Glass Processing Technology
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Lecture – 31
Lamination

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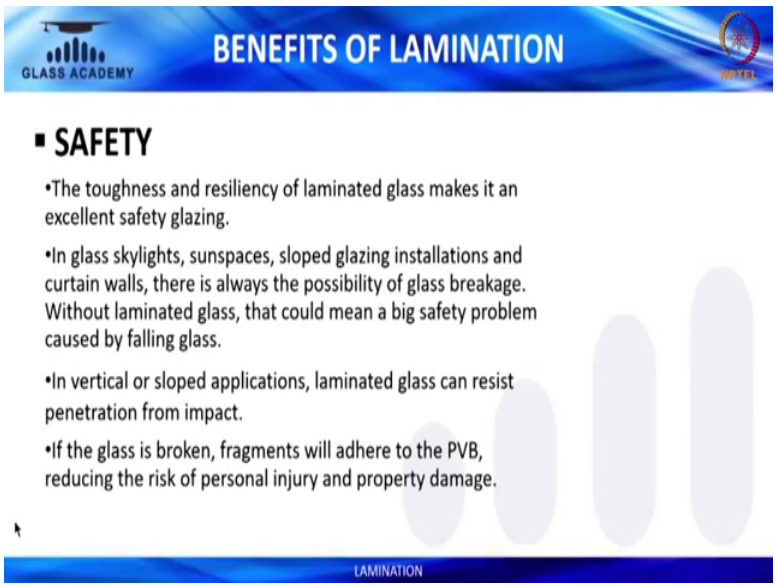

So, coming to the Benefits of Lamination let us say Safety. The toughness and resilience of laminated glass makes it an excellent safety glazing. In glass skylights, and spaces sloped glazing installation in curtain walls, there is a possibility that you have a breakage of the glass. And if you have a laminated glass, the interlayer will ensure that the glass broken glass is intact of the inter layer and there is one in the glass would not be falling and causing any damage. Whereas, if we have a tempered or annealed or an heat strengthened glass, the broken glass particle might fall and come in I mean can cause a damage impact damage so person whose nearby it.

So, lamination glass again that it is a big safety I mean the concern of the safety is eliminated if you have a laminated glass. When vertical and sloped application, the laminated glass can resist; the penetration inspect impact as we have seen in the previous videos. The glass is broken the fragments will be in contact of PVB, reducing the risk of personal injury or property damage.

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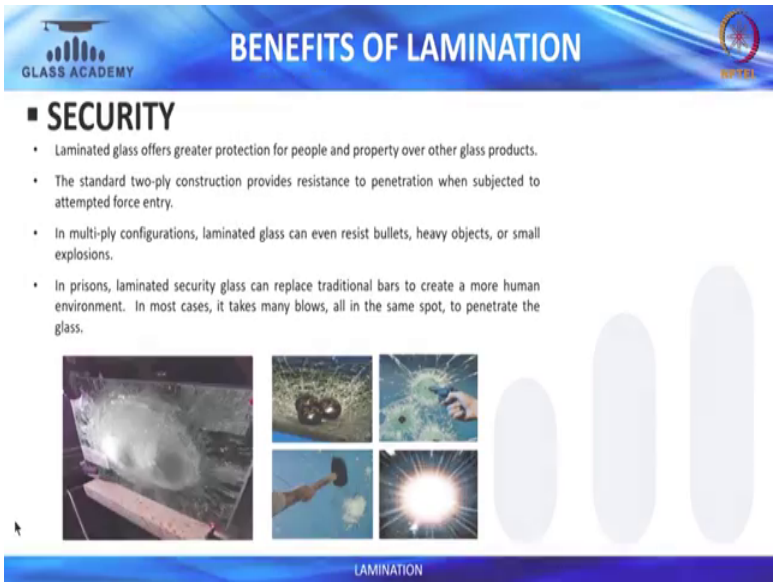

Now, coming to the security aspect, lamination glass offers great protection to the people, to the property over other glass of product as we have seen again. Basically, we have a two glass pane and it there is an inter layer in between. The inter layer it provides a resistant to penetration when subjected to forced entry. So, again laminated glass again has that a capacity of resisting bullets, heavy objects or a even smaller explosions. I mean coming to prisons if you have a laminated security glass, I mean as we have seen in the previous video's it can take many blows of band I mean vandal.

So, as we have seen it is a vandal resistant. So, if you use a laminated glass in prisons, it will be very difficult for the prisoners to know break through or no escape. So, it can be a replacement in terms of traditional bars that you have. Since, the penetration through a lamination glass is difficult. So, you can see two pictures are demonstrated here; one on the left is basically of laminated glass which has been subjected to bullet shooting basically. So, you can see that it has not penetrated and you can see the impact of the bullet on to the laminated glass. On the right side of the images, we just trying to tell you that a lamination glass, it can be vandal resistant, it can be bullet resistant, it can also behave as a blast resistance.

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We will just run through a video of know again something on vandal a resistant, the laminated glass provides. Have a look at this.

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We will have a video. You can see that even after striking six times on a laminated glass using an hammer, it is not possible to penetrate through. This is what shows the vandal resistant performance of a laminated glass. That is how we call it laminated glass as part of a security glass.

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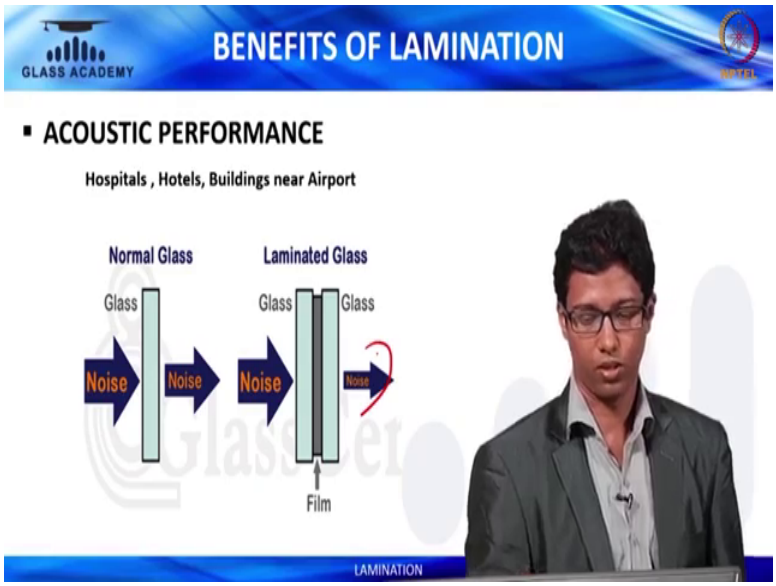

Now, coming to other benefits of lamination, you have acoustical performance. So, what do you mean by acoustical performance is basically lamination glass can give reduction of sound, who if you have a laminated glass which is nearby hospitals and at the hospital is very close to a traffic red light. We can very well imagine that patients inside would be subjected to lot of noise. So, if you have a laminated glass which is in the facade or even in the room of where the patients are there, the sound can be reduced and the patients can have a relaxed sitting over there.

Similar to hotels if you see people go there to relax; so if you have a laminated glass which is part of hotels, again you can have a comfort in the hotels and the buildings which are closer to the airports, again are subjected to lot of noise because of flights taking off and landing. So, again if you have a laminated glass, we can give very well very good acoustical reduction. And thereby, having comfort for the people who are staying over there.

So, this is what we just talked about. Reduction, if you have a normal glass there will not be much of a sound reduction. Whereas, you have a laminated glass, we can very well see the sound gets reduced to a great extent.

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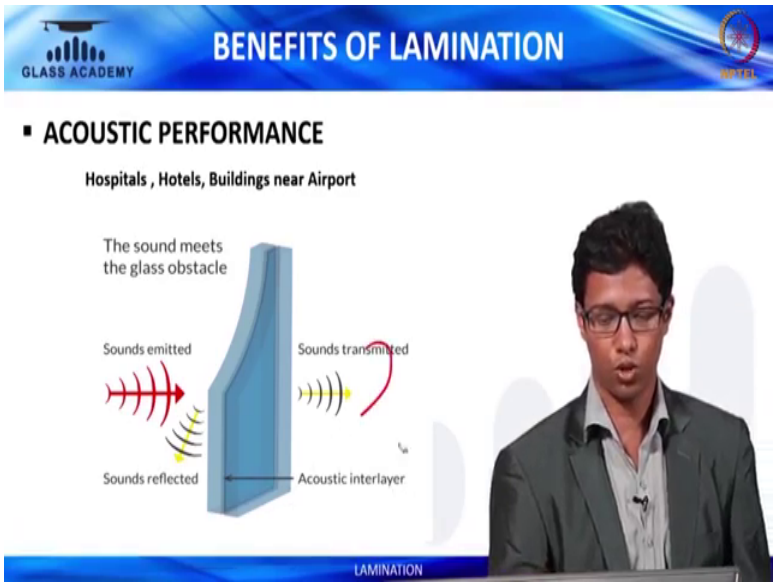

You can see that the inter layer which is there on lamination that is what gives you the reduction. And you can also have a acoustical inter layer which is one form of PVB which gives you greater sound reduction. So, this is also available in case of lamination.

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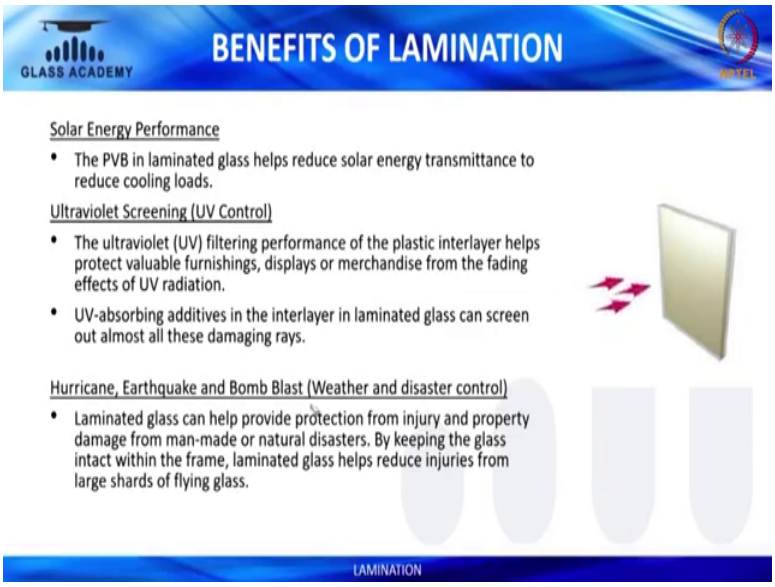

Now, coming to other benefits that a laminated glass can provide is basically Solar Energy Performance. The PVB helps reduce the solar energy transmittance. And thereby, reducing the loads onto the air conditioning and can also help you in know reducing your energy consumption that you have in the form of AC, air conditioning that you have in

the building. The other benefit that a laminated glass gives you is basically ultraviolet screening, the UV control. The UV filtering performance of the plastic inter layer helps protect valuable furnishing displays or merchandise from fading effects of UV radiation.

So, if you have a laminated glass which are used in a showrooms or let us say some displays it can prevent the ornament which is kept for display from you know coming in contact of UV, UV radiation and effects of fading can be eliminated. Again, if you have a UV absorbing additive I mean that is there in the laminated film, it can screen out the almost all the damaging rays of UV.

So, coming to the last benefit that lamination glasses offer or basically a hurricane or earthquake or let us say plus a bomb blast resistance is what we are talking about. It can provide protection from injury and property damage from manmade or even natural disasters. By keeping a lamination glass intact within the frame, the glass helps reduce injuries for from large shards or flying glass.

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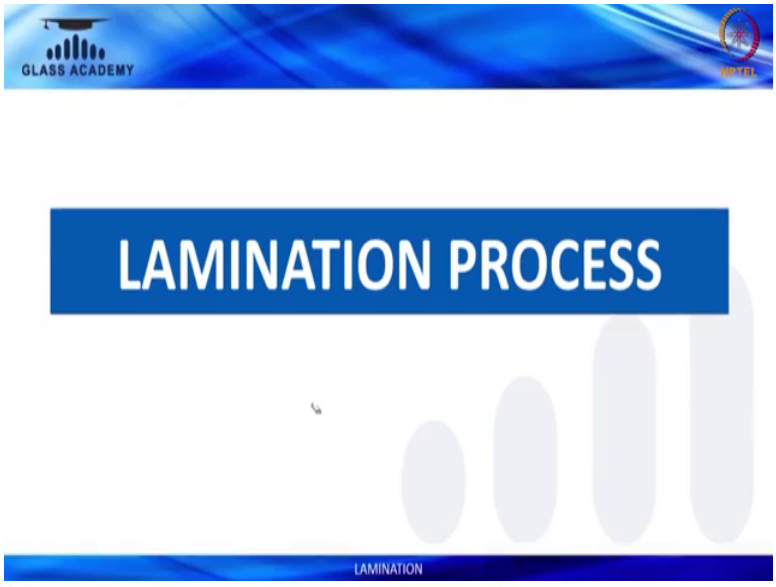

Coming to the Lamination Process.

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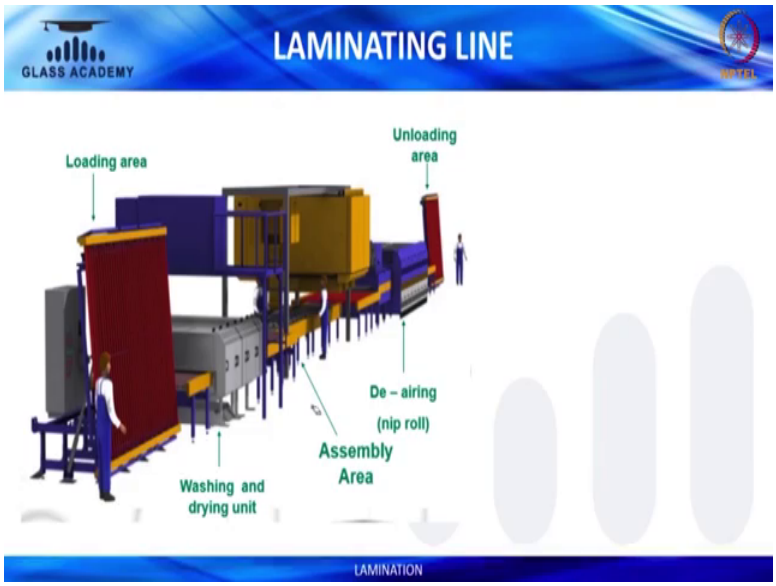

This is how an laminating architectural laminating line is designed. We have loading area, where you load the raw glass. Then, it is subjected to surface preparation, where basically we are trying to prepare a glass surface which is would be subjected to lamination in the next process. So, what we do basically is we have a de-mineralised water, we clean the glass surface using a demineralised water of conductivity less than 20.

The water that we drink basically mineral waters, (Refer Time: 07:21) mineral water and those are of conductivity range somewhere close to 180 or 200 micro Siemens. That is because we a body requires mineral. Whereas, the water that we are using for cleaning the glass surface are demineralised water, there should not be mineral. So, it's the conductivity are of very low nature; less than 20 micro Siemens is the requirement to have an ideal adhesion. Coming to once the glasses are washed, it is it goes inside and clean room or it can also be called as an assembly room or a layup room.

So, what we have in the clean room is basically we condition the PVB or let us say the interlayer which is kept inside the room. Those are conditioned in three forms; one is basically the temperature that you have, the temperature is controlled. It is of the range of 18 to 22 degrees. Then, you also have a moisture control, wherein you have an humidity basically place I could place the key role there. You have a control of humidity which is

of 20 to 30 percent is what we normally recommend that will ensure that the PVB is not subjected to high level of moisture.

And third is the dust control that we have. So, the 3 controls we talked about where the temperature the humidity and the dust. So, what happens is inside clean room, we assemble the sandwich. When I say a sandwich I mean 2 layers of glass and the inter layer which could be PVB, sentry, a glass or EVA; it should be part of the sandwich and which would be the in between of the 2 glasses.

Once you make a sandwich, you send the sandwich for further processing which is basically pre lamination which we here call as De - airing in the architectural business and what we are trying to do is basically we are trying to remove the air. In between a glass and the interlayer, air is the medium where we are making a sandwich. So, the way in which you can have an adhesion in between the glass and the interlayer is by removing the air.

So, in the nip rolls you have a 3 sets of ovens and 2 sets of pressing. So, what we are trying to do is, we are trying to go heat the interlayer and we are trying to using nip rolls we are trying to squeeze the air out. Thereby, achieving a very good edge seal and majority of the air is removed. Then, it is unloaded and kept over a cart; that cart goes inside in autoclave which is subjected to a process of 5 hours; wherein you have heating, you have holding and you have cooling and the pressure. These are the 4 processes which goes inside the autoclave. And in autoclave, what we are trying to ensure is that we are trying to increase the adhesion, and we are also making sure that the glass comes off transparent.

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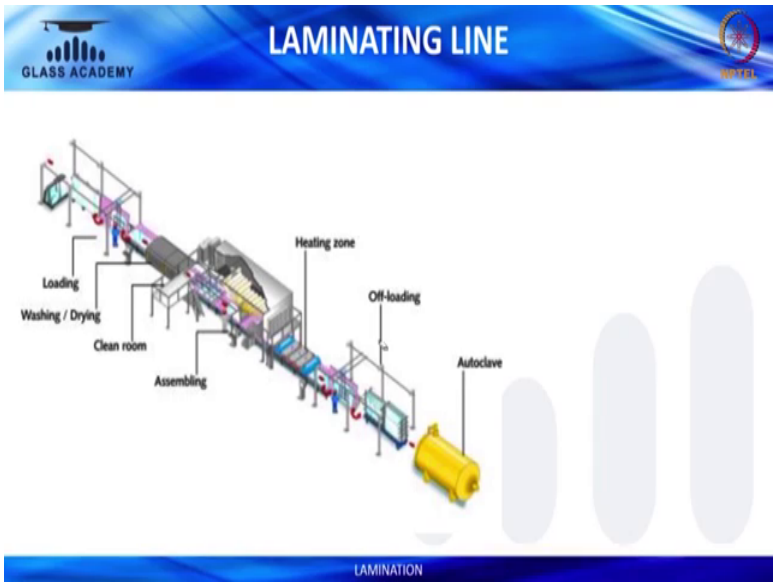

So again you can see, we have this is the ideal picture of a lamination line. You have loading, you have a washing and drying where you are trying to repair the service, you have clean room where the inter layer is stored and where the assembly of the sandwich happens. Then, you have the heating zone or let us say where you have you are trying to remove the air or which is also called as the Airing process.

We are also trying to create some adhesion of glass with the PVB and you as Steven Edge Seal which basically call as transparency in the edges of let us say 10 millimetre. And you have partial of residual air which is there in the centre of this feed portion of the glass which one subjected to an autoclave process of 5 hours, it vanishes. And you see a transparent glass with very high adhesion; which is referred to as safety or security laminated glass.

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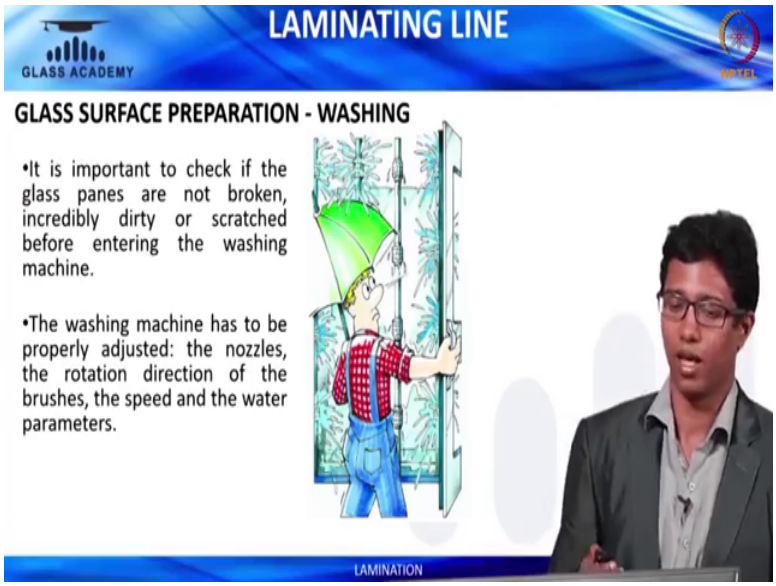

Coming to the process now we have the Glass Surface Preparation basically as we mentioned before after loading, the first step that we do is we prepare the glass surface for the process of lamination. So, what we do is we have three sets of bristle or brushes at both top and bottom. And you have tanks at the bottom of the washing machine which are pump which are filled with water, and which are the water is pumped through nozzle, and water is being in contact of the glasses and the brushes are also rotating, and trying to clean the glass surface.

So, what happens is, it is important to check if the glass panes are not broken, incredibly dirty or scratched before entering the washing machine. So, before entering itself we are trying to ensure that glasses prepared or glasses which can be processed which can be sent to the processing. Now the washing machine has to be adjusted nozzles, the rotation direction of the brushes, the speed and water. These are the parameters which we normally play within the washing machine to ensure that the effectiveness of the washing is good.

So, we have the nozzle, we have the cleanliness of the nozzle; nozzles are sometimes subjected to blockages. We have to ensure that all the blockages are removed and you have a good flow of water coming through the nozzles so that the entire portion of the glass comes in common the water is spread over the portion of the glass, and you have a very good washing. The brushes rotation again those are very significant when it talk

about the effectiveness of washing. The speed of the line it is a very important factor of that if the speed is very high, you might find that after washing there are spots of water or which are not dried or which are I mean there are portions they can also be portion of glass which are not clean.

And the water parameters, what we meant may I mean trying to convey through water parameters. Basically, there are 2 parameters which we are talking about; one is the temperature of the water and second is the conductivity of the water. So, you have 3 sets of tanks at the bottom of the washing machine: you have tank 1 which is at the entry and then, tank 2 and tank 3. The idea of heating is just to ensure that the effectiveness of washing is good.

So, what we do is we try normally keep the tank 1 we heat the tank 1 to a temperature of 40 plus or minus 5 degree. So, it is basically in the range of 35 to 45 degrees. But, why we heated is one is basically for the effectiveness, second the temperature range that is defined is to ensure that the glass when it goes inside an assembly room it is not at a temperature greater than 30 degrees. That is very important factor when you are laminating. That is why the temperature the heating is done at tank 1. Now, at tank 3, we give demineralised water which is used for cleaning again and those are at a conductivity of less than 20 micro Siemens. That is a very important factor.

Now, the washing machine per say has to be regularly cleaned.

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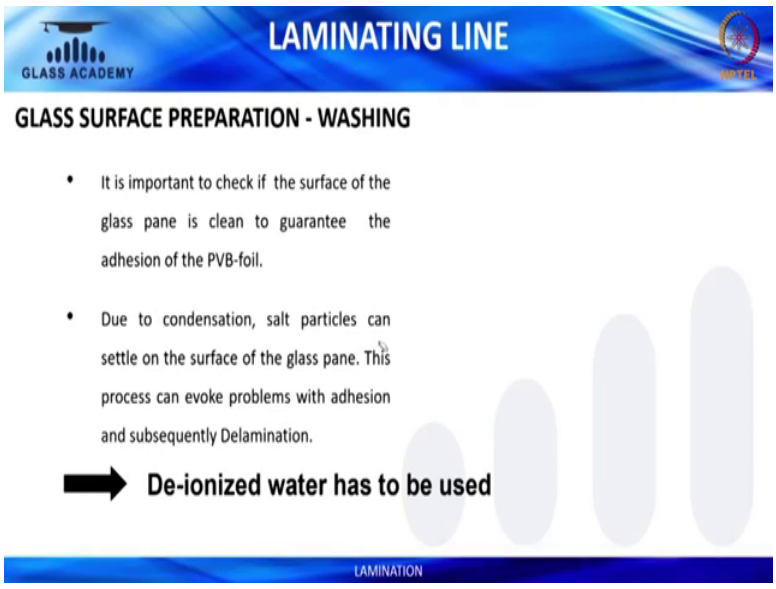

And going ahead it is important to check if the surface of glass pane is clean to click clean to guarantee adhesion of PVB foil. So, if the surface is not clean and you have an inter layer PVB which is coming in contact of the surface and subjected to further processes over a period of time you can find that there might be a little bit of delamination, if there is an impurity. That is because that will come in between the glass and the inter layer and that will create problems.

Now, due to condensation, salt particles can settle on the surface of the glass pane. This process can evoke problems with adhesion in subsequent delamination. So, the importance of De-ionized water, it again any salt particle which is there on from the water which is coming into contact of the glass. And later, when it comes in contact of the inter layer can again create problems. So, that is why the we are suppose to use de-ionized or demineralised water in the tanks of a washing machine.

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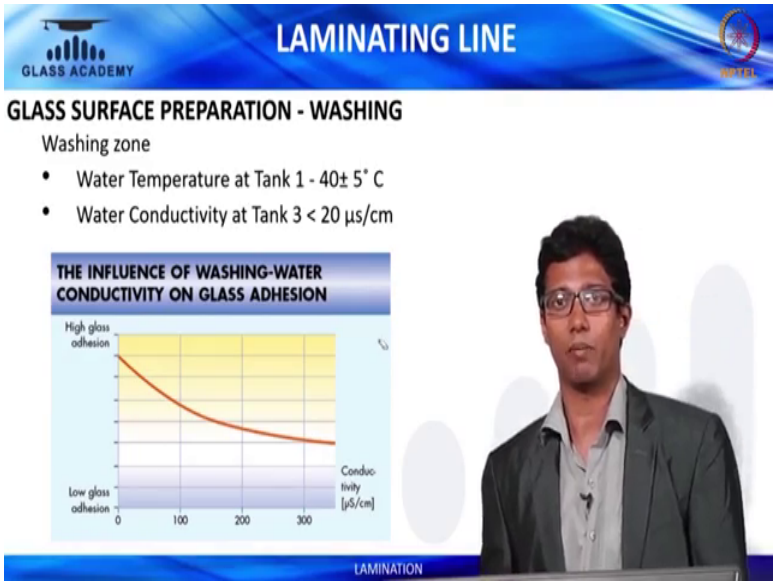

Going ahead, we have a washing zone as we discussed, the temperature is maintained at a range of 40 plus or minus 5. The conductivity is has to be less than 20 micro Siemens per centimetre. Glass Surface Preparation, it is important to check if the surface of the glass is cleaned before you prepare the glass for assembly further process. If the glass surface is not clean it can result as a in a delamination of the class in the subsequent stages.

Now, again due to condensation, if you have a water which is of very high conductivity and the total dissolved solids are there. The salt particles from the water can come in contact of the glass surface and when it is subjected to lamination, it might cause a reaction and cause trouble in adhesion with the PVB further. It can lead to delamination over a period of time that is that is that is how I mean that is why the de-ionized or demineral water are very important and the conductivity has to be less than 20 micro Siemens.

I am going ahead as we mentioned was the water temperature a tank 1 is kept at 40 plus or minus 5 that is just to ensure that the washing is effective. And again the temperature zone is defined in such a way that when the glass enters the assembly, it is the glass temperature is not greater than 30 degrees. And the conductivity of the tank 3, the water is at less than 20 micro Siemens per centimetre, as we discussed. The conductivity also plays a very important factor for adhesion.

We will have a look at the influence of washing I mean water conductivity and glass adhesion. So, if you have a conductivity which is of higher range let us a 300 micro Siemens or something, you can see that the curvature of adhesion with respect to conductivity is of in proportionate nature. If you have higher conductivity, the adhesion will be lower; if you have a lower conductivity, adhesion will be higher.

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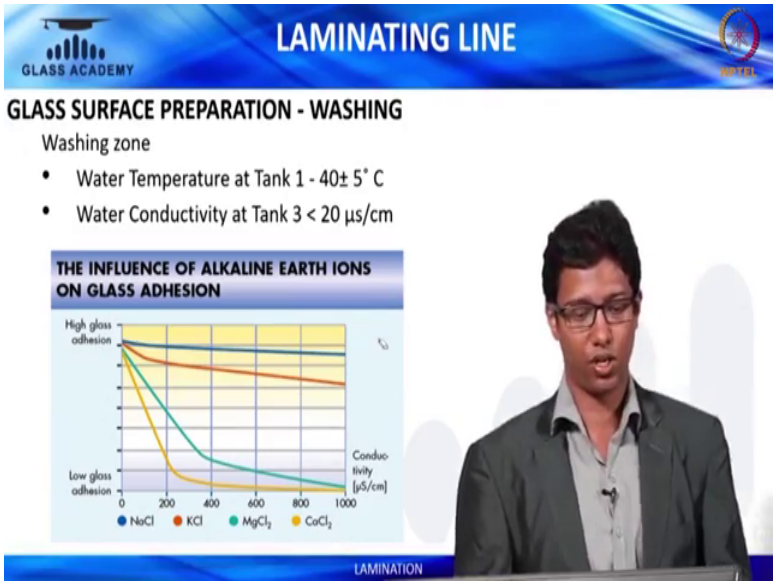

The influence of Alkaline Earth Ions on glass adhesion: as you can see you have sodium chloride, potassium chloride, magnesium chloride and calcium chloride. These alkaline may ions when you have it on the water and when it comes to the contact of glass. And subsequently when the PVB comes into contact of those, the presence of this reduces the adhesion and the presence; I mean that is how we have the blue, orange, green and yellow line are defining. Higher the higher the presence of these ions, the adhesion will be on a lower side.

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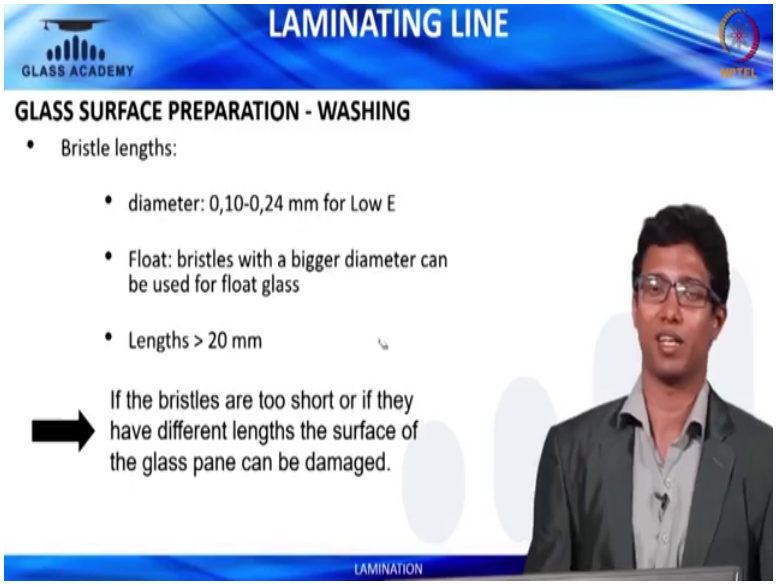

Now, coming to the bristle of the washing; the bristles can be used I mean the length of the bristles can be greater than 20 millimetre, in diameter generally 20 four mm for a low E glass. The bristles are too short or if they have different lengths the surface of glans pane can be damaged. The idea is basically to ensure that 1 mm of the bristle comes in contact of the glass, and if you have a very high level of bristle length which is coming into contact, it can lead to scratches. And, if the bristles are not in coming in contact of a glass, cleaning can also be it the effectiveness of the cleaning can also get affected.

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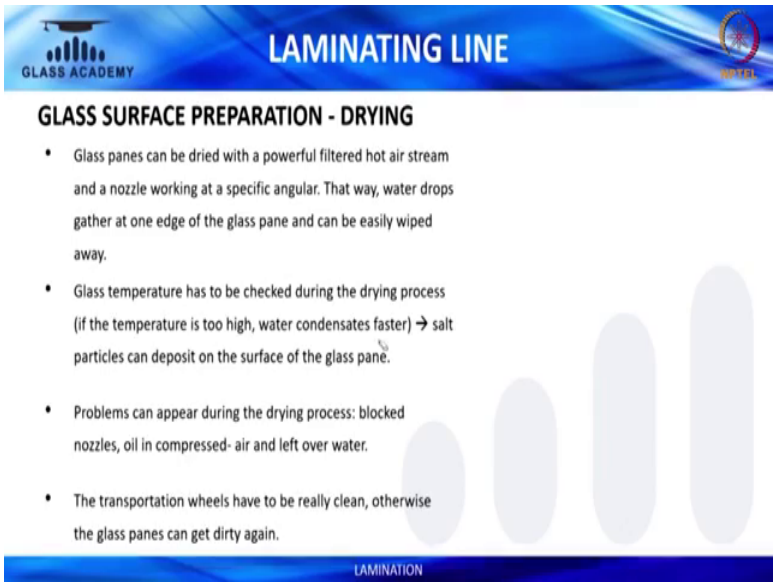

Coming to the Drying; once you wash the glass with water and bristle, it is also important to dry the glass surface. Because when you laminate a glass the surface has to be dried. So, the glass pane can be dried with powerful filtered, hot stream and a nozzle working at a regular angle. So, you have 2 sets of air mike which we call through which we blow the hot air and we try to dry the glass surface and those are at top and bottom in pairs. So, one is at perpendicular to the glass flow and second one is kept at a particular angle. So, it is kept in such a way that water drops gathered one edge of the glass pane can be wiped away easily.

The glass temperature has to be checked during the drying process; if the temperature is too high, water concert condensates faster. This is salt particles can deposit on the surface of glass pane. Problems can appear during the drying process: blocked nozzles, oil in the compressed air and leftover water. These are the three points which we need to ensure when we are washing the glass and preparing the class for lamination and this has to be ensured at a regular intervals.

The transportation wheels have to be really clean, otherwise that last panes can get dirty. What we mean by transportation wheels are basically the rollers which are conveying the glass from washing or the loading to washing to the assembly rule. Those are to be clean because glass are basically travelling over them and they are coming in contact of the rollers.

So, if the rollers are not clean, the glass surface after washing will also be not clean. Problems can appear during drying process: blocked nozzles, oil in compressed-air and leftover water. The transportation wheels have to be really clean; otherwise the glass planes can get dirty. What we are trying to convey by transportation wheels are basically the rollers. The rollers are coming the glass from loading to through washing to the assembly room and glasses are travelling in contact of the rollers. So, if the roller surface is dirty that dirtiness will, the transferred to the glass surface. And again, in future during the lamination also post lamination you will have issues of adhesion with respect to lamination.

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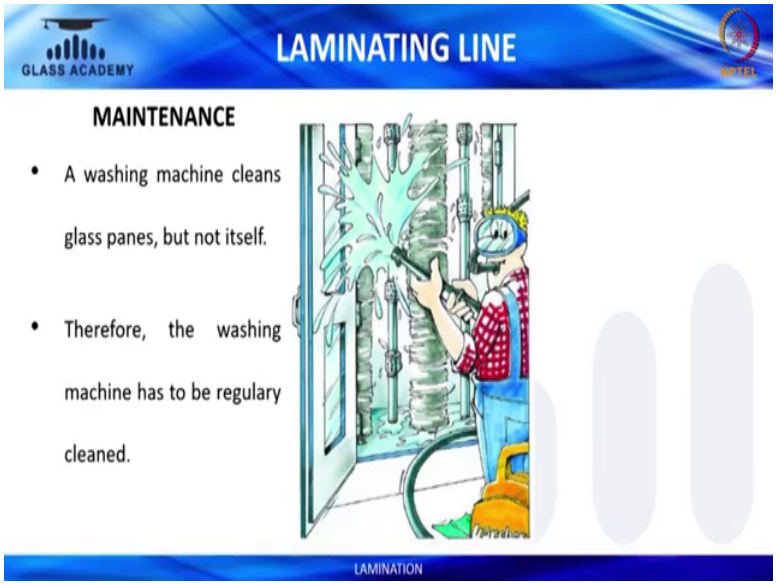

Now, coming to Maintenance; the washing machine cleans the glass paints, but not itself. So, you have to remember that washing machine though it can clean a glass surface, but it cannot clean itself; we will have to ensure that the washing machine is clean. So, we will have to engage in cleaning of the washing machine. Thus, the washing machine has to be regularly cleaned.

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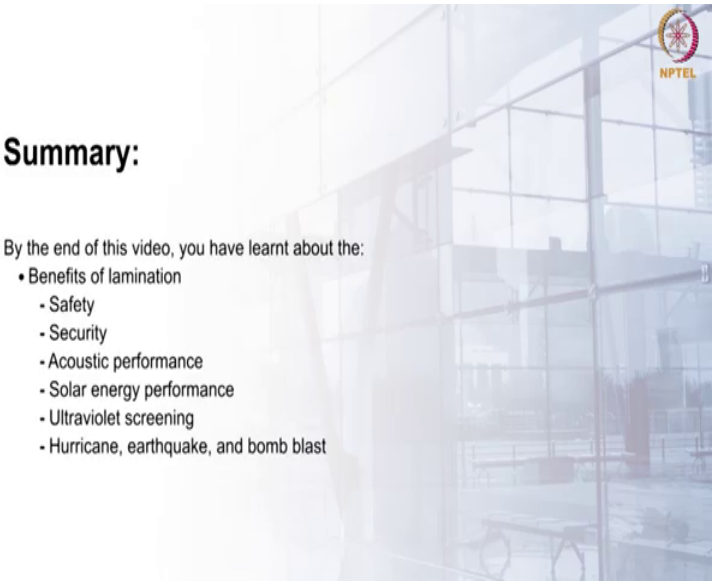

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