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THE PROBLEM OF TENSIONING AND SHAPING OF POLYVINYL BUTYRAL (PVB) FILM UNDER THE INFLUENCE OF HEAT PROCESSES IN AN AUTOCLAVE AND DIRECTIONS FOR SOLVING

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Abstract

This line of scientific work is dedicated to solving existing problems in real production conditions, in particular, to the problem of tensioning and shaping of polyvinyl butyral (PVB) film in the conditions of "Avtooyna" LLC, as well as solution directions. In the process of tensioning and forming, methods aimed at obtaining the shape of a press-form were used, in the process of keeping the moisture of the film in alternative conditions in the packaging state, in the process of heating under the influence of the gravitational weight of the glass.

Keywords: polyvinyl butyral (PVB) film, autoclave, triplex, gravity weight, optical standard, vacuum, storage time standard, lamination, deviation of geometric dimensions.

Introduction

"Triplex" laminate glass is used for the front window of the car to provide the driver and passengers safety in the event of an accident, that is, to prevent it from falling into the car cabin as a small and sharp cutting object. A triplex is a glass consisting of three or more layers, usually two - outer and inner glass, and a PVB (polyvinyl butyral) film between them (Fig. 1) [1-7].

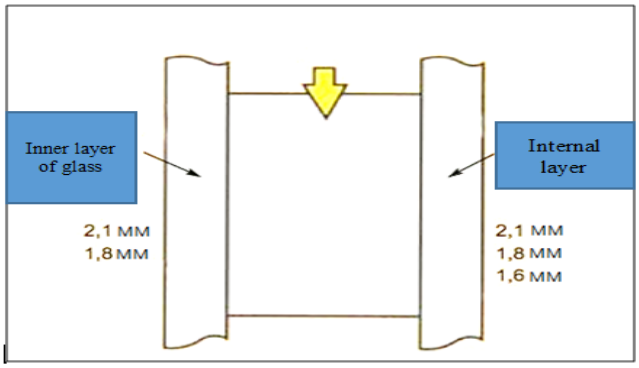

Figure 1. Triplex laminated glass.

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To develop the windshield of the car, the two glass layers and the PVB (polyvinyl butyral) film in between (glass + PVB film + glass - in the case of the assembled package and in one whole) are made of steel and fixed in a special profile (bent) shape and put in a special ultra-clean environment oven at 620 ℃ placed at the set temperature [8-12].

The Main Part

Under the influence of gravity (self-weight) and high heat, the glass bends to the desired press-form shape. The flatness of the bend is achieved due to the characteristic of the differential heating of the furnace. The high bending radius and geometric accuracy of the surface of the highly complex glass is achieved by pressing the hot glass into its final shape. The heating and then cooling is controlled by the speed of the glass packages into the furnace and the speed of movement in the furnace [13-19].

In the process of laminating the glass, the glass is placed in an autoclave at a temperature of 140 ℃ and a pressure of 10-15 kg/cm^2, and the two glass layers are fully bonded [20-25]. Triplex windows of complex shape are not passed through pressure rollers and the air between the layers is removed by vacuuming equipment between the windows - 0.95 bar vacuum.

Figure 2. Preparation for vacuum removal of air from the glass package.

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The main quality marks of laminated glass are the absence of air bubbles between the glass layers and the tension of the PVB film. However, according to the information of "Avtooyna" LLC, in the majority of the finished products, the optical properties of the glass are out of the norm due to the incomplete tension of the 5-7% PVB (polyvinyl butyral) film, i.e. the film is not full and does not stick properly, and it sinks after cutting to the glass (decreasing from its geometric dimensions).) was observed.

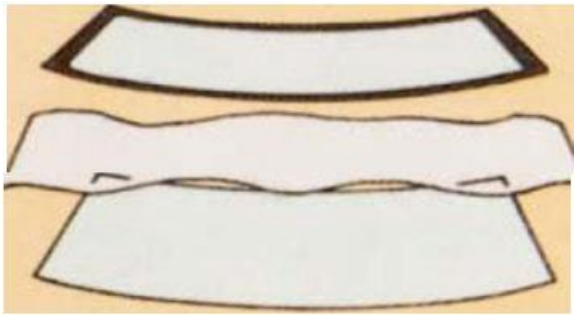

Figure 3. PVB (polyvinyl butyral) film is not fully stretched and deviates from the geometric shape.

Research - as a result of a large number of observations and measurements in the workplace, the main reasons for this situation were determined:

1. Due to improper storage of PVB (polyvinyl butyral) film in the warehouse, its physical and mechanical properties change and, as a result, the efficiency of tensioning methods decreases.
2. Storage of PVB (polyvinyl butyral) film beyond the intended period and commissioning of a film with changed physical and mechanical properties.

Ways to eliminate the indicated shortcomings and sound recommendations:

1. Improving the conditions of storage of materials used in production in terms of moisture, heat and shelf life according to the norm and bringing them to the specified requirements.
2. Revision of purchase terms and quantities in the case of delivery and storage time standards of PVB (polyvinyl butyral) film and organization according to new standards.
3. Study of PVB (Polyvinyl butyral) film propagation methods:

3.1. Mechanical tension mechanism;
3.2. Vacuum tensioning mechanism;
3.3. Fundamentally updating the method of coating and tensioning the film

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with one-sided or double-sided self-adhesive coating, and as a result, the situation observed is eliminated only by improving the method and mechanism of mechanical tensioning of PVB (polyvinyl butyral) film, taking into account that the storage conditions and periods of PVB (polyvinyl butyral) film are out of the norm. is recommended and further research will be conducted in this direction.

- Cold vacuum. At this stage, the vacuum pump is turned on and a vacuum is created in the workplace. The purpose of this stage is to remove air bubbles from the workpiece and perform it. In this case, the recommended vacuum achieved is up to the "-0.95" bar. When laminating a 4 + 0.4 + 4 mm bag (glass M1, raw), exposure at room temperature is about 15-20 minutes.
- Heating. At this stage, heating is carried out up to 100-130 °C, the temperature necessary for the polymerization of the used film. The main thing at this stage is to ensure uniform heating of the entire surface.
- Time of stagnation. The time of this step depends on the thickness of the received package. The thickness and number of glass layers, and the thickness and number of layers of the film are taken into account. For example, when laminating a package of 4 + 0.4 + 4 mm (glass M1, raw), exposure at room temperature will be 15-20 minutes.
- Cooling. Cooling takes place in a constant vacuum at a temperature of up to 55 degrees at "- 0.95" bar, after which the vacuum is released and the glass naturally cools to 45 degrees Celsius. At this stage, the production cycle is completed.

These parameters are not constant and can change depending on the desired result and material.

For example, when working with glass with a thickness of more than 4 mm, the time of the entire work cycle should be increased by 5 minutes for each millimetre of the difference in glass thickness.

The correct selection of parameters and compliance with this production technology, as well as the use of high-quality equipment for a triplex, allows for obtaining the highest quality products without endangering human life and equipment.

In addition, it is worth dwelling on the features of the production of decorative film triplex.

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The peculiarity of this technology is that, in addition to the film, a decorative material is laid between the glasses in the bag, for example, a composition of the fabric, wood, and metal elements depicted using a concave or printing technique is revealed. Annual triplex glass greatly expands the scope and allows you to get really beautiful heavy glass samples.

Thus, we got acquainted with the most basic technologies of film triplex production. But all the variety of triplex technology is not limited to film triplex. In addition to it, there is also a gel triplex. Its main difference is that a film is not placed between the glasses. Instead, a liquid polymer is poured between the already-performed glasses, which hardens and binds the package tightly together.

"How?" it's time to answer the question. Production is interesting, of course, but what manufacturer is interested in production without knowing the end result? And the end result of triplex production is all around us, you only have to look around.

Example of triplex products in construction format:

4. Windshields of all cars.
5. Heavy-duty double-glazed windows in banks and armoured vehicles.
6. Windows of multi-story buildings can compete with tempered glass in the triplex construction market.
7. Any elements of interior decoration, partitions, shelves, etc.

To give a few words to the description of materials and equipment for the production of triplex and "With what?" it's time to answer the question. Let's start with consumables.

Materials for the production of film triplex with vacuum lamination:

- Glass. Silicate glass, often 4 + - mm thick. Different colours with different transparency indices. Fits any shape in the bending oven.
- Film. EVA (ethylene vinyl acetate) film is used. Various thicknesses and widths.
- Decorative consumables. Fabrics. Paints. Wood. Metal. Rattan et al.

Equipment for the production of film triplex with vacuum lamination, and the main one is, of course, ovens for triplex.

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