LETTER

A New Method of Measuring he Surface Tension of Liquids by Using the Vertical Liquid Jet

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Lately the present writer has derived the following theoretical approximation formula(1) for the "starting critical flow rate, V_c", the lowest flow rate necessary to change the tripping flow of the vertical jet into the laminar one:

$$V_c \doteqdot \pi r^{3/2}\sqrt{2\gamma/\rho} \qquad (1)$$

where r is the inner radius of the nozzle, γ, the surface tension of liquid, and ρ, the density of the liquid, and this formula proved to be accurate for the nozzle of the radius less than 0.05 cm. experimentally. Using this relation, one can calculate the tension of the surface that is newly developing.

Experimental Results

The liquids used were of the "chemical pure" grade. The capillary nozzle that was drawn out of a glass tube was about 10 cm. long, having the circular tube section of which inner and outer radii were 0.0375 and 0.1102 cm. respectively, and it was fixed in the direction of the gravity, joined by a short rubber tube directly to a glass siphon that was dipped into the liquid in a large glass reservoir (about 12 cm dia.).

The rate of the jet flow was regulated by changing the level of the liquid, or by sliding the reservoir upwards or downwards. The value of V_c was estimated from the volume of the liquid that ran down for ten seconds after the first development of the normal laminar jet flow, and was always accurate within 0.001 cc. per second at the room temperature.

The results are listed in Table 1. The values of γ calculated by the formula(1) and those of the static surface tensioa,(2) γ_0, for most liquids agree very well; but the reason why some anomalies, such as for water, chloroform, and carbon-tetrachloride, occur is yet to be known.

Therefore, this method could be used, if one were very careful for measuring the surface tension of liquids, the degree of accuracy here being at least 97 or 98 percent.

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Table 1

Liquids	Temp. °C.	ρ g./cc.	V_c cc./sec.	$\gamma_{calc.}$ dynes/cm.	γ_0 dynes/cm.
Water	15.5	0.998	0.282	88.7	73.23
Methyl alcohol	16.0	0.796	0.156	21.6	23.45
Ethyl alcohol	17.3	0.792	0.160	22.6	22.0
Aceton	19.5	0.792	0.160	22.6	23.14
Chloroform	15.6	1.50	0.110	20.2	26.9
Carbon tetrachloride	15.2	1.60	0.109	21.2	26.24
n-Hexane	16.8	0.660	0.150	16.6	17.76
Toluene	15.5	0.866	0.171	28.2	28.72
Chlorobenzene	17.2	1.108	0.159	31.2	33.84
Nitrobenzene	20.5	1.203	0.181	43.9	43.00

(1) T. Ikeda, *Reports of the Liberal Arts Faculty, Shizuoka Univ., Ser. B, No.* **3**, 20 (1952).

(2) Landolt-Börnstein, "Phys. Chem. Tabellen", I, (1923) p. 208.