Glass in Buildings: Design and Application
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Lecture - 61
Silicone for Structural Glazing

Hello, hi today we are going to look at how silicone can be used for various application in construction.

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Essentially this is a material which is been developed 70 years ago, but it has been a significant development and the innovation which is gone into developing this material has resulted today in using this for architectural applications. I am Ravishankar. I am a polymer technologist from UDCT. I have an overall industrial experience of 23 years, out of which 15 years is in construction division. So, I work for a Dow Chemicals International and this if you all remember, it has been Dow Chemicals have taken over Dow Corning last year and Dow Corning has become part of Dow Chemicals now.

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So, with this brief introduction I want to take you through some of the you know important you know application development what is gone in using silicone for architectural applications. Essentially for the facade if you talk about there are three main components which are being where the silicone is being widely used. One is called structural glazing. It is the method of bonding a glass with the frame using a silicone and then you know the silicone takes a load and second is the thermal performance which can also be designed through having a insulating glass again for the hermetically sealed insulating glass unit silicone acts as an important and integral part of the insulating last unit.

And third last, but not the least on the facade or any application whether seal is one of the critical you know joint design which is going to impart you know significant amount of criticality for the watertight seal. So, I will take you through some of the you know details around this and also I am going to take you through some of the applications which are going to be very new which has been introduced with silicon.

So, my agenda for today is going to cover one is introduction to silicone sealants, we are going to talk about structural glazing insulating glass whether seal design application and quality control. We are also going to talk about industry standards and differences, which are the standards which talks about this particular application today and what are the references and how durable the system is. We are also going to talk about what is

essentially needed for this sort of an application to be supported with in terms of services part.

So, before we start just to give you a brief idea, if you all know or if you do not know the silicones are again a synthetic polymers, ok. They are abundantly available in the earth crust in the form of a quartz sand and from the quartz sand, it is mined and then, it is being converted into a silicone metal and for analytical art process and from the silicone metal to silicone polymer like any big you know distillation column or a petrochemical plant size, where the silicone polymer is made and this silicone polymer becomes one of the integral component for making various products used for variety of applications including constructions.

So, this is one of the you know important thing to understand is a quartz system original raw material for making you know silicone which is available in the earth crust.

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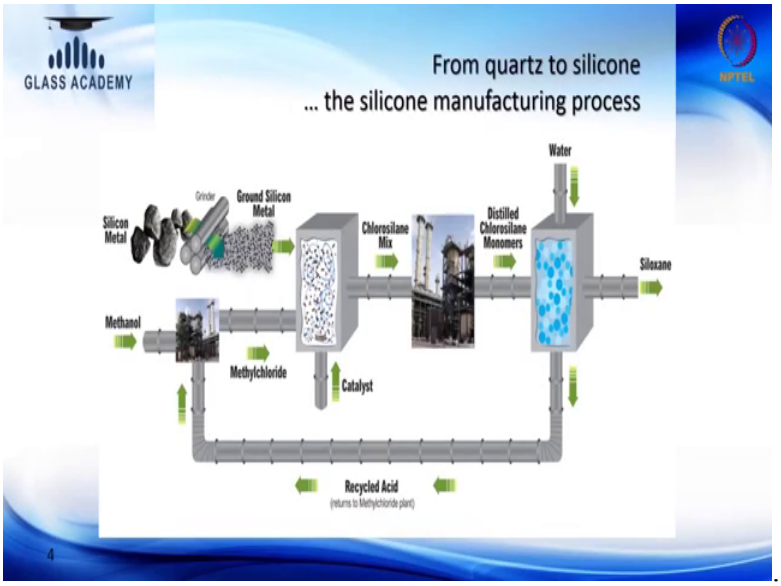

So, this is a process which really talks you know shows how the total basic train or how the silicone is being made. So, it starts from the silicone metal like a lump and then, it is grounded, form a ground silicone and this is then added with the methyl chloride where there is a mix of and with a catalyst which gets converted into chlorosilane mix. This is then distilled and it has been distilled according to the melting points and the boiling points, sorry boiling points and then, this is done through the distillation column and the

byproduct what is coming out can be recycled and the main product which comes out of this siloxane polymer.

So, there are two things which are used as an integral you know material here. One is the ground silicone metal and then, the methanol which is been added to that So, which is again converted into the methyl chloride which is then resulting into the formation of poly dimethylsiloxane. So, this is the polymer which comes out of this process. There are only very few manufacturers in the world who has a capability to manufacture from this basic process of manufacturing siloxane.

So, it must be a point for you to you know really understand because when you go to the market, probably you will find n number of brands coming out with their own products. So, it is not that you know they all, they are all the basic manufacturer of silicone polymer. They always buy the polymer from somebody like who are the original manufacturers of siloxane because they can sell this polymer into the market and depending upon the requirement, the polymer has been brought and converted into different products and one of the product is sealant, ok. So, that is the reason the formulators or the compounders who buy the polymer and then, convert that to the finished product. You know that is the reason you find many brands available in the market.

So, the difference between the original manufacturer can control the entire quality control process compared to the one who is the compounder or a formulator who just takes the material and then, converts them into the finished product. So, this is just to give you a basic idea about who is the original manufacturer and how it starts from and also to give you an idea about the compound as and where they start from, ok.

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So, this final polymer which comes out can be converted into different forms,. This can be formed like a fluid. This can act like a dispersion. So, like an aerosol or it could be any emulsion with a water based system or it can be also made into a grease type of a compound like a lubricant and by doing you know cross-linking polymerization, you can make it to a gel or you can convert it into a resin you know compound or elastomers or rubber.

So, the essential form of the sealants which had been used for the construction applications come from the elastomers are rubber you know part of it. So, we are going to go into the details of you know this particular chemistry.

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Also, just to give you an overall view of where the silicone can be used is it can be used in multiple applications. So, it will be you know interesting to know. So, it can be also used for beauty and personal care or home and personal care applications, where it can be used in the deodorants moisturizers you know or perfumes or it can be used in gels or hair shining ointments.

So, whatever we are talking about, the essential personal care those have got some amount of silicone added to that to give a good wet ability shining and also avoiding. So, it is not only in that particular segment, it is used in food and beverage, electronics, chemicals, solar or you talk about any of the household appliances, automotive, oil and gas or any packaging or textile. So, in the industrial applications like home and you know consumer goods or even an assembly and maintenance, not only that it is also used for the healthcare applications.

The chemistry is so beautiful that it can be used by formulating it to behave exactly in an opposite characteristics. Some of the interesting thing is in the construction applications we want silicone to bond, ok. We never want the silicone to leave any of the substrate where it is applied whereas, essentially if you look at some of the packaging applications, it acts like a release. So, the release coating which is applied on the liner behind the stickers is coated with silicone and it acts like completely a release. So, that is

the beauty of this chemistry that it can give you an exactly opposite properties. So, u it is a versatile chemistry which can be formulated and to suit different applications.

So, to understand the beauty and depth of this chemistry, I am going to take you through some of the you know old school what we have seen we might have read in schools about silicone and organic. So, I am going to take you through some of that now, but I am not going to really drill down into the chemistry part of showing you the formulas and making you answer me, but I am going to talk to you about the basic difference between what is silicone and what is organic.

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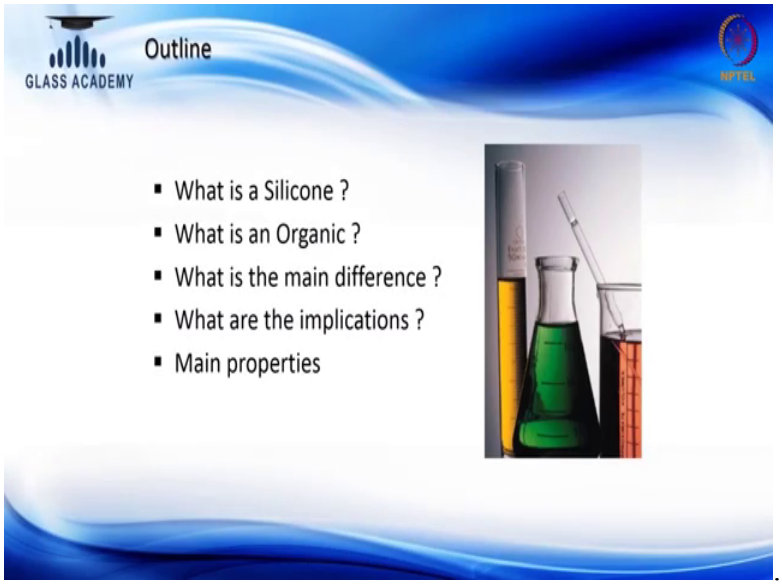

So, if you really see from the first slide, what we talked about silicone is a material which is coming from the quartz sand, ok. So, it is a material available in the earth crust like an inorganic compounds. So, this is an inorganic material which is mined from the earth and then, it is converted into a polymer.

So, the essential difference is organic polymers are generally made out of you know like you can take from the petrochemical or the crude oil chemistry, where it is cracked and converted into carbon. So, organic chemistry are mainly carbon based whereas, silicone is SiO Si which is a basic backbone and that is an inorganic chemistry. It has got side chains which are organic, but the essential backbone is coming from SiO Si, ok.

So, we are going to talk about what is the main difference, what does it really help or it does not really help or what are the complications or the implications and we are going to look at, what are the essential properties this is delivering.

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So, if I tell you about organic in terms of chemistry, the products which are being used for the adhesive applications or generally polyurethane polysulphide acrylic or epoxy. So, you may be traditionally you know you can if you know the chemistry, you can also relate them to the brands available in the market, but now just to coat, so that you get an feel of the chemistry like we all know how, alright because that is one of the powerful brand available in the retail. So, that is an epoxide.

So, similarly if you talk about different you know commercially available products, so you can relate them to the chemistry. The one which is available as an inorganic is a silicone sealant and it is which comes from various you know manufacturers like Dow Corning or Dow Chemicals or other manufacturers like moment you are seeker. So, these are some of the brands which are predominantly known in the market and again this is to give you overall feel of what is inorganic and an organic chemistry perspective.

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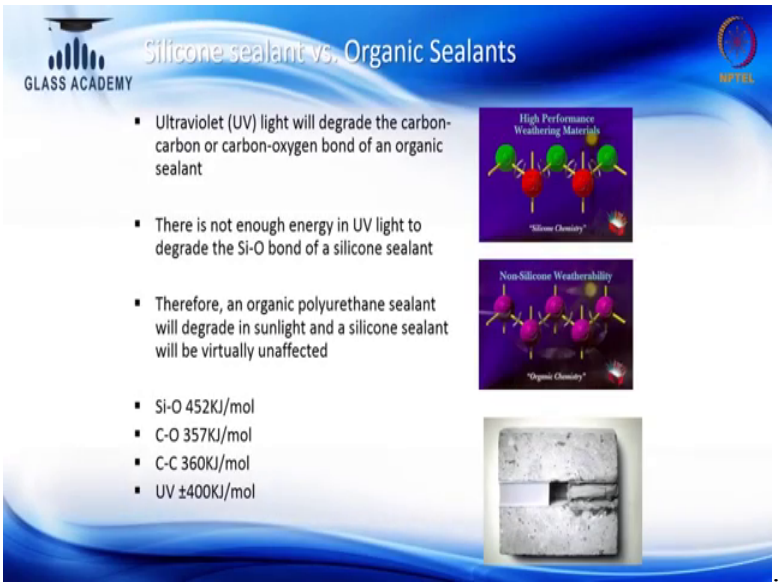

So, what it is really mean in terms of chemistry is when you talk about you know high performance weather proofing materials, silicone oxygen, the bond which is the backbone of an silicone sealant and has got an energy of 450 kilojoules per mole,. So, if you if you see for any external applications that is going to be a sunlight which is falling on it climate like India, we will have 365 days of sunlight, ok. It is hard to not to have sunlight as an leaving aside some very few times of monsoon, but still it will be bright and you know sometimes you get to see the sun.

So, what is happening essentially here is when the sun is falling on it or then, there is UV component of the sun which is falling on a particular material. So, UV has got an energy of 400 kilojoule per mole. So, this particular energy can degrade whatever is lower than that. So, that is the simplest way to understand. So, if you talk about organic chemistry, their bond energies are lower than the UV light energy. So, essentially they can be degraded, but they do stabilize them by using an external stabilizer which is which has got a limited life, but if you look at silicone, the silicone polymer has got an inherently stable backbone. So, this is essentially giving it an inherent stability against the exposure of you know against UV in the sunlight.

So, this is one of the key differentiator. That is the reason you can find this particular chemistry has overtaken many of the other products which are from the organic for you know external applications. So, on an external applications what we want is any product

which is exposed to UV. So, sunlight is falling on it. So, the UV that the product should have a good resistivity or stability against the exposures, nobody wants to apply a product wherein somebody says that you use my product, stick the glass, but what you need to do is after every 5 or 7 years, you need to remove it because the product is going to degrade. This would not have really given the product or the or this technology to move so much higher. So, the essential reason for this has become a very large success in the market today is because of the durability against exposure. It is not only against the sunlight; it is against it is it has got an excellent resistance against water, weather and also acid rains or you know rains. So, it has got accentually very good stability against most of the weather, weathering you know properties. So, that is the reason this chemistry has proven much more durable and you know long lasting than the other chemistries which came before the silicone chemistry.

So, I wanted to really understand this particular slide because this gives you an overall view of why you should use a silicone sealant versus an organic sealant for an external applications. There are few applications where in distance because there has been you know it is coming from a different climate like in Europe or any other climate, where they do not have much of an you know they may not be having such a sunlight or UV or you know weathering what we have in India. So, you might tend to see in some of the applications still organic has been used and we have seen it that for a climate like hours, it gets degraded. Even in India people have used this as a product for some of the applications like even insulating glass and we have seen cases wherein the outer pane of the insulating glass has fallen down within few months or in years of time when in this exposure to UV had converted them or degraded then, ok.

So, that is the reason now silicone has become very popular and if you really see this chemistry has been used in construction for more than 50 years essentially on the structural bonding for the glass or more than 45 years. So, that is the case 3 what we are talking about which is proving that this chemistry is your right chemistry and a very durable chemistry to be used for such application and it is not only just a durability, but what it comes out as you know along with the durability, it also gives a sustainability.

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So, essentially any product which is less durable has to be read every now and then. So, there is going to be a repeated consumption. So, what we achieve from silicone is by having a long lasting and a good durable life. So, you are able to save 3 times carbon credits you know or you know less.

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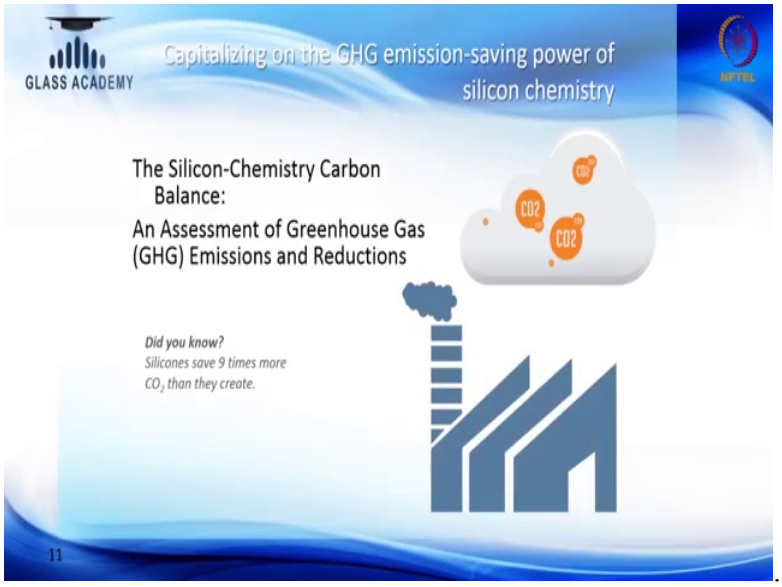

You do not essentially put the carbon greenhouse gases emissions you know. You can save 3 times compared to that organic chemistry rather silicone saved 9 times more than CO2 then they create. So, that is a punch line and you can Google it. These are all very

well available information's on the net. So, essentially you are connecting to a chemistry which is also giving you a good carbon balance and this can also be supported by getting some of the lead certificate, the leading manufacturers for their products.

So, if you are going for a gold, platinum, silver or any rating, if you essentially want how your materials are behaving and you because of that you get additional points, so with using silicone you can get an additional point because this is not going to give you the volatiles you know and which is going to be much lesser than what it is needed by the regulations,.

So, coming to the now you have understood the difference between silicone or organic and we have also understood how the silicone is made.

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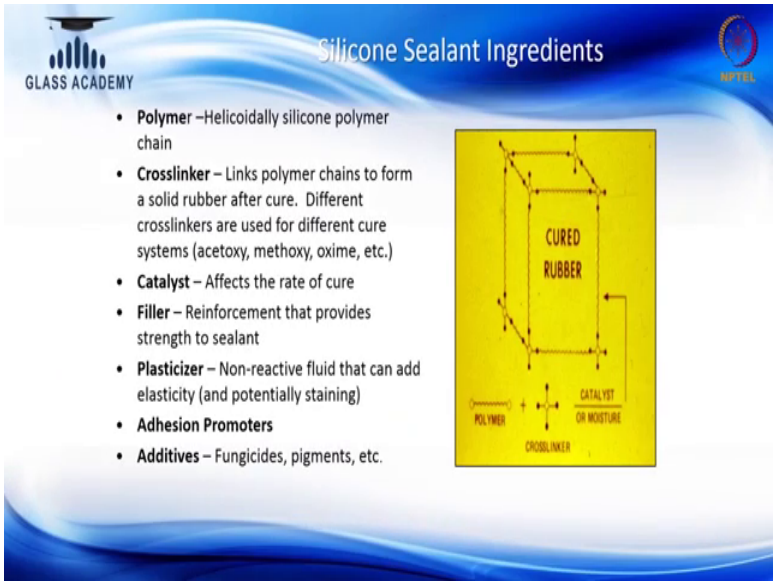

So, now we are going to go into the details of what a silicone sealant is because this is the product which is going to be used for construction application widely for our facade essentially a structural glazing, insulating glass and weather seal and also other applications. So, the essential thing again here on the slide what is needed to be understood as the silicone sealant is made with lot of material added to that. So, the one of the main thing what is really making the property of this particular product impactor is the polymer.

So, the siloxane polymer we saw that. So, that polymer has to be added to make the sealant. So, the amount of polymer added you know varies the properties and this is an essential backbone which gives a very good mechanical, physical as well as other important properties for the product. So, you have to cross-link them because this is going to be a cross-linked rubber what you get. So, for cross-linkings, you need to have different cross-linkers which has to be added. So, there is a polymer chains. So, you need to crosslink them to make it as a matrix, ok. So, the cross-linkers are added. These are again you know siloxane with the reactive ends. To make this reaction happen at a faster pace at the right pace, catalysts are added. So, the catalysts are added and this actually takes care of the rate of cure, ok.

So, the curing rate has been controlled by the catalyst. So, that is the reason you know when I talk about in my further slides, I am going to talk about what is that which is very important when you use the product or when you keep the product in shelf, [vocalized-noise. The other thing which is also giving some amount of mechanical resistance to this particular material is the fillers. So, the fillers are essentially you know different types of fillers with different forms have been used which is actually acting as a reinforcement. So, this improves the mechanical properties of the product.

So, the mechanical properties like the tensile strength you know shear strength. So, those are the properties which has essentially given by the filler so, but as you all know there is an amount of addition in the of the filler will going to reinforce, but you had a more and more, you can make the product bulkier or you can make it more with the filler, so that you can reduce the cost. So, by compromising on the polymer or other contents, you can add more filler.

So, what is important to understand is you should have a balanced chemistry of additives which are added to make this material. So, you can make it imbalance by adding some more, other more to make it cost effective, but then the application of that product needs to be understood clearly that this is not a product which is meant to be used for an application where it has to be you know designed to take loads.

So, we need to understand and then, you need to approach the manufacturer, take their guidance of using what product to be used for which application. So, for the sealant to dispense, it has to flow at a particular rate. So, normally the extrusion rate that is what it

is called as. So, it should have a minimum extrusion rate of say in one component around 200 grams per minute, otherwise you will not be able to fill or apply the sealant into the joint. So, there is some amount of passages are added to make it happen in most of the products, but you can do that with a special type of polymer selected and make it non-plasticized essentially for certain applications, where you are looking for a non-chaining or a non-bleeding weather seals. So, there the plasticizer can cause a stain.

So, this plasticizer otherwise added to the other general products is a non-reactive fluid. This is not going to react with the matrix. So, this will be separate and it will come out with time and it can potentially stay in our streak. So, depending upon the amount of plasticizer added you can see some of the facades having the black line running down from the joint. So, this is essentially because of the non-reactive plasticizer coming out of the sealant due to movement and then, the dirt and dust which gets deposited you know they can make it look black.

Other important additional special additives also are very important. The one of the one of the ingredient which is added is adhesion promoter, the sealant has got a good you know bonding characteristics to many materials and this can be further enhanced by adding an addition promoter. So, this ensures that the product burns to various substrates. So, as I told you the essential property of silicone sealant for construction application is to bond. So, the intended applications what we are looking at you want the silicone to bond and take loads or take moments. So, the adhesion is very important. So, the adhesion promoters are added as part of the ingredient and this helps in getting good bonding to the substrates and some of the essential additional features for the product can be obtained using special additives. So, some of the applications like moist area where you have a bathroom or a kitchen area. You are looking at an anti-fungal sealant and you do not want any mould growth to happen or an organism to grow on that. You want essentially that to be an area of you know moist area where it is prone to hot and humid climates or water. So, you do not want the you know growth to happen.

So, special additives like fungicides some colours to get a good different shapes in the sealant can be obtained by adding pigments. So, this is an essential ingredient slide. So, the silicone sealant comprises of these materials. So, what is also a takeaway from the slide is these are needed, but you can always vary them to get a formulation to make it

right for the application or make cheap and then, which can be used and for a wrong application and you do not give you the desired properties.

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