**Textile Finishing**
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**Module - 6**
**Lecture - 14**
**Water Repellency**

So, welcome back to the class on textile finishing. Let us see, what did we do till last time. Last time, we were talking about some of the definitions of waterproofing, water repellency and waterproof breathables.

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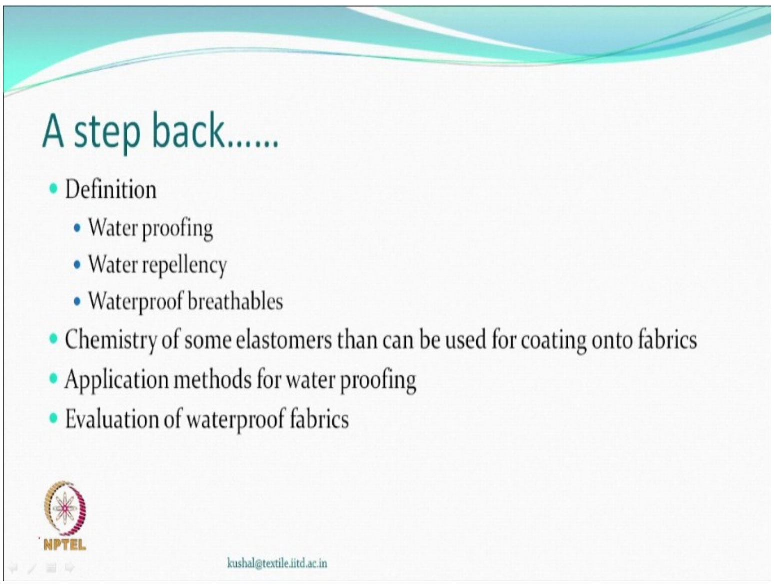


And we tried to understand what and how they are different from each other. And then, we took up little more discussion on waterproof fabrics or waterproof finish. And we did discuss chemistry of some of the chemicals which can be used as waterproofing agents. And some of these obviously were coated, can be coated on the textiles to get that effect. And so, how do we coat?

Those are some of the method that we talked about, which included; for example, knife-on-air or knife-on-roller type of methods. After coating, you could obviously dry them, cure them, depending upon what chemicals are there along with it. And then of course, how do we evaluate a waterproof fabric? Hydrostatic test is what can be used. You increase the pressure, so that the water wants to penetrate through this fabric. And whenever about 3 drops of water are visible on the surface, we say that is the pressure it can withstand. So, that is the hydrostatic pressure test.

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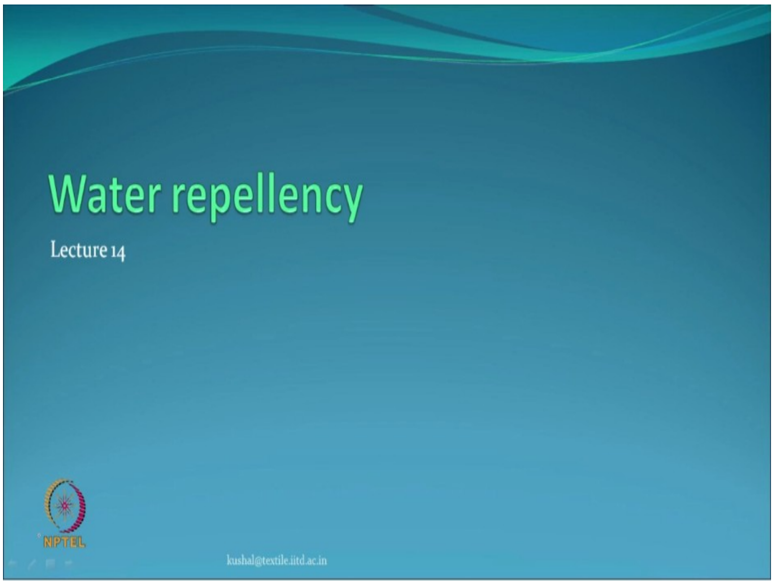


Today, we go further and talk about repellency, water repellency. You want to make a water repellent fabric; what kind of a thing that you should do? So, as against the waterproof fabrics, what are the expectations that we have from water repellent fabrics?

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One, of course is that they should repel water as much as possible. That is an expectation. As the name suggests, they, these fabrics, after finishing should repel water. That is one. We also expect that the air permeability should not be decreased too much. In waterproof fabrics, we almost said the air cannot pass through. The standard tests for checking the permeability of the air would fail or would demonstrate or would say that air permeability is almost 0.

But in water repellent fabrics, we are only interested in repellency and not, you know, decrease the permeability of air. Whether it will decrease or not, it will depend on what you do to it. But our expectation is that the air permeability will not decrease. Because air permeability has something to do with comfort. The kind of garments that we are wearing, for example, we never feel uncomfortable.

In the day to day work that we do, we, the body is continuously releasing heat. And which, if is taken by the atmosphere, then we feel comfortable. That is our physiological phenomena. And body also continuously loses moisture through perspiration. And as long as this perspiration is evaporated, we feel comfortable. Now just think or remember, anytime you have been wearing a raincoat.

Man, what is a raincoat? A raincoat is a waterproof fabric. Right. Raincoat is a waterproof fabric. So, have you, do you remember, whenever you were wearing a raincoat in a rainy season; and let us say you had to wear it for more than 15, 20 minutes, half an hour and so. Did you perspire inside? Did you feel that you are actually more wet inside, not because of the rain, but because of the sweat itself?

Did you experience or not? You never experienced? Or some of you must have experienced that when you have a raincoat, the standard commercial raincoat which has textile on outside and a rubber latex coating inside. Or sometimes, you may have seen people wearing almost plastic sheets, the raincoats just made of plastic sheets. So, what happens, you know, they obviously protect you from the rain immediately.

But if you keep wearing them for a longer period, then the comfort level is not very high. Because, the moisture that the body is releasing is not going to the atmosphere, it is getting condensed and becoming a perspiration. Your fabrics can get wet. And that is obviously not a very comfortable situation. So, when we talk about air permeability and it should be permeable to air, we also mean, the air as well as any vapor form of water should also just go out.

And if that happens, the comfort level becomes high. So, we want, actually our textiles that we wear; and I am not talking about the tent. Alright. I am talking about the fabrics, which you wear close to your body. The microclimate around the body should be such that you feel dry all the time. Alright. That is the importance of the air permeability. And therefore, the water repellent fabric is a garment, maybe a better idea if, let us say, it is a very light drizzle, you just walk through.

And suppose you just go and you shake your fabric and everything just falls off, then you are going to be happy. Right. So, that is something about the air permeability. Alright. Now, in the water repellent fabrics, do we expect some resistance to penetration of water? Do we expect the water penetration should be resisted? Well, these are contradictory requirements. They are contradictory requirements.

Because, to make sure that a fabric becomes, behaves like a waterproof fabric, you are, you have given a layer of a film which has been coated, applied on the textiles. And therefore, all interstices may have been closed. And therefore, transfer of air or vapor from one side to the other side is going to be very difficult. So, actually in water repellent fabrics, we do not expect that it should increase water penetration resistance. Is that clear?

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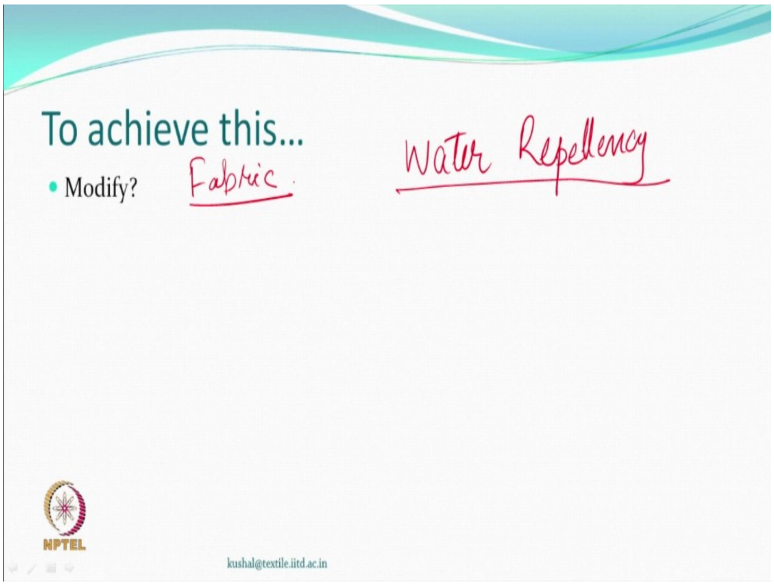


So, we are interested in water repellency. And so, what do we do? Modify what? Modify the textile, the fabric. But obviously, we should modify in a way which is different from what we did for waterproofing.

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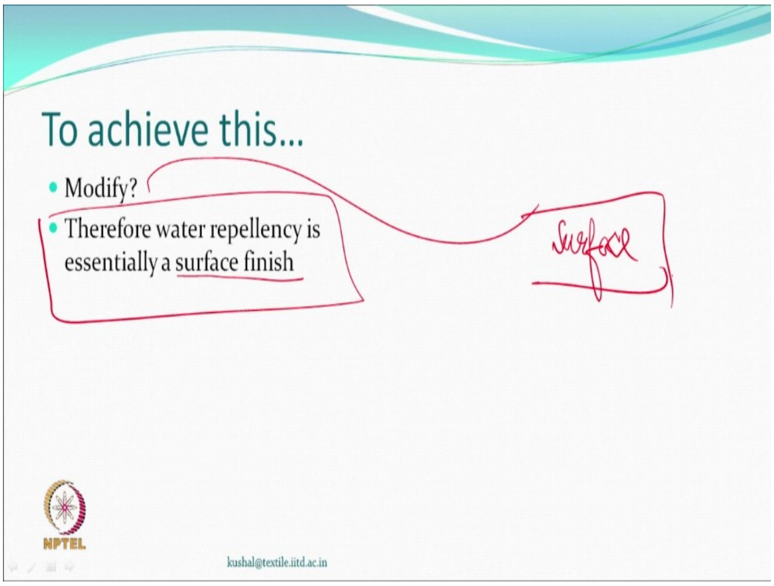


So, one important thing which we must remember that water repellency is going to be essentially a surface finish. So, what are we going to modify? Surface; we are going to modify surface. So, that is one difference, which you must remember. And therefore, we would be happy that the surface changes, but we are not blocking the pores or of the fabric or the interstices between the yarns.

And so that the water vapor which may be inside getting generated because of our physiological activity that we have. And there is a phenomena. The physical activities, the physiological phenomenal is that moisture will come out. And that must be evaporated, must be taken away from the body surface. And that can happen if we are looking at only modifying surface of fibers, surface of yarns or fabrics, but not blocking the interstices.

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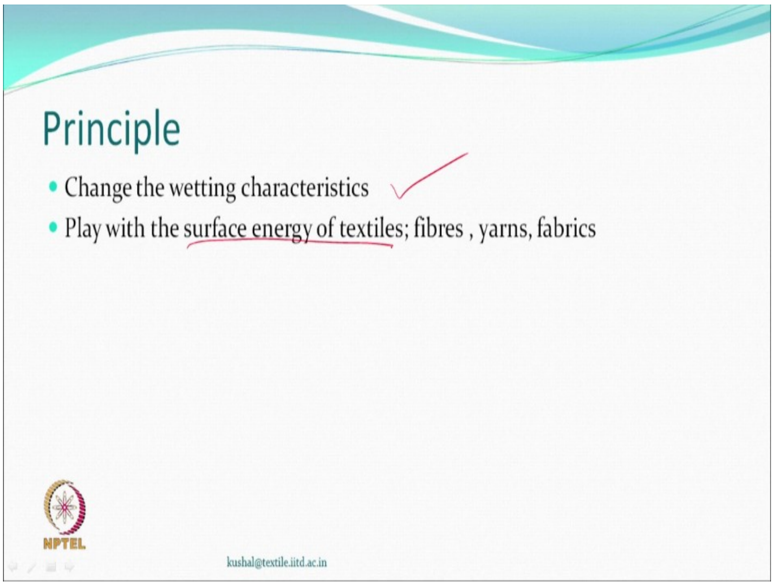

Which also means that we are wanting, we wanting to do what change the wetting characteristic of a fabric. Right. In some sense, we can say that we are going to be playing with surface energy of textile fibers, yarns and fabric. We will keep on explaining this as we move further.

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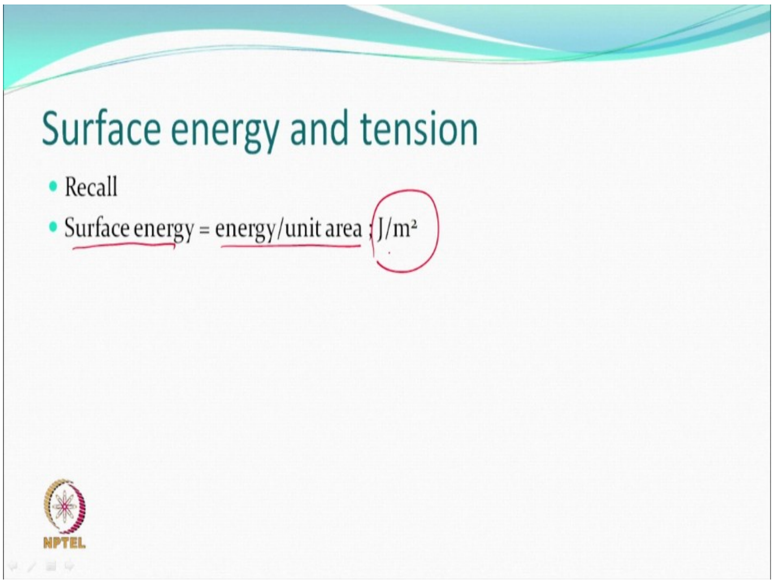


So, recall your early days of learning a bit of physics. So, what do we have? So, we have surface energy which is energy per unit area. Okay. Which is, can be expressed as joules per meter square. Alright. That is something which we remember.

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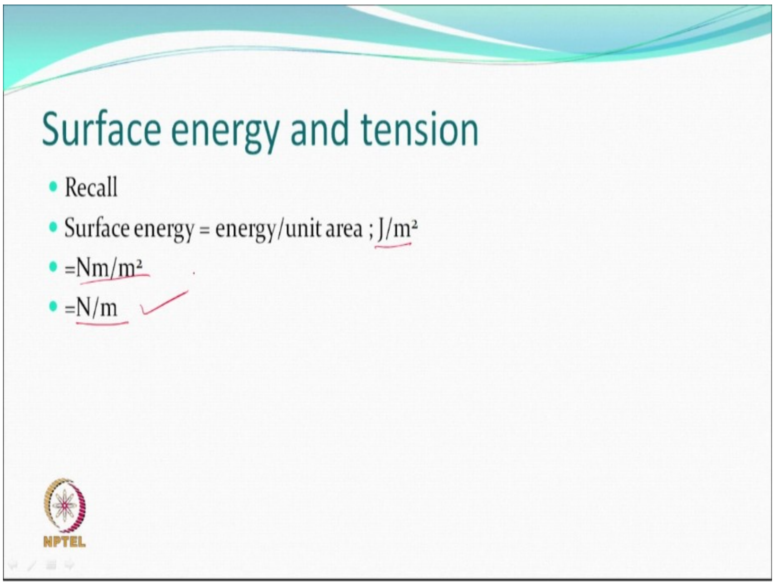


And then, this is, in a way can be expressed as newton meter per meter square, which is obviously, can be expressed as newton meter, newton per meter.

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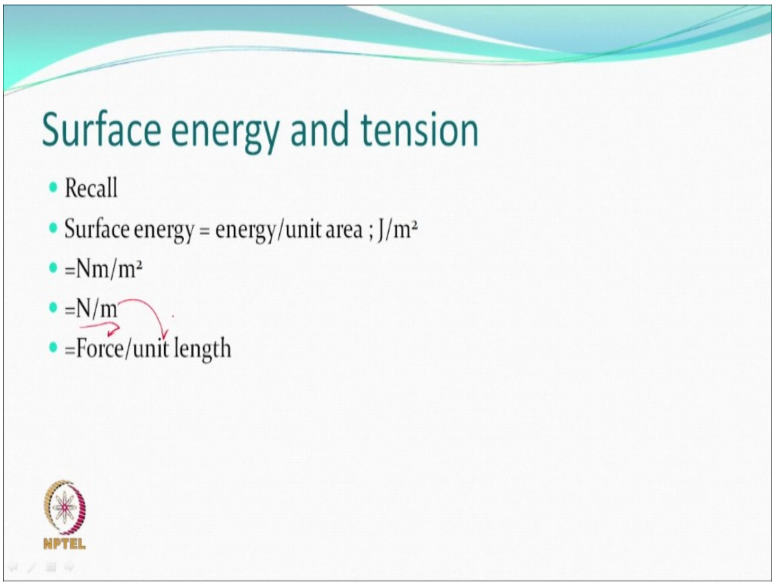


And then, if we see this, this is nothing but force per unit length. So, force per unit length is therefore nothing but surface tension.

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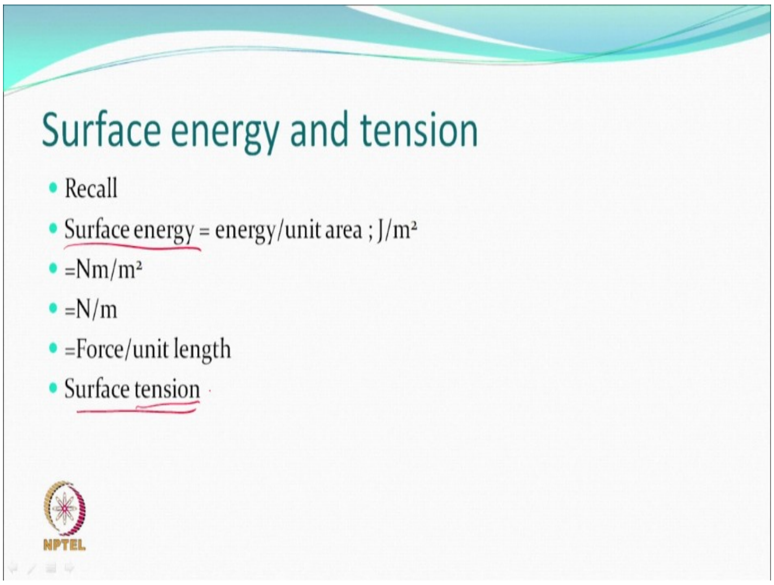


So, sometime, when somebody says, well, I am talking about surface energy modifications; or sometime they refer it to surface tension. So, they can be terms which are equivalent. But this surface energy is per unit area. And surface tension is per unit length, okay, the force per unit length. That is, energy per unit area, which becomes force per unit length. Now, this will happen.

And so, whenever somebody says, well, surface tension of this particular thing is this much and surface tension of a solid surface is this much. So, one should not get confused, because one is liquid, the other is solid. And there is an interface. So, every time we talk about surface tension, it means actually an interface, tension between some interface. If we talk about surface energy, that also is between some interface. So, without interface, there is no energy issue.

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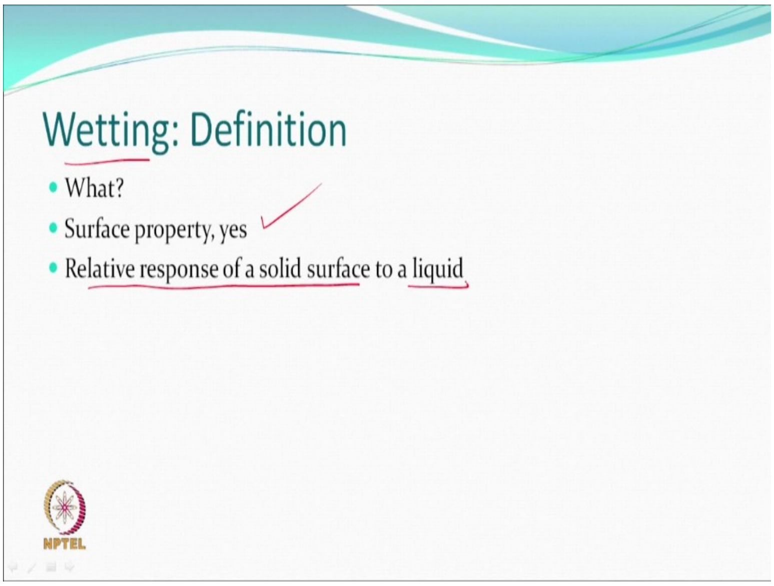


So now, for water repellent finishing, what do we want to check and do? So, what is wetting? What is wetting? I mean, do we have a situation where one is a wet wetting or wetting wettable surface, there is a non-wettable surface? Are these kind of things that we are looking at? What exactly happens? Of course, this is a surface property. And we believe that is a surface property. But, what is, for wetting, we like to see what is the response of a solid surface to a liquid.

When we put a liquid on a solid surface, what is the response? Is the response one way or the other; or there are many kinds of responses that you can actually see. That might just therefore say, wetting otherwise appear to be a simple thing. Like you put a liquid; and you see the liquid has wetted the surface. So, we say it is the wetting. But we may be able to talk about wetting in little more detail in; and differentiate between different conditions where the wetting would take place.

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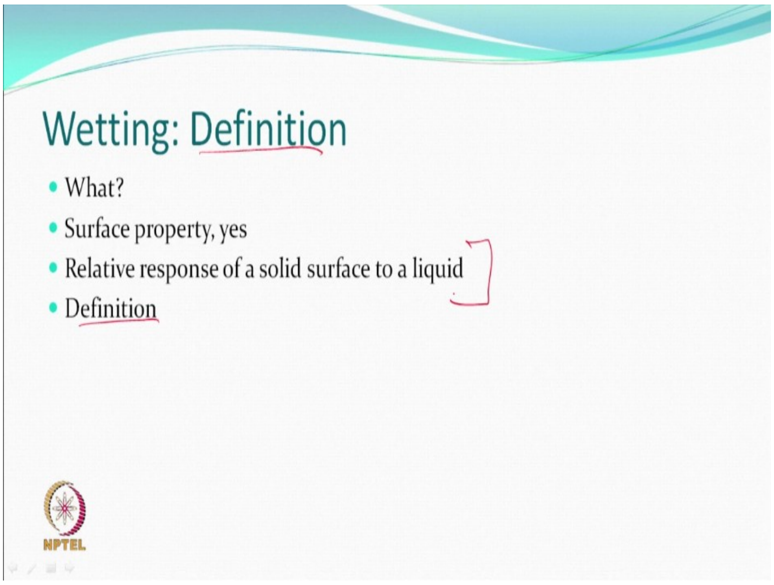


So therefore, when we talk about definition of wetting, we need it, because we do not know the response of a surface. So, based on the response of a surface, we may like to say, define the wetting. Alright.

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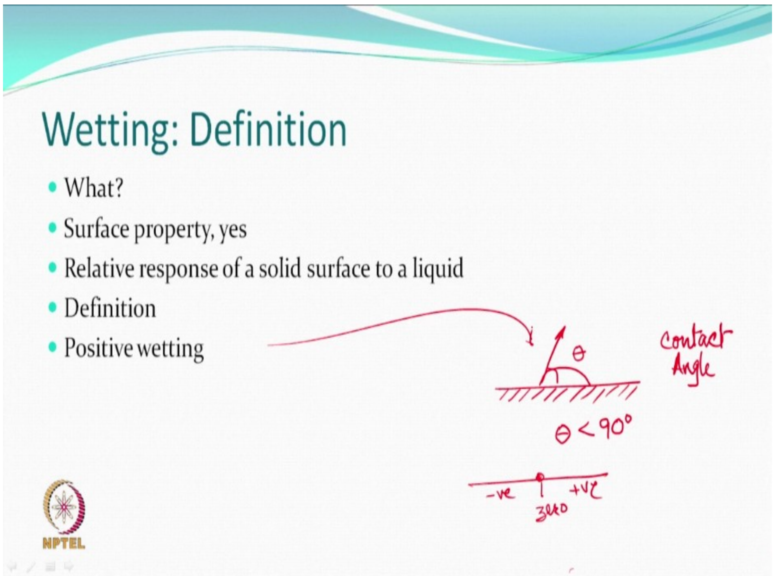


So, there is something called a positive wetting. Now, what is the response? So, there is a surface. We put a drop of liquid on the surface; and we try to see what is the response. A positive wetting means, there is wetting. Alright. There is wetting. And let us say this is the textile surface; actually any surface. And you put a drop of water. And you see some contact angle.

If the contact angle theta is less than 90 degrees, then by definition is called positive wetting. Alright. So, positive wetting. Alright. So, if there is a positive wetting in a scale, on a scale, there could be negative wetting. Alright. And there can be zero wetting. For example, if you say, well, this is the 0 point. And this is positive wetting side 0. And this is negative. Alright. This could be one of the ways of defining. So, as far as the positive wetting is concerned, this is the situation. Acute angle, the contact angle is acute. Alright. Let us go further.

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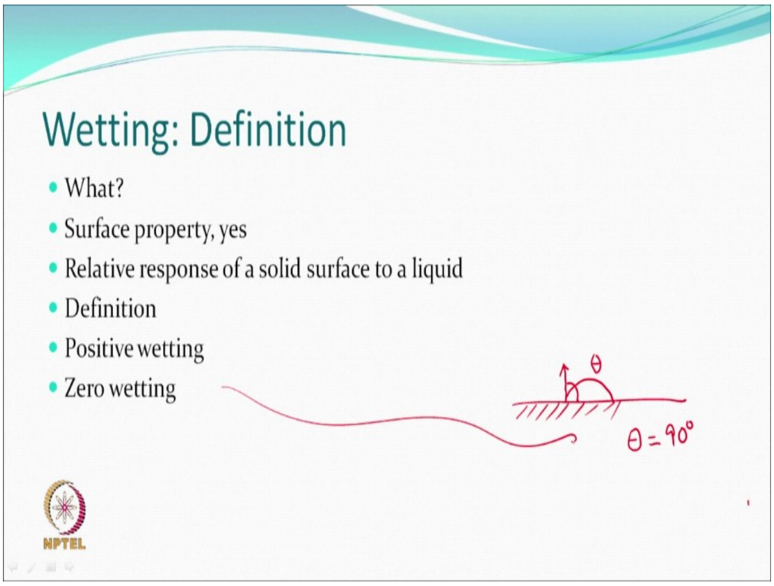


Zero wetting, like we just said before. What is a zero wetting? So, if it is a zero wetting; this is a surface and you put a drop. And if the contact angle is equal to 90 degrees; and if the contact angle is 90 degrees, then we consider a zero wetting. Okay.

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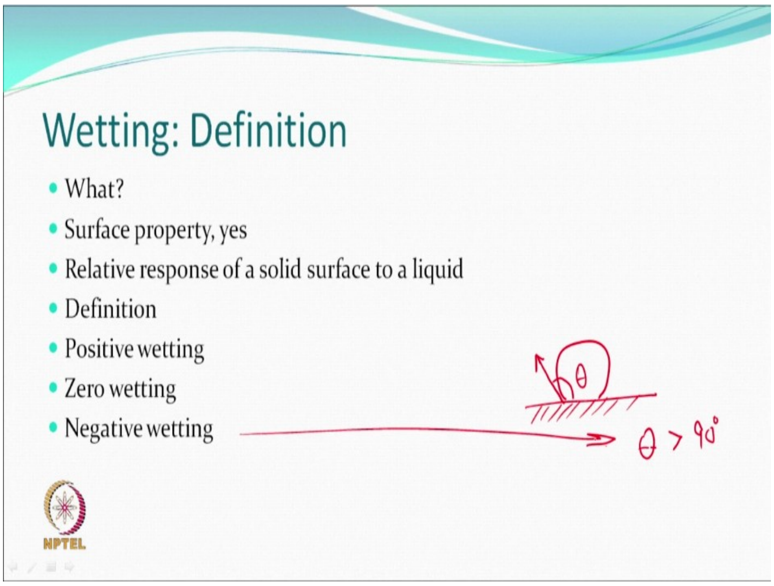


And then, we talk about negative wetting. So, negative wetting is when the contact angle is more than 90 degrees. This contact angle is an obtuse angle, then it is, then it is called negative wetting. Right. So, is there a significance of zero wetting? Well, actually, not really so much. But there can be a condition where it is from the point of view of neither positive nor negative; so, where it is. So, it is 90 degrees; that is a zero wetting. Positive wetting is acute angle, contact angle. And negative wetting is obtuse contact angle. That is one interesting thing. Then, what else?

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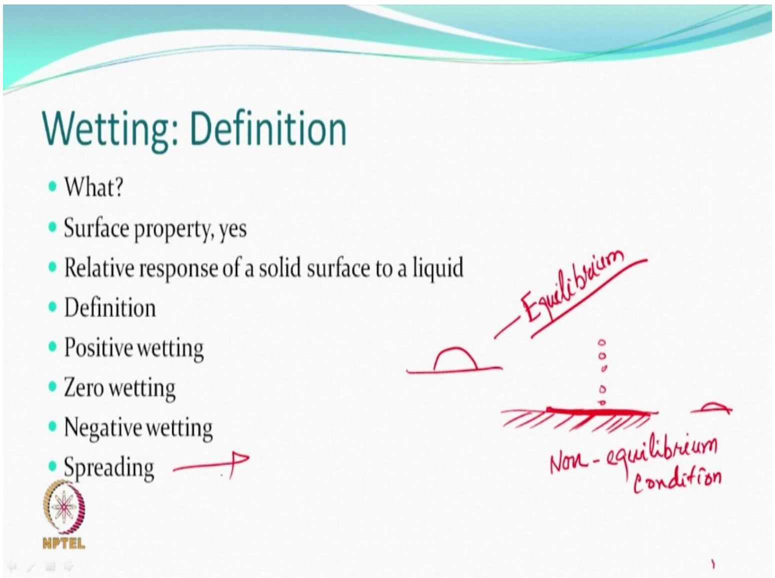


Spreading. Spreading is a situation. When you put a drop of water on a surface, within no time, it just gets absorbed. It is a very hydrophilic surface; and you put a drop of water. You just do not see. You are not able to measure the contact angle at all. You cannot measure the contact angle. You put a drop of water. And you see, immediately it spreads. So, cannot measure. So, this is in a way a non-equilibrium condition.

If you see, a drop actually; and you can measure a contact angle, then this is in equilibrium position, at least for whatever little time. Only then you can measure the contact. But in the case of spreading, it is a non-equilibrium condition. And the moment you put drop of water, it just spreads and keeps on spreading till anything which can be spread is left out. Right. So, it is a dynamic situation. Then, if this is so, then, there must be something else.

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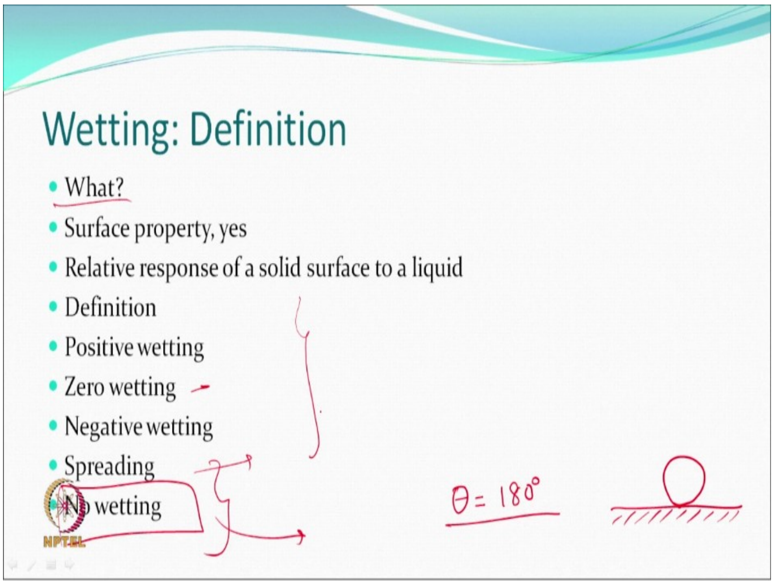


Yeah. No wetting. Remember, we should not confuse no wetting with zero wetting. Zero wetting is what? What? When theta is equal to 90 degrees. Zero wetting is on the other hand, where we expect the contact angle to be equal to 180 degrees. That just a spherical layer with a point contact. Its condition is very difficult to obtain in practical life. For various repellency requirements, we may be very happy with 120, 130, 140 degrees; very, very happy about that.

Getting 180 is practically a difficult situation. Therefore, there are 2 special conditions that we are talking about here is spreading, which will be non-equilibrium condition, it will always happen. You will not be able to define any contact angle there. You know, you will not call it a zero contact angle. It is very, very difficult. Because, it is not steady at all. Other is a no wetting condition, where theta is very high, 180 degrees.

This is the maximum possible. But, this may not actually happen. Alright. Nevertheless. So, we have some definitions. So, what is important is, when you say wetting, it means many things and not just one thing or other than one thing, right? So, there are many things it can mean. Keep that in mind.

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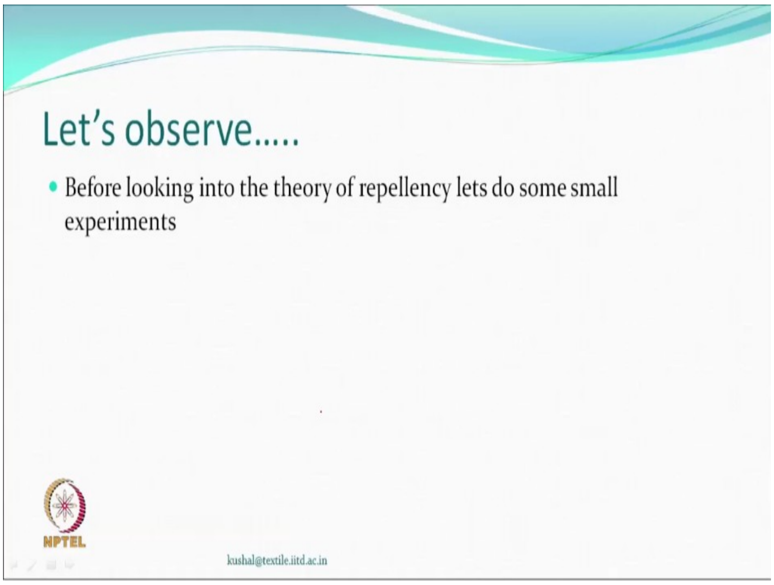


So, before let us say we go further and learn some theory, why not we check up something which might help to understand some of the things that we are talking about? Let us say here, **(Video Starts: 23:05)** here is a sheet of paper. Okay. A sheet of paper has got 2 sides. So, we will, let us say, look at one side. And I, let us say drop, put a drop of water on the sheet. Let us see how does it look?

Do you see something? Can you see the drop? Interesting? Can see the drop? Therefore, in such a case, there is some wetting, but you can still see the drop. And what will be interesting? Interesting could be that, you actually, if you roll off, maybe they roll off; they are gone. They have gone. So, this surface, in some sense is repelling water. It is repelling, not exactly the way you would have liked.

See the other surface. The other surface of this particular sheet, probably will behave differently. If we see, you see, it leaves a mark. Can you see some mark here? See that white mark. So, it is rolling, but it is also still attractive to the surface. You see some of these marks. If it was a real repellent surface, it would just roll. Let me see, if you can see the other surface. Does it roll?

See that. The water rolls off. If it rolls off, it means the attraction is less to the surface. Now, let us see some of the textiles. This is a fabric which is cotton fabric. Okay. Got creases, you know, got creases, cotton fabric, does not matter. But today, we are not really bothered about the crease recovery. We want to see something else. Okay. Oh yeah. I want to do a drop. Can you see something?

Can you see the drop here? But you see some spread here. Can you see some spreading in this area? You see the spreading? You again see the spreading here? So, this fabric, instead of keeping the drop alive, it just spreads. And that is an example of a fabric which is a normal fabric. So, what do we do? Let us say we give some treatment. If we give some treatment. And then we see, has the behavior changed?

Can you see the drop now? Is it possible to see the drop? You saw the drop. Can you see the drop? But after sometime, this drop also gets absorbed. But you see the drop here? Yeah? The drop is there. But it also gets absorbed with time. In fact, if you touch the other side. From the other side also, it is wet. So, it may be something going towards repelling but not necessarily whatever you want.

But we can keep changing this condition. We change the condition more and more, we may get more and more different response to putting a drop. This, do you see something? If we zoom little bit, maybe we can see something. Alright. Okay. You see some drops? And if we roll it, it just keeps going falling down from fabric. That means, from the fabric, I have been able to push the water down as droplets.

And so, this surface of this fabric was obviously different than the surface of the, let us say untreated fabric. Therefore, by changing the surfaces, you can create situations. This is the original polymer sheet surface, which is, still has got lot of drops, because it is not absorbing it. In such situations, what we call as some wetting is taking place. **(Video Ends: 29:13)** So, just a bit of an exercise to remember.

You can do those kinds of things wherever you are in, at home; and check which fabric wets more, which fabric wets less and so on so forth. And there are, sometimes you can, you have utensils which are, for example teflon coated. And you might just see how they repel and how the liquid actually just keeps rolling over the surfaces. So, based on what is our requirement, we can change the surfaces. So, let us now get back to what we normally do. That is the theory part of it.

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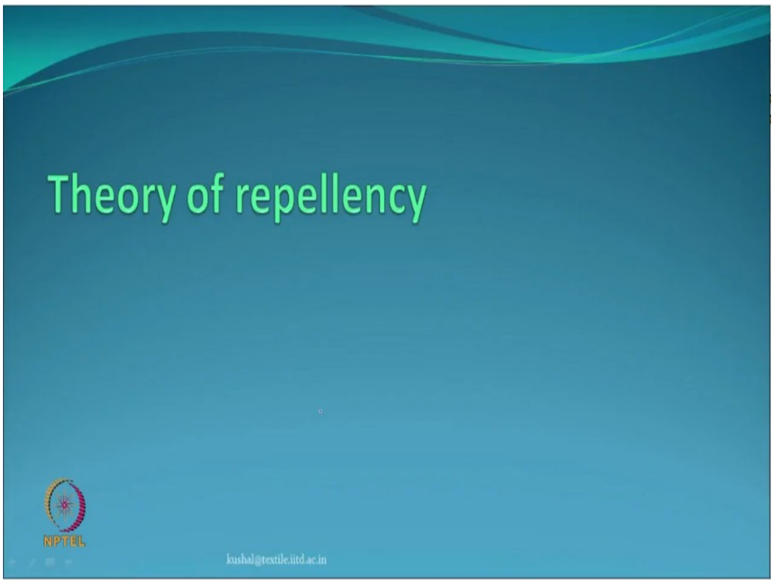


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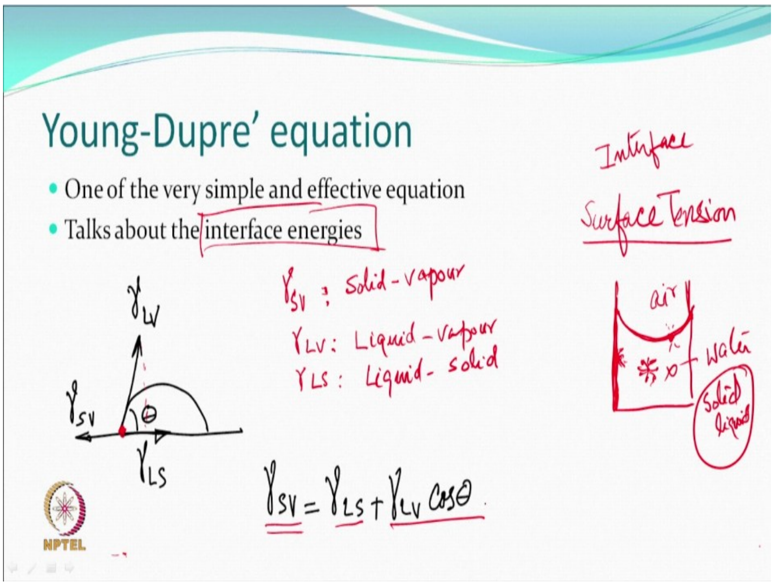


So, there is one interesting equations, very simple and effective equation which talks about the repellency and energies. Okay. So, what is this equation about? Let us see. This equation talks about interfaces. That is one important thing you must understand. There is nothing called energy or attention. If you talk about surface tension. So, what is this tension? In the case of liquids, we talk about surface tension; which we have already said, this energy is equal to surface tension.

Therefore, we can represent everything almost in the same term. Why is the tension? And where is the tension? Do you remember, in the case of liquid, for example? You see the meniscus in water and air. So, the tension is here and not here. Not here; is that? Here, for example, every molecule is attracted to the other molecule which is water, water to water. Everything for example is satisfied.

The moment it comes here, the molecule is getting attracted to the water, but does not know what to do here. Maybe this one molecule does not want to go there. But it has to be. And therefore, there is a tension. Similarly, therefore, there is kind of a disbalance. And therefore, so, if you have a tension, that means, there is a interface. And what is the interface? Here, air and liquid, air or water interface.

So, this tension is at the interface, not here. If there is a interface between the glass wall, let us say of a beaker and the water; yes, there is an interface. So, there will be some interface here. And behavior will be different. For example, if this surface was glass versus, let us say teflon. This interface is different. Water is the same. But this, the solid different. So, you can have a solid and a liquid interface, okay, solid-liquid.

So, this is what we are talking here, that there is an interface. For example, if there was a solid surface here and you put a drop. You have put a drop of, let us say a liquid. It takes up a shape and we defined something called a contact angle. Now, if let us say, in this case, the contact angle happens to be acute. So, these forces are acting, let us say at this point; trying to balance this shape. Right.

This shape is being balanced. How? This force is pulling this thing. Obviously, we have taken a cross section. Otherwise, it is a whole drop. It could be, circumference of the drop. Everywhere, this pull is there. So, you can appreciate. So, something is pulling in this direction. Something is pulling this part in inside. And the other component which is the thing which is defined.

So, how do we define? We said either surface energy. Let us say SV is solid and vapor. So, solid-vapor interface. Okay. And gamma LV is liquid-vapor interface energy. And gamma LS or sometime SL, it does not matter whatever you want to write, is liquid-solid interface. So, all these interfaces obviously are feeling, experiencing some amount of tension. A more or less, it depends.

Now, if we say the balancing. So, this, the gamma between solid vapor interface which is the called the gamma SV is equal to the gamma LS which is pulling on this side. But also, a component of this which is LV cos theta. So, there is a balance. If you change the balance, the shape of this drop will change. Right. Remember this Young and Dupre equation is valid in equilibrium conditions.

So, there is a balance of forces. This is not valid, for example, in a spreading case which is non-equilibrium condition. Okay. So, that is one interesting thing which you may like to remember.

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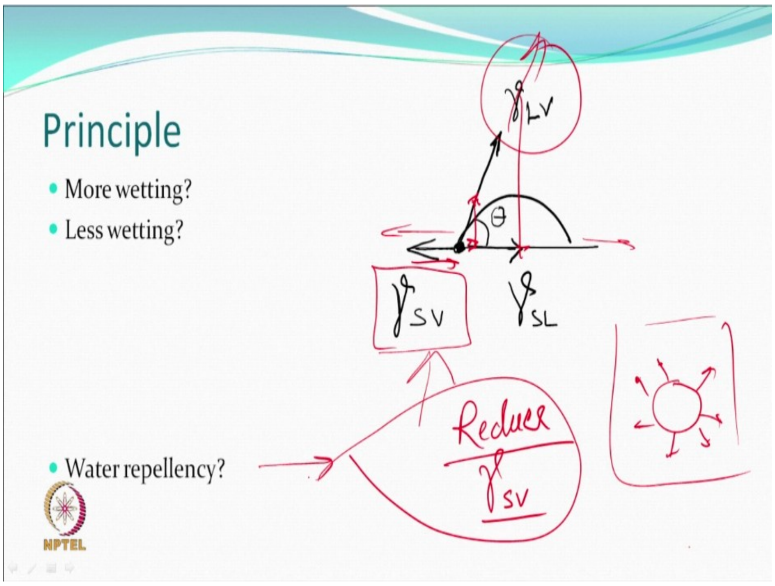


So, let us ask some questions. So, as a principle, we want more wettings. See, in a textile situation, you can have, you want more wetting. Why do you want more wetting? Yeah, I want to dye. I want to apply a chemical from aqueous solution. So, what do we do? We add a wetting agent. And what does a wetting agent do? It reduces the surface tension of liquid. So, if you reduce the surface tension of a liquid means, you are reducing this.

If you reduce this, its component also will get reduced. Alright. Its component will also get reduced. And so, what would happen? This drop will be pulled out, alright, in all directions around the circumference. So that, like this is the textile surface. The drop actually, from the top view will be looking like this. It will like to spread in all directions, if you reduce, what? Reduce the surface tension of liquid.

Or if it is possible for you, which you can also do. Instead of modifying the liquid, I identify the surface of a solid. Right. So, if I increase the value of gamma SV, then also it will spread. Okay. For example, if I take a surface and I make it more hydrophilic. I do whatever I do on the surface and make it more hydrophilic. Then what happen? I put a drop of water. It will spread. Right.

It is just like, let us say, have a oil treated fabric and I removed the oil. It will become more hydrophilic. And then it will, water will spread, otherwise blot. So, in this case, for example, this was a wax treated fabric, this was untreated fabrics; and they behave differently. Right. So, for wetting, what will you do? For wetting, you will like to either, if possible reduce the surface tension of a liquid, which we do every time, adding a wetting agent.

Remember wetting agent? Or do some more surface modification to make the surface hydrophilic. That will also attract water. Alright. Now remember, when you talk about water, we are also talking about water repellency. This is the discussion that is happening. So, the water comes into discussion all the time. Is it right? But theoretically any liquid. This is true. If suppose I want the reverse.

That is what we are calling water repellency. So, what do I do? Water repellency means what? I mean, I am walking in the rain. And I will want the water to just fall off the garment. That is water repellency. Is it right? If I am expecting water repellency, what should I do? Change the, when, what are the condition that can happen? Reverse of this. If you increase this value, gamma LV, then this component will increase.

And so, repellency can increase, because it will become obtuse; it will be easy to roll. So, that is one interesting thing, that when it becomes obtuse, it is going towards more and more repellency. So, that is one. And the other is, reduce this gamma SV. So, opposite things have to be done. And now let us see what can we do? Can I reduce the surface tension of water as it is falling on me?

I am sure it is difficult. I mean, how do you control surface tension? When you are doing a wetting and processing, wet processing; yes, I can add a surfactant and reduce the surface tension or do something to increase the surface tension maybe. But that is not possible. So, what do we do? So, we play with solid surface. We play with this only. And what are we saying?

We are saying reduce gamma SV for less wetting or water repellency. Does that make sense? Yeah, it makes sense. It makes some sense. Right. Looking at this diagram, it makes sense. So, without worrying, this is what we mean. Okay. Go further.

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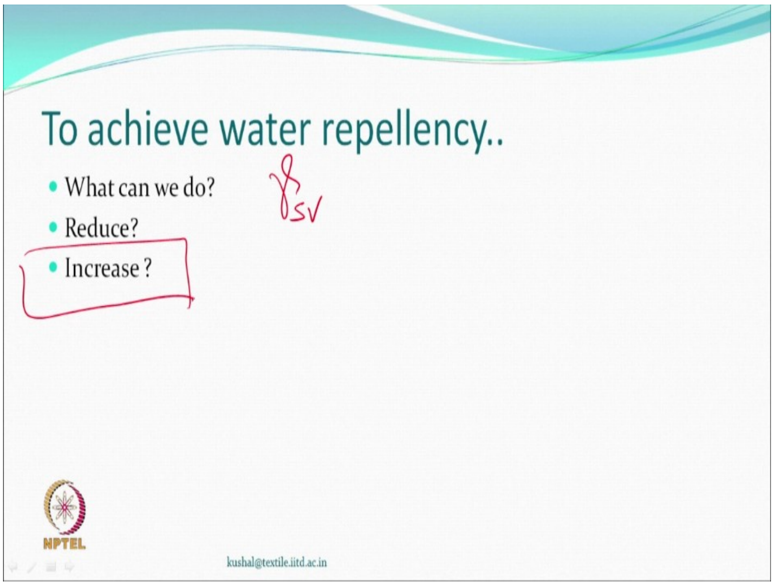


So, what we said that we will reduce gamma. But how do we reduce gamma? How do we increase gamma SV? So, we have said, as far as gamma SV is concerned, we reduce. Obviously, we will not increase gamma SV, because, otherwise it will spread. Now, the question still arises that what are we doing actually; reduce and increase; and what are we doing to the surface?

Let us say, that there is something called a polarity. I said that you make a hydrophilic surface. Then, water will obviously get absorbed. If you make a hydrophobic surface, the water will not get absorbed, because you said it is hydrophobic by definition. But in terms of surface energy, when you say, I have make a hydrophilic, somebody say you have increased the surface energy, therefore it is spreading. If you make hydrophobic, they say you reduce the surface energy from the Young Dupre equation. So, what do you mean by I have reduced? What I am going to do with it?

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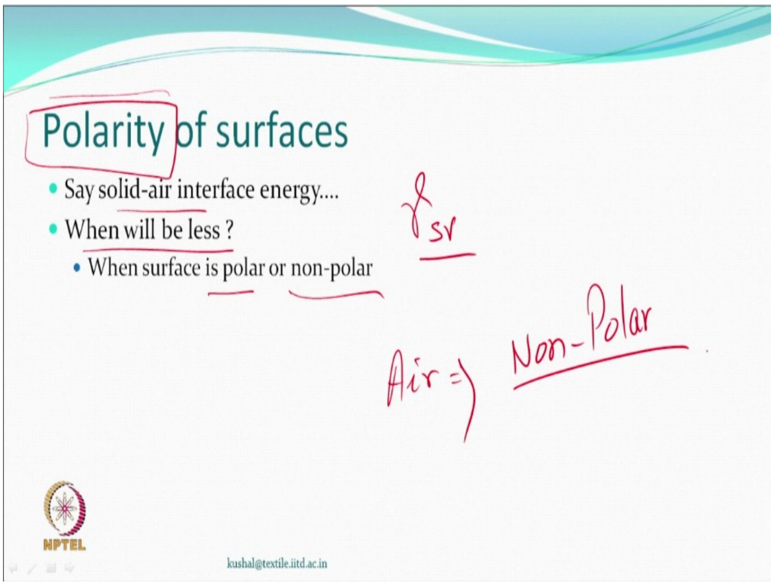


As some, this particular term called polarity has something to do with all these surfaces. So, if somebody asking when will be this interface. Let us say here, we are talking about gamma SV, will be less. Because we are interested it to be less. When will it be less, when the surface becomes polar or when the surface becomes non-polar? If this is, let us say a tension between 2 phases; therefore, you have a interface.

It is a tension. So, when the tension will be less? When you add water to water, it just mixes. If we add oil to water, they do not mix. So, their interface, for example, got tension. Therefore, they do not mix. They want to stay within their own domain, oil into oil and water into water. Right. So, we are talking about, let us say, when; so, question that remains is: When the interface energy will be less or reduce?

It will only happen when both the phases like each other or dislike each other, what is that? So, if you say gamma SV is less, that mean the interface energy is less. That means, both these phases like each other or dislike each other. Right. No? So, if they like each other, then the interface energy should be less. And why should they like? You remember that? Like dissolve like.

So, if 2 phases are let us say both polar, both are polar; then they will like each other. And therefore, they will reduce; interface energy will reduce. If both of them are non-polar, then also interface energy will reduce, because they will like to mix, attach, adhere. So, what do we do? Make the surface of textile hydrophilic or hydrophobic to make it water repellent? Hydrophobic, because that is just like water.

That is common sense. So, now we say; so, hydrophobic surfaces obviously are less polar, because they do not like water so much. But they like air. When they like air, does it mean air is polar or non-polar? What is air? Air has been defined as non-polar phase. So, if air is non-polar, the textile surface also becomes non-polar. Then, they will like each other. So, surface energy will reduce, which mean gamma SV will reduce. Would you like to find out yourself as to why air as a phase is more non-polar? I think I will leave it to you to just check it out.

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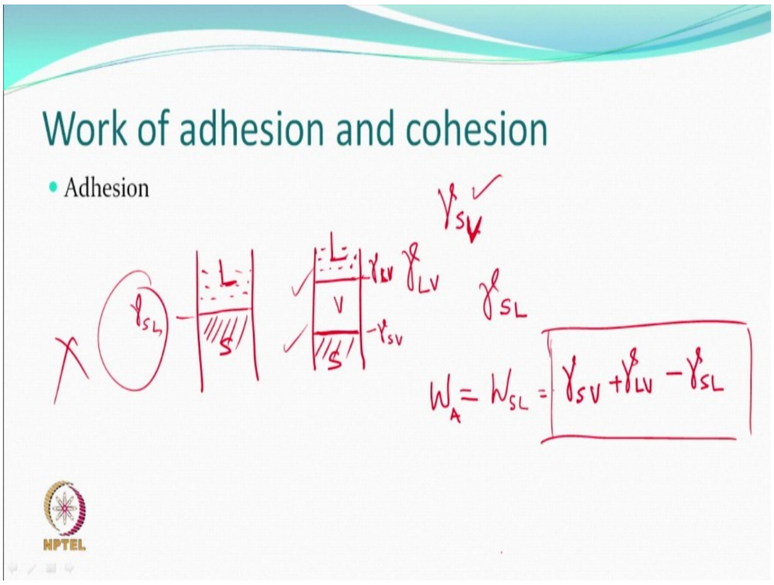


So, there are 2 more terms that we can talk about: work of adhesion and work of cohesion. Now, work of adhesion and cohesion mean that is a solid surface and liquid surface, liquid adheres to the solid. If it adheres to the solid more, then it will be, more work will be required to separate them, because they like each other. If they do not like each other, less work will be required to separate them. Right.

That is the work. How much work do you do to separate these 2 surfaces? Now, let us say there is a situation. Let us say this is some cylinder cylindrical space that we have, which is one unit area. Therefore, we can talk in terms of energies. And this is solid and this is liquid. Let us say, whatever liquid we call it. Now, we want to create a situation where these 2 have been separated.

So, liquid is here and the solid is here. So, you have separated them. You had an interface, you had an interface which was, which had an energy of gamma SL. Okay. And now, we have created one; if this is separated, so this is vapor. So, you have created one surface.

Another surface interface which is gamma SV. And you have created another interface which is gamma LV. Right.

So, what do we have now? So, work required to separate, let us say work of adhesion, which we can call as work of adhesion as let us say, we can call this as this; or we can also call this as between solid and liquid. Will be, that we have created 2 surfaces. One surface solid and vapor. One surface is solid and vapor which we have created, which is here. So, here you have created gamma SV.

And also you have created gamma LV. Okay. So, these 2 surface energies are now there in surface energies. Okay. And now; and what has gone which was earlier was gamma SL. So, we have created one gamma SV. We have created one gamma LV. And we have eliminated an interface which was gamma SL. This has been eliminated. By doing this, you have created one surface, you create another surface.

So, work of adhesion is therefore defined as the energy which will be governed by these. Now, of course, what is the surface tension of liquid? What is the surface tension of energy of a solid? That will depend. If this SV, if this gamma SV is very low, well, then the work will be low; easy to remove. Right. If the surface tension of the SL, whatever is there is, but it is dependent on both the things.

So, that means, based on the surface energies, you will be able to determine the work. If they like each other, you have to do more work. If they like, do not like each other, then you will have to do less work.

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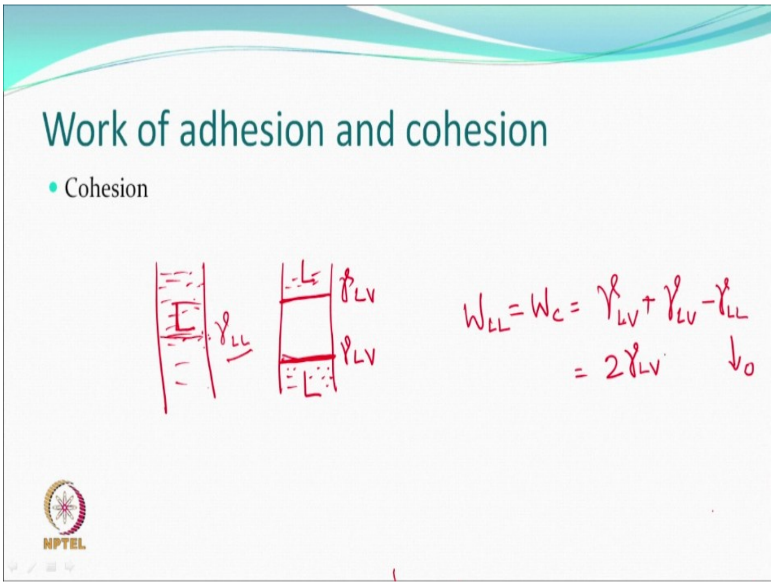


Something similar we can define as, if we have cohesion, let us say liquid-liquid. Let us say, there is a same kind of thing and you have a liquid in the thing. So theoretically, the completely liquid does not cohesion. And therefore, there is no interface as such; there is no interface. Alright. There is no interface. But, what are we doing? Let us say, I want to separate them.

So, I have created 2 situations where this was liquid itself. So, now I have another liquid column here; another liquid column here. And we have created a surface which is gamma LV here. Energy will be required to create this surface; gamma LV again. And here, imaginary, if imaginary, we say is gamma LL; imaginary. So, if we write the same equation as LL or work of cohesion will be equal to, therefore, one gamma LV plus another gamma LV minus gamma; or let me write again.

I wrote something not very good. Gamma LV and another gamma LV minus gamma LL. If you see this, this actually is nothing. Because water, if it is water likes itself, so, this is equal to 0. And therefore, this becomes 2 gamma LV. So the, to separate thing, you will have to work so much; to separate 2 liquid and create 2 surfaces. Is that right? So, now we understand work of adhesion, work of cohesion and so on so forth.

We would like to stop here only. And in the next lecture, we will see how some of the chemicals can be used to create such surfaces. And that will lead to water repellency. So, what have we learnt?

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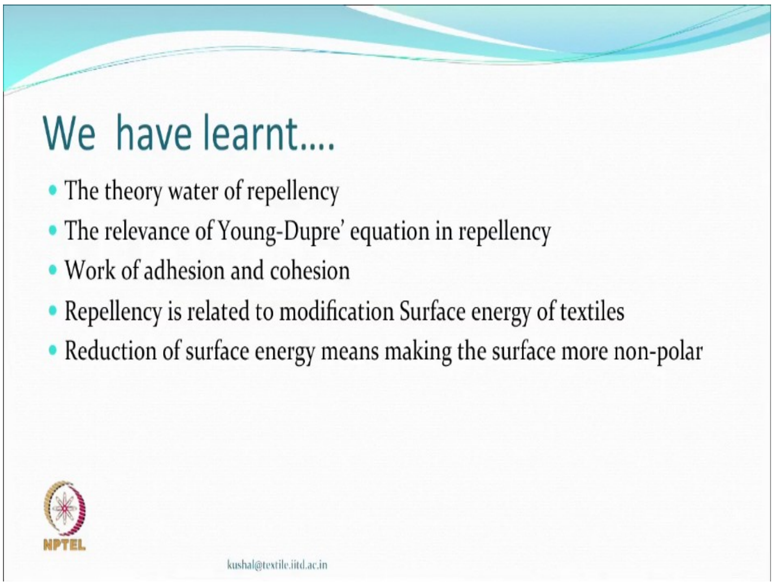


We have learnt about the fundamentals of repellency in which the Young and Dupre equation works for you. If you want the energies to be low of the surface, if you can reduce the surface energy, then you can achieve repellency. If you increase the surface energy of surface, then you will have wetting, more wetting. And in this whole process, we did define what wetting means.

Was a positive wetting, acute angle; negative wetting, obtuse angle; in between of course zero wetting. And we did talk about spreading. And also, we talked about the no wetting situation which practically is non-existent. Alright.

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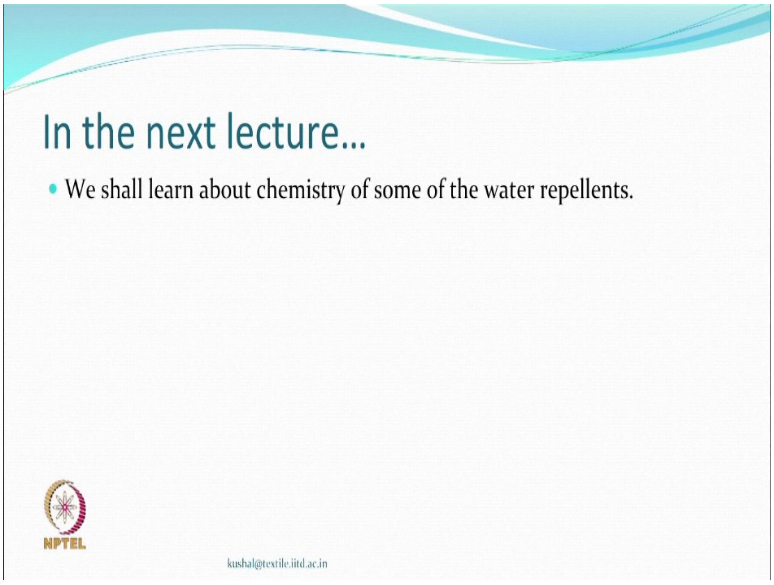


So, this is all what we covered today. Next time, we will take it up from here. Okay. Thank you.