EQUILIBRIUM

APPLICATIONS OF EQUILIBRIUM CONSTANTS

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◆ LE-CHATELIER'S PRINCIPLE

According to this principle. If a system at equilibrium is subjected to a change of concentration, pressure or temperature, the equilibrium is shifted in such a way as to nullify the effect of change.

(a) **Change in Concentration:** In an equilibrium increasing the concentrations of reactants results in shifting the equilibrium in favour of products while increasing concentrations of the products results in shifting the equilibrium in favour of the reactants.

(b) **Change of Pressure**: When the pressure on the system is increased, the volume decreases proportionately. The total number of moles per unit volume increases. According to Le-Ch atelier's principle, the equilibrium shifts in the direction in which there is decrease in number of moles.

If there is no change in number of moles of gases in a reaction, a pressure change does not affect the equilibrium.

(c) **Change in Temperature**: - If the temperature at equilibrium is increased reaction will proceed in the direction in which heat can be used. Thus, increase in temperature will favour the forward reaction for endothermic reaction.

Similarly, increase in temperature will favour the backward reaction in exothermic reactions.

◆ APPLICATION OF LE-CHATELIER'S PRINCIPLE

(A) Chemical Equilibria

(a)Formation of HI

$$H_2(g) + I_2(g) \longrightarrow \quad 2HI(g) + 3000 \text{ Cals}$$

(i) **Effect of Concentration**: When concentration of H_2 or I_2 is increased at equilibrium, the system moves in a direction in which decreases the concentration. Thus, the rate of forward reaction increases thereby increasing the concentration of HI.

(ii) **Effect of Pressure**: - In formation of HI, there is no change in the number of moles of reactants and products ($\Delta n = 0$). Thus, it is not affected by the change in pressure or volume.

(iii) **Effect of Temperature**: - The formation of HI is exothermic reaction. Thus, the backward reaction moves faster when temperature is increased. i.e., formation of HI is less.

In short favorable conditions for greater yield of HI:

High concentration of H_2 and I_2.

Low temperature.

No effect of pressure

(b) Formation of NO

$$N_2 + O_2 \longrightarrow 2NO - 43200 \text{ calls.}$$

(i) **Effect of Concentration**: When concentration of N_2 or O_2 is increased, the system moves in a direction in which N_2 or O_2 is used up or rate of forward increases.

(ii) **Effect of Pressure:** The formation of NO is not affected by change in pressure.

($\Delta n = 0$).

(iii) **Temperature**: The formation of NO is endothermic. Thus, increase in temperature favors to forward reaction.

Favorable conditions for greater yield of NO :

High concentration of N_2 and O_2.

High temperature.

No effect of pressure

(c) Dissociation of PCl_5

$$PCl_5(g) \longrightarrow PCl_3(g) + Cl_2(g) - 15000 \text{ calls.}$$

(i) Effect of Concentration: When concentration of PCl_5 is increased at equilibrium, the rate of forward reaction increases as to decrease the added concentration. Thus, dissociation of PCl_5 increases.

(ii) Effect of Pressure: The volume increases in the dissociation of PCl_5 when pressure is increased, the system moves in the direction in which there is decrease in volume. Thus, high pressure does not favour dissociation of PCl_5.

(iii) Effect of Temperature: - The dissociation of PCl_5 is an endothermic reaction. Thus, increase of temperature favours the dissociation.

Favorable conditions for dissociation of PCl_5 are: -

High concentration of PCl_5.

Low pressure.

High temperature.

(d) Synthesis of Ammonia

$$N_2(g) + 3H_2(g) \longrightarrow 2NH_3(g) + 22400 \text{ Cals.}$$

The favorable conditions for greater yield of NH_3 are: -

High concentration of N_2 and H_2.

High pressure.

Low temperature.

(e) Formation of SO_3

$$2SO_2(g) + O_2(g) \longrightarrow 2SO_3 + 45200 \text{ Cals.}$$

The favorable conditions for greater yield of SO_3 are: -

High concentration of SO_2 and O_2.

High pressure.

Low temperature.