GLASS PLATES FOR MOTOR VEHICLES AND OTHER MEANS OF TRANSPORT

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Abstract: *At present, the majority of high quality glass plate is used in vehicle industry. The paper presents the technological process for obtaining glass plate, used in vehicle industry. Besides the usual attributes of high quality plane glass, those used in vehicle industry must not result in sharp and cutting splinters when broken, being dangerous for the passengers. This quality, due to which it is called safety glass, is obtained by various methods.*

Keywords: glass, vehicles, furnace, triplex

Glass plate for vehicles and other means of transport

Window panes or plane glass are glass objects modelled under the form of plates whose thickness is relatively low compared to their length and width.

Window panes industrially produced are classified into six basic categories:

1. Sheet glass panes are transparent glass plate pieces, relatively thin, with smooth surfaces, apparently flat – parallels, with gloss specific to glass flame modelling, with its characteristic surface curls, visible under an acute angle or in reflected light.

2. Polished glass panes are transparent plates of glass, with plane – parallel surfaces, which do not distort the objects reflected through transparency under different angles. Smoothness and parallelism of the surfaces are reached through polishing and mechanic polishing.

3. Ornament glass panes are plane glass plates whose transparency is more or less reduced by imprinting decorative drawings on one of the plate's surface.

4. Reinforced glass panes are plane glass plates which have armour net in the middle. These panes can be obtained with polished or ornamental surfaces.

5. Special glass panes are different varieties of coloured plane glass plates, transparent or translucent, clear or opalescent.

6. Machined glass panes, comprise glass sheets which are polished, ornament, reinforced or special, which where supplementary machined in order to obtain new attributes, necessary for different uses.

The methods of obtaining glass panes differentiate not only by the equipment of the machining room, but especially by the way in which the strap is led. In the specialized literature there are known methods implying strap vertical circulation: Fourcault and Pittsburg methods and with horizontal circulation: Coluburn – Libbey – Owens method.

The Fourcault method implies the glass pane being drawn trough a ceramic body, directly under the form of continuous strap from the melt of a continuously operated furnace. The surfaces of the glass panes have a specific gloss because of the so-called "fire polishing" and due to the lack of imprints.

The paper presents technologies of obtaining the glass plates for vehicles and other means of transport.

Table 1.1. presents the composition of glass pane

Table 1.1. *Composition of glass pane*

Oxides	SiO_2	Na_2O	CaO	MgO	Al_2O_3	Fe_2O_3
% gram	73	14.5	7.4	3.2	1.8	0.1

Production of triplex glass plates

In manufacturing triplex glass plates there can be used glass plates obtained by vertical drawing, selected especially from the current production, with a very low number of defects and with very smooth surfaces. Preferably there are used float plates. As an intermediary elastic material, only celluloid had been used for a long time. However, celluloid triplex grows yellow in time, and the adherence of the plates on it diminishes; at present celluloid is replaced by Polyvynil Butyral. Films of Polyvynil Butyral also called butafol, are 0.5 mm thick and come in rolls. The technological process comprises the following stages:

- washing and drying the glass plates and the butafol;
- cutting the necessary dimensions with the help of patterns;
- setting up the packages;
- preliminary pressing the packages in the crushing mill, with the help of a conveyor with 5 sections, where the temperature rises with 10 °C each (from 60 la 100 °C), or with the help of vacuum created by some rubber frames where the package is placed. Thus the air bubbles between the plates are eliminated;
- visual control of quality;
- pressing the packages in the steamer, at 98 - 105°C, and 18 - 20 at, for an hour;
- adjusting contours, bevelling edges and angles;
- final control of triplex. Butafol is thawed at temperatures higher than 15°C and thus it adheres better to silica glass (adhesion force is 70—80 daN/cm^2).

Triplex plates must have over 84% transparency, must stand temperatures between - 60°C and + 60°C and thermal shock (especially plates provided with electrical heating), must stand unilateral pressure (of the 1 - 3 daN/cm^2 kind), and if broken it must not shatter in too many pieces. A broken triplex plate has radial and concentric cracks around the area where the mechanic shock occurred.

These plates are used for vehicles, railway coaches, planes, ships, protection glasses, under pressure machines (low temperatures) etc. They can also be curved, as well as with electric heating systems with internal resistance or semiconductor films, incrusted on the glass surface. Triplex is also made of hardened glass plates. Triplex is the most expensive type of plane glass and that is why it is replaced, where possible, by hardened glass plates.

Production of hardened glass

Manufacturing the hardened glass, which due to its properties is also called *securite*, consists mainly of heating the plate to a temperature close to the thawing temperature, followed by its rapid cooling with intense airstreams. Cutting the plate to the necessary dimensions, edge bevelling and any other mechanical conditioning must be done before hardening, because of the afore mentioned property.

Hardening is made in two types of installations which are differentiated by the way in which the plate is maintained: *horizontal* or *vertical*.

Horizontal installation has a continuous activity which can be completely automatic with the help of an electronic computer. Glass plates are moved on a roll conveyor, getting first into the heating furnace, where the temperature is maintained with the help of electric

resistances disposed above and below the conveyor and it is automatically adjusted. The temperature can exceed 650°C. It must be chosen so that the glass plate would not get distorted and that the inferior surface would not get imprinted with the conveyor's roll tracks. The furnace is coated with refractories that can stand thermal shock, for example glass plates of SiO_2 and isolated with ceramic fibres, and the rolls are made of ceramic with very smooth surfaces. After passing approximately 37 m through the furnace, the plates must reach the temperature necessary for hardening, which is controlled at the end of this area with the help of a pyrometer. If any deviation from the optimal temperature is detected, as the pyrometer indicates, it will automatically command the rescheduling of the temperature curve in the furnace. Then, the plates will pass through the security system, where on a length of about 25 m they will be highly cooled up with compressed air blown through nozzles disposed above and below the glass plates. The pressure of the cooling air is modified along this area in three steps, between 1800 mm H_2O and 100 mm H_2O.

We mention [1] the usefulness of achieving an atmosphere of SO_2 (about 300 ml/min) in the furnace, obtaining the hardening of the plates by depleting alkaline oxides in the superficial layer, as well as a lubricating effect on the rolls, reducing the risk of imprinting their tracks on the inferior surface of the plates.

In this type of installation there can be hardened plates having dimensions of up to 2 x 2.5 m, with thickness between 3 and 12 mm. In the case of plates of 1000 x 1200 x 0 mm productivity reaches 250 pieces per hour.

Hardening installations working on this principle are exploited at the Glass Pane Factory in Medias and Buzau.

In the *vertical installation* the glass plate is suspended to a device with several sharpened tips (claws) which ingress in the recess pairs made on both sides of the plate, along one of the edges. The device holding the plate in vertical position moves along on a monorail, ingressing on to the side of an electric oven, (fig. 1)[1], where it heats up to the necessary hardening temperature, then, a new movement leads the glass plate between two vertical metallic walls with wholes of about 5mm diameter, disposed regularly at about 25mm distance from one to another, through which compressed air is blown.

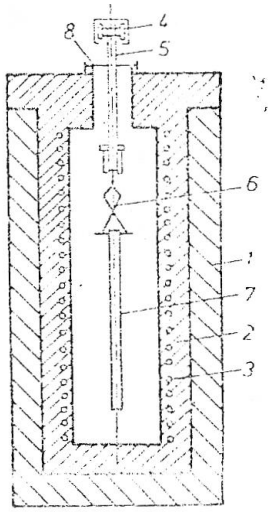

Fig. 1. *Section through a plate heating vertical furnace:*
1 — thermal isolation ; 2 — refractory ; 3 — resistances; 4 — conveyor rolls; 5 — conveyor ; 6 — clips; 7 — glass plate; 8 — closing lid of the furnace.

The two perforated walls execute oscillating moves in relation to the glass plate so that the airstream describe circles, thus covering more equally the surface of the glass plate. Both air pressure and the distance between the perforated walls considerably influence the hardening quality.

For curving the glass plates used in front of or at the back of vehicles there can be used an installation similar to the one described earlier, after the furnace, it is provided with a press whose working principle is presented in fig. 2 and which allows the production of complex and non-uniform curves. Then, the curved plates are annealed in a furnace having this purpose or they can also be hardened. For uniform curves there also be used *moulding*, respectively distortion under its own weight at an adequate temperature, on a metallic frame having the wanted form and curve (fig. 3)[1]. Curved plates can be used non-tensed, annealed, and secured.

While for lateral windows of vehicles, hardened plates are generally used, 4 – 5 mm thick; they clearly tend to 2.5 – 3 mm for windshield and back window there are more variants, in some countries the law allowing only one of them.

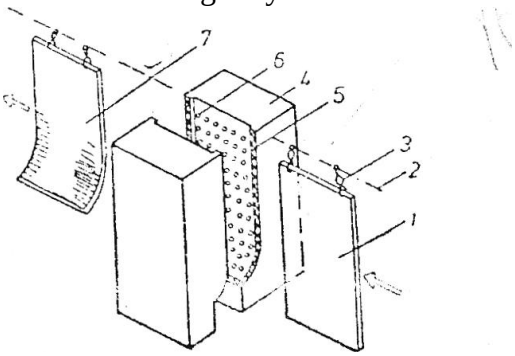

Fig. 2 *The principle of curving by pressure:*
1 – heated glass plate; 2 - monorail; 3 – holding clips; 4 – press which also serves for hardening; 5 –asbestos sealing; 6 – openings through which compressed air is blown out; 7 – curved and hardened plate.

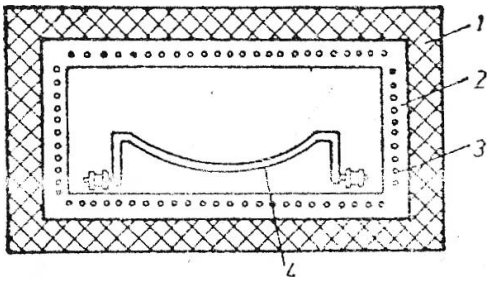

Fig. 3*. Section through the furnace for curving through modelling:*
1 – thermal isolation: 2 - refractory; 3 — heating resistances; 4 – moulding form cart

The most appreciated windshields are of two annealed glass plates, 3mm thick, having identical curves, joined through a Polyvynil Butyral film (butafol) 0.76 mm thick [1]. Windshields considered better are made up of glass plates hardened in a different way: the interior one in highly hardened, while the exterior plate is less hardened. In the fifth case, such a windshield is hit by a stone and eventually the exterior plate is broken, the chips are relatively large so that they do not diminish visibility that much, the interior plate remains intact and the stone does not get inside. If the interior plate is broken, in case of an accident, by hitting it with the head, the result is very small round chips which do not produce serious

wounds, and the head will not get through the windshield except for extreme cases, when the entire windshield is plucked out of the frame.

Windshields composed of only one hardened glass plate are the most disadvantageous, being even prohibited in some countries. In case of getting broken, the mechanic energy is released with a strong rumble which may disorient the driver. If the broken glass plate does not fall from the frame, the small chips make it almost opaque, sometimes totally reducing visibility. This last inconvenient can be eliminated by a differentiated hardening so that in front of the driver there would be areas with lower tensions which may get less opaque in case of getting broken.

In order to maintain the mechanical properties, there are made some special tests. Thus, when broken the hardened plates must form between 50 and 350 chips on a surface of 25 cm^2. For windshields there is tested the resistance to mechanical shock and to penetration with steel balls of 0.227 kg and 2.26 kg and with a piece of a head's form weighting 10 kg. From an optical perspective, the windshield must have a high transparency, without distorting the image when looking through it and without producing a secondary image.

In the case of passenger or military planes, the conditions set for certain windows are even more demanding, and thus there are required pieces made up of 4-5 plates of differently hardened glass and joined with Polyvynil Butyral films.

According to the use conditions, some windows must ensure good visibility at low temperatures, when steaming and even frost (icing) come up. One of the solutions used consists of the electrical heating of the pane using resistances set on the glass. One variant is silk screen printing some silver conducting wires built in a fusion agent. A number of 12 such wires having a certain type of section ensure the heating of the rear window of an vehicle without diminishing too much visibility [1, 2,3,4]. Another possibility consists of inserting some heating wire-resistances between the plates of a triplex pane. A third solution consists of using a semiconducting SnO_2 film or by spraying a $SnCl_4$ solution in water or alcohol. Depending on the film thickness, resistivity varies between 20 and 70 ohms and the light absorption does not exceed 20%. Electrical current is applied by means of silver electrodes set near the window frame. The semiconducting film is electrically protected and insulated with transparent varnish. If for other purposes the plates are heated to higher temperatures, SiO_2, TiO_2, Al_2O_3 electro-insulating films are deposited.

Another important problem which arises in the case of vehicle windows but also for the windows of civil buildings is preventing the penetration of intense solar thermal radiations during the summer or in those hot areas around the Globe. This challenge is achieved in two main ways: producing thermo-absorbent glass plates or depositing reflector and caloric radiation absorbent films on the normal glass plates.

Conclusions

The main qualities required for pane glass are the reduced tendency to crystallize and high chemical stability.

The two technological methods have multiple advantages:

1. the technological method consisting of sticking two glass plates on an elastic or transparent plate or material – results in the triplex plates, whose breaking forms chips that remain stuck on the intermediary elastic material.

2. the technological method consisting of hardening the plates, in which case if broken it forms small chips with non-dangerous rounded tips and edges.

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