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

Module - 7
Lecture - 17
Soil Repellency and Soil Release

Alright, so we are back to our class on textile finishing. Let us see what did we do last time.

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So, what we did was, we learnt about the principles of waterproofing, water repellency and finally production of waterproof breathable textiles. We did try to go through some of the compounds and their chemistry, which would meet the above objectives. Objectives means, whether it was to be doing waterproofing or repellency. We needed some properties, some characteristics of the final products and obviously a high performance product like a waterproof breathable textile.

That was very interesting. And of course, we did learn about how evaluation can be done of the performance of these type of products. Continuing little further.

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Can we use the principle of repellency somewhere else? We will like to check this out. Repellency obviously means that you are dealing with surface energy. Okay.

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So, in this lecture hour, we shall try to concentrate and learn something about soil repellency and soil release.

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Let us again recall, as we are talking about repellent. So, we had done water repellent finishes to the fabrics. And what did we do? We treated their surface. We did not change their bulk, but treated their surface. And how did we treat and what did we achieve? We achieved low surface energy. So, one has to understand and I think we left a question mark sometime as to what do you mean by reducing the surface energy. Hopefully, you recall all that.

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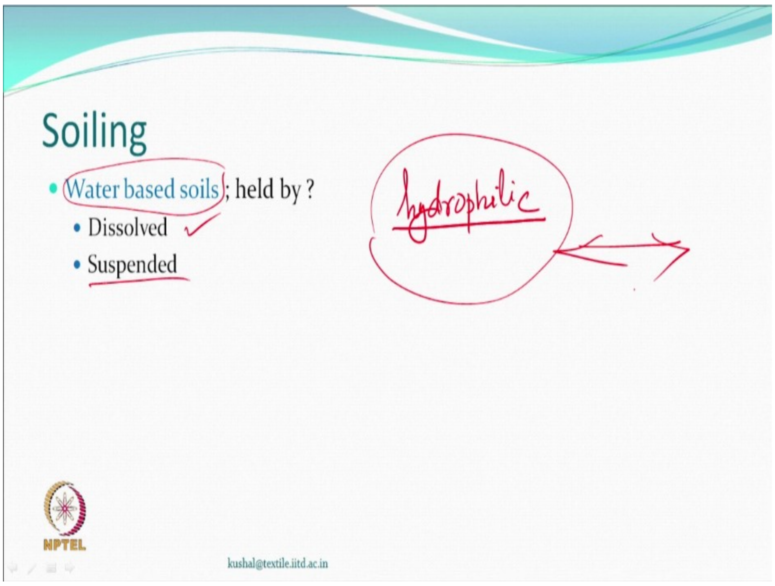

Now, we are talking about soiling. So, this is a common thing which everybody experiences every day, that the garments get soiled. How do they get soiled? Well, it could be direct impingement, something actually falls on them or they attract any kind of a soil, which ultimately has to be removed from the textiles also. So, there are 2 things which one would be interested in is: Can we repel the soil, the deposition itself?

Or if at all it happens, can we release it? So, good amount of soil that one can see on a textile could be a particulate matter. You see the dust flying all over, the smoke that comes out of chimneys and the exhaust pipes and so on so forth. There are particles also. And those particles can get adhered. If they are adhered very loosely, then it may be easy for us to remove them by, let us say mechanical shaking or even when we go to the detergent solutions and so on so forth.

Some of the particles, particularly very fine particles, they may get into the interstices. A larger particle will be absolutely on the surface. It will be easy to dislodge. A very fine particles, the micro dust sometimes we call them; or the term that people are now using is nano dust. In such situations, all these particulate matters can penetrate inside the crevices on the fiber, the interstices between the yarns and the fibers.

And once they actually penetrate, then it would be relatively more difficult to dislodge. But one will have to work on that. Maybe you have seen sometimes, even the static charge developed on a fabric or any solid surface may also attract dust particles. Have you witnessed your TV monitors, computer screens, laptop screens, sometimes seem to be attracting more dust compared to the rest of the body.

It can happen. Because, generally it is believed that the particles which are floating in the environment have negative charge on them, you know. And so, there is anything which is positive, any surface they would like to get attached to them. So, this could be one of the reasons why a textile can also get dusty or dirty. Now, some fabrics would have more tendency to attract such type of dust, others will have less.

So, ones which would be less for example, are the ones which do not develop static charge. Although, we have not talked about static charge development as of now, but maybe you have experienced that the synthetic garments generally can develop static charge on their surfaces. Much less you will see on, let us say cotton hydrophilic fibers. And that includes silk and wool also.

So, if some fabrics actually get the static charge and that is positive in nature, then obviously negatively charged dust particles will get attracted. So, if that be so, then you will have to do some effort to make sure that the static charge does not develop. Sometimes, the particulate matters which were entering the crevices of, let us say fibers. Particularly, it would be interesting if the carpet pile or which people walk quite a lot and carry a lot of dust with them.

So, one is the dust particle which is carried by something else. It just falls upon there. If it is a large particle, it is somewhere there. You can do vacuuming and remove it. If the particle which are floating in environment, they settle down, then they may get in the interstices or on the crevices. At some stage, people had also suggested that if you actually take a white dust, let us say TiO_2, very fine particles and fill this all crevices.

Then you may not have the space for the other particles to go inside those. So, most of them will be on the surfaces. And therefore, they will be easy to dislodge and get washed off. If static charge is an issue, then you can do something so the static charge does not develop. The soiling which becomes more and more important and relatively more complex is, solvent based dyes or inks or any such stuff or even particulate matters.

So, the one, the common thing that we see is the water based soil. And so, how will it be adhered? Obviously by any surface which actually appears to be hydrophilic. So, if the surface is hydrophilic, the water based soils which could be dissolved like an ink dissolved or any other dye dissolved; like coffee, tea dissolved. Others could be suspended that some of the particles are also somehow within the system, suspended, dispersed.

And then they get occupied. So, there will be some penetration issues can be there, which will be like a dyed solution falls on a cotton. And the dye is, let us say direct dye. So, along with the water which is going to spread because cotton is hydrophilic, the dye will also go in. We know that how to dye. That is what we are doing always. So, now we have to do something else.

So, they are going to be held by polar interactions. And so, the soil can also be there. What will be interesting will; can we repel it? Then we have oil based. When the kitchen people work with vegetable oils; industry, you have industrial fumes which are coming out, which have got the oils, droplets, vapors everywhere; grease, which is obviously not liquid but semi liquid at room temperature.

So, paste; they can contain a lot of oily, fatty material. In addition, they can also contain some particles. So, you may have a particulate matter in the soil, like a mechanic's clothing will be soiled by anything which is grease or oily and dust and other particles together. And of course, if something is soluble, that also will be there, part of that. So, particulate matters can come from anywhere else. So, this is how the soil will be there. And you will have to deal with it.

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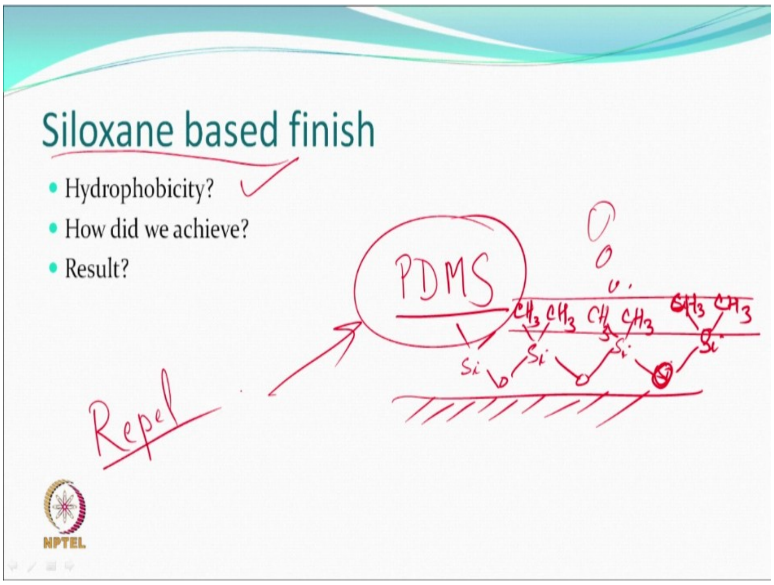

So, till now, if you remember, we had done water repellent treatments. So, if you do a water repellent treatment, then what do we expect? Obviously, it will repel water. So, by this type of a finishing treatment, what we had done is introduced hydrophobicity, alright, done hydrophobicity. What were the compounds that we had used? We had polydimethylsiloxane as one of the compounds, which was very effective, because it could create a hydrophobic surface.

So, you had the surface. And you had those silicon oxygen linkages. And on top of these, you had methyl groups sitting. Alright. And so, you could create a layer which is more or less hydrophobic. And so, any water that would fall, would be repelled. That also meant, anything which is water based would be repelled. So, if the soil is water based soil, we will definitely see, along with water, any soil which is water based also be repelled.

If it is repelled, then we are happy that there is no soil. So, we do not have to worry about removing it. So, how did we achieve it? Using siloxane molecules, polymer molecules which could be attached to the textiles. The result is repellency. So, they repel.

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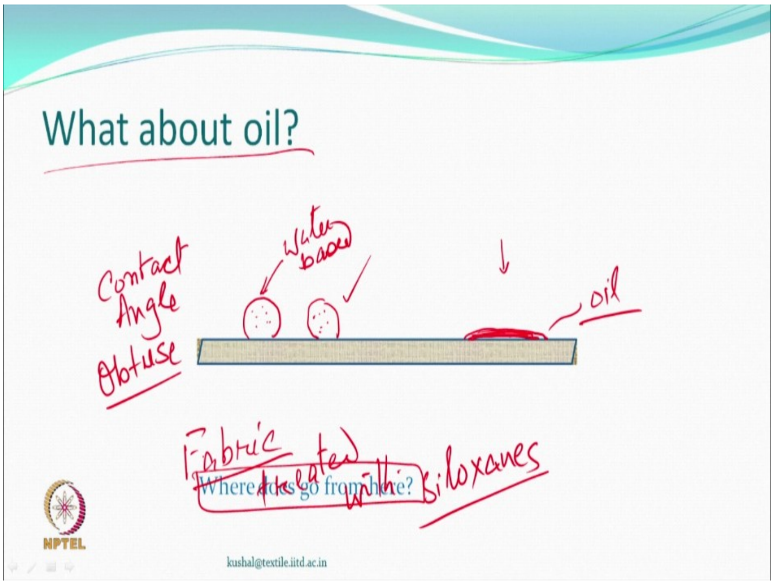

What about, instead of water we had oil. If you have a water based soil, let us say a sauce, ketchup, water based; or ink, water based; they will be repelled. And therefore, their contact angle will be high, obtuse. Right. But if you put a drop of oil. So, these are all water based. If you put a drop of oil, it will spread. So, the oil will spread, where? On a fabric treated with siloxanes.

So, what have we solved? We have solved partial problem in terms of anything which is water based will be repelled. Depends on how much you have added of course; what is the efficiency of your, efficiency of your finish. So, if that is good, then the water based will be repelled. But the oil based will not be repelled. But the soil, also like rain, you cannot choose that this is the only soil which is going to be encountered whenever you are working in any environment, let us say industrial environment or home environment or any professional things that you do.

If you cannot avoid them, then what do we do? That means, the fabrics which have been made hydrophobic by even silicon treatment are not going to be repelling any soil which is oil based. So, that is a problem. So, the question which obviously people may like to ask: Where do we go from here? Right. Where do we go from here? Okay.

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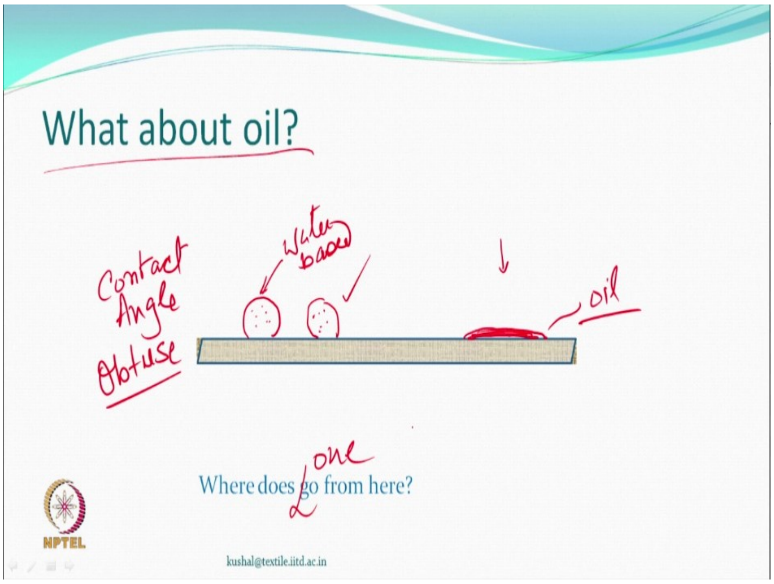

So, that is the question which we will have to answer. Where do we go from here? Okay. Alright.

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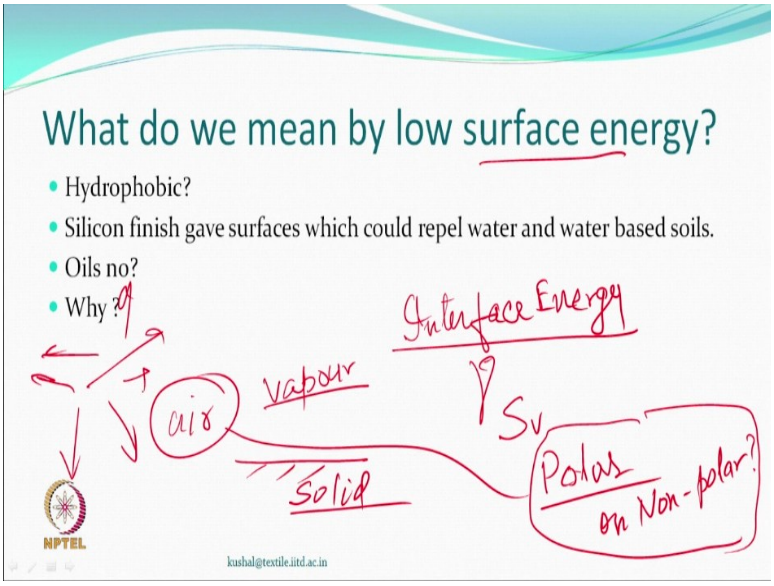

So, let us understand. Again, what did we mean by a low surface energy? When we said we have treated a fabric with silicons, we said we have made a hydrophobic surface, which was true and which we work around and saw that. That yes, it was repelling water and water based oils. Why no oil could be repelled? This is what the question which we like to ask. So, what is a low surface energy?

This is a surface; surface of a textile; surface of a paper; surface of whatever. So, what do mean by low surface energy? So, one was, make it hydrophobic. Hydrophilic is high energy surface, hydrophobic is low energy surface. And the question is oil. So, can we go further?

So, when we want to go further down, what do we mean actually? Remember we talked about interface energy. So, when we talk about surface energy, we are talking about gamma SV. Remember?

So, that is an interface; interface between solid surface and vapor. Vapor actually means in our case, let us say air. So, the question which I had left sometime was: Why and how this interface energy will go down? That will depend on whether the vapor phase dislikes this solid surface or it likes the solid surface. If it likes the solid surface, then it is a story of a different kind. Right.

So, energy will be very low, because it likes. There is no tension. Right. If it does not like, then the tension will be high. This is what the normal state is. So, when we say that surface energy is going to be low, it is with respect to air. So, what is the character of air? Is it more polar or more non-polar? The air, polar or non-polar? So, polar or non-polar? What do you think? Polar or non-polar?

It is generally a non-polar environment. Somebody can argue why? You have got carbon dioxide there, which is not absolutely can be called as a non-polar. You have water molecules floating all around. You may have gases, sulphur, nitrogen based gases. How do you say it is polar, non-polar? It is because the dipole moment, you know, when we talk about a polar molecule, we talk about dipole moment.

The dipole moment obviously has a direction. If all of them are directed in one direction or more or less in one direction, then the polarity obviously increases quite a lot. If suppose, one is pointing in one direction, the other is pointing in other direction, these dipoles. And if you find the average magnitude and direction overall cancel each other, then becomes a non-polar kind of environment.

So, theoretically we can call air as something which is generally non-polar. So, when we say air versus solid interface, which we call as gamma SV, that energy. If our solid surface more or less becomes more and more towards polar, then we will keep reducing the surface energy. And we have to go theoretically now, beyond hydrophobicity. We may have to enter the regime of oleophobicity. That is something which repels oils as well. So, we will have to now look for other chemicals which can help, hopefully to reduce the surface energy further. Does it make sense?

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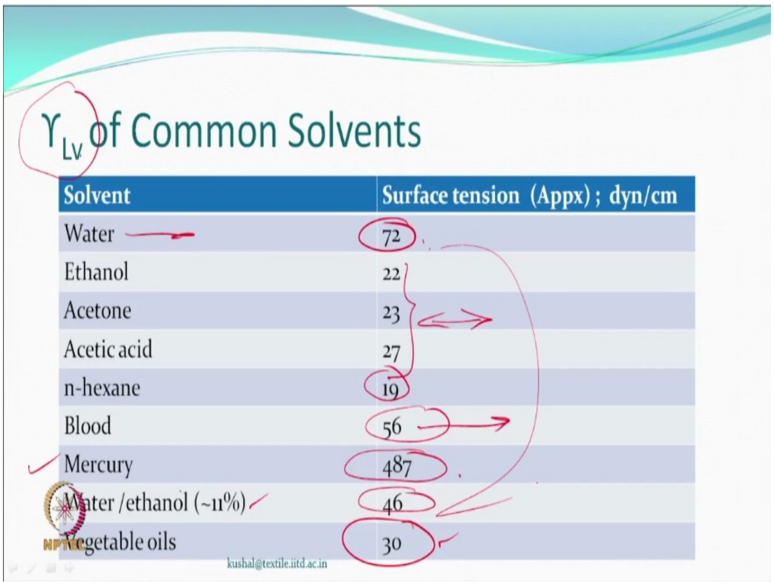

So, let us look at the surface tension. Here we are looking at surface tension of liquids, which means liquid vapor interface. Okay. So, we have been dealing with water. Right. This value is about 72 dynes per centimeter. Now, approximately the word has been used is; because these values can change based on temperatures; so, and any other way, little bit. A bit of a change of temperature can change these values.

So, we are approximately looking at, let us say about 25 degrees centigrade, if you measure, it will be close to 72 dynes per centimeter. You remember another interesting liquid which is not a solvent, common solvent is mercury. So, by itself, it likes every part of it so much, that does not like the vapor at all. It is liquid, likes itself so much. Right. That it is away from the vapor.

And so, if you drop mercury, drops anywhere, on any surface, they just roll off. You have seen that? Have you broken a thermometer? No. Thank you. You do not really have to break the thermometer to see whether the mercury actually floats all over, rolls all over. You can actually go to the lab and see there is a mercury available. You can always check that out. So much of a difference.

If you want to make anything; you do not really have to do anything to the surface. That means, either the liquid has such a high surface tension. Then it will just keep rolling on. It is not going to get attracted, because it likes itself so much. Alright. But we are not going to be dealing with mercury as a soiling agent. You know, we would be having oils. Look at this. Compared to water, the surface tension is pretty low.

And if you have some other solvents, it is very, very low. Now, if this type of a solvents are going to be put on the silicon treated, silicon finished textile, they will just spread. They will just spread, because their own surface tension is relatively low. And similarly, the n-hexane. But important thing you can note down is a blood, common fluid which in hospitals one may get it.

That also gets spread. So, that is one of the ways in which you can soil your garment. And you do not want it to become. So, some finish treatment is given to the hospital gowns and so on so forth, surgeon's gown. Based on something that you want. So, this will be absorbed more than even water. If you have mixtures, the surface tension keeps changing, depending upon how much have you added the other compound, let us say ethanol.

11% ethanol, if you add in water, the surface tension changes. And so, one has to see what liquid are we talking about now. So, if the surface tension of a liquid that we are hoping is going to soil us, right, why we are talking about this thing. The alcohols is, that people drink alcohols, wine and so on so forth. All of them have different surface tension. So, they spread relatively more easy. And if you want to make things repellent to them, something else has to be done. Because the liquid is different now.

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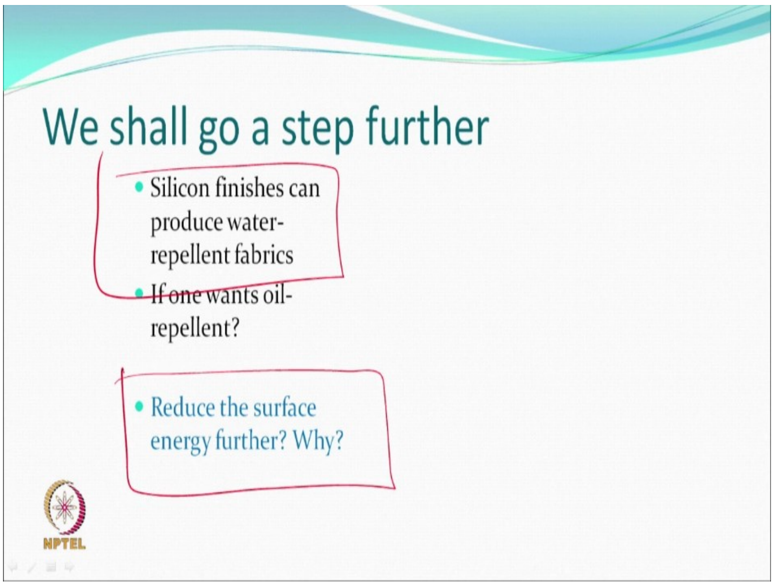

So, we have to go a step further. Okay. We have to go a step further means, the surface energy of the textile has to be reduced further. So, this is what we mean. Silicon finish could do whatever they could do. Cannot do better than that. If you want oil repellents, reduce the surface energy further. Why? Because the surface tension of these liquids like oils and organic solvents is much less compared to water. Is that clear? So, you see this Teflon.

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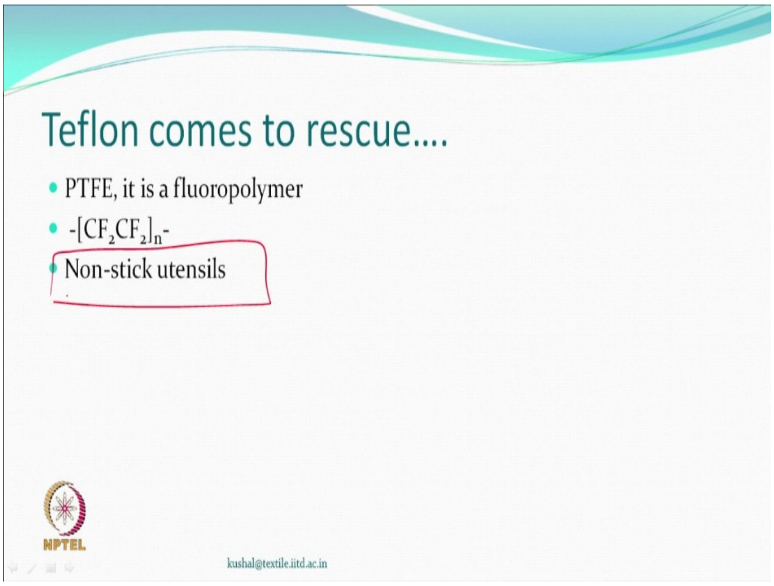

You already learnt something about where you use them for doing a different purpose. Purpose was expanded PTFE film which could be laminated on a textile surface or sandwiched between textiles to get waterproof breathable garments. So, it has one interesting property which we did talk. But now it becomes important to us. You have heard about this nonstick utensils. Okay.

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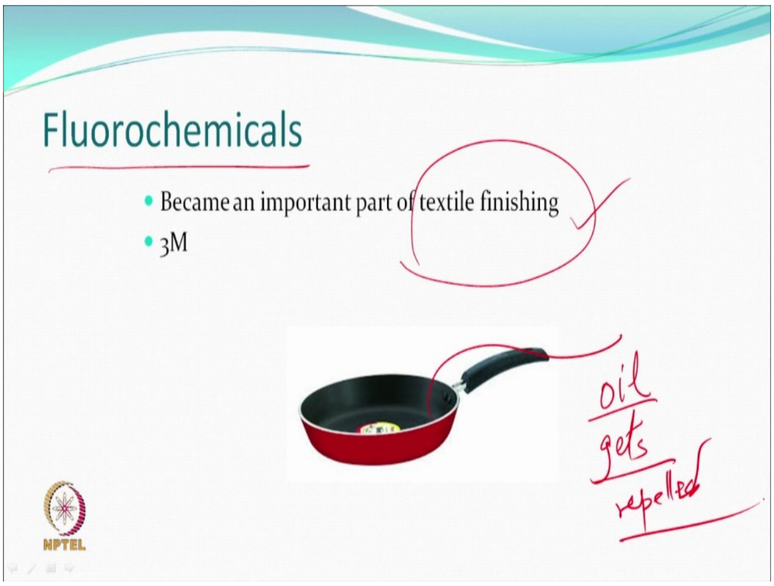

Something like this. Right. You must have seen some of these equipments in the kitchen or anywhere else. So now, if this fluorochemical; now we are calling it fluorochemical, can become a part of textile finishing. We had used them as a laminate. There our purpose was different. They were not exposed to the outer surface, because we thought they were very delicate.

So, finishing here would mean that we are not going to be making a film which is, continuous film where nothing can breathe in and breathe out, but repellency. Like in water repellency, we were interested in repelling, not change the breathability of the garment. Now, we understand what breathability is. So, we work on some type of finish, because we are quite sure, the fluorine based compounds, but not necessarily Teflon, we are not going to use.

We are not going to be using Teflon, but at least we got inspired from the Teflon. Okay. So, then repelling can happen, because here you see, in such thing, oil also gets repelled. That is important. We are looking at oils, oily soil.

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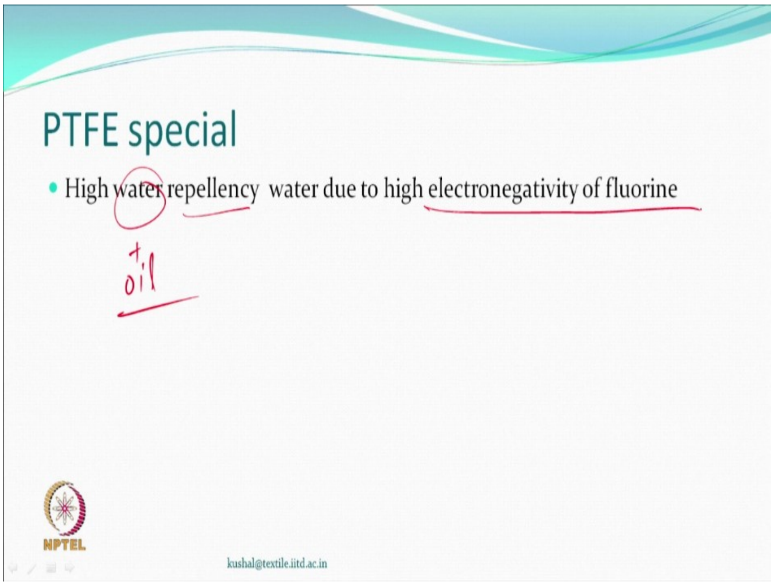

So, the high repellency, not just the water, but high repellency of water plus oil is obviously due to the fluorine atom itself. And so, many things it did. As we know, less friction; all such things are there. But now we want to use this material differently. Very interesting work, original work was done by Zisman and coworkers.

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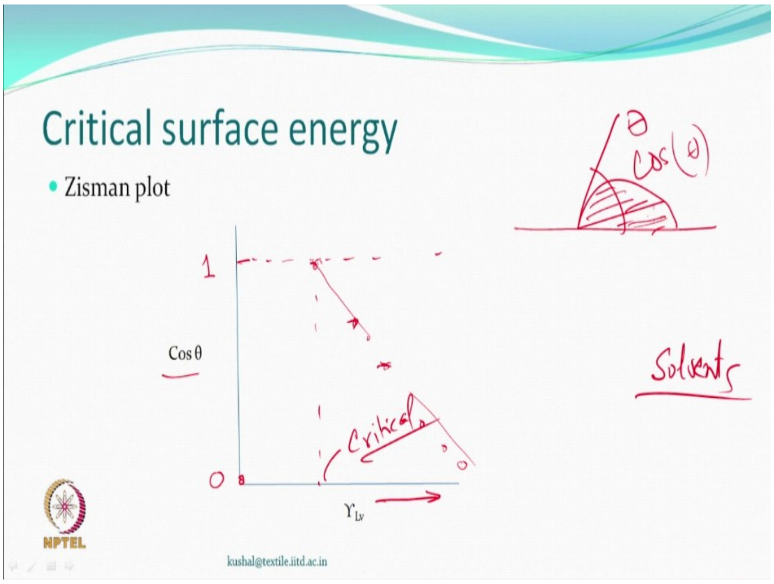

And they defined something called a critical surface energy. That means, what should be the minimum surface energy, so that anything which is low put on them, you can repel. So, what did it did was; let us say you take different solvents which have different surface tension values. And you remember your Young and Dupre equation where a drop in a equilibrium state takes a certain shape.

And you have this contact angle which is theta. And cos of that theta is what they plotted. So, from 0 value, let us say to value 1. So, they got some plots or different solvents that when it will spread. Whenever approximately, you may not be able to find a solvent which will give you this very easily. But whenever you approximately find by extrapolation or otherwise, that is what they called critical.

That would just give that, if you are able to reduce surface tensions, then some of these solvents are going to spread, if we keep on reducing; so, that kind of a surface tension. So, if your surface tension of a liquid is here, it will be easy to repel. The one which will be very close here, it will be difficult to repel. And it actually get spread. That is how they wanted to look into this thing. And what they did also was another very interesting experiment.

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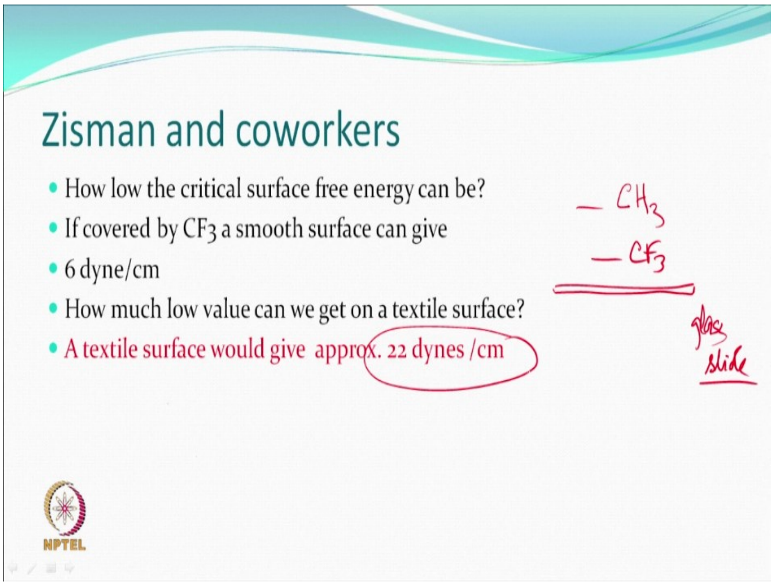

And that interest experiment was that, on let us say smooth surfaces like a glass slide, they made different types of polymers, which were fluoropolymers, fluoro compounds, try to create different surfaces which are exposed to the air. In the silicon, what was silicon finish that the polydimethylsiloxane type of compound, what was it being exposed? Exposure was CH_3, CH_3, CH_3.

If suppose, instead of CH_3, you have CF_3, CF_3, CF_3. So, they could make different compounds, where sometimes CH_2 and CF.. CF 3 could be exposed. And with a lot of hard work, they came to some interesting facts, from repellency point of view. They wanted to know this question. How low the critical surface free energy could be obtained by some treatments of these kinds?

They found one interesting thing. If it is possible by making different kind of compound, that the most the surface has CF_3 groups exposed. Then, the surface energy of the surface as low as 6 dyne per centimeter could be obtained. Now, this value, compared to remember oil, about 30; organic solvent, about 23 to 28, 29 have more surface tension compared to this surface. Definitely, then you are getting towards an equation where these can be also repelled.

But, the important thing is, the textile is not a very smooth surface. You see, if you take any textile, woven, knitted or whatever. You have got hills and valleys all over, if you look in the microscope. Right. So, you may not be able to get figures like 6 dynes. But you will get definitely much lower figure, so that oil and other kinds of things would still you may be able to repel.

So, depends on how best the work is done. You can get some level of reduction in the values. And approximately, a textile surface, by little hard work may give surface energy which are approximately in this range. If that can be done, then the chances are, we will be able to repel oil also. So, what is there? What did we talk about? We talked about replacing hydrocarbons with fluorocarbons or perfluorocarbons.

That everywhere, all hydrogens or some of the hydrogens have been replaced by fluorine. Right. So, these are new compounds, not Teflon. Know, Teflon is very different polymer. So, you do not, you are not going to. But sometimes, these finishes also got Teflon finish, but they are not really Teflon in that sense. Right. They are different compounds, but using the property of fluorine. Okay. So, inspiration can come from Teflon type of a material, but finally, these material although are going to be fluorine based compounds, but not Teflon.

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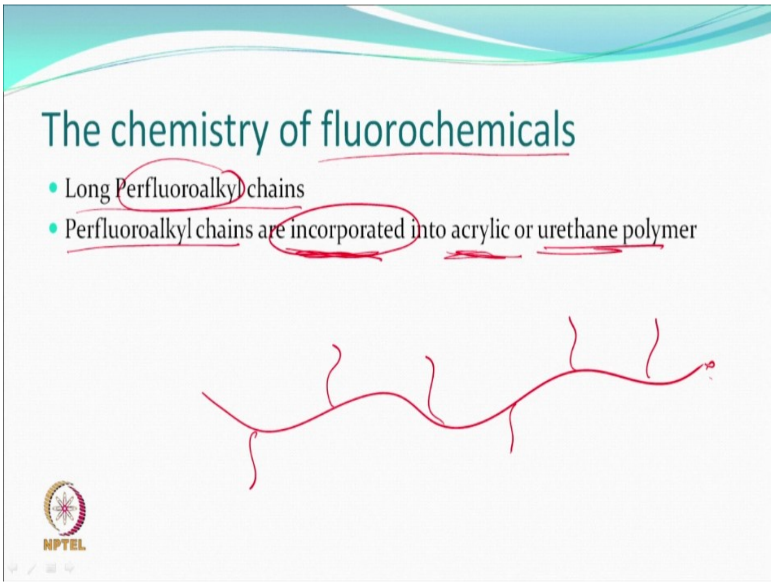

So, some of the fluorochemicals which can be used are, will have fluoroalkyl chains. And these fluoroalkyl chains are not by themselves applied, but they are incorporated into some acrylic or urethane polymer. So, you have a backbone of an acrylic polymer to which fluoroalkyl chains can be attached. So, remember, incorporated into either an acrylic type or urethane type of polymers.

That means, you have a backbone. And you have a side group, which is let us say fluoro group. So, they are different, is not it? They are different from PTFE which has everything was only CF_2, CF_2, CF_2, kind of stuff. So, let us say; so, you have a backbone. On the backbone, you are saying, well, I have long fluoro or perfluoroalkyl chains. Obviously, they may not be as long as the backbone.

But they may be C_8, C_7 type of compounds, which may be protruding from the main chain. And our long chain obviously means, you wash fastness and so on so forth also. Right. And that is how you may like to work around.

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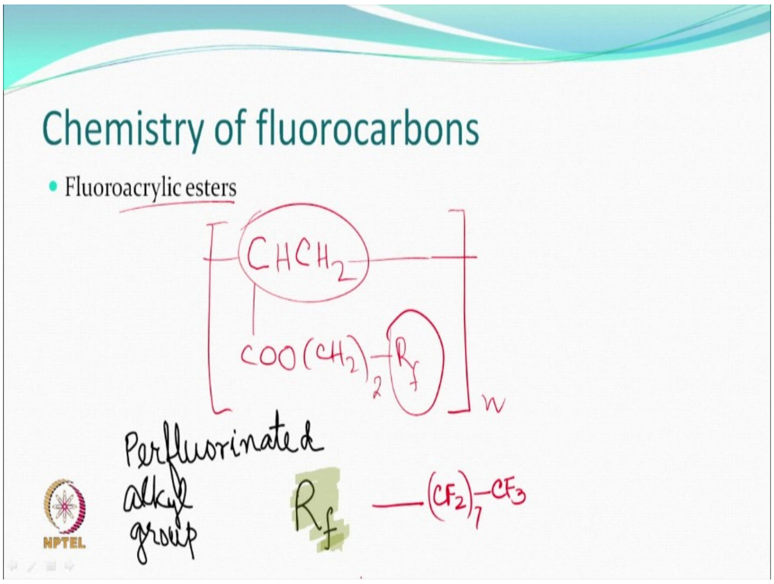

So, this for example is a fluoroacrylic ester. So, you have a main chain which is here. And then you have the fluoro compound, which is attached here. This fluoro compound could be, let us say CF_2. Okay. So, perfluorinated alkyl group has been added, but in a generally a polymer which is acrylic polymer. Right. Now, this R_f could be very simple. As we have said, like this. It could be slightly different.

It is okay, whichever way one use. But they have to have; these branchings are there, which are going to be. And, so that you can apply through, like a finish onto a textile and hope that these fluorochemical moieties are going to be exposed. Because the main chain may be linked by various bonds to the main, the surface of the textiles. And they are the ones which are going to be exposed, because they are not reacting with the surface.

So, these are going to be exposed out, whichever way. The more they are exposed out, the more repellency is going to be achieved. This was beautiful. Once you actually give the treatment of these fluorochemicals, you actually found that the oil would be repelled.

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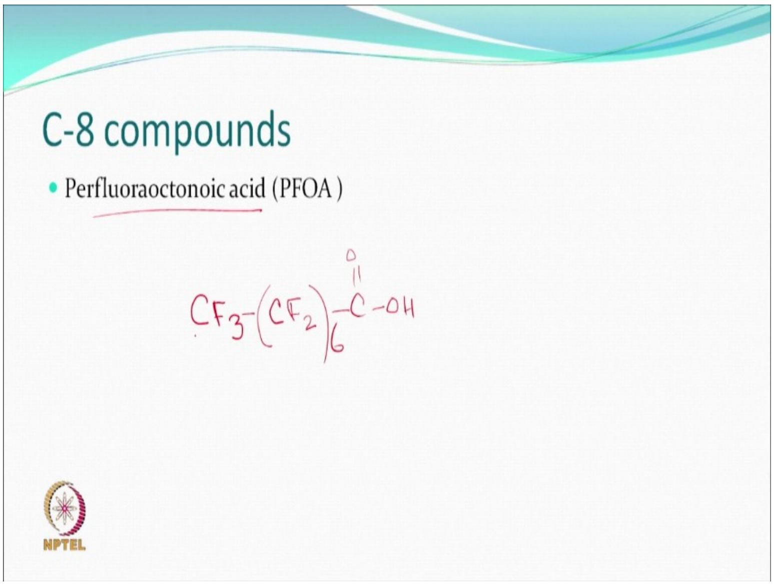

Some of the C_8 compounds which are the branches are compound based on perfluorooctanoic acid. So, sometimes they are known as PFOA. So, these compounds are the one which are branches that we are talking about. Something like this. Okay, they, this part can react with the main chain, whichever the main chain is and become a branch. Right. C_8, they are called, because 1 is here, 6 are here and 1 here. Total carbon are 8 carbon. Right.

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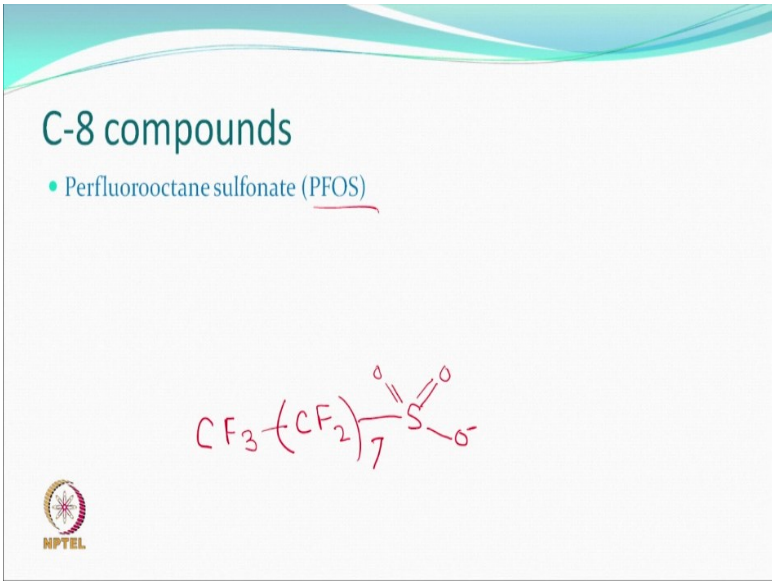

A similar compound which is called the PFOS sulfonates. They can also be reacted, so that the, they become the branches of the main chain which could be based on the acrylic or I will say urethane based polymers. Something like this. And so, interestingly, you will be able to get them. So, CF compounds.

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So, what is the magic? The magic is, if you have treated with the fluorochemicals, the water based and also the oil based. Water based and the oil based soils would be repelled. That is the magic. So, this is one of the very successful attempts in using the chemistry of fluorochemicals to design finishes which would do oil repellency. If they do oil repellency, that would be in oil based soil repellency also. So, it was, as far as repellency is concerned, the fluorochemicals can be considered a very successful synthesis and successful advent of a beautiful repellent finish.

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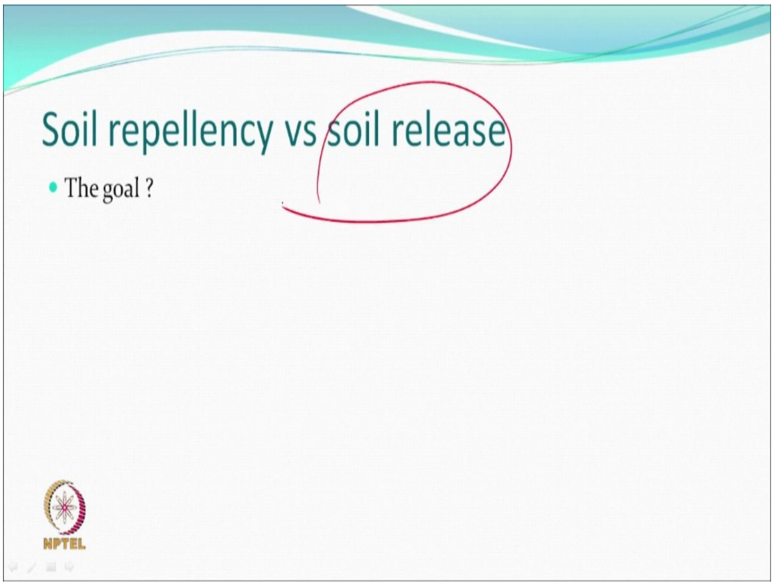

Now, there is another question which becomes important. What are we interested, repellency or release? So, we say, yeah, we are interested in repellency. If the soil is repelled, it will not be there. We are very happy about it. But suppose I have a grease in my hand and I just rub it here; force it in. So, it is not a simple thing like a drop falling. But you are taking it and impinging on it.

Like a work man's clothing or a motor mechanic's clothing, who works under the car, with the grease and everything else. It just get pushed into the textiles. So, although it, the textile surface may have been treated for repellency part, but pressure is pressure. So, if that happens, then what? Then, I will say do not worry. If it has not been repelled, I will be interested in release.

Let me wash it. All garments are going to be washed. And so, let the soil come out. If soil comes out, I will be as happy. So, if it repels, very good. If it cannot, then I will want that it be get a release during the washing process in a detergent solution.

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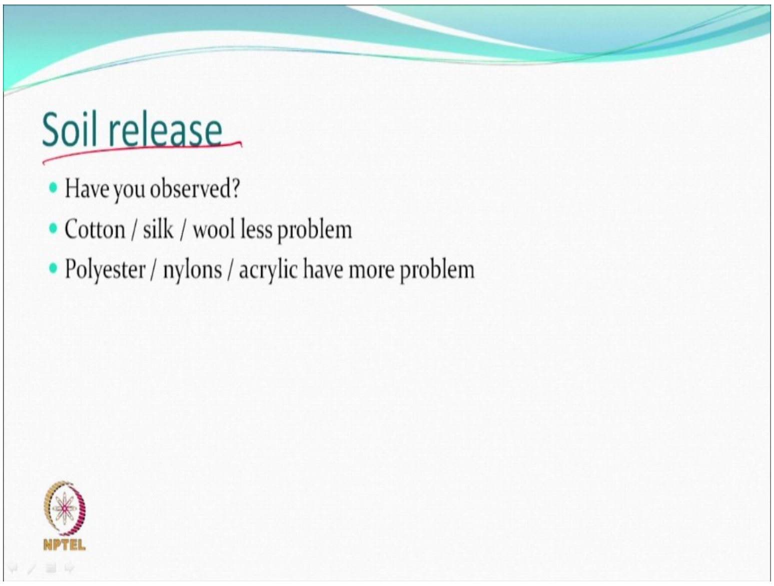

Let us see some of these experiences that you may have had. You have been wearing fabrics which were made from cotton, wool, silk. All of them get dirty. You wash them. They get clean. Then you must have seen some of the synthetic materials like polyesters. Have you seen the very white polyester? When you start using it, with time, it changes shade a bit. It does not look the same white as it was, let us say in the beginning.

Why so? What it means is, that it starts attracting anything which is more hydrophobic, because it is hydrophobic by itself. So, hydrophobic soil is getting deposited in some manner or the other; with time; little bit; slowly and slowly. And you find that, the color is changing. It is no more that white. That means, it is getting soiled more and more. Or shall we say that, even if it has got soiled, what happened.

Maybe the release was not good enough that your washing treatments were not able to take them out, for whatever reason. If that is true, then we have to worry about release. If some such soil which are deliberate or inadvertently get into the, onto the textiles and into the textile, then how do you remove them?

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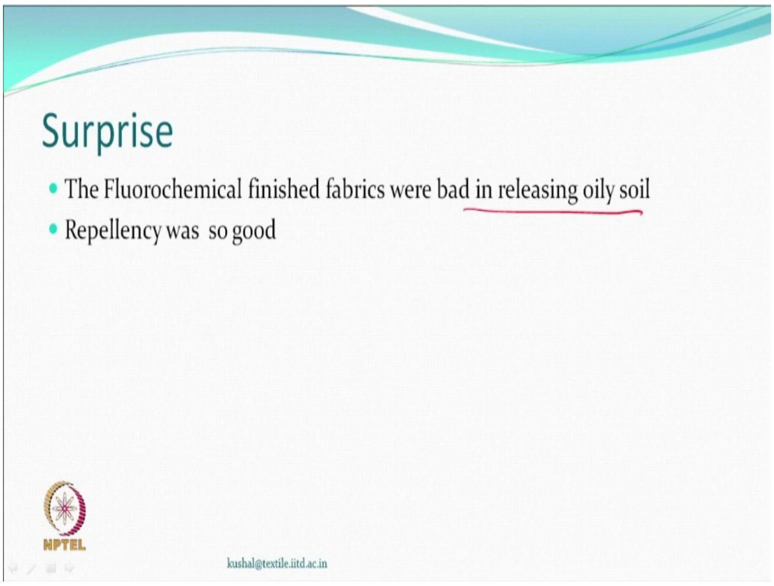

Let us see what happened with our fluorochemical treatment. The fluorochemical treatment was found to be bad if oily soil actually gets entrapped. That was pretty surprising. Something, a material which is so beautiful, repellency is so good. And still, the soiling, if there was a soiling, it was difficult to remove. So now, what has become important? So, such a beautiful material which was actually doing all repelling.

But if its, soil gets into it, difficult to remove. So, suddenly, some of the problems come. So, let us say what is the thing? So, there must be some way in which the soil is released from the surface. Obviously, what you do? You wash it. How does it remove? So, yeah. So, there is agitation, you have a surfactant. What is the role of a surfactant? How does it work? And how the soil gets dislodged from the textile surface.

So, what could be the role of detergent? The role of detergent could be many. One is dislodgement, which can happen also by mechanical agitation. But, by some way, to dislodge; or any soil which has actually come out of this fabric into the solution, let us say detergent solution, does not go back.

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So, let us say there is a soil which could be, let us say an oil droplet; if it comes out. Then, a surfactant, you know what is it; it is also surface active agent. Right. You remember that? So, what will happen? Aqueous detergent solution, so have a hydrophobe and a hydrophile. They will keep this oily particle or any hydrophobic particle which may not be oil, which may be suspended particle, remain suspended or emulsified, so that it does not go back to the fabric surface. After dislodgment, it can again go back. So, do not, do not allow. So, this is, this got so much work to do then.

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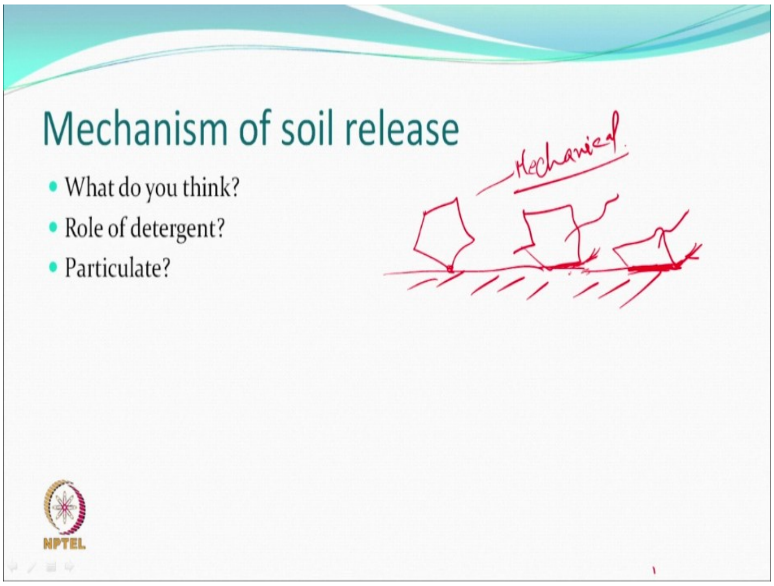

So, if it is a particulate type, for example, some octagonal, hexagonal surface lying; maybe this, any kind of a particulate shape. And this is my surface. So, what will a detergent do? This particle for example here, is very less attached. Forces, bonding forces are less. It may get dislodged by mechanical agitation. While these type of particle which were larger surface near the textile; so, even if it is a Van der waals force; so, what will the detergent do?

Because, detergent will like to get inside this interface. So, there is a interface; this solid beat with this solid. It will like to enter. The detergent solution we like to enter. And then create a different interface. Because, for some reason, it has been able to penetrate. Then this will be dislodged and will go away into a solution where the surfactant will again make it suspended into, in the solution itself. If it is an oily soil; let us say this is my textile surface.

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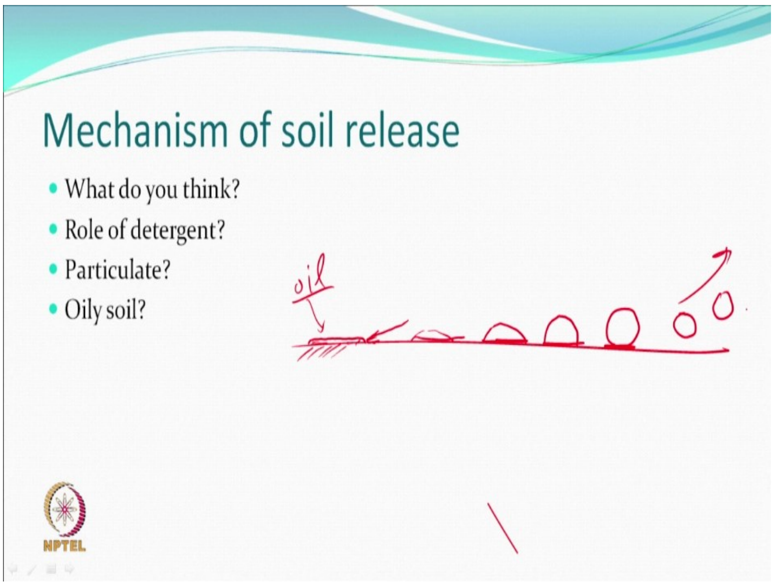

If it is an oily soil like this, then the detergent surface, detergent solution will enter the interface. And slowly will cover this interface completely, because this is oil and this is aqueous. Now, so you have a; at the moment to begin with, you had a solid surface of a fiber and oil. That was the interface. Now, if the detergent solution slowly keeps entering the, between these 2 layers. So, the, now the new interfaces are created.

One is between aqueous detergent solution and the textile. And the other is aqueous solution and the oil. So, 2 interfaces have been created. Fortunately for us, aqueous solution and the oil do not like each other. So, what happens? This thing which was almost the oil which was spread, will now start becoming higher, higher into a droplet, till the time it is all water, all over water aqueous solution, water interface and more water interface and more water interface.

And finally, it can roll off the surface and go into detergent solution. So, this is the mechanism with which the oily soil and; oily soil, that means oil plus any other thing which it has, will keep on rolling out. The other mechanism could be; so this is called the role of mechanism. Other mechanism could be, that actually do's, almost like a saponification. You have a alkaline detergent solution, which actually saponifies the oil in a way and becomes water soluble; and therefore come out.

That process is very slow. And you are not interested in that process. So, oily soil removal, in some way, oily is very oleophilic oil. And therefore, water does not like this. And so, the mechanism is roll off mechanism. So, let us see some of the interesting points.

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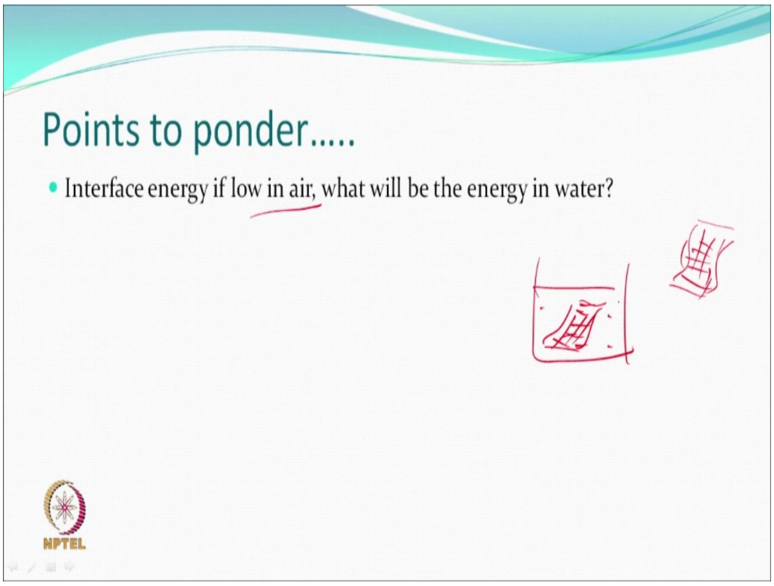

If the interface energy is low in air; now obviously interface; so, solid and air. What will be its energy in water? Interface energy, this solid surface and the water. What will be? Question you understand? If the interface energy is low in air, that is, it likes air; what will be the interface energy in water, of this surface. Like a textile which is initially in air. This is my textile in air, which has been treated, whatever but treated, untreated.

But its energy is low. That is what it says. Then, if I put it in water, the same fabric, what will be the interface energy? That is what is being asked. High or low? It will be high, because water is more polar, air was more non-polar; opposing effect. So, it is not going to like. That is a interesting thing to note. So, the detergent solution on a fluorochemical treated fabric, which has a very low surface energy in air, will not be able to penetrate it.

It does not like the oil in general, so it does not like water and aqueous system anyway. So, the mechanism of roll off can be hampered. Because, this aqueous detergent cannot enter in any way, because nothing on the surface allows it to go, because surface energy is very high. So, one thing you have to remember. A very low surface energy or in air will mean very high surface energy in water.

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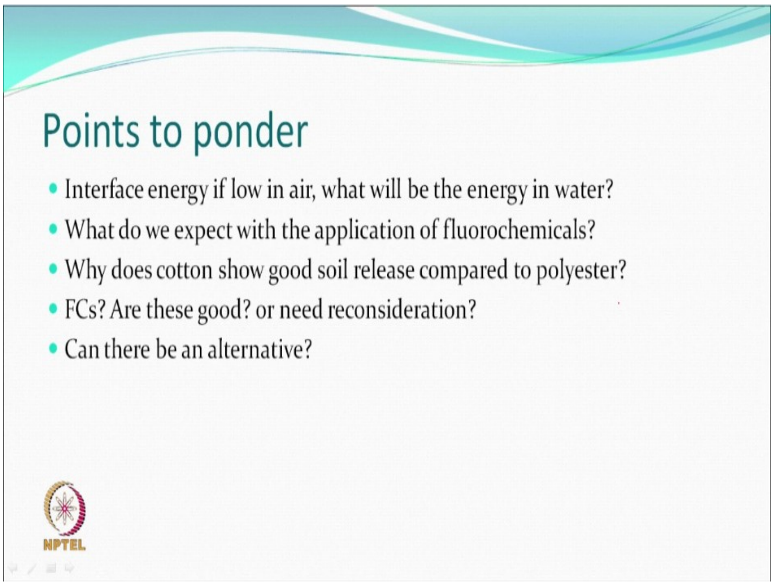

So, that is where the fluorochemicals had the problem. You have made the surface energy so low, they repel oil; they repel water. So, they repel everything. And so, detergent solution also is not able to do the job. So, why does the cotton show good soil release compared to polyester? Why? Because the polyester is hydrophobic, the cotton is hydrophilic. Is it right? You get the point?

So, the question that comes? Are the fluorochemicals then good enough? Well that becomes an issue. Are the, there any other alternatives? Such a beautiful finish. And suddenly we are almost nowhere. So, we have to look for an alternative. So, today we will stop here, pondering over these points. And maybe next time, we will raise the same and similar questions and ask, is there an alternative?

Because for us, soil release is equally or more important than soil repellency. You get the point? So, thank you very much. We meet next time and look at some of these questions which are left for us to ponder over. Thank you.