Nucleation of Freezing by Cavitation in Sub-cooled Bismuth and Gallium

In the article entitled "Nucleation of Freezing by Cavity Collapse and its Relation to Cavitation Damage"[1], it was stated that there was experimental evidence to support the suggestion that freezing in substances such as bismuth, germanium, gallium and silicon (the freezing points of which diminish with pressure up to relatively high compressions) may not be nucleated by cavitation. The complete basis for this comment was not provided and it is clear that an additional explanation is necessary. To my knowledge, no experiments involving the use of ultrasonically generated cavitation have been performed on these substances in their sub-cooled liquid states. The statement was based instead on information regarding other forms of treatment that normally induce dynamic nucleation. Apparently both sub-cooled gallium[2] and bismuth[3] are known to be surprisingly immune to such treatment. I believe that all dynamic nucleation is due to cavitation. The behaviour of gallium and bismuth is taken, therefore, to indicate that they are immune to the nucleating effects of cavitation, no matter how it is generated. Such a conclusion is obviously open to debate. The real test would seem to lie in the ultrasonic cavitation experiments.

ROBERT HICKLING

Research Laboratories,
General Motors Corporation,
Warren, Michigan.

[1] Hickling, R., *Nature*, **206**, 4987 (1965).
[2] Roellig, L. O. (personal communication).
[3] Glicksman, M. E. (personal communication).

Viscosity of Emulsions

An iterative process, using Vand's formula[1], appears almost always to be successful in obtaining a linear plot of the results of measurements of the viscosity of emulsions at varying contents of the disperse phase. The process can be carried out conveniently by means of a high-speed computer, and results are given for three dispersions, of which two are bituminous.

There is a need for a linear plot of the results of the measurements of the viscosity of emulsions, using the concentration of the disperse phase, or the equivalent of this, as the independent variable. Vand's formula gives a relation between the viscosity of a suspension and the volume occupied by the continuous phase. If the reciprocal of the logarithm of the relative viscosity η_R is plotted against the volume concentration of the disperse phase, a plot can be obtained which is linear up to about 50 per cent concentration. If the disperse phase consists of spherical particles of nearly uniform size, it appears that the best straight line through the experimental points so obtained intersects the concentration axis at about 60 or 70 per cent volume concentration. The ordinate of the accompanying figures is:

$$\frac{1}{C + \log \eta}$$

where η is the measured viscosity of the suspension in poises, and C is the quantity to be determined by iteration using some linearity criterion for the final plotted points.

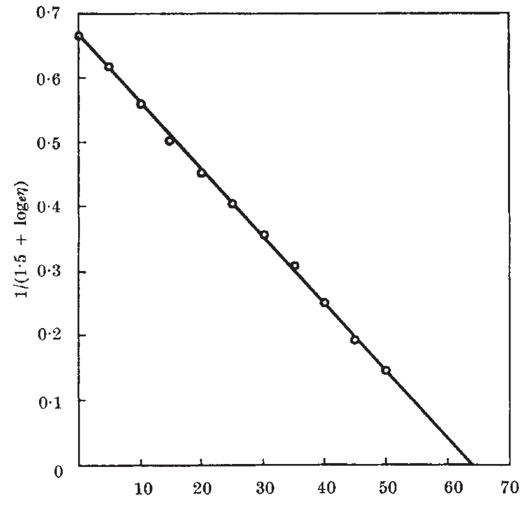

Fig. 1. Plot of $1/(1{\cdot}5 + \log_e\eta)$ against volume concentration—results from Vand (ref. 2)

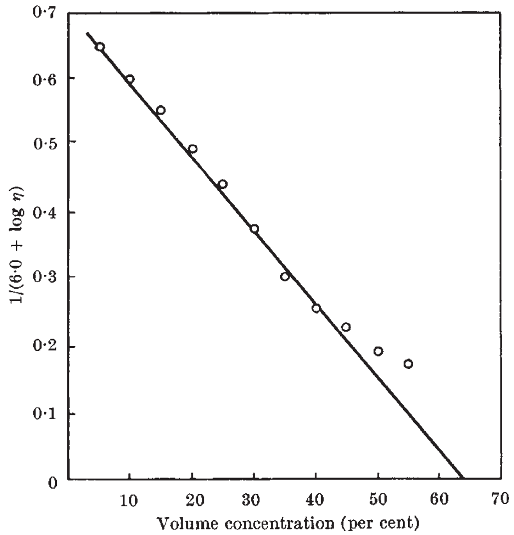

Fig. 2. Plot of $1/(6{\cdot}0 + \log_e\eta)$ against volume concentration of the disperse phase—results from Black (ref. 3)

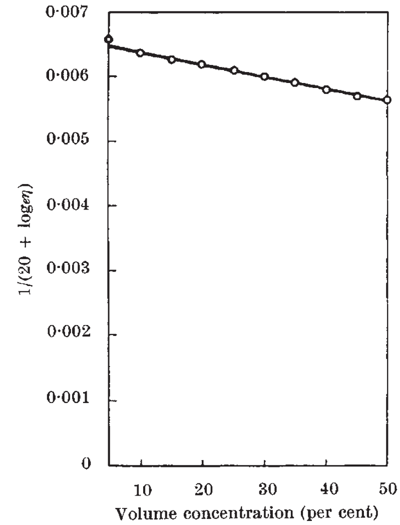

Fig. 3. Plot of $1/(20 + \log_e\eta)$ against volume concentration of the disperse phase—results from Black (ref. 3)

The results of Vand[2], which were obtained using a suspension of glass spheres in a solution of potassium iodide, are shown in Fig. 1, and indicate that a plot can be obtained which is closely linear. Fig. 2 shows results which were obtained from measurements of the viscosity of an anionic emulsion of bitumen particles with diameters varying from 3 to 6 microns[3]. This emulsion shows a variation in viscosity similar to that observed in the case of the suspension of glass spheres, except that the points diverge from a straight line at a lower concentration than those obtained from measurements on the suspension.

Measurements of the viscosity at varying concentrations of the disperse phase[3] were made on an anionic emulsion