HOMOGENEOUS EQUILIBRIA

A system in which all the reactants and products share the same physical state is defined as a homogeneous system. In the provided chemical equation,

$$CH_3COOC_2H_5(aq) + H_2O\ (I) \longrightarrow CH_3COOH\ (aq) + C_2H_5OH\ (aq)$$

the reaction takes place within a homogeneous system.

In this context, the reactant $CH_3COOC_2H_5$ is in an aqueous (aq) state, signifying its dissolved form in water. Similarly, the product CH_3COOH is also in an aqueous state, along with C_2H_5OH. The presence of "(aq)" indicates that these substances are dissolved in water and form a homogeneous mixture.

In summary, the system is considered homogeneous as all the reactants and products exist in the same physical state, specifically the aqueous state in this case. This distinction is crucial in understanding the nature of the system and the interaction between the chemical species involved in the reaction.

Equilibrium Constant in Gaseous System

When dealing with reactions involving gases, it is often more practical to represent the equilibrium constant in terms of partial pressure. The foundation for this lies in the ideal gas equation, PV = nRT, where P represents pressure, V is volume, n is the number of moles, R is the ideal gas constant, and T is the temperature.

By rearranging the equation to express pressure (P) as $\frac{n}{V}$RT, and considering concentration (C) in $\frac{mol}{L}$ or $\frac{mol}{dm^3}$, and pressure (p) in bars, the relationship between pressure and concentration can be established as p = CRT. Additionally, the partial pressure can be expressed as p = [gas]RT.

At a constant temperature, it is noted that the pressure of a gas is directly proportional to its concentration, given by the relationship $p \propto [gas]$. This principle is applicable to reactions at equilibrium.

To illustrate, let's consider the reaction at equilibrium:

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$$

The equilibrium constant expressions in terms of concentration (Kc) and partial pressure (Kp) for this reaction are given by

$$Kc = \frac{(HI)^2}{(H_2)(I_2)}$$

$$Kp = \left(\frac{P_{H1}}{P_{H2}}\right)^2 \quad \left(\frac{P_{I2}}{P_{H1}}\right)$$

These formulations provide a more convenient means of representing equilibrium constants, particularly in the context of gas-phase reactions.