## Depression in freezing point of the solvent (Cryoscopy).

Freezing point is the temperature at which the liquid and the solid states of a substance are in equilibrium with each other or it may be defined as the temperature at which the liquid and the solid states of a substance have the same vapor pressure. It is observed that the freezing point of a solution is always less than the freezing point of the pure solvent. Thus the freezing point of sea water is low than that of pure water. The depression in freezing point ( $\Delta T$  or  $\Delta T_f$ ) of a solvent is the difference in the freezing point of the pure solvent ( $T_s$ ) and the solution( $T_{sol.}$ ).

$$T_s - T_{sol} = \Delta T_f \text{ or } \Delta T$$

NaCl or  $CaCl_2$  (anhydrous) are used to clear snow on roads. They depress the freezing point of water and thus reduce the temperature of the formation of ice.

Depression in freezing point is determined by Beckmann's method and Rast's camphor method. Study of depression in freezing point of a liquid in which a non-volatile solute is dissolved in it is called as cryoscopy.

## Important relations concerning depression in freezing point.

(i) Depression in freezing point is directly proportional to the lowering of vapor pressure.  $\Delta T_f \propto p^0 - p$ 

(ii)  $\Delta T_f = K_f \times m$ 

Where  $K_f$  = molal depression constant or cryoscopic constant; m = Molality of the solution (i.e., no. of moles of solute per 1000 g of the solvent);  $\Delta T_f$  = Depression in freezing point

(iii) 
$$\Delta T_f = \frac{1000 \times K_f \times w}{m \times W} \text{ or } m = \frac{1000 \times K_f \times w}{\Delta T_f \times W}$$

Where  $K_f$  is molal depression constant and defined as the depression in freezing point produced when 1 mole of the solute is dissolved in 1kg of the solvent. Sometimes the value of  $K_f$  is given per 0.1kg (100 g), in such case the expression becomes

$$m = \frac{100 \times K_f \times w}{\Delta T_f \times W}$$

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

(iv) 
$$K_f = \frac{R(T_0)^2}{l_f 1000} = \frac{0.002(T_0)^2}{l_f}$$

Where  $T_0$  = Normal freezing point of the solvent;  $l_f$  = Latent heat of fusion/g of solvent;  $K_f$  for water is 1.86 deg – kg mol<sup>-1</sup>

Relative lowering of vapor pressure, elevation in boiling point and depression in freezing point are directly proportional to osmotic pressure.