3. Determination of partition coefficient of benzoic acid between benzene and water

Aim: To determine the partition coefficient of benzoic acid between benzene and water.

Requirements: Benzene, benzoic acid, 0.1N sodium hydroxide solution, phenolphthalein indicator, separating funnel, tripod stand, reagent bottles, two small beakers, measuring cylinder, conical flask, burette, burette stand, tile and digital balance.

Principle: When a substance is added to a system containing two immiscible liquids, it distributes between them in a definite ratio." This is called Nernst distribution law. The added substance should have solubility in the two liquids for distribution. This is known as the partition coefficient K of a substance between two liquids, given by the formula.

K = Concentration of substance in organic layer/ Concentration of substance in aqueous layer = C1/C2

The distribution of benzoic acid between benzene and water is studied in the present experiment. Benzoic acid is an organic substance and has high solubility in benzene. It has less solubility in water. As a result, benzoic acid will partition preferably into benzene layer. The formula for calculating the benzoic acid partition coefficient between benzene and water is given below. C1 and C2 are concentration of benzoic acid in organic and aqueous layer. In the present experiment, benzoic acid is shaken with benzene and water for 30 minutes to achieve distribution. Shaking is required to achieve distribution equilibrium. At equilibrium the speed of forward process is equal to the speed of backward process. Benzoic acid is distributed as associated molecules in benzene layer and un associated molecules in aqueous layer. Hence, the equation is given as follows.

$$\mathbf{K} = \frac{\sqrt{\text{Concentration of substance in organic layer}}}{\text{Concentration of substance in aqueous layer}} = \frac{\sqrt{C1}}{C2}$$

The partition coefficient K will be remains constant only if there is neither association nor dissociation of solute molecules in both the phases.

Procedure:

Preparation of 0.1N Sodium hydroxide: 4 gm of sodium hydroxide was dissolved in 1000 ml of distilled water and make up the final volume in volumetric flask.

1. Weigh the samples (250 mg, 500 mg and 750 mg) of benzoic acid into three reagent bottles and add 50 ml of benzene and 50 ml of water to all three reagent bottles.

2. Keep the bottles on constant temperature water bath and Shake the bottles for 30 minutes.

3. Transfer the contents into a separating funnel and allow them to separate as two layers.

4. Collect the aqueous layer and titrate 10ml of sample with 0.1N sodium hydroxide solution using phenolphthalein as indicator.

5. Similarly collect the organic layer (benzene) and titrate 10ml of sample with 0.1N sodium hydroxide solution using phenolphthalein as indicator.

6. Calculate the partition coefficient of benzoic acid between benzene and water.

Observations and Calculations:

Equivalent factor: Each ml of 0.1N sodium hydroxide = 0.0122 gm of benzoic acid

Concentration of benzoic acid = Volume of sodium hydroxide consumed x 0.0122

S.NO	**The volume of aqueous / benzene layer taken**	**The volume of sodium hydroxide consumed in ml**	**Concentration of benzoic acid**	**√C**	**Partition coefficient = √C1 C2**
1	10 ml organic		C1=		
2	10 ml organic		C1 =		
3	10 ml aqueous		C2 =		
4	10 ml aqueous		C2 =		

Report: The partition coefficient of benzoic acid between benzene and water is…….