Le-Chatelier's Principle Or Law of mobile Equilibrium.

In 1884 French chemist Le-Chatelier and Braun made certain generalization to explain the effect of change in, Concentration, temperature or pressure on the state of system in equilibrium.

Le-Chatelier's Principle states that the system is in equilibrium and it is disturbed by changing its Pressure, temperature or Concentration, then the system adjusts itself to minimise the effect of that disturbance created in the system.

or

"If any equilibrium is subjected to a change in Concentration, Pressure, or temperature etc. equilibrium shifts in such a way so as to undo the effect of change imposed."

Application of Le-chatelier's principle to explain the effect of changes in concentration, temperature and pressure on various reactions in equilibrium.

1. Effect of change of Concentration: – To understand the change in Concentration let us consider a hypothetical general reaction,

$$\underset{\text{Reactant}}{A + B} \rightleftharpoons \underset{\text{Product}}{C + D}$$

A little amount of A is added to the system. According to Le-Chatelier's Principle, the equilibrium will shift in such a direction in which the concentration of A is decreased.

This is only possible if more of A is used up by combination with B to form more products. In other words, the equilibrium will shift in the direct (forward) direction).

Similarly if the concentration of C is increased at equilibrium, the system will move in reverse (Backward) direction so, as to decrease the concentration of C.

2. Effect of Change of Temperature. According to Le-Chatelier's Principle, If the temperature of the system at equilibrium is increased (Heat is supplied) then the equilibrium will shift in the direction in which added heat is absorbed.

In other words, the equilibrium will shift in the direction of endothermic reaction with increase in temperature. Similarly decrease in temperature will shift the equilibrium towards the direction in which heat is produced and it will be favour Exothermic reaction.

For example.

$$N_2(g) + 3H_2(g) \underset{\text{Endothermic}}{\overset{\text{Exothermic}}{\rightleftharpoons}} 2NH_3(g) + 93.6\,KJ$$

or $\Delta H = -93.6\,KJ$

Exothermic reaction

Note:- Increase in Conc^n of any of the reactants $\xrightarrow{\text{Shift the equilibrium}}$ Forward direction

decrease in Con^n of Product $\xrightarrow{\text{Shift the equilibrium}}$ Backward direction

In this above equilibrium the forward or direct reaction is exothermic while the backward or reverse reaction is endothermic. Now, if the temperature is increased the equilibrium will change in the direction of endothermic reaction, which tends to undo the effect of added heat. Since the Reverse or backward reaction is endothermic.

In Other words, increase in temperature will result into lesser amount of 'Ammonia', On the Other hand if temperature is decreased the equilibrium will shift towards exothermic reaction i.e more ammonia (NH_3) will be formed i.e forward reaction or direct reaction.

Increase in Temp. $\xrightarrow[\text{equilibrium}]{\text{shift the}}$ Endothermic rel^n.

Decrease in Temp. $\xrightarrow[\text{equilibrium}]{\text{shift the}}$ Exothermic re^n.

3. Effect of Change of Pressure:-

Increase of Pressure On a system at equilibrium, will shift the equilibrium in the direction in which pressure is reduced. Now, as the pressure of the gaseous system is increased the volume occupied by the system decreases, so that the total number of moles per unit volume increases. [$P \propto \frac{1}{V}$, Boyle's law]

Let us Consider the reaction.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

1 vol 3 vol. 2 volume

In the Manufature of ammonia by Haber Process, we see that the volume decreases in moving from Left to right, hence increase in pressure shift the equilibrium to the right side i.e more formation of ammonia takes place and decrease of pressure shift the equilibrium to the left i.e decomposition of NH3 takes place.

Increase in Pressure $\xrightarrow[\text{in the direction of}]{\text{shift the equilibrium}}$ Lesser number of gaseous moles

Decrease in Pressure $\xrightarrow[\text{in the direction of}]{\text{shifts the equilibrium}}$ Large number of gaseous moles.