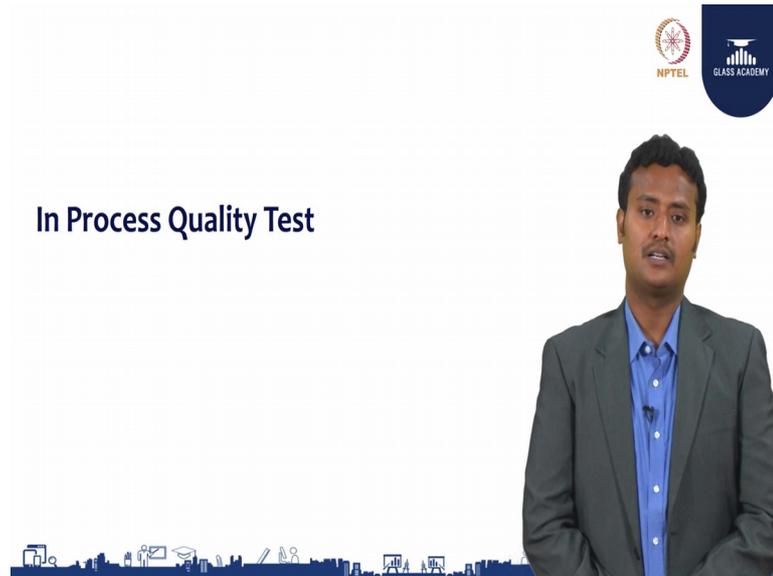


Glass Processing Technology
Prof. Mr. John Peter Raj
Department of Civil Engineering
Indian Institute of Technology, Madras

Lecture - 42
Insulating Glass Unit Part IX

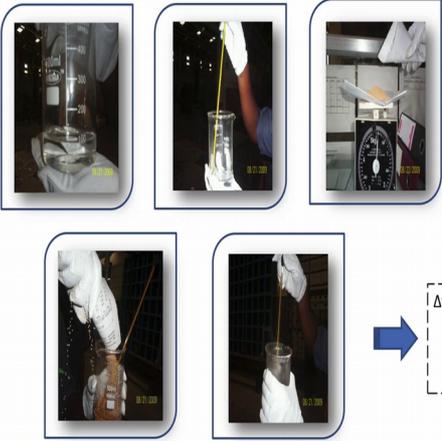
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Let us move on this process quality test which is inline process, when you are taken to the productions. What are the tests which you have to know mandatory to done at your promises though this satisfies these tests. So, not only for making test so, this will help for in a successful production less quality rejections. So, if you start doing this process quality test so, it will enable us in lot.

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Molecular Sieve Test



$$\Delta t \text{ } ^\circ\text{C} = \text{Water } ^\circ\text{C} \text{ ______ } + \text{Molecular } ^\circ\text{C} \text{ ______ }$$
$$= \Delta t \text{ } ^\circ\text{C} \text{ ______ }$$

Qualifies $\Delta t > 32^\circ\text{C}$.



Let us see the molecular sieve test what it is? So, this is you take a glass of water like with a 100, 100 ml of the water on a beaker and you measure this water temperature how much it is and you can note it probably the room temperature or less than that you can you can note it. And you weigh 100 grams of molecular sieve and take out the weightage and measure this molecular sieve, you put in a beaker you can measure the molecular sieve temperature if it is more than within a second. Like for example, if it is if you the moment you enter I mean if you moment you insert this thermometer within a 2 to three 3 you will have a 60 degree centigrade, it will be shown.

So, after you note down this point of your this molecular sieve temperature, then you will have to pour it on the I mean you have to transfer this molecular sieve one beaker to another beaker, which the water content beaker you have to pour it on the water content. Then you will have to test immediately with help of the thermometer ok.

So, the moment so, this is the calculation I will tell you so, water temperature and molecular temperature, so, both you have to add the temperature. The delta t the temperature if qualifies if more than 32

degree centigrade the molecular sieve is fit for you seeing your IGU, if it is not delta t is 32 less than 32 please do not use it.

So, this is the test we will conduct because, you will have to do it every time. So, if you are not doing the properly or if it is water observed hydrocarbons or pre nitrogen so, you will not have this you know value you will not able to get the value. So, every time please ensure you will have to test molecular sieve test ok.

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Two Part Sealant Mixing Test

✘ Poor mixing of two part sealant



✘ Good mixing of two part sealant



The slide features two logos in the top right corner: NPTEL (National Programme on Technology Enhanced Learning) and GLASS ACADEMY. At the bottom of the slide, there is a decorative blue silhouette of a city skyline with various icons representing different aspects of technology and education.

And this two part sealant mixing test so, I will different here, you can see this the first picture poor mixing of two parts silicone, you can see that a black and white it is not the homogeneity is not proper. Whereas, you can see the bottom one the good mixing of two part silicon so, which is completely black ok, nowhere it will be traces.

So, if you ensure you know how you can do this test? Basically you take a small piece of the glass and put your secondary silicon on this and take it one more pieces and skews it with your hand ok. And you can see that you know the impression which comes from the glass you can see that.

After then you can do it addition test also, for example, you can keep it here after couple of hours like for example, after um8 hours or 10 hours if you try to remove it, if you are not able to remove it, the addition is proper. So, even not only the mixing ratio you can test it here, you can addition test also you can do it here.

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Butterfly Test



1	Fold a sheet of stiff, white A4 paper in half.
2	Apply a bead of sealant to the fold in the paper.
3	Press the sheet of paper together compressing the sealant into a thin film.
4	Pull the paper apart and visually inspect the sealant for indications of poor mix.

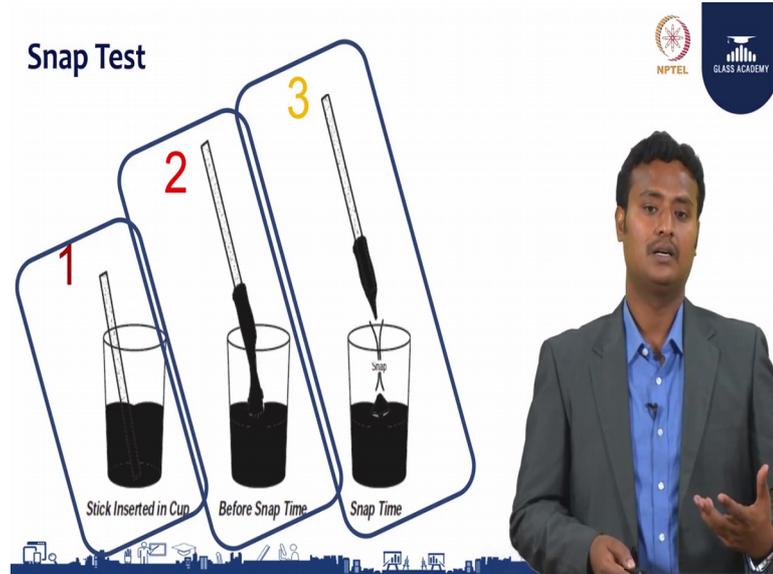


The diagram illustrates the Butterfly Test process. It consists of four numbered steps in a table, followed by four corresponding illustrations. Step 1: 'Fold a sheet of stiff, white A4 paper in half.' Step 2: 'Apply a bead of sealant to the fold in the paper.' Step 3: 'Press the sheet of paper together compressing the sealant into a thin film.' Step 4: 'Pull the paper apart and visually inspect the sealant for indications of poor mix.' The illustrations show: 1. A hand applying sealant to a folded paper. 2. Hands pressing the paper together. 3. A butterfly-shaped sealant film with a white center, labeled 'Insufficient Mixing'. 4. A butterfly-shaped sealant film that is entirely black, labeled 'Proper Mixing'. Yellow arrows point from the text 'Insufficient Mixing' and 'Proper Mixing' to their respective illustrations.

And next is the commonly people are using its butterfly test basically, you take a paper piece of paper like a four sheet, the stiff paper and you put apply the silicon on the one side of the paper and fold it and just remove it gently. And you see is there any split or which means is there any air pocket or is there any bubbles or is there any colour difference like black and white then, you can understand you can see there is third picture you can see there is a white.

Because, you should be all are all black colour, if any if you have a chance to see if the any whiteness is there, then which your mixing is not proper. The fourth picture you can see the below one which I indicated through it is completely black. So, which means your butterfly test which is qualifies your test.

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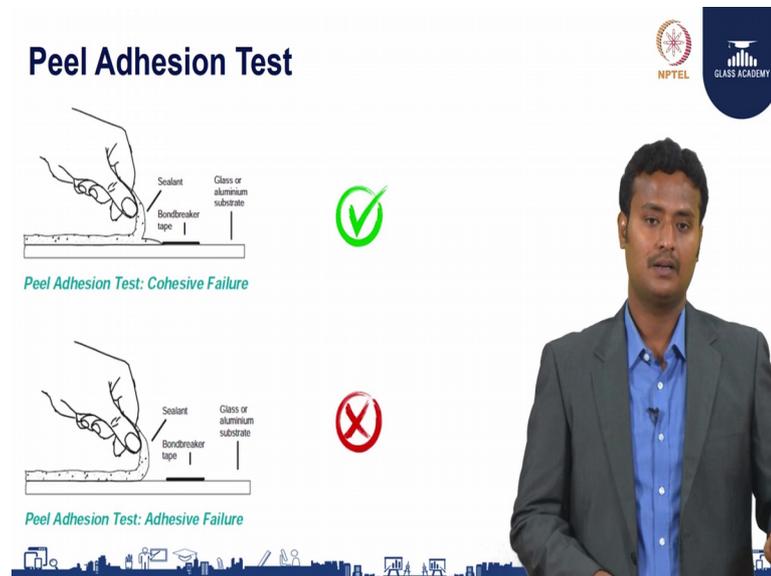
Next is snap test will go on; this is you know you take a beaker put your silicon like for example, like a small amount of secondary silicon when your mixing is done then, put like either you take any metal or aluminium spacer or glass space like in a such a way you can dip it inside the beaker you can do it try it. So, stick insert it on the cup with a silicon this is the first step.

So, next is before snapping which means; every few minutes you know you try to remove it you know very gently ok, up to 30 minutes you can do this test. So, the moment which spill off, which is you know the snap it, which is from the silicon to your the stick which is you know apart each other that moment you have to note it down that is called snap time.

So, with that will be a within every minutes you have to do it ok, every for example, 30 30 minutes you take it from this 0 minute 30 minutes every few minutes you have to conduct this slowly you have to drag it, do not do it you know like fast like pull gently, then you will understand this snap test. So, if it is not snap, if it is not cut then you will have a problem, if it is comes like you know kind of gel, it still if

they are silicon still on the stick then, will be a problem for your silicon mixing and which is not cohesively it is adhere.

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And let us see the peel adhesion test so, which means you take any metal or glass surfaces you apply the silicon and one phase where that silicon which is contacting on the phase you can apply any double side tape or you know bond breaker tape or any surface like; plastic foil better you can use a double side tape. So, that you know it will helpful for to remove that also.

So, those areas you apply the silicon in a uniform manner on a glass surface or aluminium surfaces, you can see the next second picture you try to remove it if you are able to remove it like for example, gently you just try to remove it. If you are able to remove it which means, it is peel adhesion test adhesion failure is there, it is not completely adhesive in nature it is not compatibility is failure is here, which is you are able to remove.

Whereas, if it the first picture it shows here that is a right, which is cohesive failure which you will not able to take out the silicone from the surface either it is a glass or aluminium channel which means your peel adhesion test is satisfied as this one.

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SHORE HARDNESS TEST

- Sealant is applied on a 100 x 100 mm glass plate to make 10mm thick layer of the sealant
- Allow 24 hours for curing
- Check the hardness after 24 hours
- IF OK (FOR SILICON SHORE A WILL BE 35- 50 SHORE A).



And this is shore hardness test which we will use like 100 by 100 aluminium channel where you fill this desiccant sorry, secondary silicone you can use this shore hardness test, you can keep after curing it, you just use this instrument to test it. So, after 24 hours of curing you check the hardness. So, that the shore hardness if it is the silicon shore hardness could be 35-50 shore A, if it is its satisfied more than 32 or 35, which means your mixing is proper, your secondary silicon it is you know mixed properly we can use a very well use it.

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The companies that produce sealants:

- Dow Corning
- Truseal
- PRC
- GE silicones
- Wacker
- Bostik
- United Polymer Lab Limited



Let us see the what are the companies have been producing the silicones? So, Dow Corning, Truseal, PRC GE silicone, Wackers, Bostik, United Polymer Lab Limited. So, these are the companies are widely supplied all over the world as well as the India so, you can see this.

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Edge deletion

- ⌘ This is done mainly on soft coated low e glass.
- ⌘ The main purpose of this is to remove the coating .
- ⌘ The coating contains silver .
- ⌘ Silver reacts with silicone present in the secondary sealant if edge deletion not done.
- ⌘ Edge deletion is done by a resin bonded alumina wheel.

The slide includes a video inset showing a glass edge being processed by a wheel, with a yellow arrow pointing to the contact point. Logos for NPTEL and Glass Academy are visible in the top right corner.

And let us see the edge deletion; this is the most important process of IGU, whenever you do the low E glass you say just not this is not require for the clear glass double glazed unit. This is only for low E glass usage because, the low E as a silver in nature that will react with the coating and you will have a golden edge finished. So, that is why in order to avoid that golden edge finish and the silver should not get in that a oxidized.

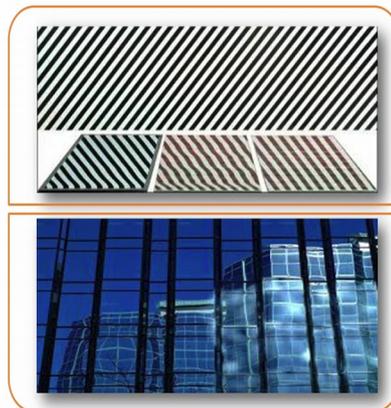
Basically, the if it is contact with the air will get oxidized to prevent that one. So, we will have to remove from the coating from the glass. So, so this is the picture you can see here with at the time of cutting or after tempering also you can do it here or manually also you can do it also. So, only the periphery of the edges we have to remove this the nano coating of metal oxide coating has to be removed.

So, these wheels are resin bonded alumina wheel has to be used. So, it will be gentle so, thereby it would not create scratches on your surface

of the glass. So, the function of edge ratio only to remove those edges the periphery edges of coating. So, not to adhesion it will promote your adhesions and it prevent oxidization and these are the you know facilities.

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Visual Distortion for IGU



Local distortions

- ✘ Roller waves and overall bow resulting from the heat treatment process (FT)
- ✘ Glazing Constrains



And let us look at it visual distortion; we have a local distortion which is a roller wave and overall bow resulting from the heat treatment process basically, tempering process will have a effect of a roller wave. See the time of tempering you will have a zebra board, you can see here so, 1st picture and 2nd and 3rd picture you will have see the so, as long as you can able to see the zebra line and as uniform in a straight line, your tempering process is it can be ready to use as a glazing.

If it is not there then, the same effect will be seen on your glazing when the facade system, when you glaze it the same glass which has a distortion. Then you will you are forced to see that distortion would effect on your after glazing it on your facade and this is how your facades going to be located.

So, we have to be very careful in terms of roller wave which basically, the heat treatment process. So, that it can be controlled, it cannot be

eliminated this can be controlled with help of a heat treatment process called a tempering process. And glazing constraint; there are some times the glazing constraints are there that is the glazing if it is not properly used to silicon or if any bolt, nuts which is you know piercing it or it is contacting on the glass surface is one edge will be tightness you know than the rated capacity tightness. So, your structure also will give a glass deflection. So, that will also go into effect and it will effect as a distortion effect.

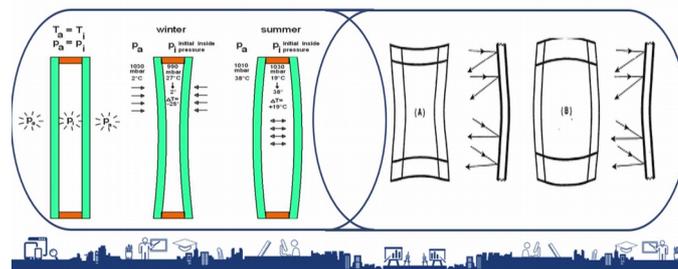
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Visual Distortion for IGU



Deflection by climate conditions

- ⌘ Variations in atmospheric pressure.
- ⌘ High Altitude



And visual distortions like deflection by climatic condition not only the process also the climatic changes also like; variation atmospheric temperatures and high altitudes will play a major role. Where example; when you produce here, when you send it to like a higher like more than 2000 sea level if you go and glaze it. So, there will be a different altitude together when you glaze it on the sea level so, we will have to keep in mind we will have to figure out.

So, you can see the here this is how normal glazing if it is winter the glass will go into bulging effect and stay inside. If it is the summer will be bulging out towards right so, because of the convection air get heated up inside so, thereby the bulging out the air winter so, it will

suck the air. So, that is why it is goes inside. So, you can see the next picture the band you know which way concave and convex way.

So, whichever way the deflection goes on the either way we will able to see the distortion. So, we will have to be carefully ah; select the altitude pressure basically, the altitude we cannot select, but we can have a pressure equalizer at the time of glazing or dispatching itself.

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DGU Failure Causes



- Poor spacer corner or spacer joint construction.
- Failure of the structural seal due to aging.
- Incompatibility of glazing materials with the insulating glass sealants.
- Extreme environmental conditions.
- Poor quality control.
- Window washing with cleaning products that are chemically incompatible with the sealing material, etc.



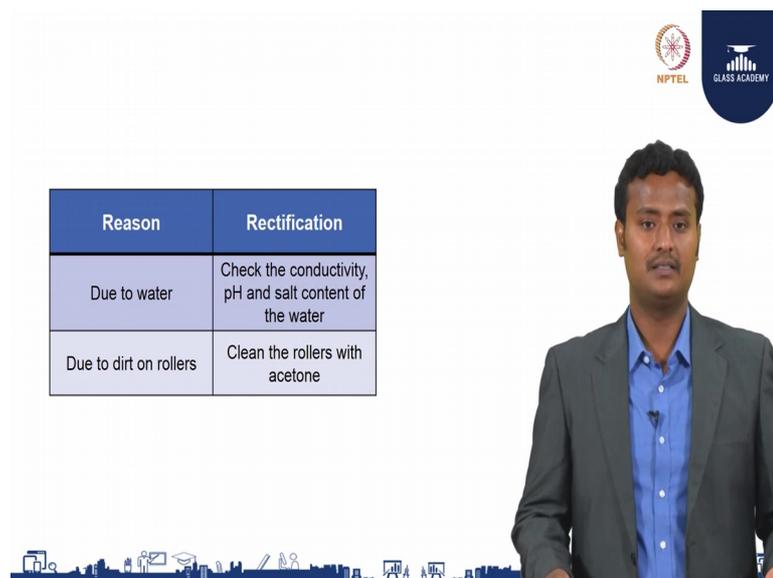
And failures poor spacer corner space joint constructions, failure of a structural seal due to aging, in incompatibility of glazing material if you use it and extreme environmental conditions, poor quality control like window washing like cleaning product that may effect chemically and incompatible with the silicon materials. So, these are the common DGU failure will cause effect.

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The slide features the word "TROUBLESHOOTING" in a large, bold, blue font at the top left. In the top right corner, there are two logos: the NPTEL logo (a circular emblem with a gear and a book) and the Glass Academy logo (a blue shield with a white building icon). A male presenter in a grey suit and blue shirt stands on the right side of the slide. At the bottom, there is a decorative blue silhouette of a city skyline with various icons representing technology and education.

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The slide displays a table with two columns: "Reason" and "Rectification". The table is positioned on the left side of the slide. The presenter, the same male in a grey suit and blue shirt, stands on the right. The slide also includes the NPTEL and Glass Academy logos in the top right corner and the same decorative blue city skyline silhouette at the bottom.

Reason	Rectification
Due to water	Check the conductivity, pH and salt content of the water
Due to dirt on rollers	Clean the rollers with acetone

Let us move on to the troubleshooting like any like having said that we are discussed with the pre processing most important. So, check the water quality, check the conductivity like it should be the 0 to 10 microsiemens pH should be 6 to 8, microns pH and salt content of the water should be less should not be acetic or should not be alkaline it should be the neutral. That is why we are discussing about it should be pH in the range of 6 to 8.

And due to the dirtiness so, your roller, your machine has to be maintained properly. So, thoroughly you have to be keep it, in case you find any substance or any stains on your rollers you try to use on the acetone. So, you can thereby you can eliminate those strain marks on the glass and this is the an IGU with the condensation effect.

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So, this effect which you widely we discuss about this will have because of your ; desiccant which failed. This basically, it absorbed pre absorption nitrogen or hydrocarbons water it is enormous water has been absorbed. So, it cannot perform because, it is already absorbed 100 percent. So, it would not be performable. So, that is why the IGU the you will get failed so, we will have a effect of condensation, which means foggy effect you are not able to see through inside outside so, you will have to replace your DGU.

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Reason	Rectification
Desiccant is absent in the spacer	Desiccant should be provided in the aluminium spacer
Secondary sealant is absent in patches	Apply secondary sealant properly along the edges
Time delay between desiccant filling and secondary sealant applying at the end of the process	Time delay should be maximum 30 minutes. Longer the time delay, greater the chance of desiccant absorbing moisture from atmosphere
Proper sealing not done after argon gas filling	Sealing should be proper after argon filling

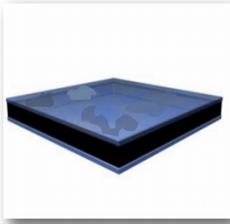


Next reason is like desiccant absence in space it is complete fail, you know desiccant absence in the spacer desiccant should be provided in the alumina spacer. So, we will have to keep in mind if you are not able to use a desiccant or if you send without the desiccant will be a problem. And secondary silicone is absent in patches like apply thoroughly; uniformly continuous manner that it is not be in it is continuous manner. So, they saw them and proper sealing not after organ gas filling sealing has to be done properly.

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Reason	Rectification
The atmosphere should be free of any dirt	The room should be enclosed and the room atmosphere should be free from dust
Dust in water used for washing	Water should be free of any dirt and filter should be cleaned periodically



Which we discuss almost you know dirtiness should be there in their machines, but you will have to avoid. So, you have to should not live with that you will have to come up with the solution called how we can protect this from you know dust ah; water washing quality this thing. So, this will be a maintenance process and at the time of production you will have to keep in mind you will have to thorough visual quality checks and each and every process because, it will help us in the long run.

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And IGU with scratches so, this is major due to your brush, which is has the high abrasion because, it is served lot, maybe your micron will be less and your become hard brush at the time of washing people should not use hard brush, but be used to mild brush our glass is stacking, splinters any form of you know scratches can be can be created in a many form in the processing. So, we will have to carefully do it at the time of a processing.

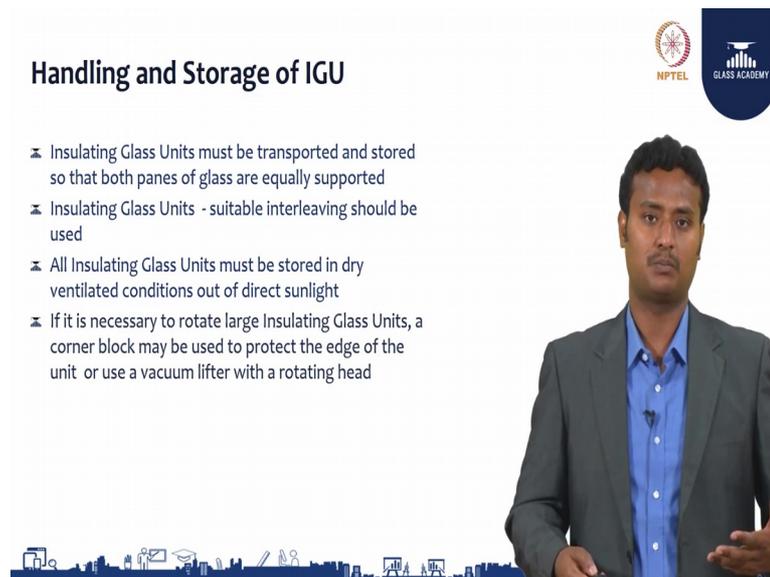
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So, sagging effect which we discuss about the more panel, the size of the panel length and width is more size. So, the gravity force of a glass it tends to you know go down. So, not to avoid that one you will have to use argon gap or any performance gases so, thereby it will be you know dry air also it can be used. So, it will be in a sagging effect would not be there.

And moreover, if you use as a vertical glazing instead of a doing on a horizontal glazing, vertical glazing will not have a sagging effect, if you use robotic machine rather than doing a manual process. So, this is a troubleshooting.

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The slide features a title 'Handling and Storage of IGU' at the top left. In the top right corner, there are two logos: NPTEL (National Programme on Technology Enhanced Learning) and GLASS ACADEMY. The main content is a bulleted list of four points regarding the handling and storage of Insulating Glass Units (IGU). To the right of the text is a photograph of a man in a grey suit and blue shirt, who appears to be the presenter. At the bottom of the slide, there is a decorative blue silhouette of a city skyline.

Handling and Storage of IGU

- ✦ Insulating Glass Units must be transported and stored so that both panes of glass are equally supported
- ✦ Insulating Glass Units - suitable interleaving should be used
- ✦ All Insulating Glass Units must be stored in dry ventilated conditions out of direct sunlight
- ✦ If it is necessary to rotate large Insulating Glass Units, a corner block may be used to protect the edge of the unit or use a vacuum lifter with a rotating head

And let us move on that is the final slide of my presentation, this is a handling and storage of IGU. So, handling and storage is you know it is a part of processing not only the production once you are done the curing is cleaning is over you should not know away from that practice. So, handling is most important because, you have done a proper job so, far from cutting, grinding, washing tempering, IGU process that secured now ready for the test match.

Because, the customer wants to receive this you are finished product. So, that handling should be a proper basically, you have to separate with the separators and use like wherever you need a paper or you need a interleaving powder, you have to use it and ensure you know transportation and storage of both panels are equally supported.

It should not stack in a zigzag way or should be in a 6 to 7 degree at the angle of you have to stack, it should do not stack it on horizontally and transport it should be in a frame should be the 6 to 7 degree. So, such a way we have to do it.

And insulating glass when a suitable interlink should be used and all insulating glass unit must be stored in dry in ventilation conditions, it should not you know expose to the sun or the heavy rainfall. So,

because your customer going to receive if it is a rainfall or anything during this one place to another place their transportation the drive water substance will dry and it will accommodate the duster from the atmospheric it will have a different effect altogether again people wants to clean at the surface.

Again when the time of cleaning the people who tends to create the scratches so, we have to be very careful at the time of dispatching also would protect the tarpaulin you know prevent from abnormalities whether it is stacking or transporting please keep in mind that one.

And if it is necessary to rotate large panels of IG unit, you can use the corner blocks like a way the you can use a corner block you can ready madly made, it can be used at the time of bigger DGU when you lift, it we can use it as a corner block. So, it will not break again the vacuum lifter like you can use manual lifting is not possible then, you can use automatic vacuum lifter it can help us in a long run.

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Summary:

By the end of this video, you have learnt about the:

- In process quality test
 - Molecular sieve test
 - Two part sealant mixing test
 - Butterfly test
 - Snap test
 - Peel adhesion test
 - Shore hardness test
- Sealant manufacturing companies
- Edge deletion
- Visual distortion for IGU
- Handling and storage

So, with that I am finishing with my presentation.

Thanks for learning, happy learning.