Textile Finishing
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Lecture No 12
Emulsion Softeners

Welcome back to the class on textile finishing. Let us see what have we done till now.

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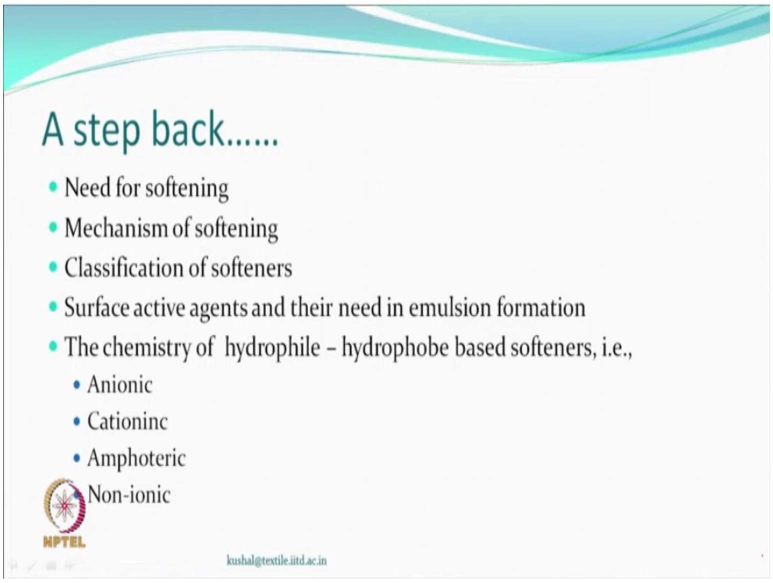

We have talked about need for softening, mechanism of softening, classification of softeners, surface active agents and the chemistry of the hydrophile, based on that the classification takes place is the anionic, catatonic, amphoteric, non-ionic. These are the type of softeners based on the chemistry of the hydrophile. This is what we have discussed and we shall continue further.

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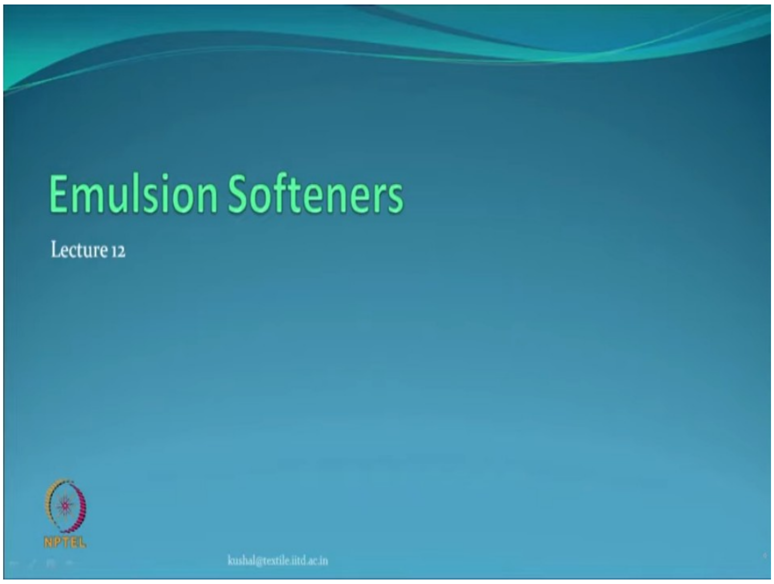

We will talk here about emulsion softners. So, as the name suggests, for application of these softeners, we will have to emulsify them. So, what are we talking about?

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Softeners that do not contain a distinct hydrophile in their structure and therefore, they are only hydrophobes. And so, they will have to be emulsified because they are not going to be water soluble. Because they do not have a hydrophile, right. So, these are the type of compound that we will be talking today, which have been suggested to be used as softeners.

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The first set of compound that we can think of are waxes, okay. That is another important softener based on polyethylene, which is commercially useful compound and the other category that we will talk about will be polysiloxane based compounds.

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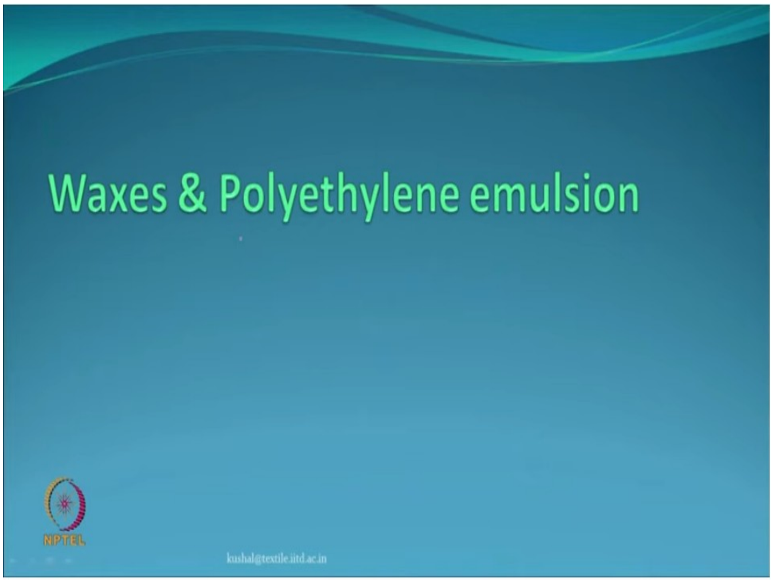

So, let us say first we talk about waxes and polyethylene emulsion.

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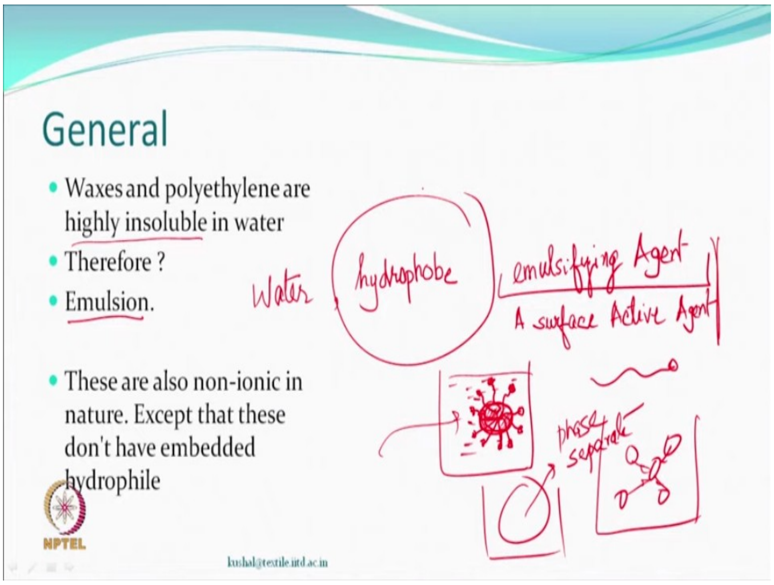

In general, the waxes and polyethylene are highly insoluble in water. I do not think we need to remind wax, oil, fats, they do not dissolve in water by themselves and polyethylene obviously does not. And therefore, these compound which are based on waxes and polyethylene will have to be formed into an emulsion and what is an emulsion just remind. Therefore, they would have obviously the medium as water, then this hydrophobe, which is the softener.

And they would need an emulsifying agent, alright, which is what? A surface active agent, do you recall how does this work? These agents, when we put, let us say, a hydrophobe in water, because hydrophobe, it does not like water. But if you can make small particle, bubbles, droplets, then a surface active agent, if you remember it has a hydrophobe and a hydrophile. So, you will have hydrophobes, which are going to be sticking or ensuring going towards the fatty, waxy hydrophobes.

And so we will be able to make sure that this droplet does not coalesce. So, there may be many other droplets, if all these droplets are not supported by this, then there will be a tendency of the droplets to come together and become a bigger droplet. And then finally, phase separate. And so, we make emulsion and a surface active agent is the one which helps us to do something like this, wherein all such particles, droplets, etc., will be surrounded by the surface active agents with their hydrophobic part towards the hydrophobe.

And hydrophilic parts exposed to the water and so, it becomes a stable system. So, what do we remember here, important thing that we like remember is, these also are something like a non-ionic softener except that they do not have an embedded hydrophile, right. Now, the most important thing they have is hydrophobe, which is required for softening.

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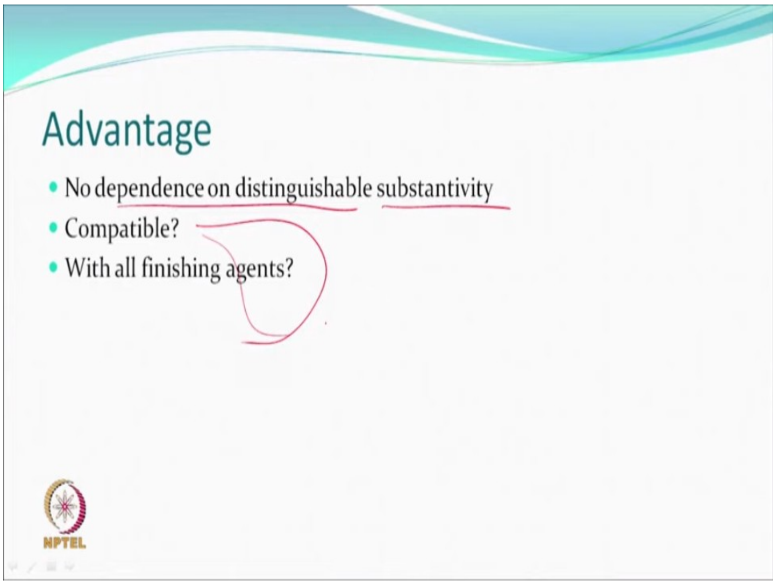

The advantage obviously, is these also are not dependent on any substantivity, they can be applied to any textiles, are compatible with all types of finishing systems because they are non-ionic in general. So that is how it is going to be, unless and until, we break the emulsion, that is, we somehow interact, add chemicals which interact with the emulsifying agent itself and that precipitates and so things can separate out, of course we can do that.

Remember, milk is also an emulsion, right? If you add a bit of a acid or a drop of a lemon and it just you see that the things separate out. So that of course one can do. But if you do not do that, they are compatible.

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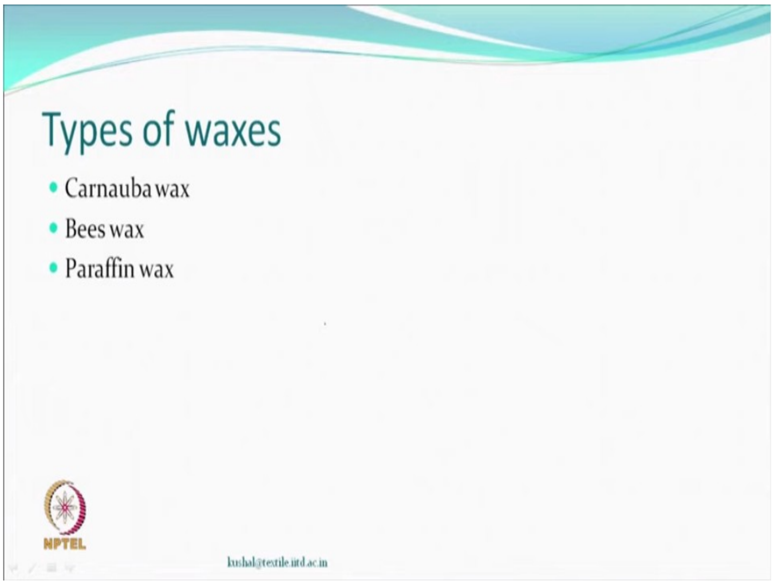

So when we first talk about, let us say, waxes, there are some names which come to the mind. Some of them are written here, which is carnauba wax, bees wax, paraffin wax. All of them are obtained from different sources. But one thing is very clear, they are hydrophobic, but all of them will melt at a certain temperature. This temperature obviously will be somewhere around 45, 50, 60 degrees, 65 degrees. Some of these will melt and they will become droplets. That is the right time to emulsify them or shall we say right temperature.

To emulsify them in a very small droplets, sizes would depend on how fast are you agitating them and then you get a stable emulsion. If somebody asks this question, would you like to use oils, well oils are also hydrophobic. You can use them, but most of the oils are un-saturated compounds, the waxes are saturated. Therefore, they are solid at room temperature, most of the oils are liquid at room temperature, alright. So the oils have a tendency, if you remember, to become rancid, that means you will start smelling or whatever type smell, okay.

And so, they can change their composition with time, more easily than a saturated system, okay. You may have been told sometimes or may ha3ve read, for us, when you want to consume fats or such things, we are suggested, we are advised that you eat oils rather than saturated compounds. So, you have unsaturated compound which are easily degradable. So, in one case it is good, you want it to be degraded, but in the other case like textile softener, you may not like it to be degraded so easily and they smell.

That may not be a good idea. So, based on the requirement, if we are looking at a food item, we may want for unsaturated compound, which will be oils in general. Waxes on the other hand are going to be solid at room temperature, that means they are saturated, and of course long chain compounds, no doubt about that.

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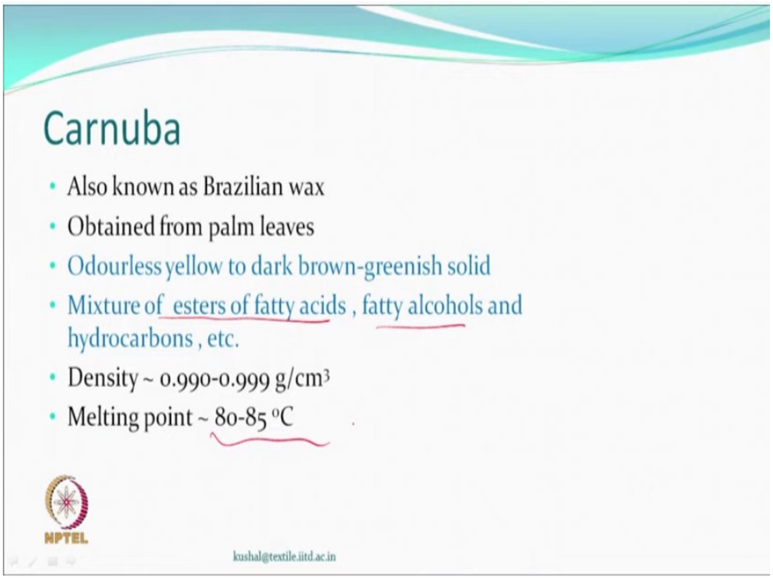

So just to learn, carnauba is also known as Brazilian wax. Initially obviously, a lot of it was synthesized, extracted, and then marketed from Brazil and obtained from palm leaves, that is okay. But theoretically they can be produced anywhere. So, they of course, odorless but yellow to dark brown and greenish type of a color, the solid is there, which is the yellowish, greenish, brownish solid, that is one. And these are complex compounds, always nature produces complex compounds.

Based on mixtures of fatty acids, esters of fatty acids and fatty alcohols and some hydrocarbons could be a part of a carnauba wax. Density is less than water, so they will float. I hope you remember all the oils float on water, there will be few such compound which will sink in water. And so, they even as a solid or a liquid will like to float. So, when they are in a molten state, which, let us say, a melting point of these has been found to be somewhere around this.

The range is there because first of all they are compound which do not have a, shall we say, a fixed molecular weight or the composition thereof. And because of that, if you do not have fixed one, therefore you cannot have a very rigid melting point. So, the range based on what, but generally you can say, it is quite high airy. So, what you can do is, you melt it and then emulsify and when you cool it also, then because the particles are very small, they do not merge and you see milky white emulsion.

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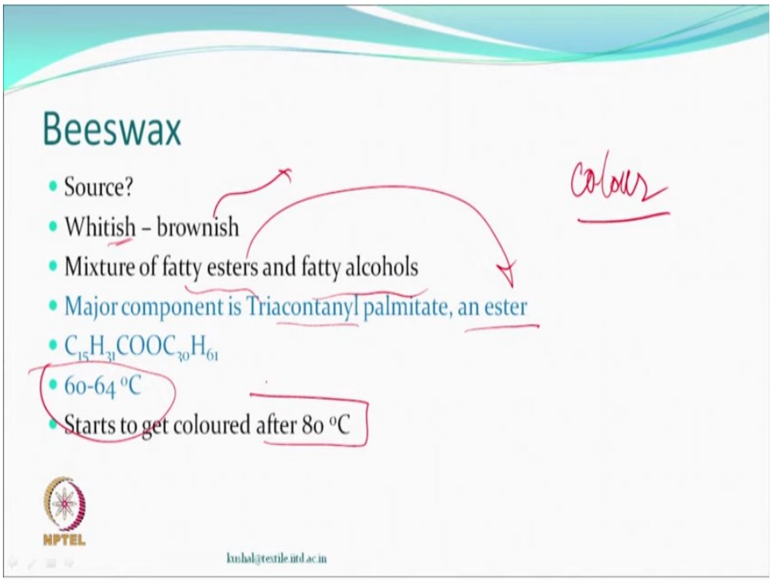

Another wax that we had listed there was bees wax. So, from where do we get them? Obviously bees. So, the beehive, basically has a lot of waxy material, something which is the food, is the honey, which you take it off, something which is not to be used by, let us say, oral consumption is what we call as the wax, and which is the bees wax. Of course, there is a lot of use for this, in various ointments and so on and so forth. But we know it is a hydrophobic compound.

It is whitish to brownish compound. Again fatty esters and alcohols are the ones, which form the main compound. So there are mixtures of these compounds. One of the major component is triacontanyl palmitate, which is an ester, fatty ester and some alcohols of course could be there. Here the temperatures are in the range of 60 to 64 and they also, as we can see, can be melted and after melting you can make an emulsion out of this. What do you notice in the first one and second one is the color, alright.

The earlier one also was a brownish, yellowish, greenish kind of a color. Here also you have some brownish color therefore, of course some white could be their here, but generally, let us say, it is colored wax, naturally colored wax. And so, one will have to be, you know informed about it that this this is a colored compound. So, when you apply something, which is color to something which is white, let us say, textile bleached fabric, then you will see some effects.

Also some stability issues maybe there that after 80 degrees, after melting and if you keep raising temperatures, it may start becoming more and more colored, basically going towards yellow, that is a sign of degradation. So, that one also should be noted.

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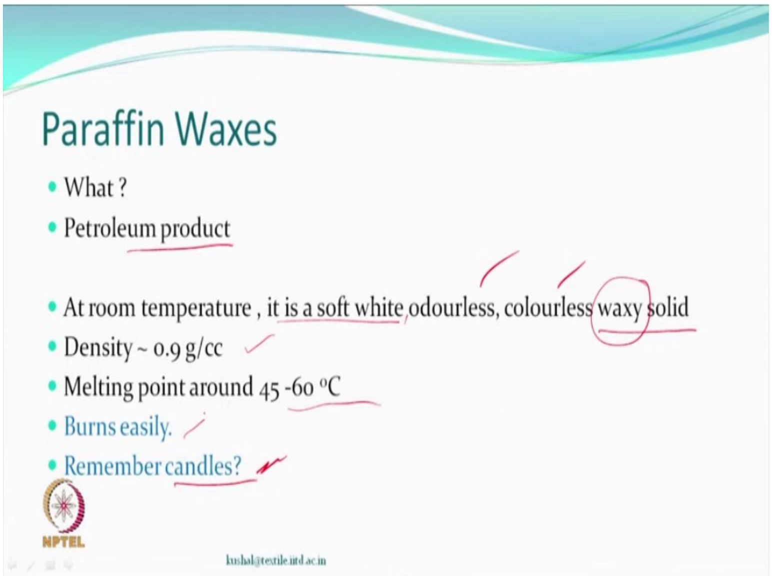

Then the paraffin waxes, industrially important compound, not dependent on, let us say, the plant or the insect, alright, it is a petroleum product. So, therefore, it can be synthesized more, it can be extracted more and may be controlled also. So, the paraffin wax are, as we said, petroleum products. It is considered at room temperature soft, white order less, color less, waxy solid. So, the waxy term also the solid has been obtained, but all the previous ones are also waxy solids.

So, the density is again less, so you can appreciate that this will also float. Melting point could be varying between whatever kind of product that we have and so you again, can melt it and then emulsify it and use as a softener. Remember, candles obviously, the candle burns. So they also burn easily. So if we just use all the waxes and want to burn them, they will burn, but if we apply them correctly at lower concentrations, will be safe. But if you take a textile, normal textile, a cotton or a polyester, they also burn.

But they burn at a temperature which is relatively going to be lower, but at the burning point the temperature is very high.

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So, as far as the chemistry is concerned, they are mixtures of hydrocarbons. So, they also may not be exactly same molecular weight. But in general, we are quite sure their chemical structure is going to be like this, alkane, alright A typical structure maybe, a typical paraffin wax may have a C $_{31}$ and H $_{64}$ type of a molecular weight, but if it has got this molecular weight only, then chances are, you will get a sharp melting peak, but not necessarily true, it may be mixture and if it is mixture, then we will use it as.

So, it is important because it is color less or it is white in color, whiter, that is something more, it not yellow, brown or green. So, it can be used after emulsification and application on to textile as a softener.

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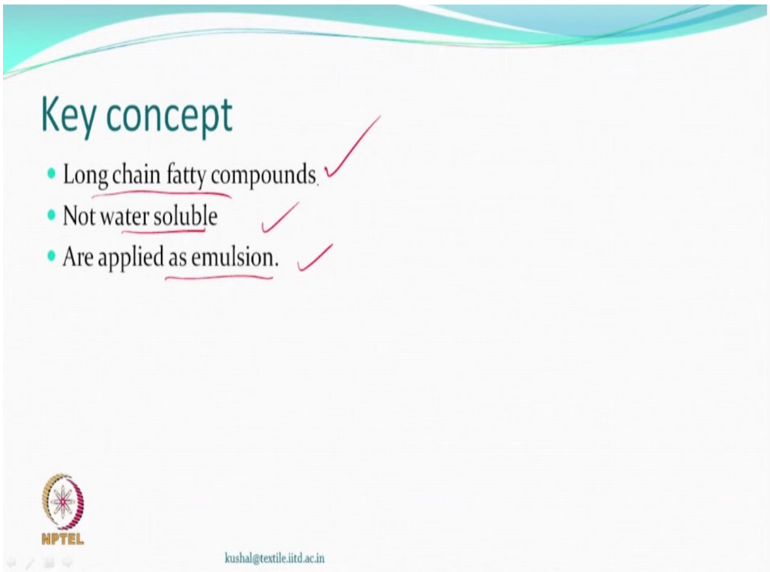

So, the key concept here is they are going to be long chain fatty compounds, yes, they are not water soluble and therefore are applied as emulsion, right. No confusion there.

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Now we look at another class which is polyethylene softener, they are also quite popular. When you say polyethylene, what comes to the mind, yes, the polymer, the film, polythene bags, everyone carries, sometimes we want to ban them, sometimes we want to recycle them. But anyway, it is a film that you come to mind of course, polyethylene fibers also are there, which could be, if aligned properly, could be very high tenacity fibers. So, what are we talking about, we are talking about film, fiber, softener what are we talking about?

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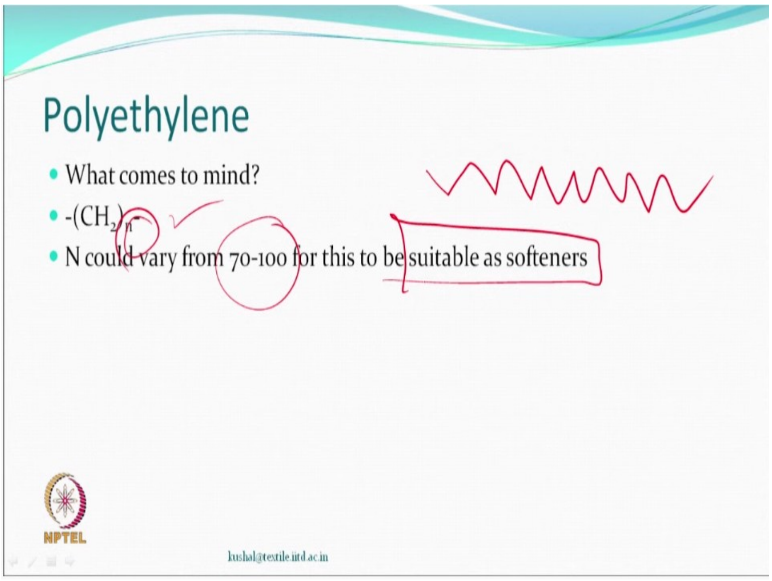

So, important thing will be, what is the molecular weight. As far as the representation is concerned, well this is simply polyethylene, CH_2-CH_2-CH_2-CH_2-CH_2 molecule simple, but what is the value of n. If n is very high, then it can go to the film formation, fiber formation and so on and so forth, but if it is not so high, then some of these compounds or some of the product of the polyethylene can be suitable as softeners. This is an important thing for us, but what is important is what is the difference between alkane and this?

Hardly any difference, that is also CH_2-CH_2-CH_2 may be at the end, you have two -CH_3 groups. Here also, if you end the thing it may become -CH_3 at the end also, because you cannot have something hanging at the end, if it is almost a similar compound. So, it is hydrophobic and we know, and the density of this compound is more than water or less than water, density of this compound is it more than water or less than water? Obviously, less than water, polyethylene floats in water. Is it true or not? Yes, okay.

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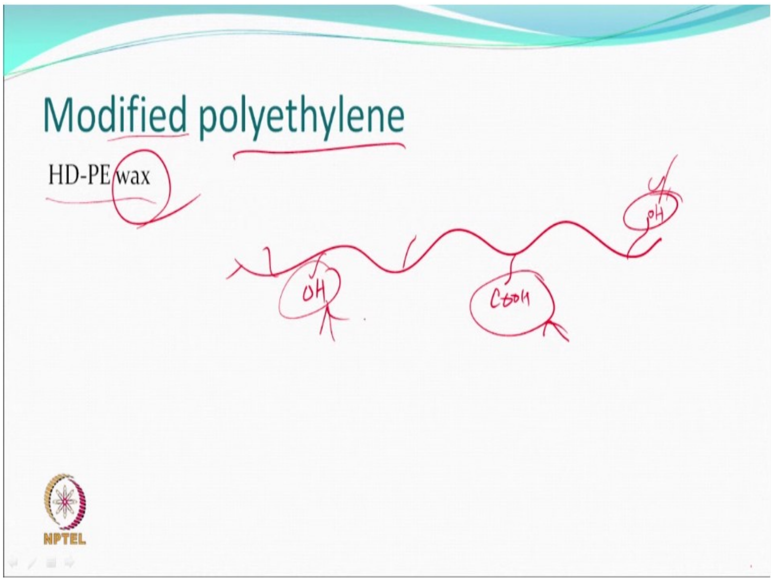

So, the polythene can be used as it is, with reduced molecular weight after emulsification, but because you can see there are no functional groups there, if there are no functional groups, then what will happen, the only possible linkages with the surfaces of textiles will be Van der Waals forces alright, that is okay. If it is a long molecular weight so many Van der Waals forces. So, it also becomes quite fast, it will be difficult to wash off, because not water soluble as such.

You remember if you have a colored oil in water, which is floating around and you take a piece of paper and then take it to the, the solution or shall we say, a mixture which has not really been emulsified, oil which of green, blue, red colors and you take a paper which is through this water oil system, what you will see is the oil has a tendency to stick to the paper, when you say paper is cellulose, cellulose is hydrophilic, why does it happen? But compare it with water, if you compare with water, then obviously the oil droplets find much more comfort in attaching themselves to paper.

So, people do various kinds of interesting artwork and abstract painting can be obtained just by this, whatever happens. That means, if we use some of these compounds as emulsions because they just do not like water, they will like anything other than water to start with. If it is also a hydrophobic surface they will love it more, even if it is a hydrophilic surface like the one, which we talking about, a cellulose, cotton, viscose they will still stick, they will like this surface more than the water.

But to get little more affinity towards textile substrate, people have also done a bit of modification on polyethylene, which can be done. And so sometime it is called high density polyethylene wax and what do we do? We do an oxidation process and, let us say, this is a polymer molecule, which otherwise was simply hydrocarbon, CH_2-CH_2-CH_2, get some oxygen attached in some way, maybe you can create a hydroxyl group somewhere, maybe you can create a carboxyl group somewhere, not everywhere.

So, you may have some little functional groups getting attached and then this type of material is also known as wax, but actually we know it is polyethylene just an oxidized polyethylene in one way or the other. So, theoretically speaking, such groups, if are also attached, will be able to attack with textile substrate in a more substantive way. But still you can understand these numbers are not so high to make them water soluble.

But once they are applied as an emulsion onto the textile, some of these groups will help in better association, shall we say that, okay.

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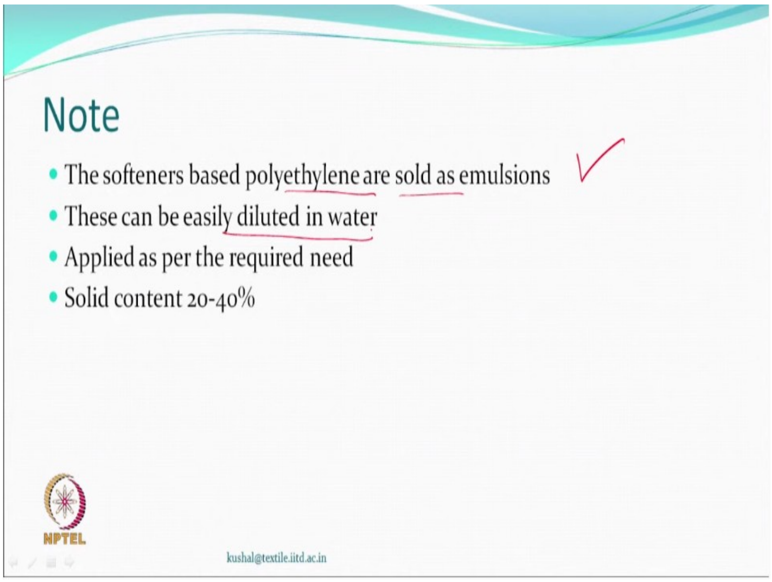

So, let us note as far as this group of compounds are concerned based on polyethylene are sold as emulsions, which we know why. These emulsions can be diluted easily, so, you take an emulsion of a polyethylene emulsion, you dilute it based on what is the requirement and if you look at the emulsion, they may be available as 20% to 40% solids, what it means is, if you evaporate the water, solid content maybe of this range You do not require 20% on textile, that will be too much, right.

What we will require is only less than 1% of such material will give us softness. So, you will dilute it and then apply.

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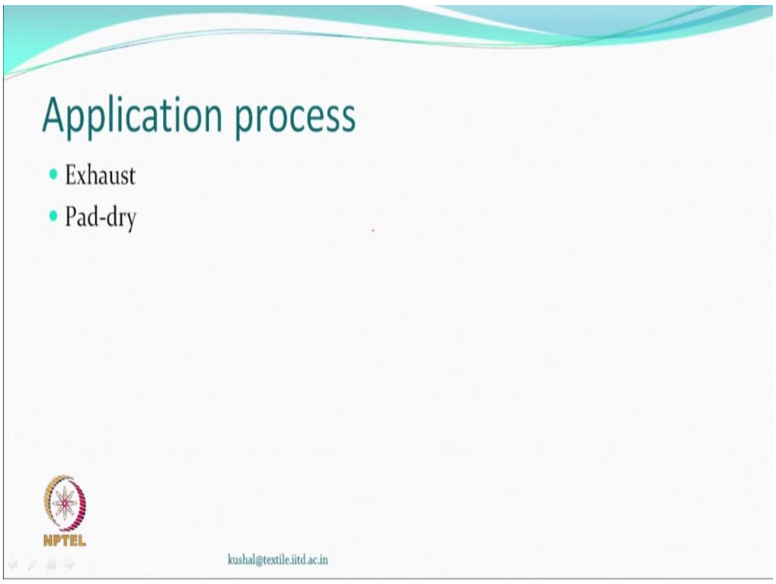

How do you apply? You can use the normal exhaust process, as I said. If you have oil water kind of a situation and an emulsion immersion also and if you have other compounds also which exhaust. This compound will also go towards the textile because basically it does not like water. So, whenever it gets something else, it will get attached more. And if it also has some functional groups, then association can be better, of course pad dry. By themselves, you have to apply, it is a pad dry.

But if you are using it along with, let us say, another finishing process, so that chemical along with this softener can also be applied. This will remain there on the textile, we are only hoping and we must hope that this is not going to get degraded during the curing of the other compound if it is required, like crease resistant finish. They can be applied.

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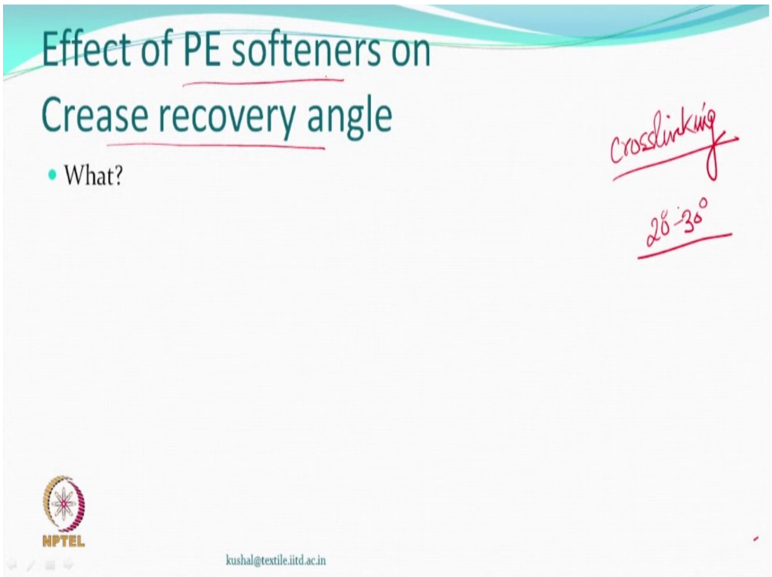

Very interesting, I mean, we have seen crease recovery processes, I mean crease recovery angles as after creasing, after crease resist finishing or before crease resist finishing, they obviously change. So, what does this talk about effect of emulsion polyethylene softener on crease recovery angle. So, normally, we understood that we have to do cross linking, which obviously increases the crease recovery angle.

But it has been found that of 20 to 30 degrees can be enhanced just because some of these compounds get absorbed and diffused into a structure of a fiber. If it goes inside, if it is only outside, it behaves like a something it diffused, why? It is a long chain compound, getting entangled with the other molecules inside if it has been able to diffuse if it does not diffuse as I told you, it will remain on surface, you may not say.

But if it diffuses in a hydrophilic system, if it diffuses because it is an emulsion, it might just go if the size will permit, then by a mechanical entrapment they get retained and when you bend, they also contribute to recovery because of the mechanical entrapment. But not so much. I mean you cannot say that, well I use only polyethylene emulsion, which is a softener, only pad dry and add nothing else, the crease recovery will be anywhere near the wrinkle resistance that you want to obtain, in a wash and wear or a durable press garment, that will not happen.

But it can enhance, that has been seen, it is interesting. So you get a soft material, you get a higher crease recovery, not a bad idea.

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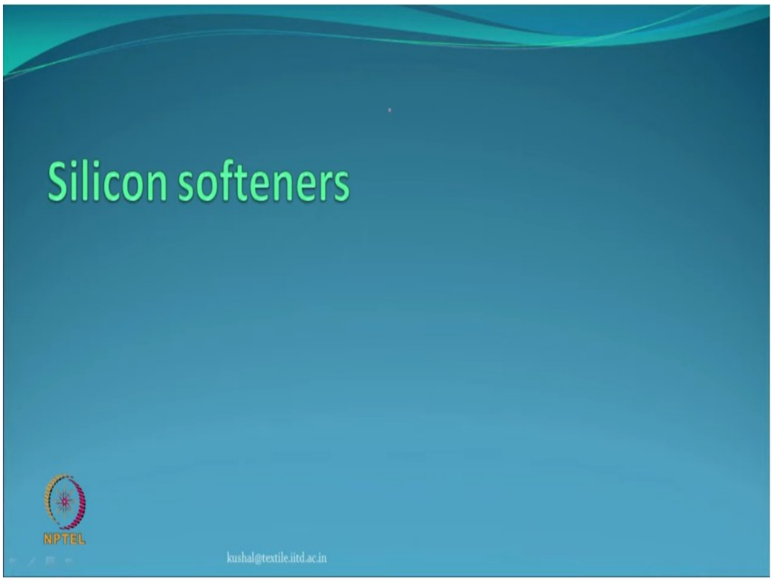

The other compound that we will talk about, which are quite important are silicon softeners, they generally termed as silicon softeners. That means, silicon as an element is present there. And the other compound that we now we talked about, you have carbon, hydrogen, generally a little bit of oxygen or support systems of esters, alcohols, and so on and so forth. But here we are talking about a chemical, which has silicon as an element present, which is interesting compound. And so, this group of softeners are very important commercially.

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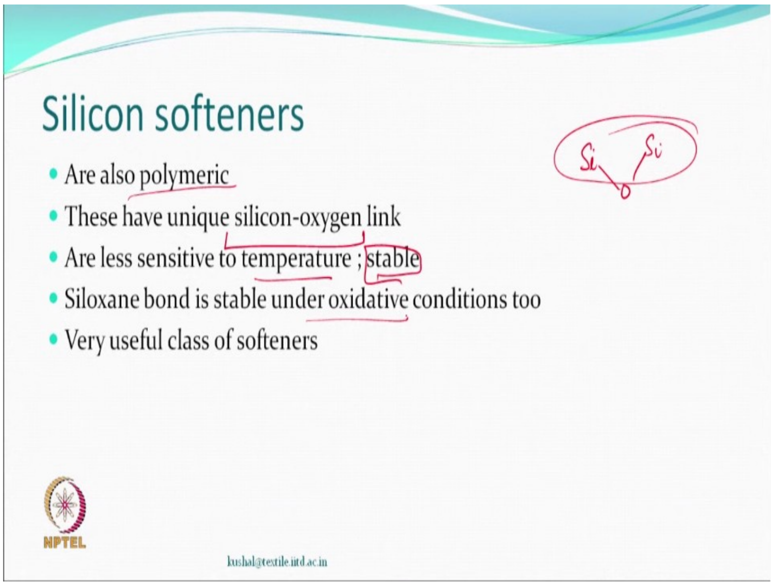

Incidentally, they are also polymeric, right. They are also polymeric and so large molecular weight and because they are polymeric, therefore they must be starting with some monomers. So, you can have monomer during curing, it can get more polymerized and length can increase or you can polymerize before and take the polymer as an emulsion and apply, all those things are possible, but interestingly they are polymers.

And they have the unique silicon oxygen linkage. And because of this, there is a polarity associated with this link. So this is a polar link. And because of polarity, the polar polar interaction can also take place with this substrate, the polar polar interaction also can take place with substrate and therefore, one can expect better wash faster, because they are polymeric and also because this type of a unique link is there, which can do polar-polar associations.

They are very stable to temperature. That is quite interesting. I am not sure whether you have heard of something called silicon oil, they are very, very stable, unlike a normal oil, which will start fuming as you keep on heating, they can be used at very high temperatures, without much degradation. You may have seen silicon rubbers, which are also heard of that the silicone rubber they are also quite stable to heat. Normally, most of the rubbers would start degrading very easily when you keep increasing temperature.

So stability is something which is also an inherent property, characteristic of this type of compound. Also not easy to oxidative degradation. Therefore, also stability is more, that means they will not be changing colors with storage like other compounds can. Color change obviously means some degradation has started. And therefore, we call them very useful class of textile softener.

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Emulsion, of course, you have to make emulsion because they are also not water soluble. But the whole overall structure, the polymeric structure is hydrophobic. Of course, with a special silicon oxygen link, which gives us polarity.

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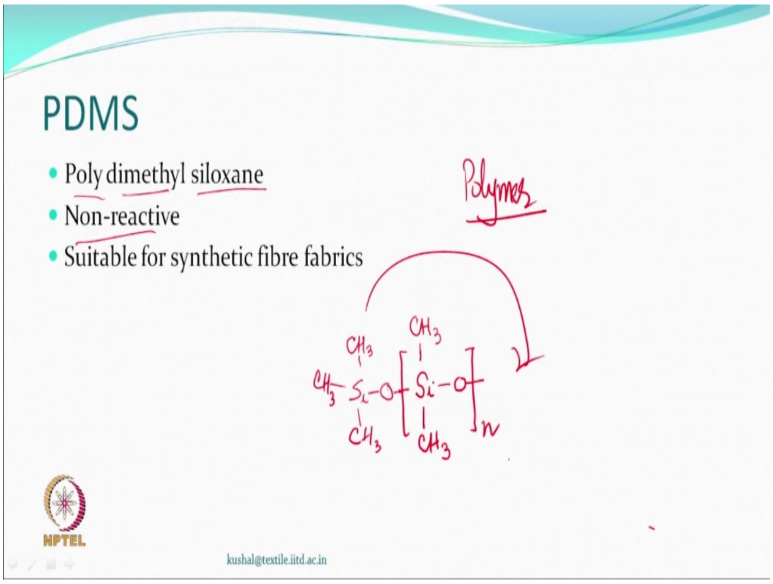

One of the interesting compounds that we have is called the poly dimethyl siloxane. How does it look? Well, if you have reached an end, then you will see at the end, which may have methyl at the end. But, as you can see this group can keep repeating itself and therefore, it becomes polymer, something like this can be on this side as well, end of the molecule. So, this is polymeric because of these methyl groups, there is lot of let us say hydrocarbon available, because every such unit has.

Because of silicon oxygen you have a bit of polarity because of this ‘n’, you have a polymer and nonreactive, because generally there is no chemical reaction is going to be formed but polar-polar interactions or Van der Waal forces are going to be, definitely very suitable for synthetic fabrics, fiber fabrics, but has been applied on cotton textiles as well, I mean the hydrophilic textiles as well.

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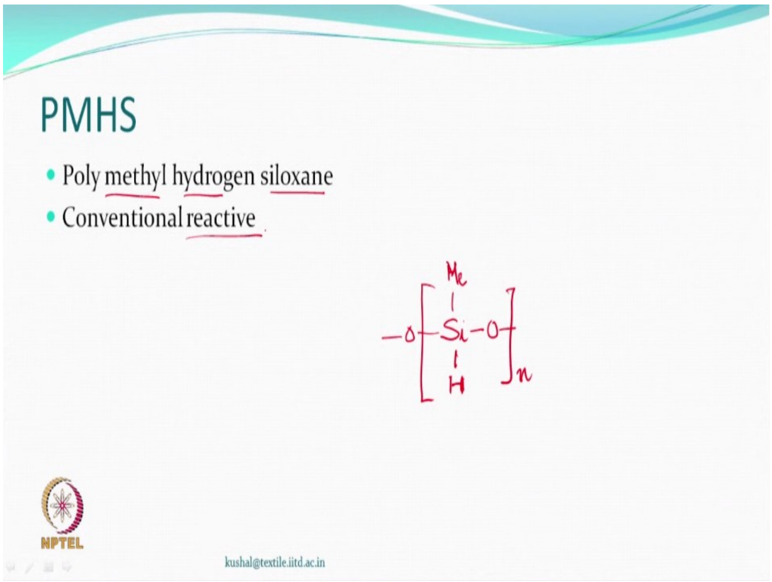

A little modification of this compound is poly methyl hydrogen siloxane, this is silicon oxygen polymer system, that molecule that link is called the siloxane. So how is it different? So, you have one methyl group and the other is hydrogen. So, like, you see these compound were chlorosilanes, they were everywhere there was chlorine and the chlorine has been replaced by a methyl group or a hydrogen group.

Now, because of this hydrogen group, they are relatively the possibility of these groups, this part reacting with something else at some let us say, curing conditions is possible. After all, they could react with methyl group as such, they can also react with other groups of the bounds that we have and the fibers have lot of functional groups, so some of these things as possible and therefore, they are called conventional reactive.

So, they will be at least to the hydrophilic systems, they will be more, there is a possibility they will react with themselves, form a network and they can react with substrate also is possible. And therefore, their wash fastness is likely to be better. Sometimes you may have mixtures of these two, the poly dimethyl siloxane as well as poly methyl hydrogen siloxane mixture can also be used, views part reacts part is just available as such for hydrophobicity. Now, remember hydrophobicity is related to reduction in friction related to therefore softness.

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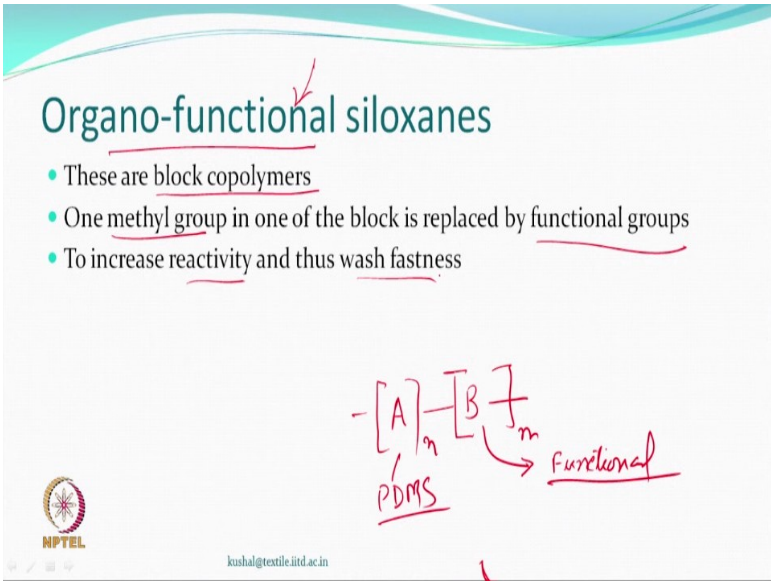

The other class of compound were later generated, which are called the organo-functional siloxane. There is a functionality being introduced and what is functionality? You want something to react, something to make crosslinks, networks. So, that wash fastness is increased, that is an important thing. So, invariably, these are going to be block copolymer, you understand block copolymer. Block copolymer means that you have a block A react with Block B and this is 'n' this is 'm'. And so, the polymer blocks are there.

So, you have one monomer, which makes a block and this is attached to another monomer, which also makes its own polymeric block. So, the 'n' 'm' and so they can extend in some manner or the other. Now, the advantages that you may have, let us say, this as a functional siloxane and this is a normal PDMS. So, what is happening, one of the methyl groups in one of the blocks for example, this is replaced by a functional group. And the aim obviously, is to increase reactivity, and thus the fastness, right, interesting compounds.

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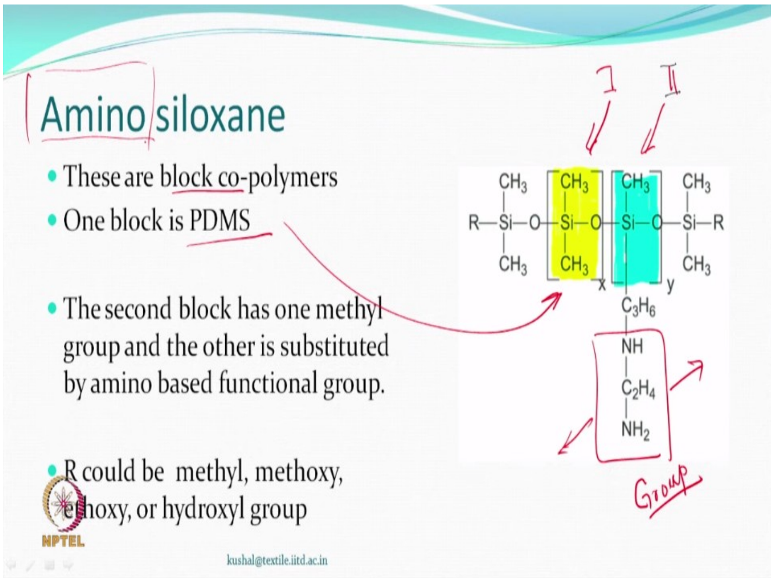

One example, people do talk about amino silicones or I am writing it as siloxane, so they are siloxanes. So, they are block copolymers, one block and second block, alright, block one and block two. And you can see this is nothing, but PDMS and the second block has got a functional group based on substituted amine. So, you have two blocks, one a functional block, other than normal PDMS. Well, normally these 'Rs' will be methyl, but one can end them by methoxy or hydroxy groups as well, no issues either, this okay.

That means there is an interesting compound. So, some interaction with the substrate can take place with these type of groups, which are now, we are calling them as functional groups, because they are amine based, therefore they are called amino siloxane or amino silicons as commercially people may know them.

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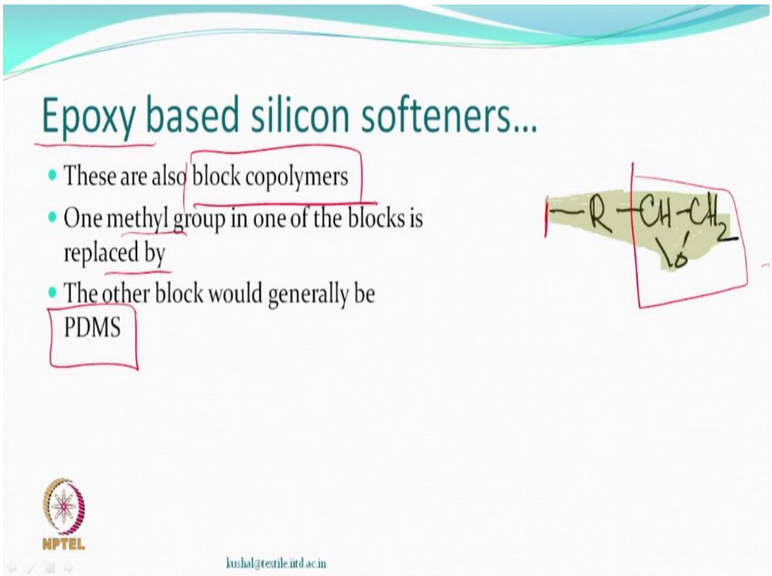

To increase the functionality, you do not really have to do only amino base, you have epoxy based compounds can also be there, they are also block copolymers, which means one of them is PDMS, the other may have an epoxy group. So, other methyl group could be replaced by some epoxy based compound, no issues, something like this, alright. So, you have this group is a group, which is replacing one of the methyl groups. This 'R' could be -CH_2 or may be CH_2-CH_2 or something like that.

But this, you know what it is, this is going to be more hydrophilic, correct, it will give you a little more hydrophilic, but functionality, if right things happen, epoxy group can covalently bond, right, can it covalently bond? Yes. We have seen epoxy based cross linking agents. So, that is it is. So, you are trying to make sure that this happens and we said other block could be PDMS. So, again a block copolymer, correct.

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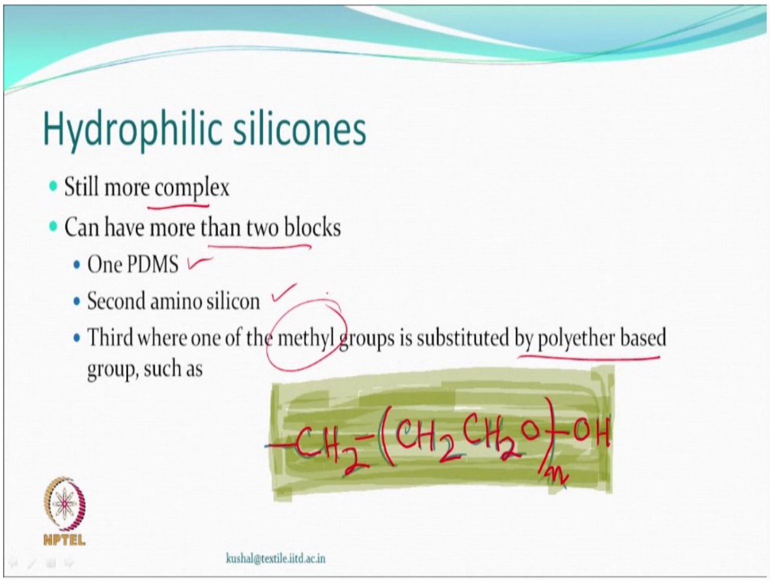

Once the organic chemists start working, they will like to do everything. Because normally as a said silicone are known as oil, so they were emulsion, these are known, now can I make a hydrophobic silicon? So, what do you do? Well, you increase the hydrophilicity. So, little complex molecule, but the chemical architecture can be changed as desired.

So, they can have more than two blocks also, one could be simple PDMS, second could be amino silicon and third could be a block which has polyether based groups, which obviously are more hydrophilic and therefore, we call it hydrophilic silicons. So, what is this? This is a (CH_2-CH_2-CH_2O) n, is it visible, so what let me just write it on top of this so that it is more visible. Are you familiar with this type of a compound, this type of a group.

Here also you have a polymeric component, maybe oligomeric component shall we say, okay. So, this group is substituted instead of one methyl group and now you have a different component altogether. Therefore, you have flexibility in designing this polymeric compound. So, depends on how much is PDMS and how much is amino silicone and how much is this hydrophilic, so hydrophilicity can be increase, but at least there is a possibility that it is going to be relatively more hydrophilic, good or bad is a different story altogether.

Sometimes you know you keep optimizing the chemistry, so as to look into a better property particularly in durability and also the wash fastness is something to do with durability anyway.

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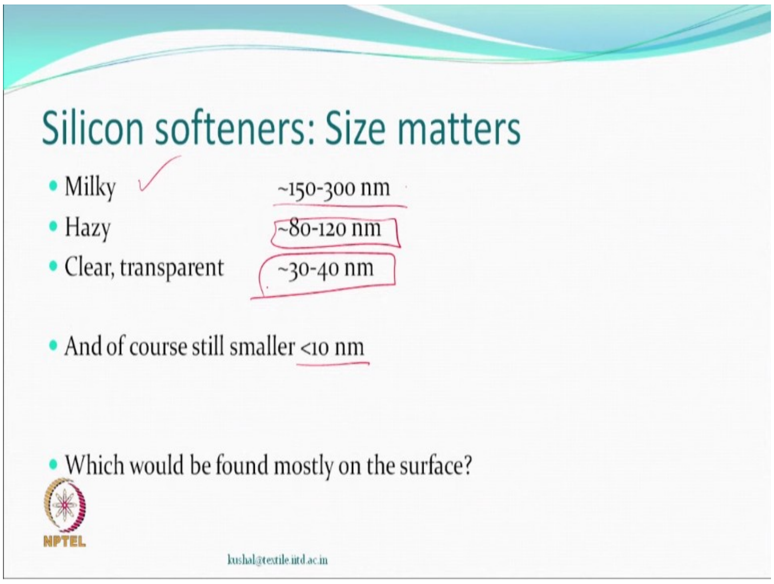

Silicon softeners, so you stir very highly, little stirring, at a lesser RPM, at a very high RPM and depending on that you can create molecules, which are shorter in size also, you can have. And can have emulsions, if they are very small molecular weight systems, then you can get particles, which are smaller particles, if the particles are very small less than 10 they will call the nano-emulsions. But if the sizes are in this range, they are very milky looking.

If the size reduces of the particles to this level, they are approximately hazy, translucent and if the size is reduced of these things to this, they become almost transparent, the particle size becomes less and of course nano. So, what is important is if you want more diffusion to take place, well you get to the nano size and the particles can diffuse into the fiber structure, yarn, between the fibers, yarn structure. So, you are looking at possibility of more fastness and so on and so forth.

Sometimes people believe that that will be more effective, but remember, softening is a surface property, if too much is going into the bulk, it can increase maybe the durability, it cannot increase the softness so much, get the point? So, ultimately the surface friction is more important. So, out of these compounds, if somebody wants to know which will be found mostly on the surface, which will be found mostly on the surface? The one which has larger size, of course.

Solid content, again, if you remember, we just talked about solid content, because they are emulsion, so there has to be something which is solid, which has been emulsified. And that is what we consider as the solid content, they evaporate water and it will be there.

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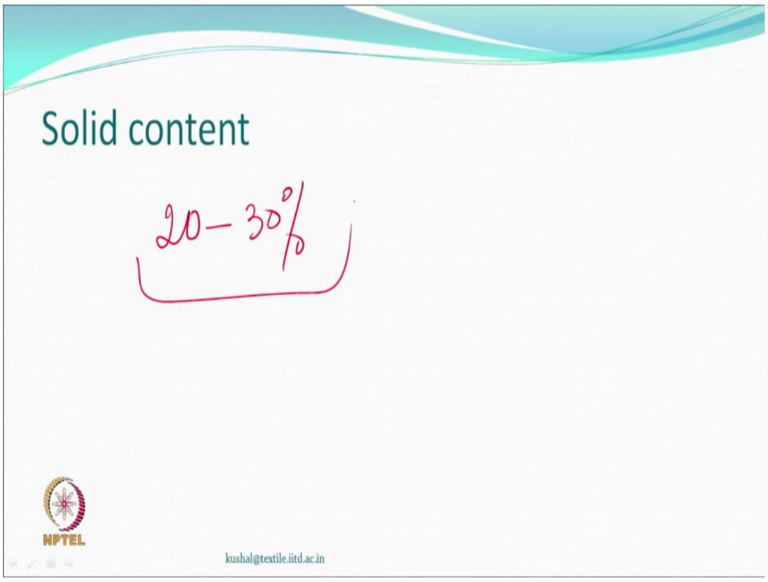

So maybe 20% to 30% solid based emulsions may be sold.

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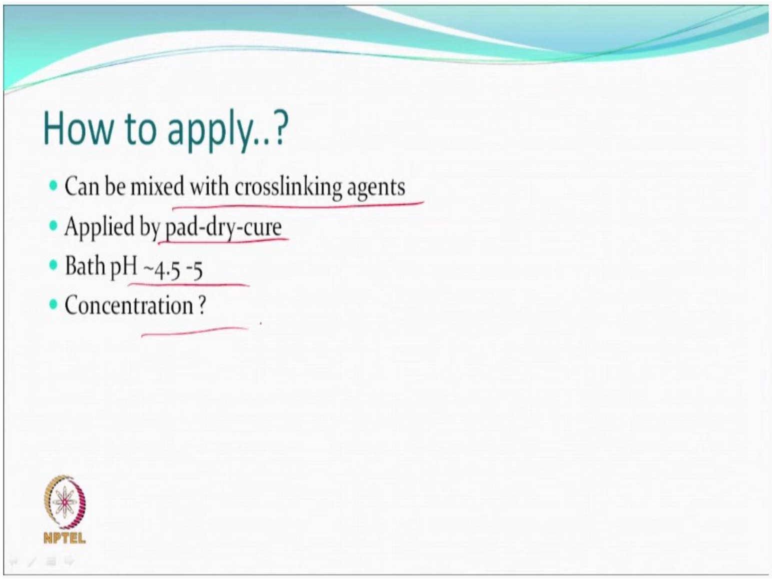

How do we apply? Yeah, we can apply these definitely with cross linking agents, because there is a possibility of their linking and cross linking and making a network. So pad-dry-cure is obviously a good process. Anyway, we are doing the curing, some of these things will happen here. No issues of the pad bath, which is acidic, which they have no issues at all. And concentrations required to do the right job is going to be less than 1%, much less than 1% can do the job as far as softening is concerned.

You do not require too much, because we are interested in modification of surface only, not the bulk property. How do you evaluate the softness?

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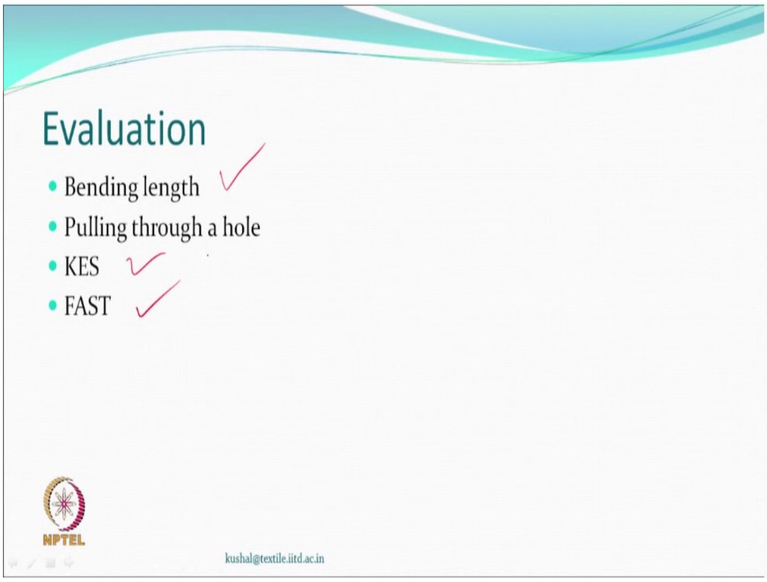

We had seen the bending length, there is another interesting thing, which one can do is, let us say, you have a textile, this is a not a textile, you pass through a hole, right. You pass through a hole it resists, if you apply a bit of oil on this, it will go faster, but this is rigid, much rigid compared to a textile and so, tests are based on these also, ring, take a folded fabric, take it through the ring. Obviously, some dimensions have to be there, you can learn about this.

Of course the modern systems like Kawabata, FAST, are also the one which can talk about the softness or stiffness of a finished fabric.

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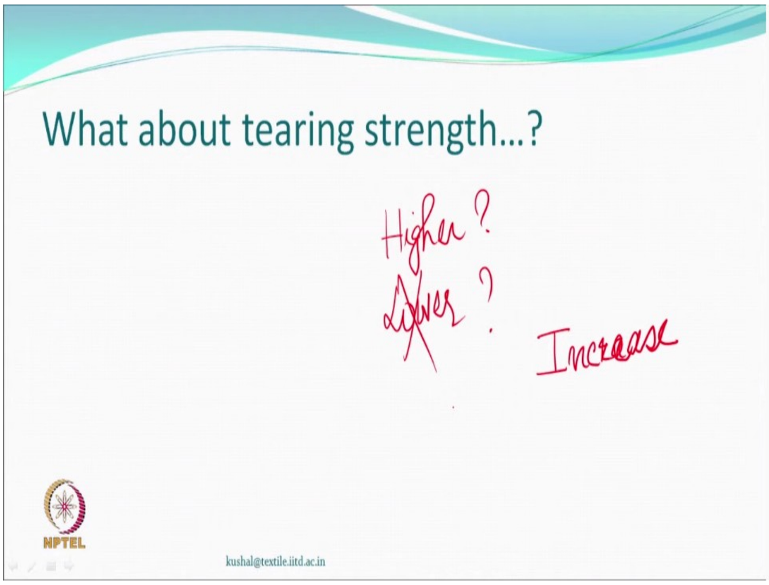

What about tearing strength? Of course, we are interested in softness. Whenever you apply a softener, what is happening? We said fiber to fiber friction, yarn to yarn friction is reduced, right. So, if it is reduced, what will happen to the tearing strength? This material tears very fast, a textile like this and a textile which is knitted, you know the tearing strengths are different. When you apply a softener, what do you expect, tearing strength to be high or low?

The tearing strength will increase or decrease? It will increase, right. Because these yarns can slip and come together, make a bundle and so tearing will be difficult.

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Durability, how do you measure? Obviously, you wash it once, you wash it twice and you have standards, you wash 10 times and see the softness. If it changes, obviously it changes. So there will be standards you can think about, the washing is one of the things. We are not talking about the durability in terms of the aging, where you keep it for one year and then see whether it is working, of course that can change, colors can also change, but we are talking about water durability.

Because if it is a garment we are talking about, then you have to keep washing it, wash and check.

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Yellowing, this has been one of the general concerns of the textile finishers that some of the softeners, particularly the one which are amine based, that means a lot of them are cationic softeners or even silicon, amino silicon where the amine is coming into picture and they do show yellowing with time or with heating. So one has to be careful as to how much we apply and what we do, of course, this is also part of thing we must know.

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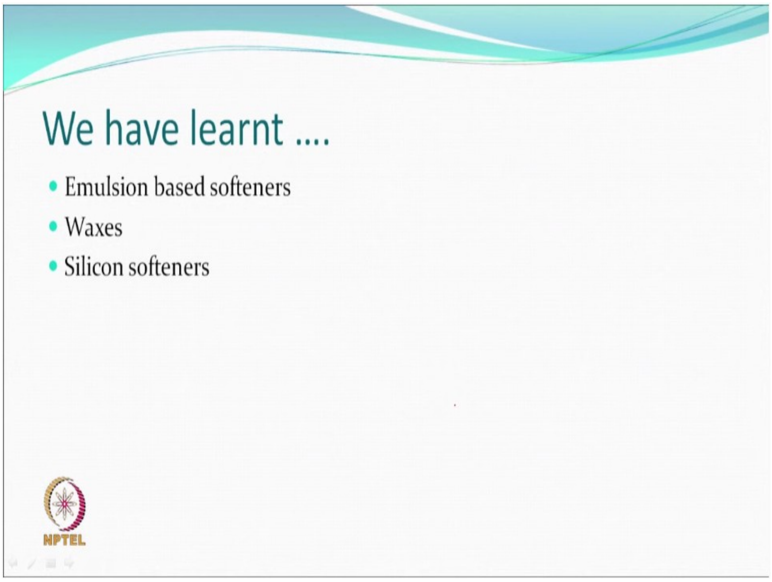

So what have we learnt? We have learnt that there are emulsion based softeners and we have to emulsify them because they by themselves are not water soluble. And these are either waxes, polythene emulsion and silicon emulsions, right. That is what we learnt.

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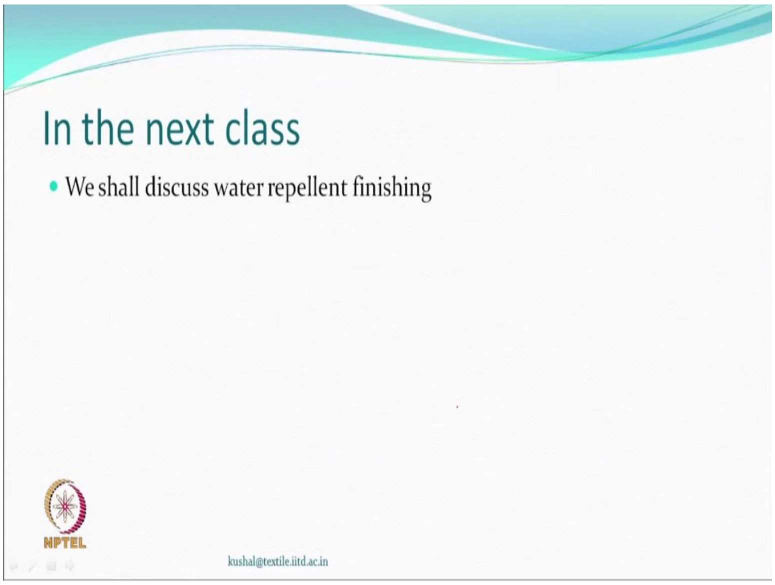

Next time when we meet, we should talk about water repellency or water repellent finishers. All the best, see you. Thank you.