At equilibrium $2\pi r.\gamma = \pi r^2 h.dg$

Or $\gamma = \frac{rhdg}{2}$ dynes Cm^{-1}.

Parachor Mcleod (1923) found the relation between the surface tension and temperature and suggested the following equation,

$$\gamma^{1/4}/D\text{-}d = C$$

Where D = Density of liquid

d = Density of the saturated vapour of the liquid.

C = Constant.

Sugden modified the above equation by multiplying both sides by molecular weight (M)

$M\gamma^{1/4}/D\text{-}d = C.M. = [P]$

There [P] is the parachor of the substance.

At ordinary temperature d is very small hence the equation may be written $M\gamma^{1/4}/D = [P]$

If $\gamma = 1$ then $[P] = M/D$ Hence parachore is defined as the molecular volume at a temperature when the surface tension of the liquid is unity. Parachor has an additive and constitutive properly. Parachor of the molecule can be obtained by adding the atomic parachors of the constituent atoms.

tube with a bulb in the middle and a fine capillary with sharp edge. At upper end, a rubber tube is connected for sucking. There are two marks, one just above the bulb a, while the other is just below i.e. b. In order to measure the fraction of a drop we can calibrate for a short distance above and below the upper and lower marks. This calibration can be done by first determing how many scale divisions correspond to one drop.

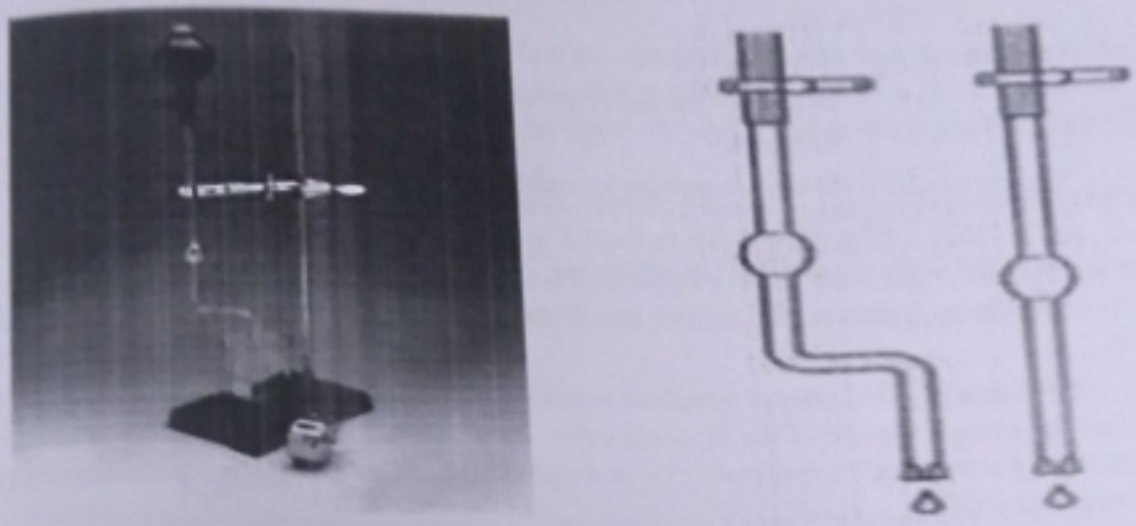


Fig-1e

The apparatus is cleaned with warmed chromic acid and washed 2-3 times with distilled water before working. It is kept vertical clamping it with a burette-stand. It must be borne in mind that the tip of lower end should not come in contact with hand, desk or some other things, as it will be contaminated with a trace of grease. Slight traces of grease will alter the size of the drops. The desirable number of drops fast or very slow release is avoided.

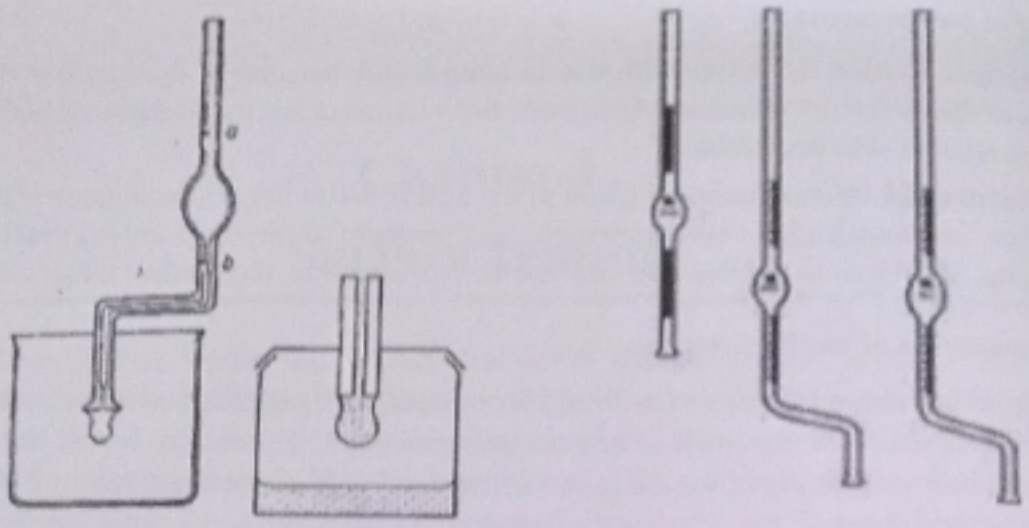
b) Capillary Rise Method: When a capillary tube is immersed in a liquid it rises the capillary tube. The height, for a given capillary tube varies with the surface tension and density of the liquid.

Force due to surface tension

$F=2\pi r.\gamma$ dynes

Force of gravity pulling the liquid downward

$= \pi r^2 h.dg$



1 (c)

from above equation. The densities of the liquids can be measured by means of a Pyknometer or specific gravity bottle.

Stalagmometer: This instrument is use to determine the surface tension of liquid. A different variety of stalagmometer is available in the market. It consists of a pipette like glass

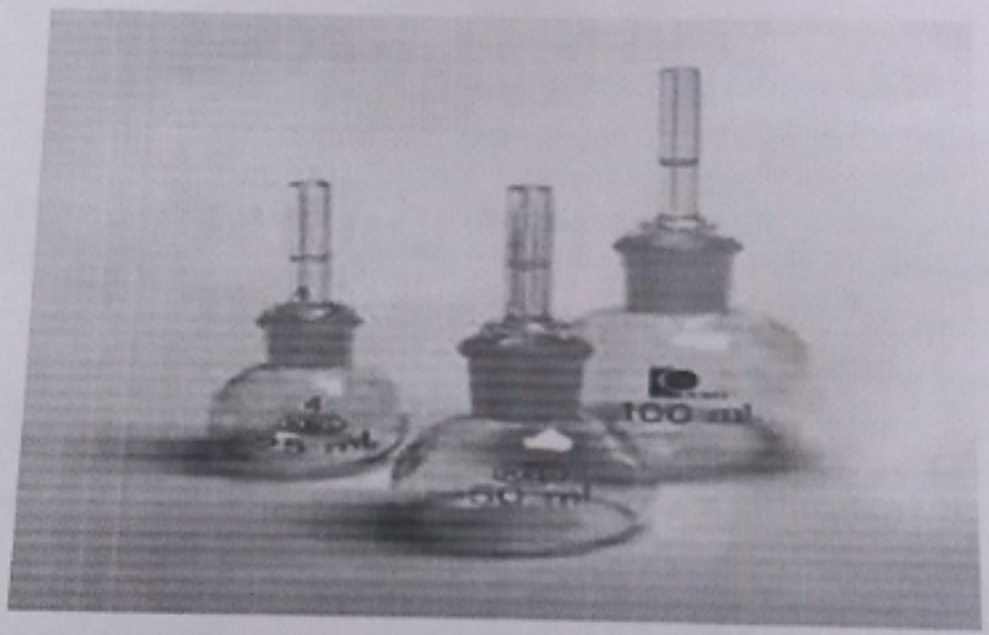


Fig-1d

Effect of temperature:

Surface tension decreases with rise in temperature because of the fact that the kinetic energy of the molecules increases. As a result, the intermolecular forces decrease and therefore, surface tension also decreases.

Nature of Liquid: Surface tension of a liquid is due to intermolecular attractive forces; therefore the magnitude of surface tension is a measure of intermolecular attractive forces. When the attractive forces between the molecules are large, the surface tension is large.

Consequences of surface tension:

(i) Spherical shape of drops - The liquid drops have nearly spherical shapes. Surface tension tries to decrease the surface area of a liquid to the minimum. Since the sphere has minimum surface area for the given volume of liquid, therefore the liquid tries to adopt spherical shape.

(ii) Capillary action: The rise of liquid in a capillary tube is called capillary action. It is due to inward pull of surface tension action into the surface which pushes the liquid into the capillary tube.

Example water below the surface of the earth rises to the plants through the roots, oil rises into the wick of an oil lamp, and ink rises in a blotting paper.

(iii) Liquid wets the things: Liquid wet the things because try to spread across the surface as this flow.

The common methods of determining surface tension of liquids are

a) Drop weight method b) Capillary rise method.

Drop weight method: The method is based on the principle that is weight of liquid falling from a capillary tube held vertical, is approximately proportional to surface tension of the liquid. If we consider two liquid having surface tension γ_1 and γ_2 w_1, w_2 are mean weights of their drops falling from the same capillary tube, then

$\gamma_1/\gamma_2 = w_1/w_2$ (The liquid drop weight equal to $2\pi r\gamma$)

r=radius of tube

Suppose the number of drops of two liquids be n_1 and n_2 for the some volume V of th iquids i.e., from x to y. Therefore,

$W_1 = Vd_1/n_1$ $W_2 = Vd_2/n_2$

Where d_1 and d_2 are the respective densities of the liquids, Hence,

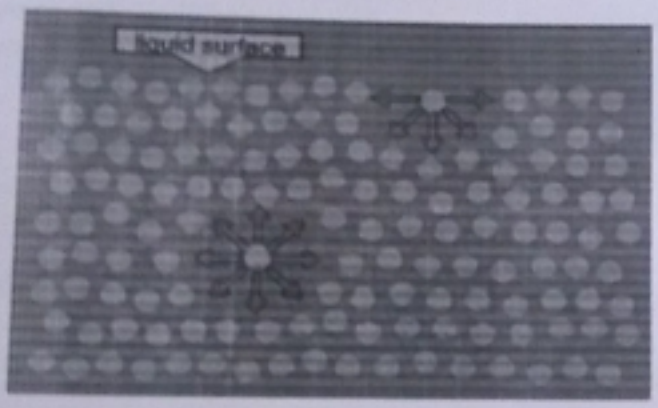
$\gamma_1/\gamma_2 = W_1/W_2 = Vd_1/n_1 / Vd_2/n_2 = n_2d_1/n_1d_2$

If the surface tension of one of the liquid is known then that other can be easily calcula

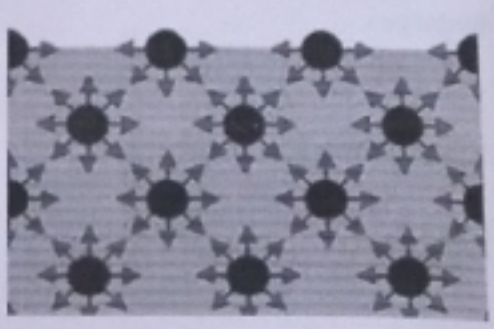
Chapter-1

Surface Tension

Liquids exhibit an interesting property known as surface tension. It is also related to intermolecular forces in the liquid. A molecule in the build of the liquid is attracted equally on all sides so that the net attractive pull on the molecule is zero. However a molecule which lies at the surface is subjected only to the attractive forces of the molecules below it. Therefore, surface molecules experience a resultant downward attractive force from within the liquid. Liquid surface is under tension due to imbalanced forces. This effect is called surface tension. As a result of this the molecules at the surface are pulled inwards and tend to make the surface area of the liquid as small as possible.



1 (a)



1 (b)

The energy required to increases the surface area of the liquid by one unit is called surface energy.

Force per unit length acting perpendicular to the tangential line drawn on the surface of the liquid is called surface tension. It is represented by γ(gamma)

γ=F/L. Units is dyne/cm in SI system Nm^{-1}. Example surface tension of water is 72.75×10^{-3} Nm^{-1} and that of mercury is 47.5×10^{-2} Nm^{-1}. Due to surface tension, the liquid drops have nearly spherical shape.