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STABILITY CRITERION OF THE PRODUCTION TECHNOLOGY FOR DIFFUSERS FROM FLASIlED OPAL GLASS

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Generalized data on systematic control over the density, the TCLE, and the index of inhomogeneity of colorless transparent, rose-colored and opal glasses are presented. The causes of spoilage in the production of diffusers from flashed opal glass are considered. The advantages and disadvantages of the methods for determining the physical properties of glass are described.

The efficiency of any technological process is determined by its stability. The principal stage in the technology of industrial glassware is glass melting. This process is power consuming and technically complex and is therefore hardly controllable. The production operations can be made reliable only if we know the criteria for their stability. An important characteristic in the production of glass is the constancy of its chemical composition, which determines the constancy of the requisite technological parameters of molten glass and the service properties of glassware.

For several years, a considerable part of diffusers especially from flashed opal glass at the Beltsy Plant of Lighting Fixtures has been rejected. The search for the causes of spoilage and its reclaiming were conducted at random mostly because of the poor equipment in the plant's laboratory. For example, the chemical analysis of glass was performed by the conventional technique, the data were delayed (because the analysis lasted for three days), and the results were inaccurate. For this reason, rejects were not recovered in time and the causes of disruption of the technological process were usually not determined.

It became clear that the physical properties of the glass should be controlled continuously in order to establish the criteria that characterize the stability of the technological process of glass melting. Therefore, running control was organized over a few physical properties of glass and the methods for analyzing the glass, charges, and raw materials were modified. We could not find data on the constancy of physical properties of flashed glass in the course of its production in the literature.

The old and new productions of the Beltsy Plant of Lighting Fixtures produce diffusers from colorless transparent, rose-colored and flashed opal glass. The transparent glass is melted in tank regenerative side-port furnaces. Since the diffusers are shaped by hand, the operating parts of the furnace have several discharge windows each. Opal and rose-colored glass is melted in small direct-fired furnaces. The glass is colored rose with selenium and is opacified with fluorine.

The specified chemical compositions (in wt. %) were 72.5 ± 1.0 SiO₂, 2.5 ± 1.0 Al₂O₃, 7.5 ± 0.5 CaO, 17.5 ± 1.0 Na₂O for colorless transparent glass; 74.0 ± 1.0 SiO₂, 8.0 ± 1.0 CaO, 12.0 ± 1.0 Na₂O, 6.0 ± 1.0 K₂O (plus 0.02 Se and 0.14 Sb in addition) for rose-colored glass; and 68.0 ± 1.0 SiO₂, 6.2 ± 1.0 Al₂O₃; 3.2 ± 0.5 CaO, 12.5 ± 1.0 Na₂O, 4.5 ± 1.0 K₂O, 5.6 ± 1.0 F⁻ for opal glass.

The method for determining the properties of the glass and preparing samples consisted in the following. In the first stage of the investigation, samples of fluid glass were taken simultaneously from different places of each furnace in order to determine the scattering of the controlled physical properties. Based on these data, a constant place for taking samples of fluid glass was chosen in the working parts of the furnaces. The controlled physical properties were the density, the homogeneity, the TCLE, and the dilatomelric temperature of glass softening. Specimens in the form of small bars for controlling the listed properties were prepared from one sample by the same shaping regime. After shaping, the glass bars were not annealed except for some special cases.

The density of the control specimens was determined by hydrostatic weighing of small bars 1 – 3 cm long and 3 – 5 mm in diameter. The running control of the changes in the glass density was performed by the method of free precipitation on
a PRPS device [1]. The error of measurement in this operation was ± 0.1 kg/m³. The density of the sample from which a few bars were prepared was determined with an error of ± 0.5 kg/m³, which was caused by greater fluctuations in the composition of molten glass in a larger volume. Calculation of the number of correct digits in the data on the glass density by the method in [2] showed that the fifth significant digit was unreliable, i.e., the method of hydrostatic weighing and free precipitation gives data with four correct significant digits (this is also proved by the reproduced results of the experiment).

Analysis of experimental data showed that the density of transparent colorless glass is preserved at a rather stable level deviating from the mean value by 1 – 2 kg/m³. A fragment of a typical dependence of the variation of the density of colorless glass in March 1990 is presented in Fig. 1.

When the density of transparent glass deviated from the mean value by 3 kg/m³ and more, the number of rejected items increased sharply. For example, on March 19, 1990, the output of fit glassware decreased noticeably, which can be explained by a decrease in the density of the transparent glass (see Fig. 1).

It also follows from Fig. 1 that the density of opal glass in the same period was less stable than the density of transparent colorless glass. Opal glass melted in different glass furnaces had close densities.

In the case of the multiple rejects that occurred in the second half of August 1990, the density of transparent colorless glass remained virtually invariable, whereas that of opal glass from furnace No. 6 substantially decreased, which is clear from Fig. 2. The data on the density of opacified glass for furnace No. 4 are absent because it was shut down for repair.

Consequently, regular control of the glass density is a very important criterion of the constancy of its chemical composition. We should stress that determination of the density of glass by the method of free precipitation gives highly reproducible results and is fast. In addition, we can estimate the homogeneity of molten glass by the scattering of the density of small bars from one sample.

The parameter of inhomogeneity was measured on an industrial OSTs-2 installation by centrifuging glass powder in a mixture of organic liquids [1]. The quality of the fluid glass was evaluated by the temperature range of powder stratification with respect to the density. Separation curves gave fuller information on the homogeneity of the glass. In order to obtain the curves we plotted stratification of the glass with respect to the density with the temperature placed on the abscissa and the amount of centrifuged powder on the ordinate.

A typical characteristic of the homogeneity of colorless transparent and opal glasses is presented in Fig. 3.

The stratification range for colorless transparent glass is 3.0°C and that for opal glass is 4.3°C and 5.0°C for furnaces Nos. 6 and 4 respectively. Consequently, the homogeneity of transparent glass is much higher than that of opal glass. It also follows from Fig. 3 that colorless glass is sufficiently homogeneous although it contains heavy impurities, which is verified by the presence of a flat branch in the upper part of curve 1. Opal glass from furnaces Nos. 6 and 4 includes foreign light and heavy fractions simultaneously, because curves 2 and 3 have flat branches both in the upper and in the lower