Chemical Equilibria, Le Chatelier's principle & K_c

Reversible reactions

A reaction in which the products can react to form the original reactants is called a **reversible reaction.**

Dynamic equilibrium

A condition called dynamic equilibrium is achieved if the rate of forward reaction is **equal** to the **rate** of backward reaction and the **concentrations** of reactants and products do not change.

Effect of changing conditions on the equilibrium constant

- When pressure and temperature remain constant, changes in the **concentration** of reactants and products do not change the equilibrium constant.
- The equilibrium constant is unaffected by changes in **pressure**.
- The equilibrium constant **changes** with changes in temperature.
- The presence of a **catalyst** does not affect the value of Kc.

The **larger** the value of Kc, the more favourable it is for the formation of products. A **lower** Kc denotes that the reaction is more favourable towards the formation of reactants.

Le Chatelier's principle

Le Chatelier's principle states that if one or more factors affect the position of the equilibrium, the position of equilibrium shifts in the direction that reduces the change.

Effect of change in **concentration** of reactants or products: oppose the change

Effect of change in **pressure**: When pressure increases at a constant temperature, reaction shifts in a direction to reduce the number of molecules.

Effect of change in **temperature**: When the temperature increases, the position of equilibrium shifts towards the endothermic.

Effect of **catalysts**: no change on position of equilibrium

The equilibrium constant Kc

For a general reaction

mA + nB ⇋ pC + qD

$$K_c = \frac{concentration\ of\ products}{concentration\ of\ reactants}$$

$$K_c = \frac{[C]^p[D]^q}{[A]^m[B]^n}$$

The concentrations are given in mol/dm^3

Equilibria in industrial applications

- Production of **ammonia**

N_2 (g) + $3H_2$ (g) ⇋ $2NH_3$ (g) ΔH_r=-92 kJ/mol

- Production of **sulphuric acid**

$2SO_2$ (g) + O_2 (g) ⇋ $2SO_3$ (g) ΔH_r=-197 kJ/mol