

8. Studies on the Variation of the Density of Glass Articles

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For a long time, it has been the common knowledge among the technical personnel of a glass factory that a container blown up from a blank of inadequately homogenized glass is quite frangible. Hence, the constant control of homogeneity of the blank is most essential for producing the glass articles of commercial quality.

For this purpose the usual methods of chemical analysis are unsatisfactory in accuracy as well as in quickness. The following figures are the results of the author's examination on the accuracy of the routine analysis made by an analyst of a glass factory.

Rejection Limits of the Results of Analysis.

(Level of Significance 0.05)

SiO_2 65.00 ± 0.48 , CaO 7.00 ± 0.11 , R_2O_3 7.00 ± 0.31 %.

Hence, the authors have adopted the density measurement by the sink-float method as an alternative for examining the quality level.

1) **Measurement of Gob Density.** In order to find out the relations which might exist between the tendency of frangibility and the daily variation of the quality, the gob-density was measured once a day at every feeder. A single drop of gob, taken out from the furnace producing 3.2 pint bottles was drawn to the rod of 3.5-4.5 mm in diameter and allowed to cool down in air. The rod, having been cut to the pieces of 10 ± 1 mm long, was submitted to the density measurement using potassium mercury iodide as heavy liquid. Ghering (Jour. Amer. Ceram. Soc., 27, 373 (1944)) has already worked out the three day range, the range of density variation for three days, and recognized the correlation of these values with the amount of remaining strain in the bottle. From their own data the authors have also confirmed that the containers produced on the day, whose three day range exceeds a certain limit, are frangible after forwarding. The 3σ control limits worked out from the values of three day range obtained during a month were 0-0.002 and 0-0.005 for the tank furnaces operating, respectively, in steady and unsteady conditions.

In order to trace the origin of density variation, gobs taken in every three days were analysed by the A.S.T.M. method. Since the correlations between the density and the content of lime and silica were established with the significance level of 0.005, the authors have concluded that the density variation might come from the change of the batch composition.

2) **Density Distribution in a Bottle.** The authors have confirmed that the density of the bottles, produced on the day corresponding to large values of

three day range, varies considerably from point to point. Fig. 1 gives an

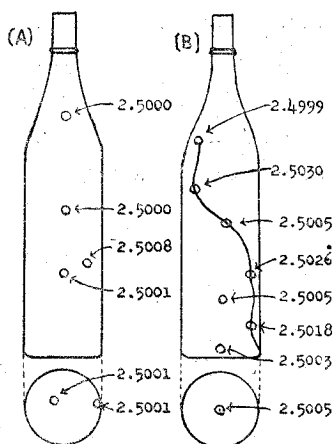


Fig. 1.

example. The density of the bottles was measured with the small fragments cracked off at the spots indicated in the figure. The bottle (B), produced on the day corresponding to the three day range of 0.0061, gave the wide range of the density distribution of 0.0031. In this case a crack has developed spontaneously as indicated in the figure. The three day range as well as the range of density distribution for the bottles of higher quality were found to be, respectively 0.0011 and 0.0008 (A).

Due to the enormous increase in number of samples it might be too much to examine, as routine works, the range of the density distribution for the products turning out from all machines. However, for the purpose of checking the shipment of the articles, the density distribution, because of the higher accuracy, should be examined at least when the values of the three day range shows the tendency of approaching the upper critical limit.

9. Studies on the Homogenization of Glass. (I)

Tracing the Flow of Glass in Tank by Means of Model Experiments

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The problems, how an indicator, having been charged at the dog house with the batch, would pass through a tank, the channel being strongly influenced by the convection currents, and how it would come out from the feeders during the operation have been investigated by Bowmaker and Bishop using, respectively, barium carbonate and ceria as the reagent.

This method, however, has the demerit of being not capable of watching the movement of the indicator during the passage through the tank. As this requirement will easily be met by the experiments with model the authors have tackled this problem with the scale model of 1/30 in size of the actual tank operating in a bottle factory. Glycerin was used in place of molten glass. The conditions of the experiment were fixed so as to satisfy the law of simi-