*. Clausius – Clapeyron Equation :-

The Clausius-clapeyron equation is derived from the Gibb's - Helmholtz equation. A system consisting of any two phases of a single substance in chemical equilibrium is the clausius-clapeyron equation.

Let the system studied be –

$$\text{Liquid} \rightleftharpoons \text{Vapour}$$

$$G_A \rightleftharpoons G_B$$

Here, there will be no change in free energy –

i.e. $\Delta G = \Delta B - \Delta A = 0$

$$G_A + dG_A = G_B + dG_B \quad \text{——(I)}$$

A/c to law of thermodynamics –

$$dG = Vdp - SdT \quad \text{——(II)}$$

In eqn – (I), for phase –'A'.

$$dG_A = V_A dp - S_A dT$$

and for phase –'B'

$$dG_B = V_B dp - S_B dT$$

Since, $G_A = G_B$

$\therefore$ from eqn –(I)

$$dG_A = dG_B$$

$$\therefore \quad V_A dp - S_A dT = V_B dp - S_B dT$$

or, $\frac{dp}{dT} = \frac{S_B - S_A}{V_B - V_A}$

$\therefore \frac{dp}{dT} = \frac{\Delta S}{\Delta V}$

We know that —

$\Delta S = \frac{q}{T}$

So, $\boxed{\frac{dp}{dT} = \frac{q}{T\Delta V}}$ —— (III)

This eqn- is called Clausius - clapeyron eqn.

Since,

$\Delta V = V_B - V_A$

So, eqn — (III) becomes —

$$\boxed{\frac{dp}{dT} = \frac{q}{T(V_B - V_A)}} \quad \text{—— (IV)}$$

This eqn — (IV) is another form of clausius - clapeyron equation.

Where,

q = molar heat of vaporisation = ΔH_{vap}

V_B = volume of water in vapour phase = V_g

V_A : volume of water in liquid phase = V_l

$\therefore$ eqn — (IV) becomes —

$$\boxed{\frac{dp}{dT} = \frac{\Delta H_{vap}}{T(V_g - V_l)}} \quad \text{—— (V)}$$