

**Glass Processing Technology**  
**Prof. Somnath**  
**Department of Civil Engineering**  
**Indian Institute of Technology, Madras**

**Lecture - 35**  
**Insulating Glass Unit**

(Refer Slide Time: 00:22)



The slide features the NPTEL logo in the top left and the Glass Academy logo in the top right. The main text reads "GLASS PROCESSING IGU PART 2". A lecturer in a light blue shirt is shown on the right side of the slide, gesturing with his hands. The bottom of the slide has a blue decorative border with various icons.

Now, let us come to the glass processing of IGU.

(Refer Slide Time: 00:28)



The slide features the NPTEL logo in the top left and the Glass Academy logo in the top right. The main text reads "3.2. INSULATED GLASS - THE PROCESS". On the left, there is a 3D cutaway diagram of an insulated glass unit (IGU) showing two glass panes separated by a spacer bar with a desiccant strip. A lecturer in a light blue shirt is shown on the right side of the slide, gesturing with his hands. The bottom of the slide has a blue decorative border with various icons.

Figure 17

What we basically have the starting is a washing machine, it can have 3 or 4 pairs of brushes.

(Refer Slide Time: 00:34)



(Refer Slide Time: 01:01)

**3.2.2. MACHINES USED FOR THE PROCESS**

- ⌘ The machines used in the process of making insulated glass are –
  - ⌘ Washing unit
  - ⌘ Drying unit
  - ⌘ Spacer conveyor
  - ⌘ Butyl extruder,
  - ⌘ Pressing unit, which is vertical.

Coming back to this you have a washing unit, you have a drying unit, you have a spacer conveyor, you have a butyl extruder, you have a pressing unit, which is normally vertical ok.

(Refer Slide Time: 01:11)



### 3.2.3. WASHING – PURPOSE

- Let's now learn about each stage of the process in detail.
- The first stage is washing. It is very important for the following reasons:
  - Residues of the cutting oil used for cutting the glass remains on the glass.
  - This has to be cleaned. When a score or v-cut is made in the glass, some splinters tend to remain on the glass.
  - These splinters must also be removed.
  - Any finger marks made while handling the annealed or tempered glass have to be removed as well.



Now, let us come back to washing; it is almost the last process in a glass processing. You need to have very clean surface before you make the IGU. So, glass washing plays a major role in it. You will have cutting oil residue; you have a small particles of glass which will be stuck on the glass surface. So, that has to be removed which is done by a washing.

Any finger marks which is from the operator that has to be removed which is done by a good washing machine.

(Refer Slide Time: 01:44)



### 3.2.4. WASHING - THE PROCESS

- The glass now moves through the vertical washing machine.
- The washing machine has two chambers.
- The first chamber has warm water and the next chamber has water at room temperature.
- The water used for washing is recycled constantly.
- The chamber has three pairs of cylindrical brushes, which help in cleaning both sides of the glass lites.



The glasses now move through the vertical washing machine and it has got 2 chambers, which has got a warm water as well as the normal room temperature water. Normally it has got 3 to 4 cylindrical bristles, which touches the glass surface and cleans the surface of the glass.

(Refer Slide Time: 02:05)



### 3.2.4. WASHING - THE PROCESS

- These brushes are made of nylon.
- There is a fourth set of fine brushes specially fitted to clean soft coated Low-E or solar control glass.
- As the glass passes through each of these chambers, these brushes brush the glass and the water cleans it.
- The rollers between the brushes help the glass move along the machine.



Normally the brushes are made of nylon; you also have polyamide which is being used for high end washing. And for low E or the soft coated type of glass you have the 4th pair of brushes which is used to clean the surface of water.

(Refer Slide Time: 02:22)



### 3.2.5. WASHING MACHINE - PRE-REQUISITES

- It is very important that the washing machine should not have any greasy internal surfaces.
- To ensure this, follow the steps given here.
  - Change the water in the first tank every day.
  - Change the water in the final tank every week.
  - Clean the entire machine with water once a month.



It is very important that the washing machine should not have a greasy internal surface. To ensure that change the water in the water tank everyday, change the water in the final tank every week. And change clean the entire machine with water once in a month these are very good practices to be followed.

(Refer Slide Time: 02:42)



### 3.2.5. WASHING MACHINE - PRE-REQUISITES

- ▶ This process takes approximately three hours.
- ▶ The machine also needs to be cleaned with Hydrogen peroxide or RBS 50, once every six months.
- ▶ This process takes almost an entire day. Keep the nozzles clean and free from dust.



This process takes approximately 3 hours. The machine also needs to be cleaned with hydrogen peroxide or RBS 50 once in six months.

(Refer Slide Time: 02:51)



### 3.2.6. WASHING - MEASUREMENT OF WASHING QUALITY

- ▶ Although the glass goes through the entire washing process, there are chances that the glass might still be dirty.
- ▶ To determine the washing quality, certain tests are carried out. For example:
  - ▶ A drop of demineralised water is placed on the clear surface of the glass, and the angle of the water drop is measured.
  - ▶ If there is absolutely no spreading of the water droplet, and the angle is equal to 90 degrees - the glass is said to be very dirty.

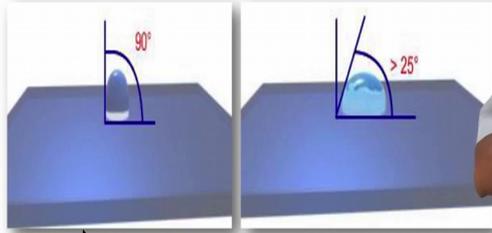


Now comes the measurement of water called washing quality, you often feel are we washing it properly is the wash is the glass come out wash right or not. So, how do you determine the washing quality? So, what you do is you take a drop of demineralised water; place it on a clean surface a on a wash a surface, and then see the angle of the drop. If the angle of the drop is almost like 90 degree, the glass is said to be very dirty.

(Refer Slide Time: 03:22)

 **3.2.6. WASHING**  
**- MEASUREMENT OF WASHING QUALITY** 

- ✎ If insufficient spreading of the water droplet is observed, and the angle is greater than 25 degrees - the glass is considered to be dirty.
- ✎ If there is sufficient spreading, and the angle is less than 25 degrees, then the glass is considered to be clean.



You can see in the image when the angle is almost let 90, it is the glass surface is really dirty. And if the angle is greater than 25 degree, the glass is considered to be still dirty. And if the angle is less than 25 then the surface of glass is said to be clean.

(Refer Slide Time: 04:15)

 **3.2.6. WASHING**  
**- MEASUREMENT OF WASHING QUALITY** 

- Another test to determine the washing quality is the chalk method.
  - Apply a wax chalk on the surface of the glass, and pass the glass through the washing unit.
  - If chalk marks remain on the glass, it follows that the machine will have to be cleaned and the water in the chambers changed.



Another test which can be used is a chalk method. Apply wax chalk on the surface of the glass and pass the glass through the washing unit. If the chalk marks remain on the glass it follows that the machine will have to be cleaned and the water is to be changed.

(Refer Slide Time: 04:33)



Not effective cleaning - Figure 21



Effective Cleaning -Figure 22



You can see the image on the left hand side; you can see the chalk marks still left on the glass surface. On the right you can see it is very clean surface.

(Refer Slide Time: 04:42)



### 3.2.8. DRYING AND INSPECTION

- Once the glass is washed, it moves on to the drying unit.
- In the drying unit, air is blown over the glass with great pressure.
- There are air knives in the unit that help to dry the glass.
- These air knives should be installed at an angle in order to clean the water in the opposite direction of glass movement.
- The glass then moves on to the inspection area, where it is checked.



Now, comes the drying and inspection area, once the glass is washed it moves on to the drying unit you have knives in the drying unit air is blown over the glass with great pressure. There are air knives on the unit that helps to dry the glass. This air knives should be installed at an angle in order to clean the water in the opposite direction of glass movement.

The glass then moves on to the inspection area where it is checked, you will have some light which is from the behind for making it easier to for inspection.

(Refer Slide Time: 05:15)



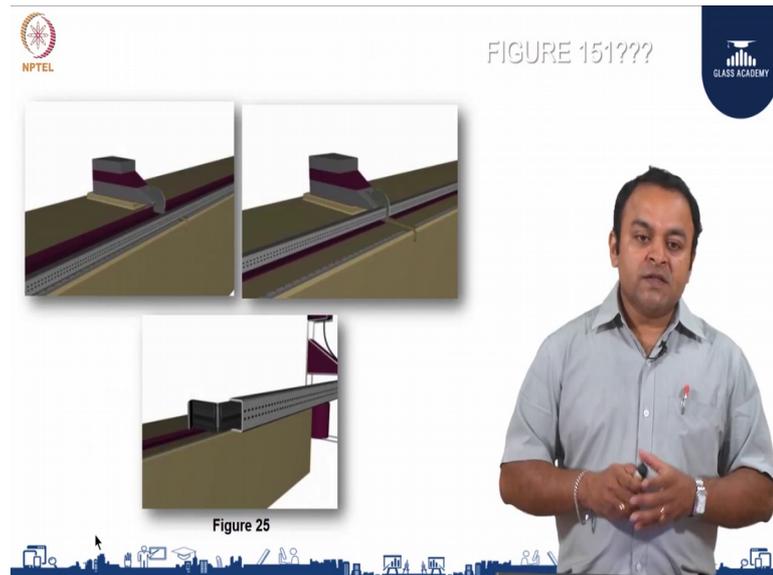
### 3.2.9. FRAME MANUFACTURING

- Frame manufacturing occurs as a parallel process, while the glass passes through the washing stage.
  - The spacer material is cut to the specific size.
  - The spacer bar is then kept at an angle/slanting position in the desiccant filling machine.
  - Desiccant is filled into spacer bar.



Now, comes the frame manufacturing frame is nothing but a aluminium spacer which is bent, you can have either a corner key or you can have a bent spacer which can be used. The spacer materials cut to the specific size the spacer bar is then kept at an angle slanting position to fill the desiccant. You can also have a automated machine where you can fill the desiccant inside. And that drilled hole is sealed with a primary sealant.

(Refer Slide Time: 05:42)



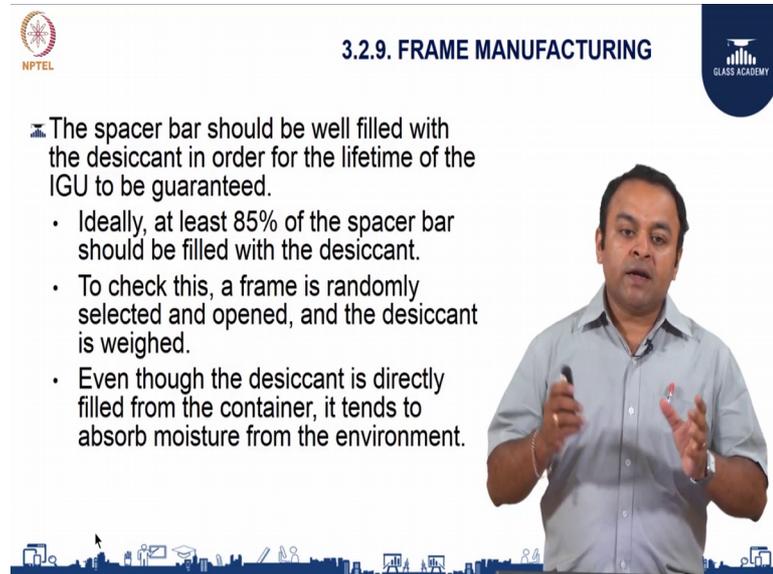
We can see the aluminium spacer which is cut based on the dimensions, which is required.

(Refer Slide Time: 05:48)



And you have either the semi manual filling of desiccant or you also have a automated way of filling the desiccant.

(Refer Slide Time: 05:56)

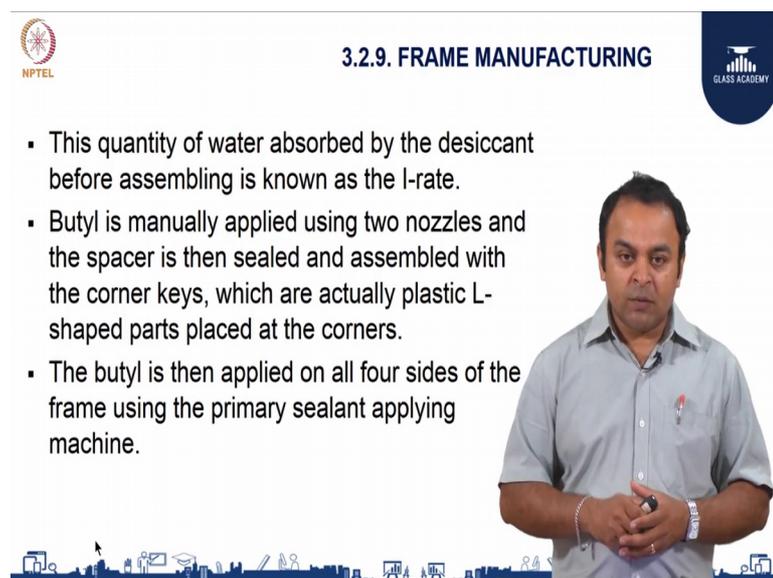


**3.2.9. FRAME MANUFACTURING**

- The spacer bar should be well filled with the desiccant in order for the lifetime of the IGU to be guaranteed.
  - Ideally, at least 85% of the spacer bar should be filled with the desiccant.
  - To check this, a frame is randomly selected and opened, and the desiccant is weighed.
  - Even though the desiccant is directly filled from the container, it tends to absorb moisture from the environment.

You should have at least ideally 85 percentage of the spacer bar which to be filled to give a life of at least 5 to 10 years of the DGU. Even though the desiccant is directly filled with the container it tends to absorb moisture from the environment. So, the time between the filling of desiccant to the assembly to the unit has to be the minimal.

(Refer Slide Time: 06:17)



**3.2.9. FRAME MANUFACTURING**

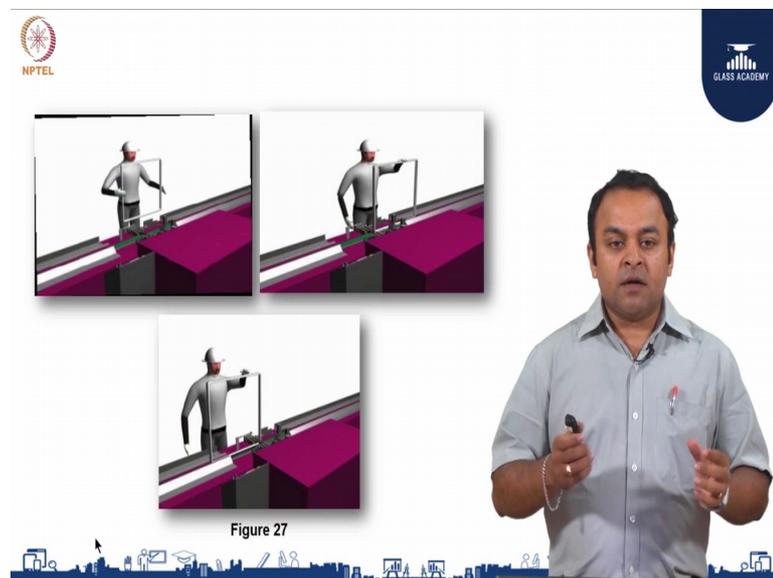
- This quantity of water absorbed by the desiccant before assembling is known as the I-rate.
- Butyl is manually applied using two nozzles and the spacer is then sealed and assembled with the corner keys, which are actually plastic L-shaped parts placed at the corners.
- The butyl is then applied on all four sides of the frame using the primary sealant applying machine.

The quantity of water absorbed by the desiccant before assembly is known as the I rate. The butyl is then applied on all the 4 sides of the frame using the primary sealant application machine.

(Refer Slide Time: 06:27)

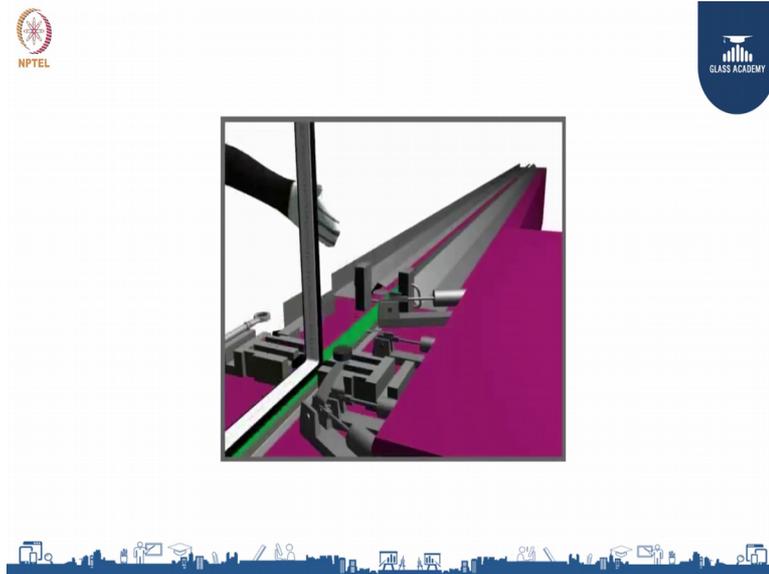


(Refer Slide Time: 06:52)



Thus take care that proper gloves are worn by the operator because otherwise the adhesion will be effected.

(Refer Slide Time: 06:58)



(Refer Slide Time: 07:19)

**3.2.9. FRAME MANUFACTURING**

- As the frame created in this process has four joints, the heat loss is more.
- To address this, the frame or the spacer bar is bent at 90 degree angles and the frame is assembled with joint.
- This is referred to as a bent frame.
- In the bent frame, two holes are drilled, and the desiccant is filled through these.



As the frame created in this process as got 4 joints, the heat loss is considered to be more. To address this the frame or the spacers bent at 90 degrees and the frame is assembled with a joint that is called the bending spacer.

(Refer Slide Time: 07:32)

 **3.2.9. FRAME MANUFACTURING** 

- It is then sealed with butyl.
- The assembled frames are kept stacked on the spacer conveyor.
- Ideally, pressing should be done within one and half hours after filling, but it can go up to three hours.
- The deviation in temperature (day and night) must be checked while filling the desiccant.



It is then sealed with butyl, the assembled frames are kept stack on the spacer conveyor ideally pressing should be done within 1 or 1 and half hour from filling, but it can go up to 3 hours.

(Refer Slide Time: 07:45)

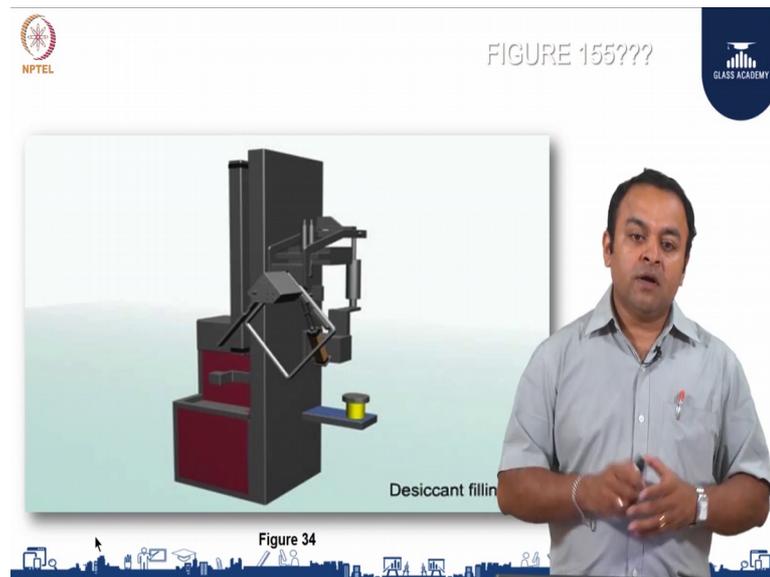


Figure 32



It is always ideal to hang the filled aluminium spacer with desiccant like a frame which is shown in the picture.

(Refer Slide Time: 07:56)



(Refer Slide Time: 07:59)

### 3.2.9. FRAME MANUFACTURING

- Butyl temperature settings must always be less than the maximum temperature recommended by the supplier.
- Handling should be minimal –
  - Use only finger tips where necessary, and touch only the frame, not the butyl ribbon.
- Monitor the quantity (test frames) and the continuity (each frame) of applied butyl.
- Monitor the frame positioning on the glass.

This is a automated desiccant filling machine Butyl temperature settings must always be less than the maximum temperature which is recommended by the supplier. Handling should be minimal to improve the adhesion of the spacer. Use only the finger tips when necessary and touch only the frame not the butyl ribbon. Monitor the quantity and the continuity of applied butyl that is very important, monitor the frame positioning on the glass.

(Refer Slide Time: 08:26)

 **3.2.10. POSITIONING OF THE FRAME** 

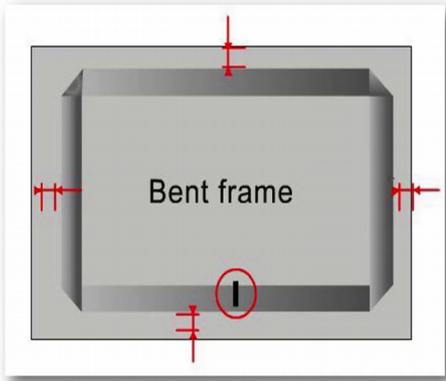
- Once the frame has been manufactured, it needs to be positioned.
- The frame is now taken to the assembly area and mounted on to the first washed and dried glass.
- The second glass lite then appears after washing.
- This is placed over the frame and both glass panels are aligned.



Once the frame has been manufactured it needs to be positioned this is the only process which is manual in this IGU and that has to be done very skilfully.

(Refer Slide Time: 08:37)

 **FIGURE 157???** 



**Bent frame**

**Figure 37**



The picture shows a the skill which has to be applied. So, that the bite is uniform for all the 4 sides.

(Refer Slide Time: 08:44)

NPTEL

3.2.11. PRESSING

GLASS ACADEMY

- After the frame has been positioned, the glass goes through the next stage in the process, that of pressing and gas filling.
- The glass is now passed through the pressing unit. Pressing is done vertically.
- The sides of the pressing unit are lined with felt, which protects the glass from scratches.
- A pressure of 6 bar is applied, and the glass is pressed.

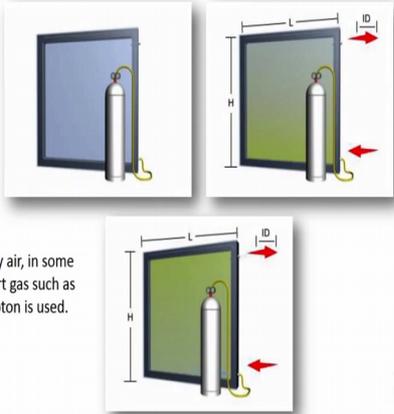


After the frame has been positioned the glass goes through the next stage in the process; that of the pressing and the gas filling. The glass is now passed through the pressing unit pressing is done always vertical. The sides of the pressing unit are lined with felt which protects the glass from scratches. A pressure of 6 bar is applied minimum to have a better adhesion of 2 glasses.

(Refer Slide Time: 09:08)

NPTEL

GLASS ACADEMY



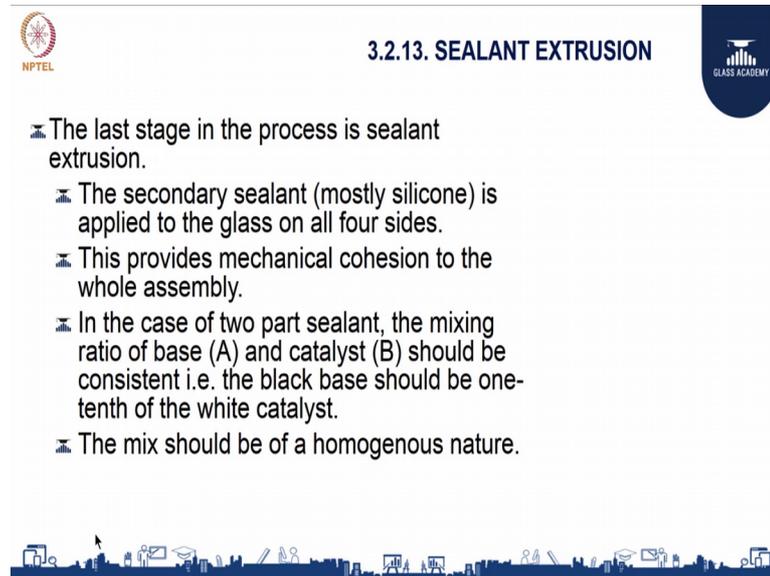
Instead of dry air, in some cases, an inert gas such as argon or krypton is used.

Figure 40



Inert gas that can be filled from the machine or you can also have a semi manual machine as shown in the picture. Based on the volume of the DGU you can fill the inert gas in it either argon or krypton.

(Refer Slide Time: 09:37)



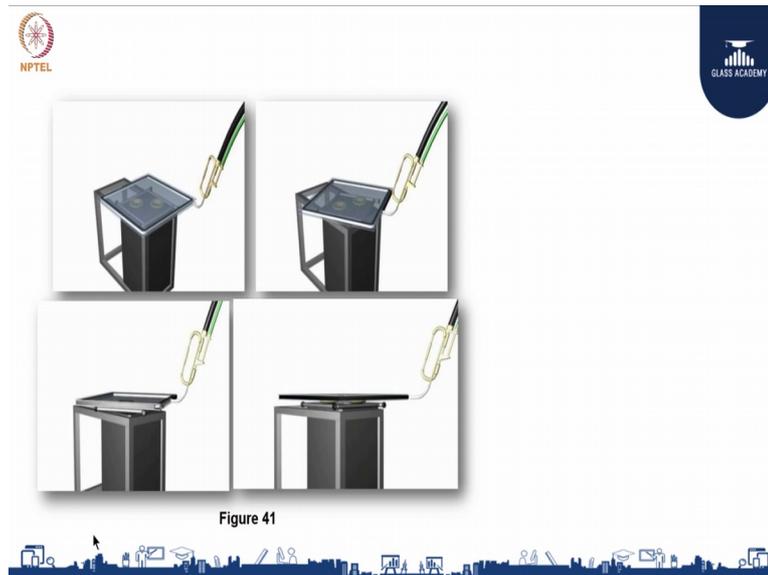
The slide features a white background with a blue header and footer. The header contains the NPTEL logo on the left, the title '3.2.13. SEALANT EXTRUSION' in the center, and the Glass Academy logo on the right. The main content consists of five bullet points. The footer is a decorative blue bar with white icons representing various educational and industrial concepts.

**3.2.13. SEALANT EXTRUSION**

- The last stage in the process is sealant extrusion.
- The secondary sealant (mostly silicone) is applied to the glass on all four sides.
- This provides mechanical cohesion to the whole assembly.
- In the case of two part sealant, the mixing ratio of base (A) and catalyst (B) should be consistent i.e. the black base should be one-tenth of the white catalyst.
- The mix should be of a homogenous nature.

The last stage in the process is sealant extrusion. The secondary sealant mostly silicon which is used in our country is applied on all the 4 sides. This provides mechanical cohesion to the whole assembly. In case of 2-part sealant the mixing ratio base A and catalyst B should be consistent. Normally it is mixed in the ratio of one is to 10 ratio and this has to be of homogenous nature.

(Refer Slide Time: 10:05)



You can either have it manual like the way it is shown in the picture or you can also have a Robo ceiling which is most ideal.

(Refer Slide Time: 10:32)

### 3.2.14. SEALANT EXTRUSION - TESTS

- Certain tests are conducted to check the adhesion and hardness of the sealant.
- Lets learn more about these.
  - To check adhesion, take a glass sheet, and fix an aluminium frame on it with butyl.
  - Try to remove it after 24 hours.
  - If it does not come out, you can conclude that the adhesion is good.



Now let us come back to the test which is performed in a double glaze units. The first test is the adhesion test, take a glass sheet and fix an aluminium frame on it with a butyl. Try to remove it after 24 hours if it does not come the adhesion is said to be really good.

(Refer Slide Time: 10:50)

 **3.2.14. SEALANT EXTRUSION - TESTS** 

- The butterfly test is done to ensure that the sealant is of the proper mix.
- Put silicone on a sheet of paper, fold it and then press it.
- Check the colour of the mix which indicates whether it has been mixed properly or not.
- Another test is conducted to check proper mixing.
- Place the silicone between two sheets of glass.
- If the mix is completely black as shown in the image, it means that the mixing is proper.



Second test can be a butterfly test which is most commonly done in our country. Put some silicone on a sheet of paper fold it and then press it. Check the colour of the mix which indicates whether the it has been mixed properly or not. The same thing can be performed by having 2 glass sheets and put the silicone in between. And if the mix is completely black as shown in the image, it means that the mixing is proper.

(Refer Slide Time: 11:14)

 **1. POOR MIXING OF TWO PART SEALANT** 

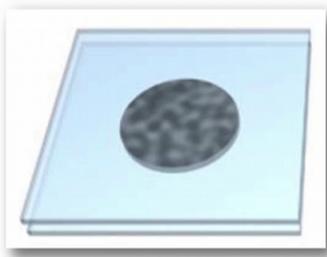
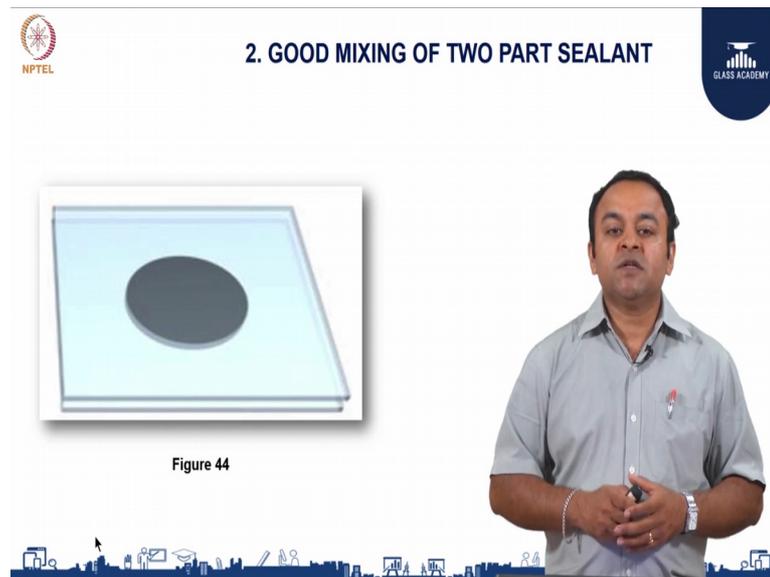


Figure 43



This image you can see the mixing is not proper because you can see some white strikes.

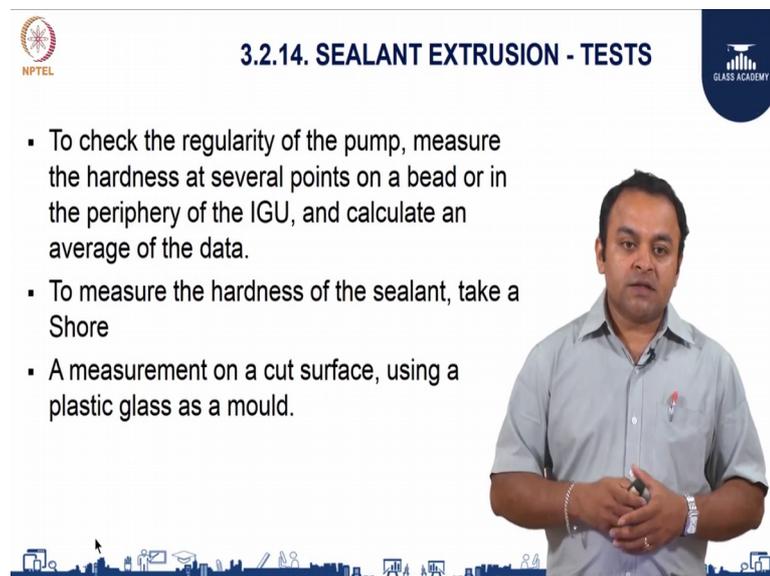
(Refer Slide Time: 11:19)



The slide features the NPTEL logo on the top left and the Glass Academy logo on the top right. The main title is "2. GOOD MIXING OF TWO PART SEALANT". On the left, there is a photograph of a square frame containing a dark, circular sealant bead. Below the frame is the caption "Figure 44". On the right, a male presenter in a light blue shirt is speaking.

And while this image is shows the mixing is really good.

(Refer Slide Time: 11:23)



The slide features the NPTEL logo on the top left and the Glass Academy logo on the top right. The main title is "3.2.14. SEALANT EXTRUSION - TESTS". On the left, there is a bulleted list of three test procedures. On the right, the same male presenter from the previous slide is speaking.

- To check the regularity of the pump, measure the hardness at several points on a bead or in the periphery of the IGU, and calculate an average of the data.
- To measure the hardness of the sealant, take a Shore
- A measurement on a cut surface, using a plastic glass as a mould.

Now the next test to check the regularity of the pump; measure the hardness of at several points on a bead on a periphery of the IGU and calculate an average of the data, you can have a shore a hardness test, which is done on a secondary sealant after it cures after 24 hours.

(Refer Slide Time: 11:41)



Figure 45

(Refer Slide Time: 11:43)



### 3.2.16. THE FINAL PRODUCT

- After sealant extrusion, the IG unit is lifted using the vacuum suction lift.
- A curing time of about 8 hours is allowed.
- The IGU is now ready for use.



This showed a hardness tester normally the curing time recommended is 8 hours, after which the IGU is ready for use and transportation.

(Refer Slide Time: 11:49)

 **3.2.17. TRACEABILITY** 

- There are possibilities that complaints may arise within the guaranteed lifetime of the insulating glass unit.
- Hence the details of where the glass was processed, when it was processed, the name of the manufacturer, the person who processed it, the date of manufacture of the frame, desiccant, etc. should therefore be accessible.
- In the event of claims, you will be then able to trace back and see if there are other complaints or problems with that particular batch.



One important thing is the traceability; we always need to have some traceability of the consumables, which is used while making a IGU. So, please have a log book which will have all the records of the spacer used the consumable used for making IGU.

(Refer Slide Time: 12:11)

 **2. VERTICAL EDGE DELETION MACHINE** 

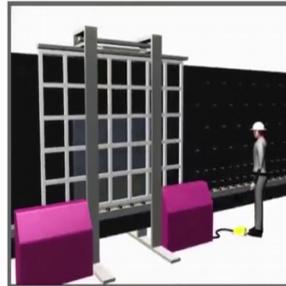


Figure 49



For low E glass you have something called the edge deletion, which you might have heard. So, that can be done either in the edge U machine or in the cutting machine.

(Refer Slide Time: 12:19)



(Refer Slide Time: 12:44)

### Summary:

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

- The glass processing of IGU
  - Machines used for the process
  - Washing - The process
  - Washing machine - Pre-requisites
  - Measurement of washing quality
  - Drying and inspection
  - Frame manufacturing
  - Positioning of the frame

