EQUILIBRIUM

FACTORS AFFECTING EQUILIBRIA

❖ Factors Affecting Equilibrium Constant

(a) Mode of Representation of The Reaction

$$A + B \longrightarrow C + D$$

The equilibrium constant for the reaction

$$K_c = \frac{[C][D]}{[A][B]}$$

If the reaction is reversed

$$C + D \longrightarrow A + B$$

then, $K_c^1 = \frac{[A][B]}{[C][D]}$

The two-equilibrium constant related as → $K_c = \frac{1}{K_c^1}$

Ex. For $N_2 + 3H_2 \longrightarrow 2NH_3$ if $K_C = 5$ then find K_C' for reverse reaction.

Ans. $K_C' = 1/5 = 0.2$

(b) Stoichiometry of The Reaction

When a reversible reaction can be written with the help of two or more stoichiometric equation, the value of equilibrium constant will be numerically different.

For reaction $2NO_2 \longrightarrow N_2 + 2O_2$

$$K_C = \frac{[N_2][O_2]^2}{[NO_2]^2}$$

For reaction $NO_2 \longrightarrow \frac{1}{2} N_2 + O_2$

$K_c^1 = \frac{[N_2]^{\frac{1}{2}}[O_2]}{[NO_2]}$ The two constants are related as $K_c^1 = \sqrt{K_C}$

(c) **Temperature**: The value of equilibrium constant changes with the change of temperature. If K_1 and K_2 be the equilibrium constants of a reaction at absolute temperatures T_1 and T_2 and ΔH is the heat of reaction at constant volume, then:

$$\frac{d(\ell nk)}{dT} = \frac{\Delta H}{RT^2}$$

$$\log\frac{K_2}{K_1} = \log K_2 - \log K_1 = \frac{-\Delta H}{2.303R}\left[\frac{1}{T_2} - \frac{1}{T_1}\right]$$

(According to Vant Hoff equation)

(i) $\Delta H = 0$ (neither heat is absorbed or evolved)

$\log K_2 - \log K_1 = 0$

$\log K_1 = \log K_2$

$K_1 = K_2$

Thus, equilibrium constant remains the same at all temperatures

If temp. T_2 is higher than T_1

$$\frac{1}{T_2} - \frac{1}{T_1} < 0, \log K_2 - \log K_1 = \frac{+ve\Delta H}{2.303R}$$

(ii) When $\Delta H = +ve$ (endothermic reaction)

$\log K_2 - \log K_1 > 0$

or $\log K_2 > \log K_1$

$K_2 > K_1$

The value of equilibrium constant is higher at higher temperature in case of endothermic reactions.

$K_C \propto T$

(iii) When $\Delta H = -ve$ (exothermic reaction)

$\log K_2 - \log K_1 < 0$

$\log K_2 < \log K_1$

$K_2 < K_1$

The value of equilibrium constant is lower at higher temperature in the case of exothermic reactions.

$K_C \propto 1/T$

The value of equilibrium constant is independent of the following factors: -

(a) Initial concentrations of reactants.

(b) The presence of a catalyst.

(c) The direction from which the equilibrium has been attained.

(d) Presence of inert materials.