Elevation in boiling point of the solvent (Ebullioscopy).

Boiling point of a liquid may be defined as the temperature at which its vapor pressure becomes equal to atmospheric pressure, i.e., 760 mm. Since the addition of a non-volatile solute lowers the vapor pressure of the solvent, solution always has lower vapor pressure than the solvent and hence it must be heated to a higher temperature to make its vapor pressure equal to atmospheric pressure with the result the solution boils at a higher temperature than the pure solvent. Thus sea water boils at a higher temperature than distilled water. If T_b is the boiling point of the solvent and T is the boiling point of the solution, the difference in the boiling point (ΔT or ΔT_b) is called the elevation of boiling point.

$T - T_b = \Delta T_b$ or ΔT

Elevation in boiling point is determined by Landsberger's method and Cottrell's method. Study of elevation in boiling point of a liquid in which a non-volatile solute is dissolved is called as ebullioscopy.

Important relations concerning elevation in boiling point

(i) The elevation of boiling point is directly proportional to the lowering of vapor pressure, i.e., $\Delta T_b \propto p^0 - p$

(ii) $\Delta T_b = K_b \times m$

Where $K_b =$ molal elevation constant or ebullioscopic constant of the solvent; $m =$ Molality of the solution, i.e., number of moles of solute per $1000\ g$ of the solvent; $\Delta T_b =$ Elevation in boiling point

(iii) $\Delta T_b = \dfrac{1000 \times K_b \times w}{m \times W}$ or $m = \dfrac{1000 \times K_b \times w}{\Delta T_b \times W}$

Where, K_b is molal elevation constant and defined as the elevation in B.P. produced when 1 mole of the solute is dissolved in 1 kg of the solvent. Sometimes the value of K_b is given per $0.1 kg$ $(100\ g)$, in such case the expression becomes

$$m = \frac{100 \times K_b \times w}{\Delta T_b \times W}$$

Where w and W are the weights of solute and solvent and m is the molecular weight of the solute.

(iv) $K_b = \frac{0.002(T_0)^2}{l_V}$

Where $T_0 =$ Normal boiling point of the pure solvent; $l_V =$ Latent heat of evaporation in cal/g of pure solvent; K_b for water is $0.52 \text{ deg} - kg \ mol^{-1}$