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Ostwald Isolation Method

This method is used to find out the order of complex reactions. If nA, nB and nC molecules of substance A, ~~when~~ when B and C are in excess, the order of reaction will be nA.

When A and B are in excess, the order of reaction will be nC.

When A and C are in excess, the order of ~~nB~~ reaction will be nB.

EX-34 When the initial concentration of a reaction was doubled, its half life become half, what should be the order of the reaction?

Sol: Rate law for product of a reaction is as follows:

$$Rate = K[A]^n \quad \text{and} \quad \frac{t_{0.5}}{\frac{t_{0.5}}{2}} = \left[\frac{2a}{a}\right]^{n-1}$$

$$2 = [2]^{n-1}; \quad n-1 = 2$$

$$n = 2$$

20. TEMPERATURE EFFECT:

The rate of reaction is dependent on temperature. This is expressed in terms of temperature coefficient which is a ratio of two rate constants differing by a temperature of 10. Generally the temperature selected are 298K and 308K. It is mathematically expressed as

$$\text{Temperature Coefficient} = \frac{\text{rate Constant at 308K}}{\text{rate Constant at 298K}}$$

$$= \frac{K_t + 10}{K_t}$$

The Value of temperature Coefficient for most of the reactions lies between 2 to 3.

21. ARRHENIUS EQUATION:

Arrhenius derived a mathematical expression to give a quantitative relationship between rate Constant and temperature. The expression is

$$K = A.e^{-Ea/RT}$$

(Here, A = frequency factor; Ea = activation energy, R = gas Constant and T = temperature.)

If K_1 and K_2 are rate constants at temperature T_1 and T_2 then

$$\log \frac{K_2}{K_1} = \frac{E_a}{2.303 R}\left[\frac{T_2 - T_1}{T_1 T_2}\right]$$

Ex. 35 Ethylene oxide is decomposed into CH_4 and CO. Rate constant for this reactions may be described by the equation $\log K (s^{-1}) = 14.34 - \frac{1.25 \times 10^4}{T}$

(i) what will be the energy of activation of this reaction?

(ii) what will be value of k at 670 k?

(iii) At what temperature will its half-life period be 25.6 minute?

Sol. (i) We know, $\log_{10} A - \frac{E_a}{2.303 RT}$ ——— (i)

Given, $\log k (s^{-1}) = 14.34 - \frac{1.25 \times 10^4}{T}$ —— (ii)

Comparing Eqs. (i) and (ii), we get

$$\frac{E_a}{2.303 R} = 1.25 \quad 10^4$$

(ii) $E_a = 1.25 \quad 10^4 \quad 2.303 \cdot 8.314 \quad 10^3$

$\therefore E_a = 239.339$ kJ/mol

substituting the value of T (670 K) in Eq. (ii),

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$\log k (s^{-1}) = 14.34 - \frac{1.25 \times 10^4}{670} = 4.3167$

$\therefore k = 4.82 \quad 10^{-5} s^{-1}$

(iii) $k = \frac{0.693}{t_{1/2}} = \frac{0.693}{256 \times 60} = 0.000451 \ sec^{-1}$

$\Rightarrow \log 0.000451 \ sec^{-1}$

$= 14.34 - \frac{1.25 \times 10^4}{T} \Rightarrow T = 706.79 \ K$