


51. H. Suzuki et al., "Strength increase in WC-10% Co cemented carbide caused by eliminating coarse residual pores," ibid., 39, 749-753.


CARRYING CAPACITY OF COMPOSITE SPHERICAL GLASS CASINGS

Yu. I. Kozub, K. K. Amel'yanovich, V. G. Soluyanov, and N. A. Mishchenko

In contemporary production technology of glass products, pressing is the method which gives the highest accuracy of the planned geometry for the article; and the thermal hardening which creates considerable compressive stresses in a thin surface layer of the glass helps to increase the tensile bend strength of the glass and the stability of the article during thermal and mechanical impacts. In view of this, semispheres were made by hot pressing; they had an outside radius of 125 mm and a wall thickness of 7 mm and were of aluminum silicate glass with the addition of metal oxides (about 20 vol. %) which allows thermal hardening of the surface of the product. The hardening of the glass surface was achieved by heat treating the prepared semispheres by heating to 800°C in 2 min followed by cooling in an air stream to 30-40°C in the course of 0.5 min.

The brand of glass used belongs to the so-called "short" glasses, whose viscosity changes sharply in a narrow range of temperatures near the softening point. From Fig. 1 it is evident that in cooling the glass from 1500 to 1050°C its viscosity increases more than three orders of magnitude, which sets limits to the dimensions of products to be manufactured.

As the experience of manufacturing a batch of the semispheres at the Merefan Glass Factory showed, the geometric imperfections in the shape of the products in the majority of cases appear during the removal of the semispheres from the mold, during their transferal to the furnace for heat treatment, and during the heat treatment itself. Typical imperfections are the out-of-round shape and the nonplanar equatorial section of the
Fig. 1. Thermal dependence of the viscosity of the aluminum silicate glass.

Fig. 2. Typical sketch of the gaps by placing the semisphere with untreated edges on a flat plate.

The nonplanarity of the surface edge of the semisphere is characterized by a sketch of the gaps (Fig. 2) obtained by placing the semispherical element on a flat plate.

The semispheres were joined together with a cold setting adhesive based on ÉD-6 epoxy resin. The surfaces to be bonded were first cleaned of impurities, and after the application of the adhesive, were pressed together with a force which gave the minimum adhesive gap (its magnitude depends both on the pressing force and also on the viscosity of the adhesive compound) and a sufficiently firm fixation of the mutual position of the bonded elements along the whole perimeter of the joint when the adhesive layer hardens.

A batch of composite glass casings amounting to more than 120 pieces were tested in transient loading with an external hydrostatic pressure. The tested casings will be divided into three groups according to the nature and degree of geometric imperfections.

In the first group belong the casings made up of elements which were not given any preliminary treatment. Pairs of semispheres before bonding were selected by visual control in order to avoid excessive misfit of the joined surfaces both because of nonplanarity and also because of the deviation of the shape from roundness. As a result, the gap between the joined semispheres did not exceed 1 mm. The absolute values for the deviations of the semispheres from the correct shape in this group of casings were not regulated.

The misfit between the equatorial sections of the bonded semispheres which have an out of round shape causes overhanging edges. A displacement of 1.5 mm was accepted as the maximum allowable. Measuring the radius of the semisphere in the region of the pole showed that its maximum deviation from the average computed value was 10 mm, which is 1.4 times higher than the average wall thickness of the casing.

The second group includes the casings formed from semispheres with carefully treated edges which butt against each other very well. Thus a uniform adhesive layer at a minimum thickness was attained and overhanging edges in the seam zone were absent. However, the semispheres from which the casings of the second group were assembled had dents on the surface, especially noticeable at the poles. The maximum deviations of the radii of the semispheres in this region were the same as in the casings of the first group.

The composite spherical casings with minimum imperfections of the shape of the semispheres and in the zone where they are bonded together belong to the third group. The bearing edges of the semispheres were polished. The amount of the edge overhanging due to misfit of equatorial sections of the joined elements was not more than 0.5 mm. A decrease in the radius of the semispheres due to flattening at the poles did not exceed 3% or the half-thickness of the casing wall.

The casings were tested in chambers by loading with an external hydrostatic pressure. The breaking pressure was recorded with respect to the reading of the manometer at the moment of the little bang or click which corresponds to the appearance of a crack. The most characteristic test results are given in Table 1.

The carrying capacity of the composite spherical casings to a significant degree is determined by the level of imperfections present in them with respect to shape and joint of the semispheres. The casings of the