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

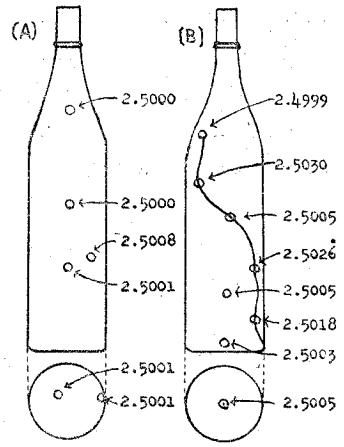

Fig. 1.

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.

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

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

Ikutaro SAWAI, Megumi TASHIRO, Katsuaki TAKAHASHI

and Kazuo TABUCHI

(Sawai Laboratory)

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-

litude as far as possible, using Raynolds Prandtle and Grashof numbers as the criterions.

The model, furnished with glass walls, was framed with metals and the glycerin, being charged at the dog house, was allowed to flow out from the four feeders. To establish the necessary temperature distribution in the glycerin, the tank was covered by a lid furnished with the electric hot plates.

The conditions of the experiments are tabulated in the following.

Table.

Items	Glass		Glycerin	
Max. and min. temp. of liquid in tank (°C)	1480	1280	53	30
Length of tank (cm)	1270		42.6	
Average velocity (cm/sec) of fluid in tank for the pull rate of glass				
30 t/day	2.88×10^{-3}		5.40×10^{-4}	
60 t/day	5.76×10^{-3}		10.80×10^{-4}	
120 t/day	11.52×10^{-3}		20.60×10^{-4}	
Pr. No.	40.7	33.4	135	541
Gr. No.	23.2×10^{6}	1.79×10^{6}	32.8×10^{6}	2.14×10^{6}
Re. No. for the pull of glass				
30 t/day	4.5		4.5	
60 t/day	9.0		9.0	
120 t/day	18.0		18.0	

The following experiments carried out with model have brought these results:

(1) **The velcoity distribution in tank** was measured by drawing fine vertical lines with the glycerin coloured with phenolphthalein, and observing their bending with respect to time through the glass wall. The flow in tank was found to be nothing but the superposition of pull and convection currents, and for the latter the superficial back, superficial, throat and spring currents were exactly reproduced in model tank.

(2) **The movement of coloured glycerin in tank** was traced from the time, when the colourless glycerin, having got into the steady flow, was replaced at the dog house by coloured one. For the experiment a part of glycerin used having been added with sodium hydroxide to 0.24 N, was coloured red with phenolphthalein.

Carried by the pull current the coloured glycerin, whose boundary was found to be the shape of flattened spindle at the tip, proceeded to the spring, suffering in the mean time the considerable agitation by the superficial back- and cross current. After the tip had got to the spring it parted into two streams, one ascended upwards along the superficial current, while the other proceeded directly to throat, being drawn by the pull current. With large pull rate the majority of coloured glycerin flowed directly to the throat without having sufficient time to be mixed up throughly with the previously existed colourless glycerin by the superficial and cross currents. Hence the efficiency of the homogenization will be lowered.

(3) **The change of the concentration of alkali with time** at the discharging end was investigated by titrating the liquid flowing out from feeders successively at definite intervals with hydrochloric acid. The concentration - time curve thus obtained was confirmed to be similar in shape to those given by Bishop and others, who have analysed the content of the indicators, for instance cerium, in the glass, turned out from the operating tank.

From the curves, obtained by repeating the same kind of experiments by changing the pull rate, the concentration of alkali and the charging amount of glycerin, the authors have confirmed that the concentration-time curves may be expressed, approximately, by the equation including two parameters E and $\bar{u}$ such as

$$\frac{\partial c}{\partial t} = E\frac{\partial^2 c}{\partial x^2} - \bar{u}\frac{\partial c}{\partial x},$$

in which c is the concentration of alkali, t the time, x the longitudinal distance from the charging end. The constants E and $\bar{u}$ vary according to the degree of agitation and the pull rate.

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10. Physico-chemical Properties of Surface Active Agents. (VIII)

Molecular Weight of Pure Polyoxyethylene Glycol

Rempei GOTO, Naokazu KOIZUMI, Naomi HAYAMA,
Takeo SUGANO and Yasushi HIRAI

(Goto Laboratory)

Molecular weights of pure polyoxyethylene glycols were determined by the cryoscopic method in five different solvents (benzene, dibromoethane, dioxane, *tert*-butanol and phenol).

Samples used were tetra-, penta-, hexa-oxyethylene glycols and *sym*-pentaoxyethylene dichloride. These substances were synthesized in the laboratory by the following method: The mixture was prepared by the successive addition reaction of ethylene oxide to ethylene glycol and was separated to each polymer by fractional distillation under reduced pressure. Finally each polymer was several times carefully purified by fractional vacum distillation. Pentaoxyethylene dichloride (ω, ω'-) was obtained by the reaction of thionyl chloride with pentaoxyethylene glycol in pyridine.

Some typical curves of molecular weight Mc calculated from the lowering of freezing point against the concentration C g/100g. solvent are shown in the figure.