CHAPTER 2

pH and Buffers

ACIDS AND BASES

Bronsted and Lowry have defined acids as proton donors and bases as proton acceptors. Each acid, therefore, has always a conjugated base.

Acid $\rightarrow$ Base + H^+

$HCl \rightarrow Cl^- + H^+$

Alkali refers for the compound that yields hydroxyl ions on dissociation.

Base $\rightarrow$ Conjugate Acid + OH^-

$NaOH \rightarrow Na^+ + OH^-$

The strength of acids or bases is the ability to lose H^+ or OH^-. Weak acids and bases dissociate only to limited extent.

$H_2SO_4 \rightarrow H^+ + HSO^-{}_4$

$KOH \rightarrow K^+ + OH^-$

Potassium hydroxide

$CH_3COOH \rightarrow CH_3COO^- + H^+$

(Weak acid)

$C_6H_5NH_2 + H^+ \rightarrow C_6H_5NH_3{}^+$

(Weak base) (Aniline)

Table 2.2 Standard pK values of some monocarboxylic acids

Acid	*Mol. Wt.*	*pK*
Hippuric acid	179.17	3.6
Lactic acid	90.08	3.9
Benzoic acid	122.12	4.2
Acetic acid	60.05	4.8
Imidazote	68.08	7.0
p-Nitrophenol	139.11	7.1

Table 2.3 Standard pK_1 and pK_2 values of some dicarboxylic acids

Acid	*pK_1*	*pK_2*
Oxalic acid	1.3	4.3
Tartaric acid	3.0	4.3
Malic acid	3.5	5.0
Succinic acid	4.2	5.6

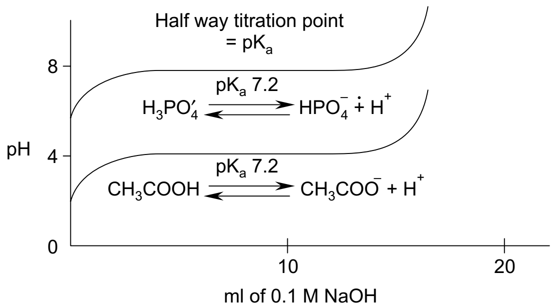

Fig. 2.1 pH titration curve of monocarboxylic acids

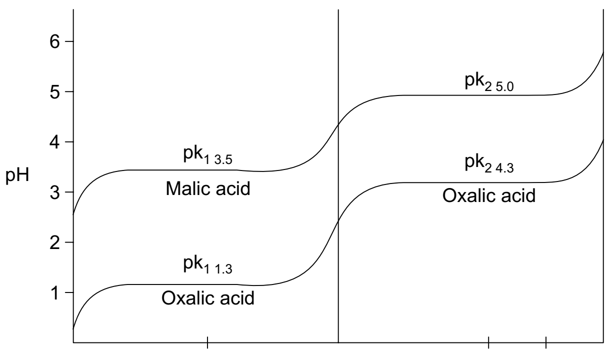

Fig. 2.2 pH titration curve of dicarboxylic acids

4. Electrodes must be washed with distilled water before and after use.
5. The pH must be calibrated before use, using standard pH tablets. A pH tablet generally contains potassium hydrogen phthalate. The pH meter must be calibrated with standard solution whose pH is close to that of the test solution.
6. For the extreme pH values of strong alkalis use lithium glass instead of ordinary glass electrode.
7. pH meter should be switched to zero but it should remain on line.
8. Never allow the electrodes to dry out.

BUFFERS

Buffers are acid-base conjugate pair aqueous systems that tend to resist the changes in their pH, when small amounts of acid (H^+) or base (OH^-) are added. A buffer consists of a weak acid and its conjugate base e.g., a mixture of acetic acid and acetate ions at the mid-point of a titration curve represents the buffer system.

This relatively flat zone is the buffering region of the acetic acid-acetate-buffer pair. The pH at this point in a titration curve of acetic acid is equal to its pKa.

A plot of the dependence of the pH of a solution on the amount of OH^- is added is called titration curve.

If a strong acid is added to the buffer solution, the hydrogen ions are picked up by the conjugate base of the buffer.

$$CH_3COO^- + H^+ \rightarrow CH_3COOH$$

According to Henderson-Hasselbalch equation:

$$\text{pH} = \text{pKa} + \log \frac{([CH_3COO^-]_0 - X)}{([CH_3COOH]_0 + X)} \qquad \text{(i)}$$

where X is the amount of strong acid added to the solution and $[CH_3COO^-]_0$ and $[CH_3COOH]_0$ are the initial concentrations of CH_3COO^- and CH_3COOH respectively. Since the equilibrium for the equation (i) lies in the direction of formation of acetic acid. The changed value of $[CH_3COOH]$ corresponds to $[CH_3COOH]_0 + X$. If

EXPERIMENT 2.2 Titration of gastric juice with 0.1 M of KOH

Requirements

1. Gastric juices from stomach washings or mock sample (40 ml of 0.1 mol. HCl + 15 ml of 0.1 mol. acetic acid + 45 ml of water).
2. Potassium hydroxide (0.1 mol.).
3. Thymol blue (0.1% W/V in 20% V/V Ethanol).

Principle

Gastric juice is a mixture of HCl, and weak acids like phosphate, protein and organic acids. The relative quantities of HCl and organic acids are determined by titration with KOH using pH indicator thymol blue that has two pH ranges.

pH 1.2-2.8 Red-Orange-Yellow

pH 8.0-9.6 Yellow-Green-Blue

The titration using the first colour change gives the quantity of HCl and second change total acidity.

Procedure

1. Take 10 ml of gastric juice sample or mock sample in a titration flask.
2. Add 5 drops of thymol blue indicator in it.
3. Titrate it against 0.1 mol, potassium hydroxide until end point is reached and the colour changes to yellow.
4. Note the volume of potassium hydroxide used.
5. Continue the titration until blue colour is formed and note the volume of potassium hydroxide used again.
6. Calculate the 'free HCl' and total acidity of the sample in ml 0.1 mol. acid/100 ml of sample.

Normal Value

Free HCl 20-30 ml 0.1 mol. acid/100 ml

Total acidity 30-70 ml 0.1 mol. acid/100 ml