

①

21/6/21

class \Rightarrow B.Sc. (Hons.) Part-I

Subject \Rightarrow Chemistry

Chapter \Rightarrow Physical properties of liquids.

Topic \Rightarrow Surface tension and Parachor.

Name \Rightarrow Dr. Amarendra Kumar
Deptt. of Chemistry
Jain College, Ara.

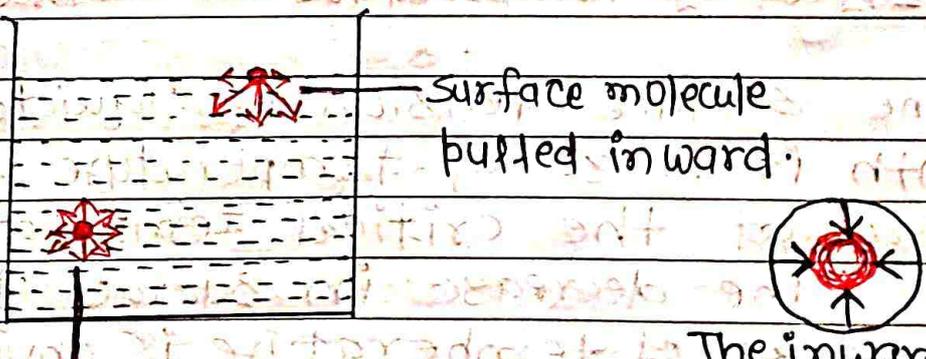
Surface tension

The existence of strong intermolecular forces of attraction in liquids gives rise to another property known as surface tension.

Mathematically, the force in Newtons acting at right angles to the surface of a liquid along 1 meter length of the surface is called surface tension.

Surface tension is represented by γ .

The phenomenon of surface tension is explained by following figure.



Interior molecule pulled equally in all directions.

The inward forces on the surface molecules minimize the surface area and form a drop.

Explanation \Rightarrow A molecule lying inside the liquid is surrounded by other molecules and so is

(2)

attracted equally in all directions.

Hence, the net force of attraction acting on the molecule is zero.

i.e. cancel the effect of one another.

Consider a molecule at the surface of the liquid. The downward attractive forces are greater than the upward forces because there are more molecules of the liquid below than in the air above the surface.

These unbalanced attractive forces acting downward tend to draw the surface molecules into the body of the liquid and, therefore, tend to reduce the surface to a minimum.

Units of surface tension \Rightarrow

In S.I. system

Newton per meter (Nm^{-1})

In CGS system

Dynes per centimeter (dyne cm^{-1})

Effect of Temperature on Surface Tension

The surface tension of liquids decreases with increase of temperature and becomes zero at the critical temperature.

The decrease in surface tension with increase of temperature is obviously due to the fact that the kinetic energy of the molecules increases ($\text{K.E.} \propto T$) and, therefore, the intermolecular attraction decreases.

Eotvos gave the relationship between temperature and surface tension

(3)

$$\gamma \left(\frac{M}{\rho}\right)^{2/3} = k(t_c - t)$$

Where M = Molar Mass, ρ = density and γ = surface tension, t_c = Critical temp., t = any other temperature, $\left(\frac{M}{\rho}\right)^{2/3}$ represents molar surface energy of the liquid, k = ~~is~~ constant (temperature coefficient).

Since, the surface tension almost vanishes roughly at 6° above the critical temperature instead of critical temperature.

Ramsay and Shields gave the relationship between surface tension of a liquid and its temperature.

$$\gamma \left(\frac{M}{\rho}\right)^{2/3} = k(t_c - t - 6)$$

Parachor

The following relationship between surface tension and density exists:

$$\frac{\gamma^{1/4}}{D-d} = C \quad \text{--- (1)}$$

- where γ = Surface tension of the liquid
- D = Density of the liquid
- d = Density of vapour at the same temp.
- C = Constant, independent of temperature

Multiplying both sides of equation (1) with the Molecular weight (M) of the liquid.

④

We get

$$\frac{M \gamma^{1/4}}{D-d} = MC = [P] \quad \text{--- (2)}$$

The constant $[P]$ thus obtained is called Parachor.

At ordinary temperature, d is very small in comparison to D and hence can be neglected in the denominator. Hence equation (2) becomes

$$\frac{M \gamma^{1/4}}{D} = [P] \quad \text{--- (3)}$$

Putting $\frac{M}{D} = V$, the molar volume of the liquid.

Equation (3) becomes

$$V \gamma^{1/4} = [P]$$

In this equation if $\gamma = 1$, then

$$[P] = V$$

Thus Parachor of a liquid is the molar volume of the liquid at a temperature at which the surface tension of the liquid is unity.

The parachor values associated with the atoms are called **Atomic parachors**.

The parachor values associated with structure of the molecules e.g. the multiple bonds, closed rings etc. are called **Structural Parachors**.

—x—
 $\frac{1}{M}$