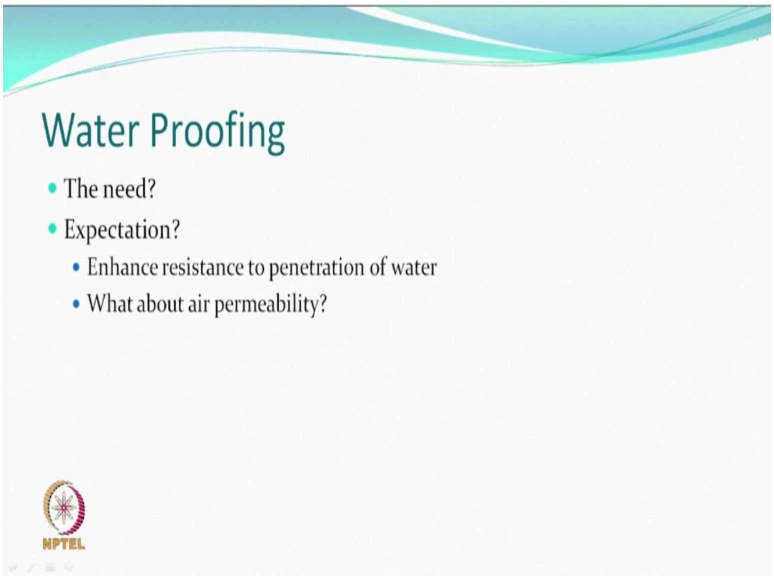

We must enhance the resistance to penetration of water. Now, enhance the resistance. How much well that depends on what application we are looking at, but it increases tremendously. How do we do it? We will check that out. When we talk about the air permeability, we just talked that, generally we will expect the permeability to the air will be reduced considerably.

In fact, if we say that air cannot pass through, it also be a good statement to make. Right. That is what is the expectation.

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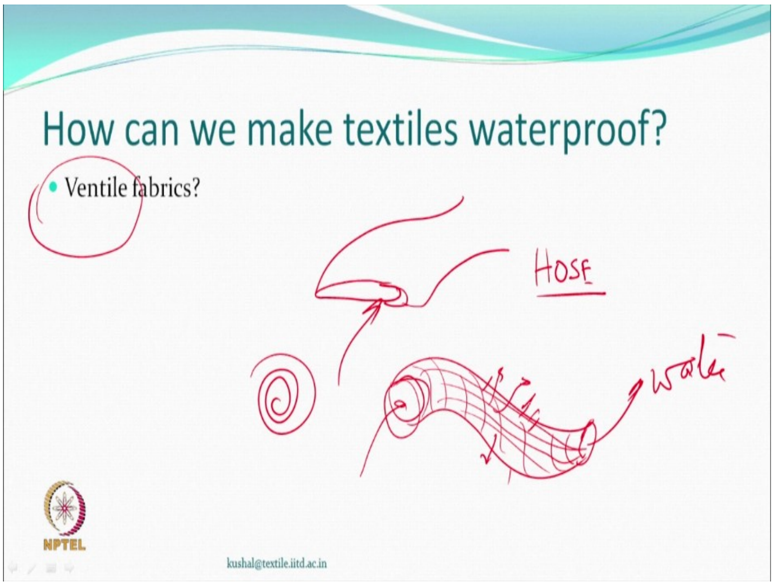

So, early days, I do not know whether you have heard about materials called the ventile fabrics. Ventile fabrics, have you heard of them? See, if you make fabrics which are tightly woven from hydrophilic material like cotton for example; if you wet them; as a tightly woven system and if you really wet them, they swell. So, when they swell, whatever little gaps that were there, they also almost disappear.

And so, the whole thing becomes very tight. And so, it does not allow water to go through. One of the interesting application for these thing goes the hose. Hosepipe, which is let us say of, for fire hydrant, you have hose pipe. This is, let us say, made of textiles, but tightly woven. So, water can go through and come out from the other end. But we would not want the water to get out from the sides.

So, in this kind of a hose, when people pump the water, initially, water starts coming out from this, the wall of the hose. But as it gets wet, we certainly find, the water does not come out at all, because of swelling; swelling of fibers, the swelling of yarn; and then making everything tight. And so, water do not come out. Such type of fabrics were called ventile fabrics. Alright. So, they could otherwise let the air pass through.

And therefore, it is like, they could, they are vents. But in any case, advantage of this type of material initially people felt was, that you can pass the, pass lot of water through these tubes, the hose, but it may not require or use a lot of volume. Because, a textile pipe or hose, in, can be flattened. And then, you can roll it; roll it like this. So, storage space becomes less. Whenever you open, it will open. And then, you pass the water, it will become cylindrical. And then, after some time, water may not come out at all. So, these type of fabrics were called ventile fabrics. So, that is one of the ways. But there are other ways to make fabric waterproof.

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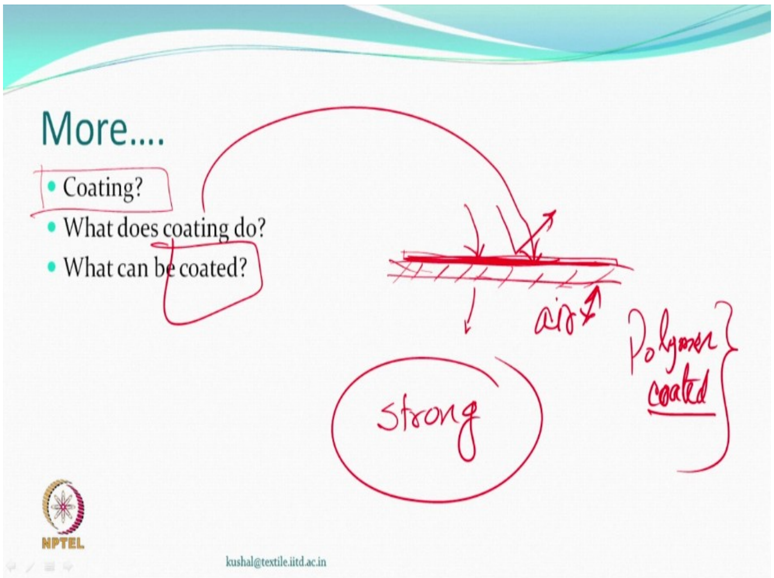

And the most popular way to make a waterproof fabric is coating. That is, you have a textile material and you can coat it. What will the coating do? So, this is a textile material; a fabric, let us say. On top of it, let us say you make a coating of some polymer, let us say. So, it closes the interstices. It completely closes the interstices. If it completely closes the interstices, it will be difficult for water to pass through; very difficult.

So, in a way, it is going to be thrown out, not repelled; resistance to penetration. Alright. What can be coated? Yeah, there is it, some polymers, which are suitable polymers. They can be coated. What is expected of the polymer coating? That it would resist the penetration. That it would make a film over the surface. Okay. By doing this, obviously, it will be difficult for the air also to pass through, difficult to, for the air to pass through also. Right.

So, this is what we will do. And what is the role of a textile? Textile is a strong material. So, the final product that we have, the tensile properties, the strength are going to be contributed by the textile. While the coating that you will do, this coating; this will help to increase the resistance to penetration by water. Is it right? So, both of them have a role to play. So, interesting role is textile gives you strength.

Of course, it is flexible. But you make a film or a coating so that the water does not penetrate. That is how you make things waterproof. Now, when you coat, you remember we talked about stiffness. If you coat something like be the starch or any such material, then the stiffness increases. And we did talk about something like glass transition temperature. Right.

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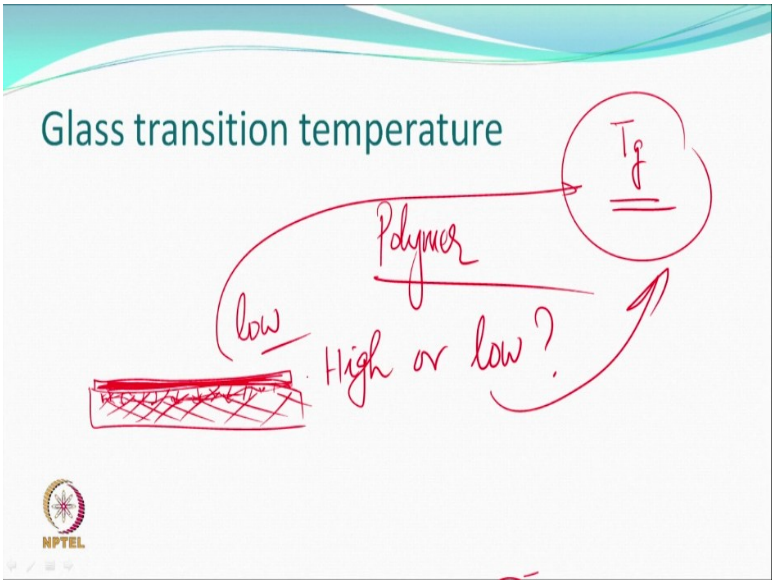

But here, our aim is to ensure a resistance to penetration. That is one. Our aim is not to make it stiff. So, the so called polymer which will be coated should have a glass transition temperature which is low or high. A polymer which you want to coat on a textile, the glass transition temperature of the polymer should be high or low. Yeah. It should be low. Why should you lose your flexibility?

You may not like to wear a raincoat which is like a sheet. You will want the raincoat also to drape on your body the way any other textile would do. And that would mean that you definitely want materials with a low glass transition temperature. Okay. It would be great if there is a textile and you just create a layer. And this layer which has been created also has a Tg which is low.

Then, this whole composite structure is going to be as flexible as you would desire. But obviously, some of it, for anchoring purposes may penetrate if you are working through solutions into the structure, to get good anchoring, so that does not delaminate very easily.

And so, people will want some amount of diffusion, so that there is a good anchor. That will happen of course.

If that happens; so, whenever there will be lot of anchoring, let us say the whole of it passes through, goes through all interstices; interstices will be closed. If it is a high Tg, it will become very stiff like a board. If it is a very low Tg, it can flexible, it will be flexible, it can bend, twist and so on so forth. That will be our main interest. So, low transition, glass transition means, some polymers, some of them are called elastomers.

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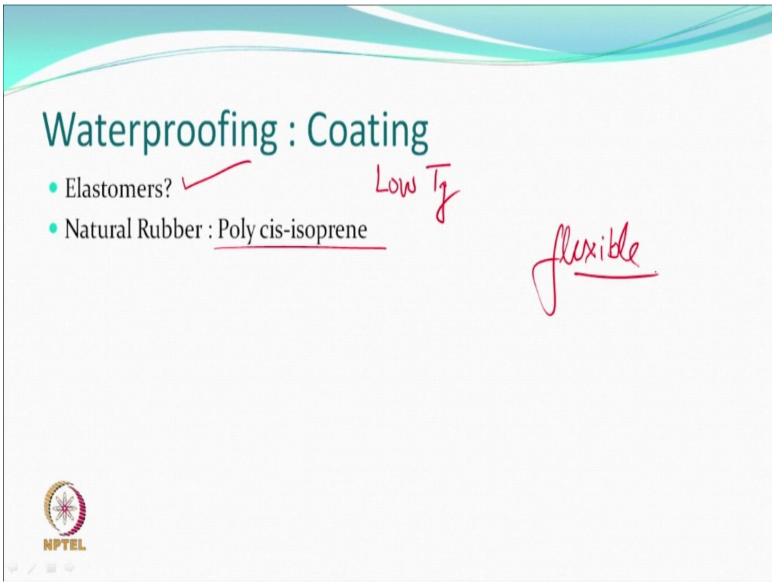

Elastomers, you understand? Something which has elasticity. But not just the elasticity, the way talk of metal. It can stretch to 200%, 300% and so on so forth. And then, recover also. So, if that is the kind of property that acquire in a polymer, those kinds of polymers will be considered as what we call as the elastomers. Okay. They are elastomers. Alright. So, let us see what kind of polymers you may like to use.

So, one of the polymers, a class of polymers which are called elastomers definitely have low glass transition temperature. What are these elastomers? Elastomers are compound which can stretch easily. For example, they can stretch to 200%, 300%; and come back. So, because of this, they are very soft. So, they stretch easily and they recover. If that kind of a polymers that we have, those will be called elastomers.

And one of the examples is ploy cis-isoprene, which is natural rubber. You have seen rubbers? Yes? They stretch easily; come back. Alright. If you have a rubber yarn, what will happen? It will stretch, come back. Do you know any other elastomer? Spandex yarn. You have heard of spandex, lycra? So, they also stretch easily, come back. So, such type of elastomers, if you can coat them on the textiles, because they have low glass transition temperature, the overall product will be also flexible. And it will also serve the purpose of waterproofing.

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So, this is what we just talked about; natural rubber which we know. But there are other rubbers which are synthetic rubber, which are, otherwise did not exist in nature, but are available. You can use them for coating purposes also. Some of these, we will just talk about them one by one. Just take their just general structure, not go into detail of how they are prepared, manufactured. But at least we should know what the structure is.

And of course, we have our own interesting material called the polyurethane, PU. You have seen various kinds of applications of PU. And then, other polymers which are relatively low glass trans temperature, but not necessarily as low as, let us say natural rubbers and synthetic rubbers. They also can be used to make waterproof materials like PVC, polyethylene, which is a softer material. Can also be somehow applied onto the textile to make them water proof.

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Let us first look at rubbers, which we said are elastomers. And the first thing we talked about was a natural rubber.

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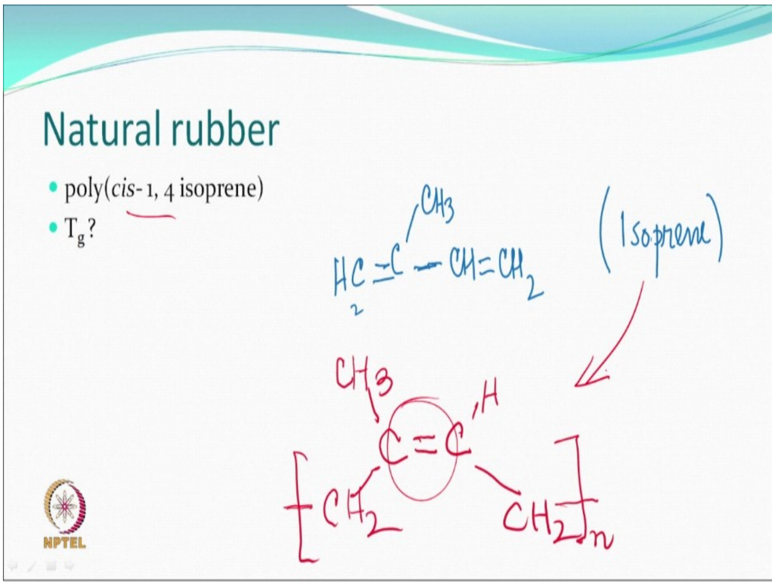

It is a polymer of cis 1, 4 isoprene. See an isoprene is, has got 2 double bonds; one here and one here. So, these double bonds obviously make sure that you can make an additional polymer. But also, the polymer can be generated in many ways. One of the ways is, 1, 4 linkage is that first carbon and fourth carbon are linked. You see, this is the carbon 1; then this is carbon 2; carbon 3; carbon 4 of the main chain.

And of course, it has got a methyl group. Right. Now, 1, 4 means, it will be starting from here, there. But there is a cis. That means, you have this configuration has been fixed. And because of that, the properties change. For example, what will be the structure of this? Let us look at it. The structure is, this is first carbon, this is fourth carbon. Okay. And the CH_2 groups, if they are on the same side, against this; same side, opposite to the methyl. Then this type of a material is cis poly cis 1, 4 isoprene, which is your natural rubbers.

Obviously very elastic. Glass transition temperature of a natural rubber, depending on what have we done also; what is the molecular weights also; could be – 70 degrees. That is much below a room temperature. It is just like, sometimes people talk about, explaining the physics of rubber or rubber elasticity, using almost as if it is a gas. Alright. So, it is a very, very low glass transition temperature.

Therefore, very flexible. As such, it is difficult to use rubber, because it is a very fluid kind of a situations. So, you have to do some amount of vulcanization or cross linking. And it can be done. Because, in the polymer, you see, there is a double bond already. See, therefore, you can do some cross linking of the polymer itself. Alright. So, this is a rigid structure; because of that you get cis transformation configuration.

And so, you get from isoprene to polyisoprene. So, this is natural. It has been used for various purposes, including coating on textiles. Alright. So, one, of course, as we said, you could make theoretically anything.

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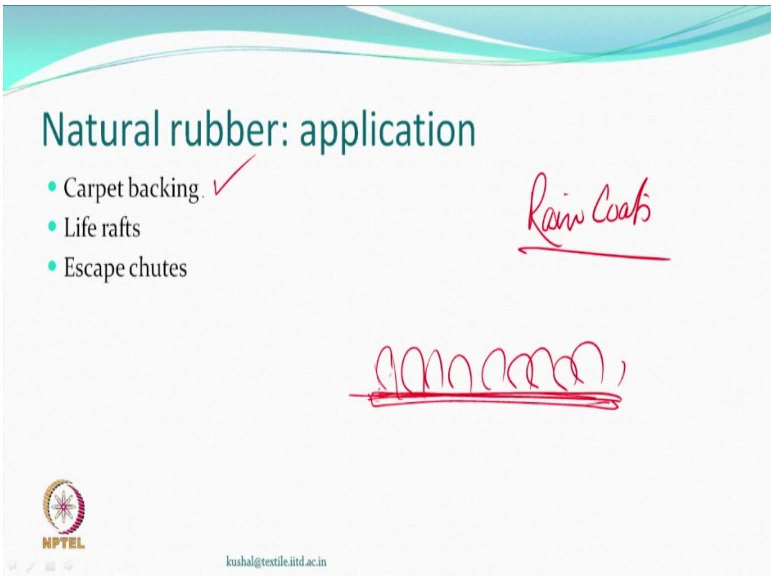

So, shall we say, raincoats? Yeah, people earlier were making raincoats. And others are carpet backing. For example, you have a carpet which is a pile carpet for example, with a lot of piles are there. And how to make sure that these piles; and sometimes, they may be cut piles. Right. So, how do you make sure that they do not come out. So, at the back of the carpet, you make backing.

Life rafts, where the air is pumped in. And so, where there, there can be, it can be used; escape chutes, etcetera. The natural rubbers can be applied; sometimes, as it is; or sometimes, in combination with synthetic rubber. The only thing is that the degradation or stability of the natural rubber is relatively less. So, you may find that the material is getting deteriorated with time.

That can happen with everything, but natural rubber has. So therefore, people thought there can be, there is a need for development of other compounds also. Alright. So, with time, so theoretically, you can coat this rubber without any problem.

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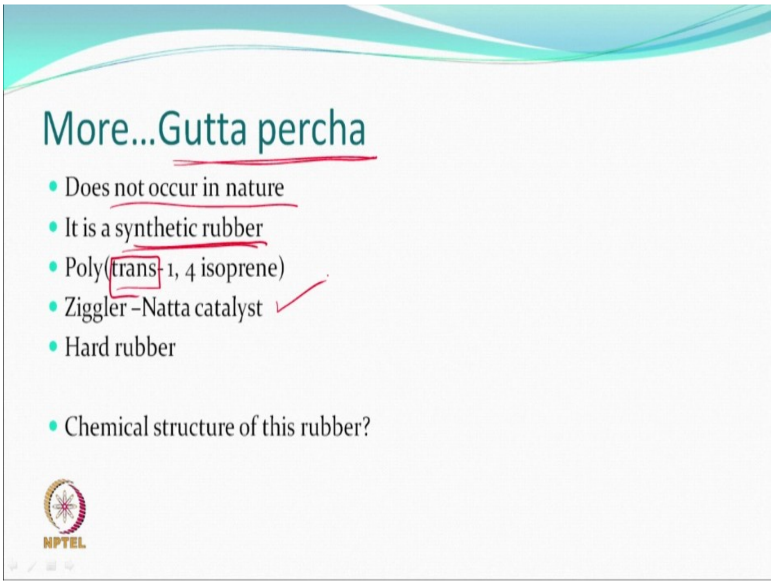

Another interesting elastomer is also known as gutta percha. This does not occur in nature, unlike; why I am talking about is, because it is also isoprene, polyisoprene. Alright. But it does not occur in nature. So, it is a synthetic rubber. But, what is the difference? Difference is, this is trans 1, 4 isoprene. Just changing this configuration can change the properties. And how do you ensure this?

You have to do some kind of catalysis to make sure you get instead of cis, trans. And this is also sometime known as hard rubber compared to natural rubber, because of this configuration. So, what could be the chemical structure when how will this polymer look?

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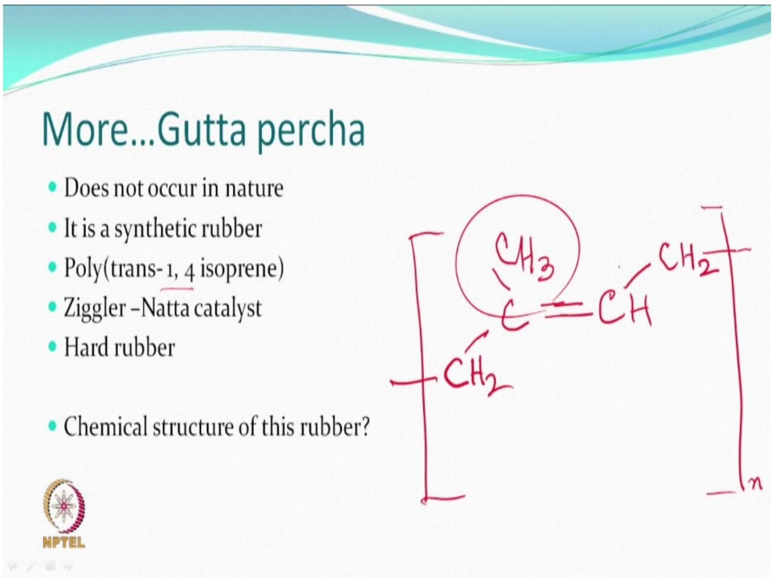

The polymer would look again similar, but now you can see that this CH_2 group are not on the same side. They are on opposite side. So, there is still 1, 4, but opposite sides in relation to the methyl group that we are talking about. Right. So, it changes the property. So, it is interesting that you can always make different kinds of rubbers which would give you different properties.

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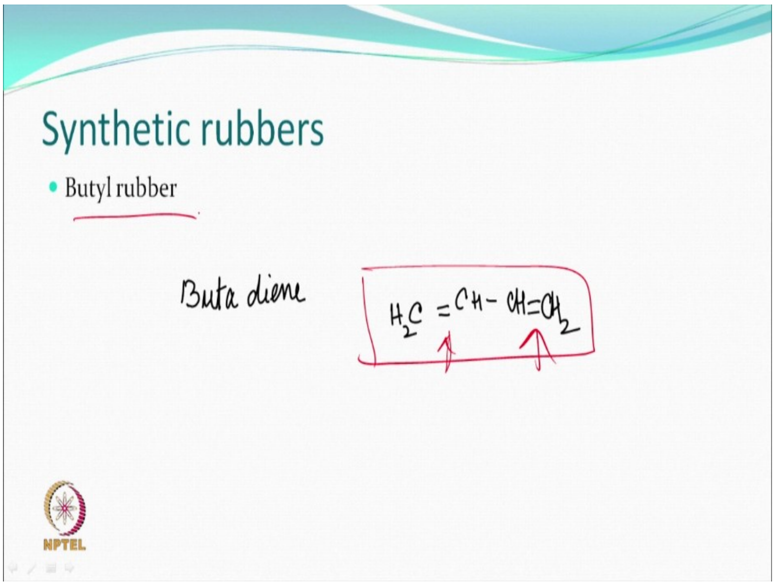

Another interesting synthetic rubber is called the butadiene or butyl rubber. Butyl rubber, inspiration again is from the isoprene, but this is also not natural, it is synthetic. Alright. So, you again have a compound which has got 2 double bonds. Isoprene also had 2 double bonds. Right. And so, this can be polymerized to something what we call as a butyl rubber. And if you do that, how will it look?

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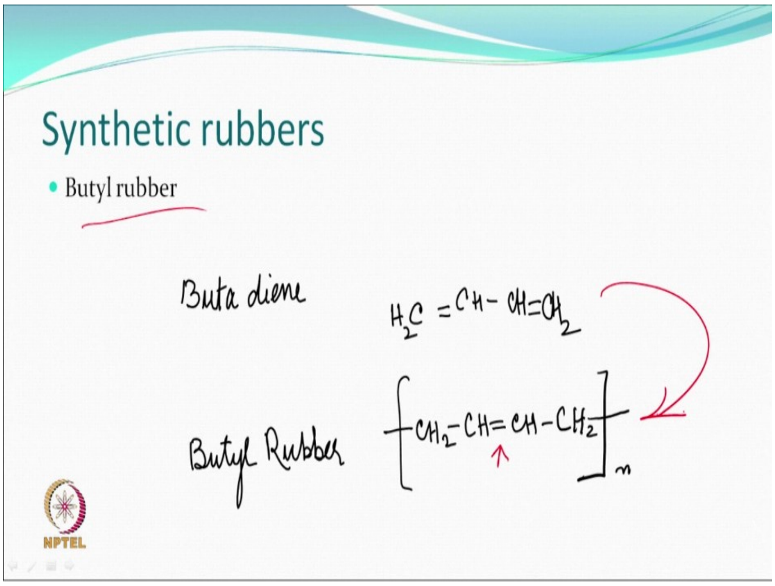

Well, it will look like this. The double bond goes in the center. So, it is also in some sense an unsaturated rubber. Now, the hardness of this material can be changed by cross linking. This double bond will help you. Right. So, those can be done like a natural rubber we talked about. Sulphur can be used for vulcanization. Some of these things can be used here also. This double bond will then cross link and it will become more rigid. Right.

Did you hear about some word called ebonite? Ebonite, it is of the highly cross linked natural rubber is an ebonite. It is a very strong rigid system. So, the more you cross link, you can make it rigid. So, all earlier principles are in work, that the cross linking between the molecules can make them rigid, make them stiff and so on so forth. So, based on how much stiffness do you want, you can change that. So, that is a interesting property. So, you have a butyl rubber which is from butadiene. So, butadiene to butyl rubber. This can be also coated in textiles.

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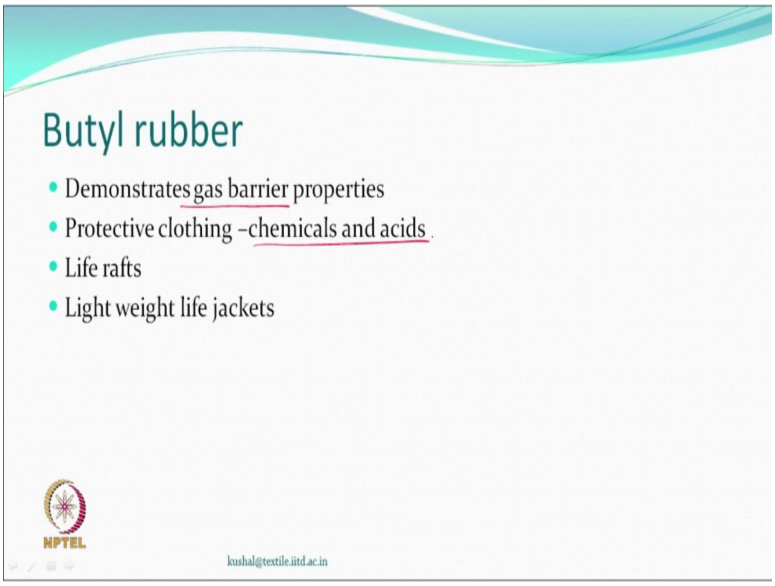

Interestingly, it demonstrates gas barrier properties. So, if you are filling up gas in a coated textile material, so you can expect that the, it does gas impermeation also. Otherwise, we said water proof fabrics do not very easily allow the air to pass through. But now, here we are looking at, under pressure also it does not come out. Right. So, for those, it becomes very interesting.

This rubber can be used for protection against chemicals, acids, so on so forth. So, you have aprons which will be interesting, so that they, the protection, for the protection of the worker for that matter. Jackets, lightweight jackets can be made; rafts and so on so forth, which require a fabric. Remember, what does a fabric do? Fabric gives you tensile strength; of course, it is flexible.

And the coating gives you resistance to penetration. Now, it is important, Right. Here we say gas. Important means, you do not want water to go through. But you have an application where you do not want the air to go through also. So, coated textiles are useful; waterproof textiles are useful. Another interesting elastomer is called the neoprene.

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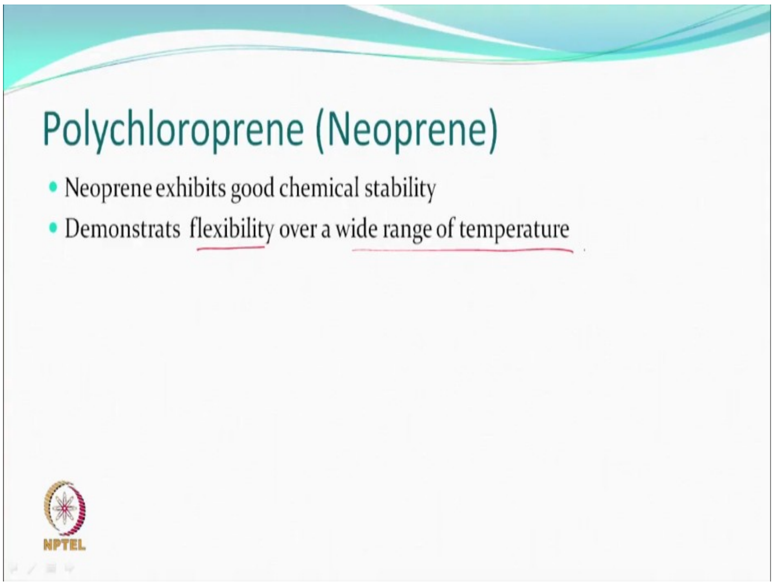

These days you may see a lot of products where the neoprene has been coated on textiles; a knitted structure, a woven structure, where the whole thing can stretch and come back, the whole textile. If you have knitted structure, it can stretch and come back. And these kinds of products obviously do not allow, let us say water to penetrate. Or if you have products which are waistbands, for, and you do exercise, lot of sweat comes out.

And the sweat will not pass through and not go to the textile and remain outside. Those type of applications, people do use. And in general, it has been seen that it is quite flexible over a wide range of temperatures. You know, does not degrade very easily. So, this is some interesting rubber. So, what do you have done here?

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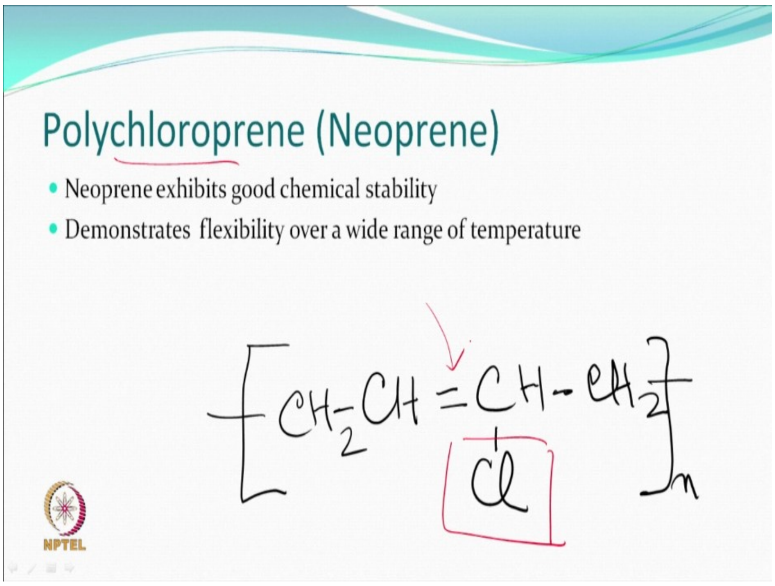

Again, a similar compound, but what you have done is, on the butadiene, instead of putting a methyl group, now you also have put a chlorine. So, it is a chloroprene. And also sometime known as a neoprene. It is a interesting rubber which is coated. So, the material which can be coated onto the textile is an elastomeric material. They are all soft. But at the end, as I said before also, you are leaving it with a double bond. So, by itself it gives some amount of configurational changes can be obtained; plus it allows it to be cross linked if required.

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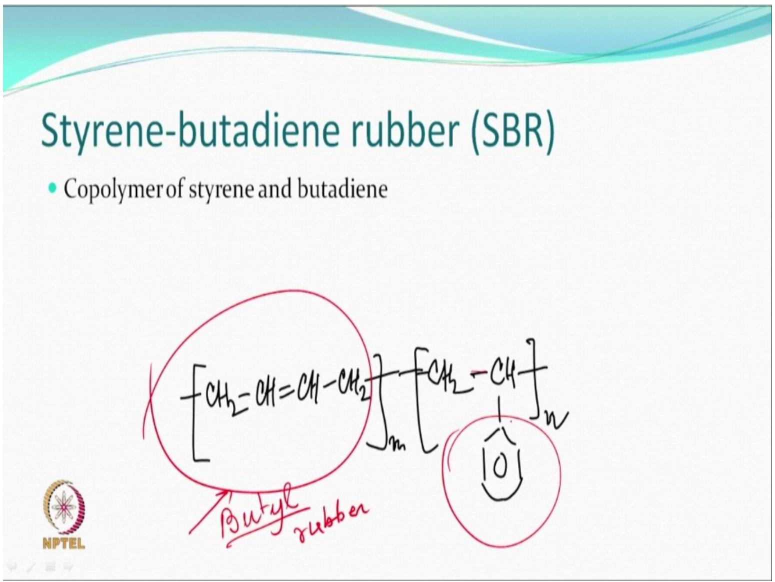

Very interesting industrial rubber which can also be coated and they are used in conjunction with textiles in many places is SBRs, styrene-butadiene rubber. So, butadiene is something which we know already. This is the butadiene which was there. But now, if we use styrene; so this part is like a butyl rubber, you know, made from butadiene. Okay. You know what is a styrene?

It is also a double bonded structure, but after polymerization, it becomes a single bonded structure. So, it gives more flexibility but rigidity and some of the properties come from this aromatic ring. And it is very interesting rubber, in blends with many other rubbers. It can be used. People use it for tires and so on so forth. Remember, tire also is a very interesting material. They are called textile, tire chords. But there, the purpose is different. But, it still gives the strength. But you can coat this rubber as it is.

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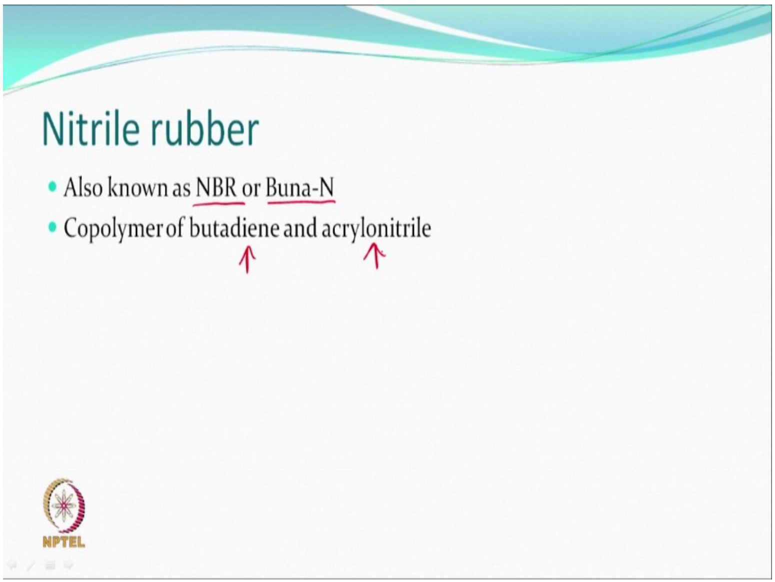

Another interesting material elastomer which can be coated onto textiles is nitrile rubber. Nitrile rubber, also sometimes known as NBR and Buna-N, based from the monomers, acrylonitrile and butadiene. The SBR was styrene and butadiene. So, butadiene is a very important monomer for making rubbers. Okay. Now, composition of how much is acrylonitrile, how much is butadiene.

This can change and you can make a different type products. But all of them are elastomers. And therefore, they can be coated, they can be applied onto textiles, make it waterproof, but still keep it flexible. So, what do we have here?

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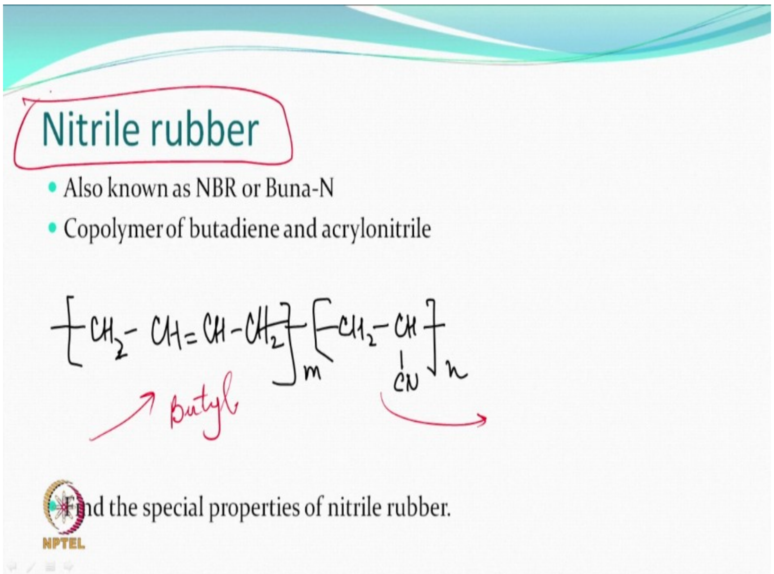

So, you have again; you remember now, from butadiene, you got the butyl component. And from acrylonitrile, you have a nitrile, polyacrylonitrile type of a component which you know also is; if it was by itself was a fiber forming compound. But gives you very interesting thing which is called the nitrile rubber.

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So, let us look at the other polymers which are, which can also be applied. One of the interesting ones which people use quite a lot is polyvinyl chloride.

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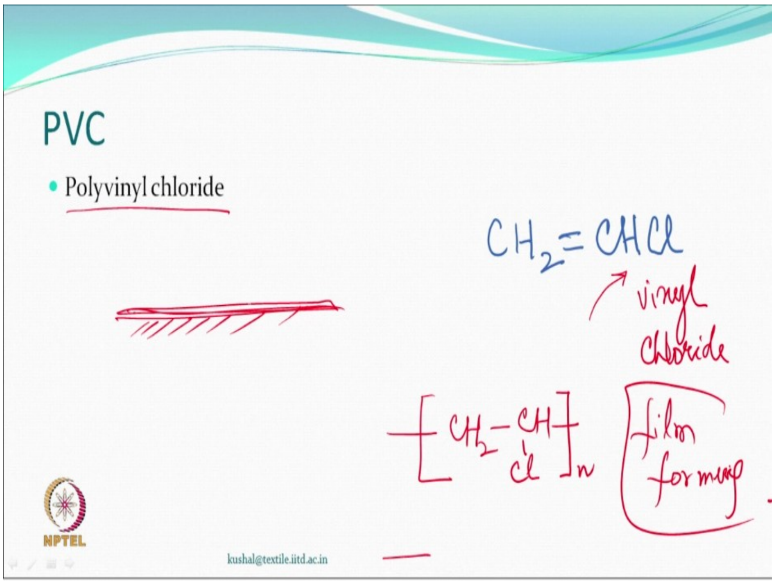

So, this is your vinyl chloride. This is vinyl chloride. But if you make a polymer out of this, this will be; so it does not have a double bonded structure. Configurations are not going to be very easily changed. But is a very important component, does not burn very easily. We will talk about it later, when we talk about flame retardancy. What makes a substance a polymer which is a film forming polymer?

So, it makes a film. So, you have a textile. And then, you have a film. So, this can be used also. By itself, it may not be as soft as, let us say rubbers. But by adding plasticizers or other things, we can make it softer. By itself, it is grass trans temperature is not that low. It has applications almost everywhere.

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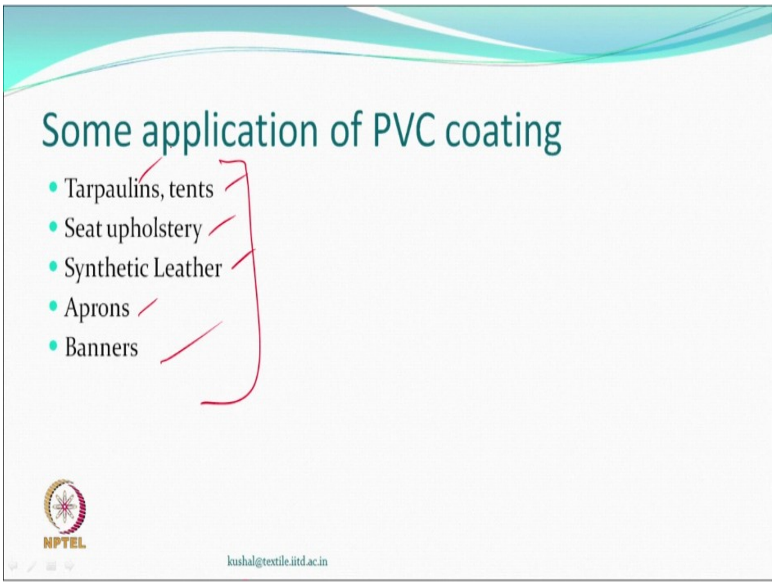

The banners that you see on the road side, the aprons people wear for various types of, particularly in the chemical resist systems, synthetic leather, upholstery, tents and tarpaulins; all of them can be made by PVC as well. And if you have a coating, you can make designs also on top of these; and they will stay. The another interesting material which we call as a polyurethane.

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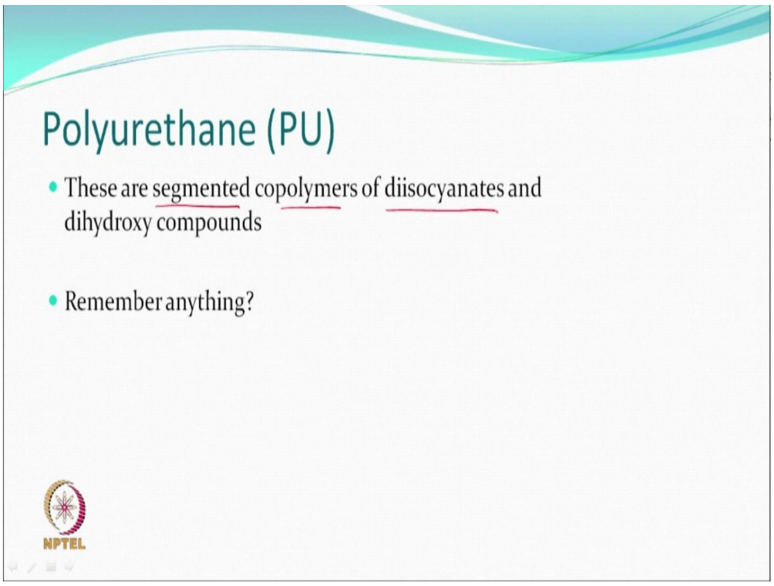

Alright. I mean, this is really one material where you can make hard, soft, polymer depending upon what you do with various components that you add. So, a segmented copolymer of at least one component in diisocyanate. Did we remember isocyanate? Did we talk about somewhere? In the cross linking of cotton also, we talked about diisocyanates. There, there was a hydroxyl group which was from cellulose.

And we thought it will react with them. But again, I remind you again, it reacts very, very fast with water. Controlling the reaction is certainly very critical and difficult to do it. You remember, in India, we had a Bhopal gas tragedy, where the water somehow came into contact with isocyanates; and then you had trouble, lot of trouble. But, if you have a controlled system, then you can make very interesting films, polymer fibers and so on so forth.

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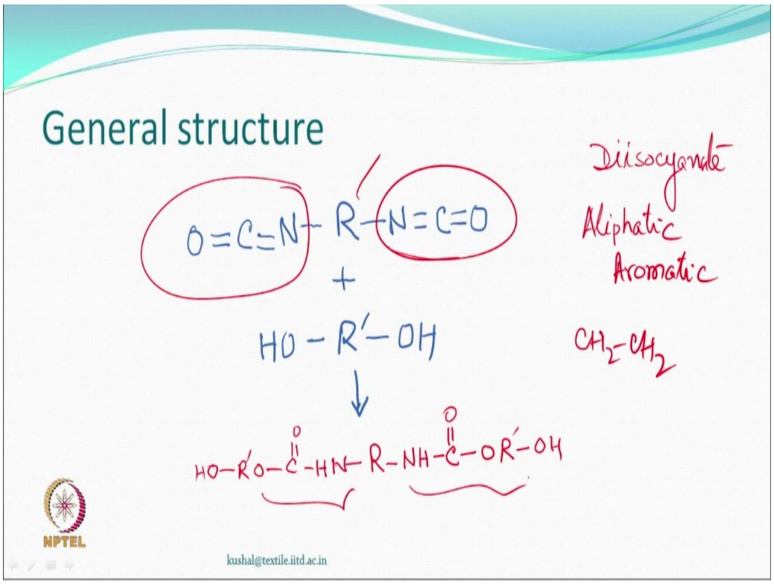

So generally, what will we have, that this is an isocyanate. Okay. Remember this isocyanate? This is an isocyanate group. So, you have a di. Now, this R could be aliphatic or aromatic. This depends on your choice. So, you have lot of flexibility here. Based on that, things will happen. Then you have a dihydroxy type of compound or polyhydroxy compounds could be also there. But let us say dihydroxy compound where the R prime could be anything.

Could be aliphatic like CH_2, CH_2, just 2 units, 5 units, 6 units, more units. So, if it is, this R is aromatic, we call it a, as if it is a cross linking hard kind of a segments getting created. If you have this as a lot of long chain aliphatic, so it will be flexible compound, more flexible chain and segments. And together, they can form a material which will be, which will have a property of elastomer as well.

For example, you may finally get some structure. Alright. So, both sides, you will have something. So, this is the urethane link; therefore polyurethane. Everything can be made out of them. Films can be made, fibers can be made. Obviously, therefore you can make coatings. Very, very versatile material;

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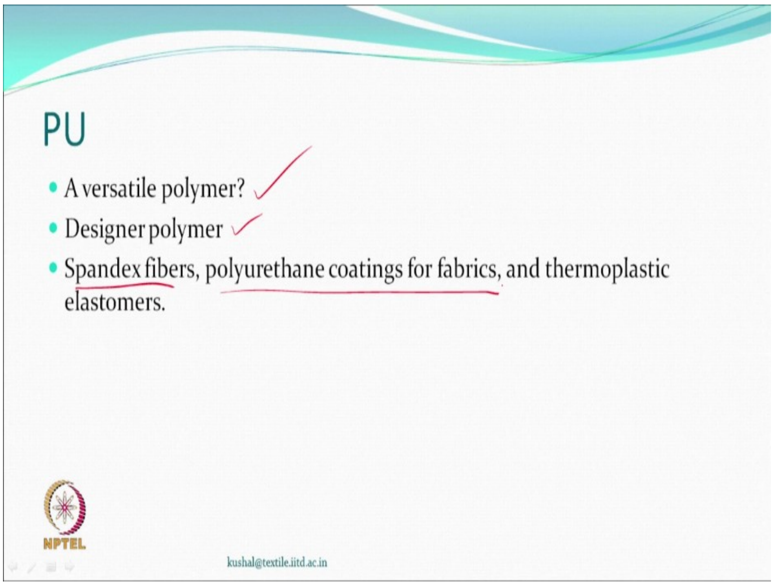

Polyurethane, very, very versatile material. You have talked about just the designer polymer; add this component more or add the other component less. And based on that, the hard segment and the soft segments can be changed. And the properties can be completely controlled, much, much more than any other material. Therefore, this is one of the more popular systems.

So, you have fiber, sometimes spandex, sometimes lycra. These are the names that you see. Coatings on the fabrics, beautiful coatings, very flexible systems can be made. You can make thermoplastic elastomers as well.

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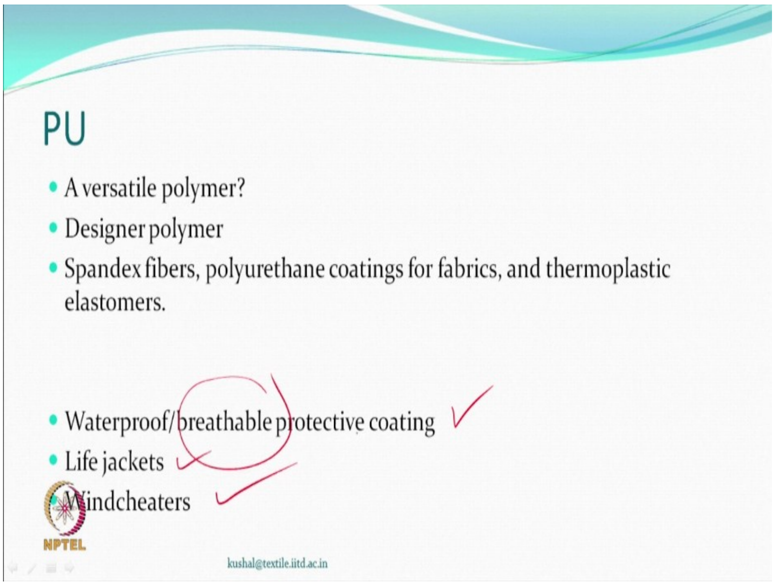

So, we can make waterproof, breathable, mentioned we will talk about later; life jackets, wind cheaters. Very thin coatings can do the job. And very lightweight. And that becomes an important. So, polyurethane is one of the interesting materials for using on textiles. So, in a nutshell, what have we talked about is;

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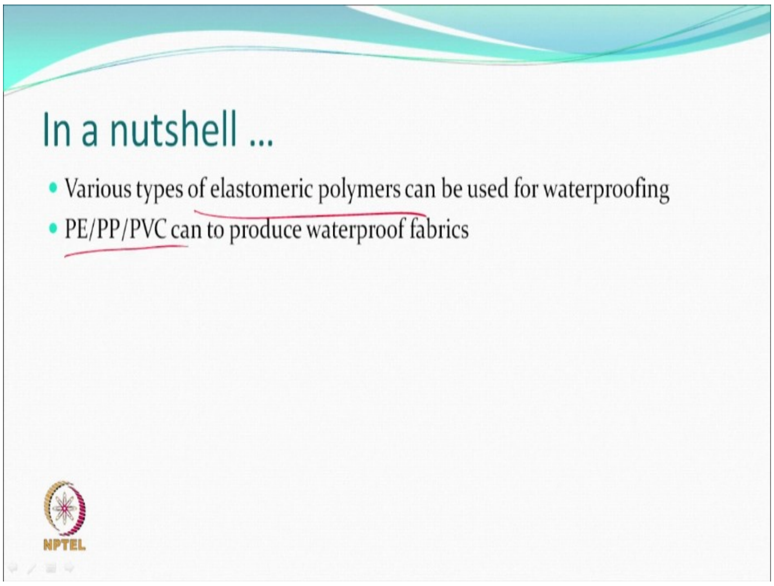

That various types of elastomeric materials including polyurethane can be used for making textiles waterproof. Right. Of course, other materials like PVC, we talked about. Similarly, PE, PP can be coated or applied in different ways; not necessarily it has to be coated only, you can apply different ways. So, that can make waterproof. As long as there is a layer which is called a film and there is a layer which is called a textile; so, it is a coated textiles.

Application process: How do we apply? There can be many ways. We will talk about one or two. So, if you can make a solution; when you apply the solution, mix a solution and then apply it. So, how do we make a solution? How can we make a solution? In water?

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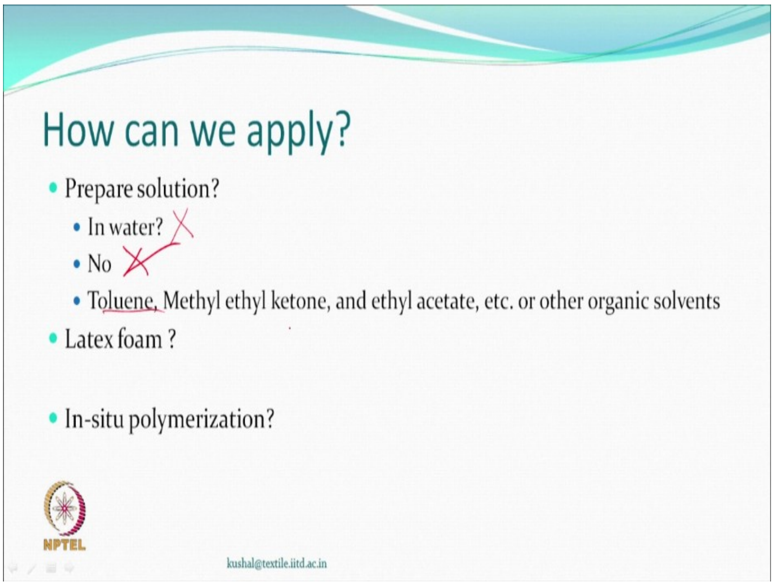

No. In water, we cannot make a solution, because they are not going to be water soluble. If they are water soluble, how would you, what is the point in adding them onto the textiles, which will be washed off. They are polymeric; they cannot be water soluble. So, you can use organic solvents. Various solvents, toluene, methyl ethyl ketone, ethyl acetate and other organic solvents can be used, can dissolve.

Otherwise, you can make latex. Latex are available, which can be used as it is or you can foam them and apply. Or you can have a situation where one monomer has been applied in one way and the other which is highly reactive applied in a second go. You can make in-situ polymerization also on the textile. Let us say, the conventional processes that we normally may like to use if it is;

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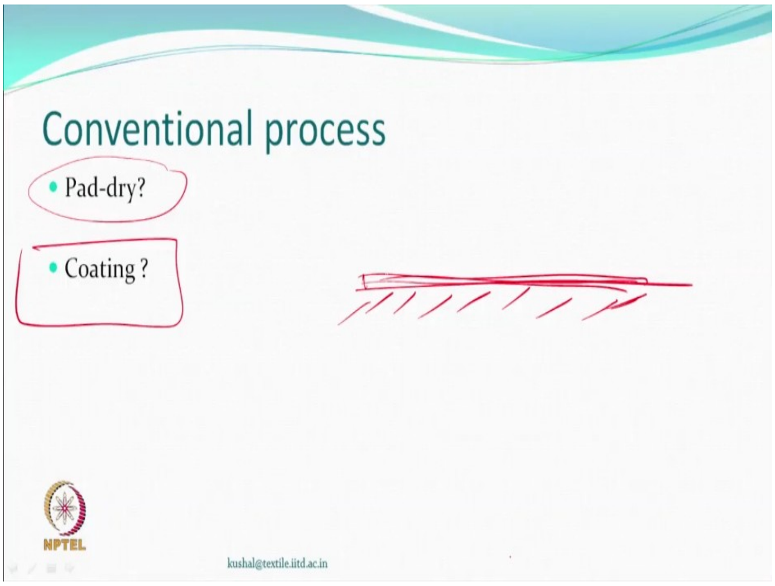

Can we use pad-dry? Of course, if we have a solution, you can have, use a pad-dry type of material. But, invariably, we do not want to completely cover the textile from both sides; unless and until our aim is not just waterproofing, but making sure the gas also does not pass through. If that is the thing, then obviously, you can coat from both sides; you can pad-dry also. But better method people believe is coating.

Coating, we just said that you have a textile. And on one side, you actually want to make this. The other side, just looks like normal textile. Okay. For example, a raincoat. Okay. What we do? You see outside, it looks like a normal textile; inside, there is a coating. Okay. It can have the reverse also. But, so you feel that it is okay. So, that is the way you can do the coating. Coating is one of the most popular methods of producing waterproof fabrics, but not the only one. Right.

Coating means, there is some solution, some latex, some foam which has to be applied onto a textile. So, one surface generally is coated, the other remains as a textile; but you can coat both sides. So, one of the interesting techniques is called the knife on roller.

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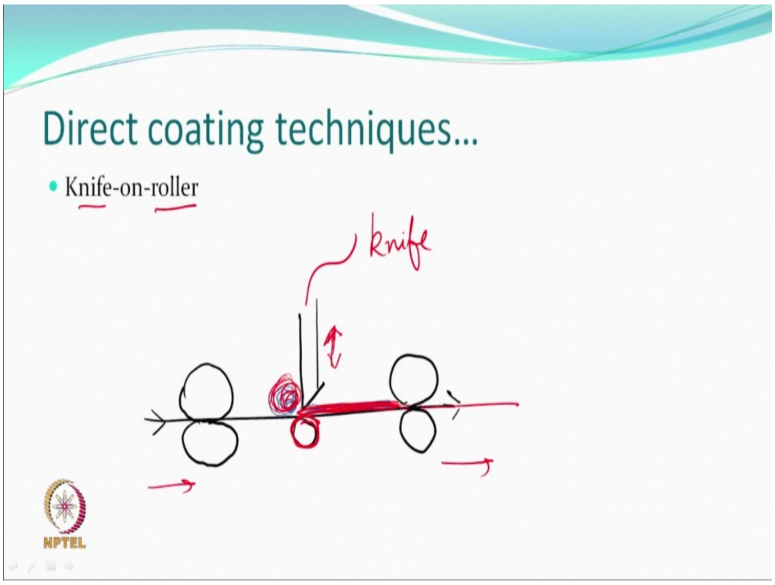

So, what it means that, if you want to control the thickness of the coating, then this type of technique can be used. Where by adjusting the distance between the roller and a knife which controls like a doctor blade. It controls and we call it a knife, which allows only a certain amount of solution or a foam or a latex to pass through. One simple diagram we can try and explain.

This is a knife. So, you have 2 rollers. So, you pass the fabric in this direction. So, there is this latex, foam or whatever you have. It goes through this. And then, there is a collapse and thing. And after that, you can dry it, cure it; and depends on what actually, finally will be the product. Based on that, you do what you want to do. If it cross-links, then you do that. If anything else has to be done, you can do that.

But that is how you apply. So, thickness can be controlled by taking the knife up or down. So, this thickness can be controlled. So, how much amount of material will go? And this roller therefore supports the fabric, so that this distance can be adjusted. So, here there is a control in thickness.

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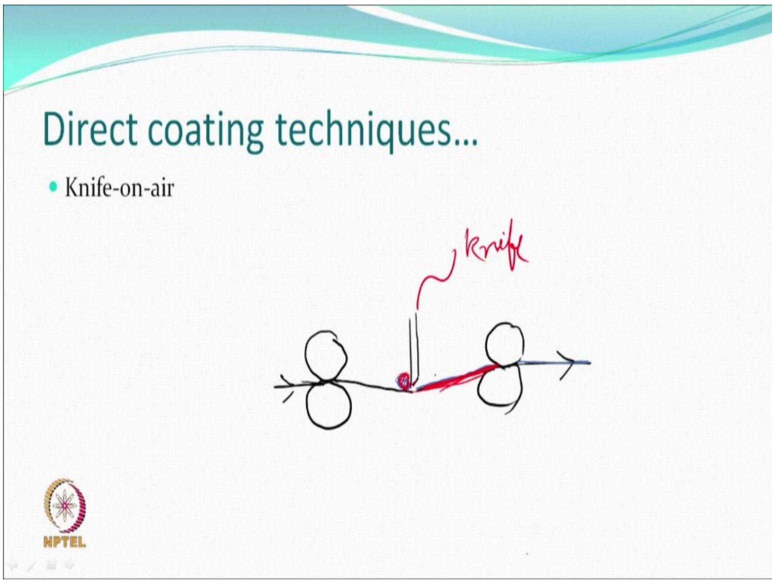

The another thing which hopefully, maybe we talked about it and you remember it, knife-on-air. Here, there is no roller, you know, below the knife. So, what happens is, that this knife is touching; touching the fabric. So, very, very small amount of material will go through this. So, you would not really see the thickness. It will just be that interstices are closed and very thin film has been made.

And then, after all, you do what you want to do. So, that is, these are direct coating techniques which can be used. There others are transfer coating, melt coating, all those kind of thing can be also used, particularly if you have certain plastic polymer which can melt very easily. And then, you can do that also. So, what would happen is;

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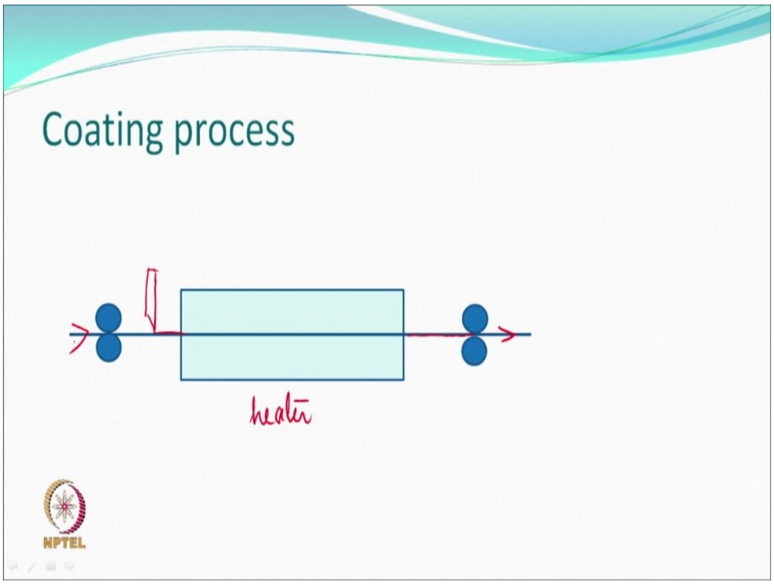

That you have a material. For example, here, you have applied something through a knife-on-air. For example, some very light material is coated. Then you pass through a heater. It can dry or cross link. And then, finally, what you have is very fine coating coming out on the textile. Alright. So, padding, we use only if you want both sides a complete immersion of the material. You can do both sides coating also; no issues.

But these are some of the direct coating processes. Well takes care of some of the things which we are looking at a waterproof textiles. How do we test them? So, one of the interesting test is to increase pressure, hydrostatic pressure. For example, if there is a tent, okay, the tent. The tent is like this. Alright. The water falls on it. The water will get settled.

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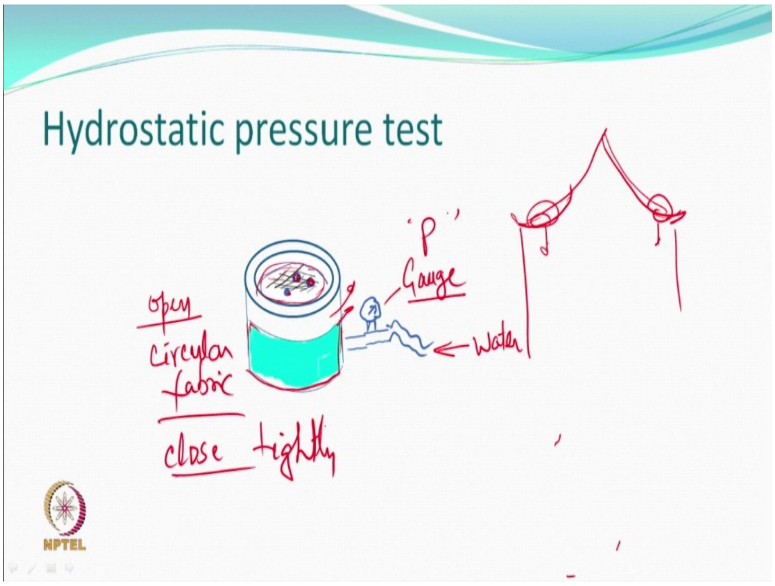

Like, you have this tented structure. And so, water can come and settle here. And may have a tendency to drip down. Right. So, under some amount of hydrostatic pressure, we would like to see how much water penetrates. Or we increase the pressure by any motorized system; and then see what happens. So, one of this test is that, these are 2 pieces. One at the bottom can be filled with water.

So, this is a piece which can be filled with water. Then, this is a piece which can be unscrewed and it can come out. In between, you, there is a space where you can put a circular fabric. And then close. So, you open, put a circular fabric and close tightly. Alright. So, once you close tightly means, now there is water; so that nothing, no water can leak from either this side or from the sides of the fabric.

And the fabric is where? This is the, let us say the fabric, the cross one is fixed inside this frame. And then, you have the water being pumped in through this tube into this. And so, pressure increases. There is a gauge, pressure gauge. You can measure the pressure, could be analogue or digital, does not matter. Keep on increasing the water pressure till you see the water from this chamber is been forced out through the fabric, not from the sides.

If it comes on side, that means the placement of the fabric and the sealing is not good. But if it is good, then it will come out from somewhere. So, the current test say that, if 3 drops of water are seen, you can measure that kind of a pressure and say, well, this much hydrostatic pressure is required before the water will leak. That will give you the resistance to penetration of water. Because we talking about waterproof. And the observations is;

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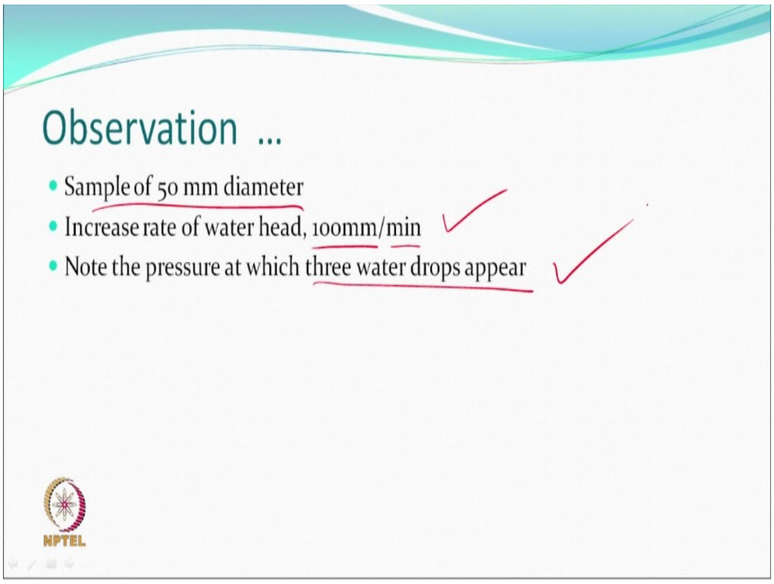

Let us say you have the sample size 50 mm diameter fabric. Increase the rate of water head, let us say at 100 millimeter of water per minute. And then, when 3 water drops appear, you stop the test and say: well, this is the pressure. And that becomes your hydrostatic pressure test. Right.

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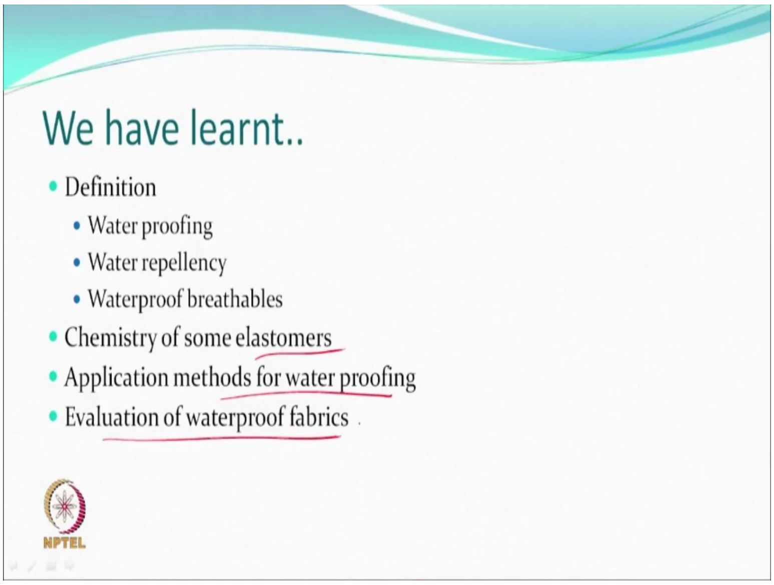

So, what have we learnt today? We have learnt the definitions of waterproofing, water repellency, waterproof breathables. We have talked about chemistry of some of the elastomers which can be used as a coating on the textile surfaces. And a method for application, which is the knife-on-edge or a knife-on-roller direct coating. And, we have also said how this waterproofness can be evaluated. Alright. Next time, we will talk about water repellency. Till then, all the best.