Buffer solutions and application

Ahammad Musa
Roll: SH - 54
Group: B - 08
Session: 2014-15

Department of Chemistry
University of Dhaka

July 18, 2017

Definition

A buffer solution is one which results change in pH when small quantities of acids or alkalies are added to it.

Type

There are two types of buffer solutions-

- Acidic buffer solution
- Alkaline buffer solution

Type

Acidic buffer solution

Acidic buffer solutions are commonly prepared from a weak acid and its salt with a strong base.

Example

A mixture of CH_3COOH and CH_3COONa acts as an acidic buffer.

Type

Alkaline buffer solution

Alkaline buffer solution are commonly prepared from a weak base and its salt with a strong acid.

Example

A mixture fo NH_4OH and NH_4Cl acts as an alkaline buffer.

Mechanism of Buffer Solution

Acidic buffer solution

To describe the mechanism fo acidic buffer solution we consider the acidic buffer solution prepared by **acetic acid** and **sodium acetate** as example.

$$CH_3COOH(aq) \rightleftharpoons CH_3OO^-(aq) + H^+(aq)$$

$$CH_3COONa(aq) \longrightarrow CH_3OO^-(aq) + Na^+(aq)$$

Mechanism of Buffer Solution

Acidic buffer solution

Removing of H^+ ion When a small quantity of an acid is added the H^+ ions are removed by the reaction -

$$H^+(aq) + CH_3COO^-(aq) \rightleftharpoons CH_3COOH(aq)$$

Removing of OH^- ion When a small quantity of base is added then the OH^- are neutralized by the reaction

$$OH^-(aq) + H^+(aq) \longrightarrow H_2O(l)$$

Mechanism of Buffer Solution

Alkaline buffer solution

To describe the mechanism of alkaline buffer solution we consider an alkaline buffer solution prepared by **ammonium hydroxide(**$\mathrm{NH_4OH}$**)** and **ammonium chloride(**$\mathrm{NH_4Cl}$**)** as example.

$\mathrm{NH_4OH(aq)} \rightleftharpoons \mathrm{NH_4^+(aq) + OH^-(aq)}$

$\mathrm{NH_4Cl(aq)} \longrightarrow \mathrm{NH_4^+(aq) + Cl^-(aq)}$

Mechanism of Buffer Solution

Alkaline buffer solution

Removing of H^+ ion When a small quantity of strong acid is added to this solution the H^+ ions are removed as -

$$H^+(aq) + NH_4OH(aq) \longrightarrow NH_4{}^+(aq) + H_2O(l)$$

Removing of OH^- ion When a small quantity of strong base is added to this solution the OH^- ions are removed as -

$$OH^-(aq) + NH_4{}^+(aq) \rightleftharpoons NH_4OH$$

pH calculation from solution

The pH of an acidic or basic buffer can be calculated by using Henderson-Hasselbalch equation.

For acidic buffer solution-

$pH = pk_a + \log \frac{[salt]}{[acid]}$

For alkaline buffer solution-

$pH = pk_w - pk_b - \log \frac{[salt]}{[base]}$

Buffer capacity

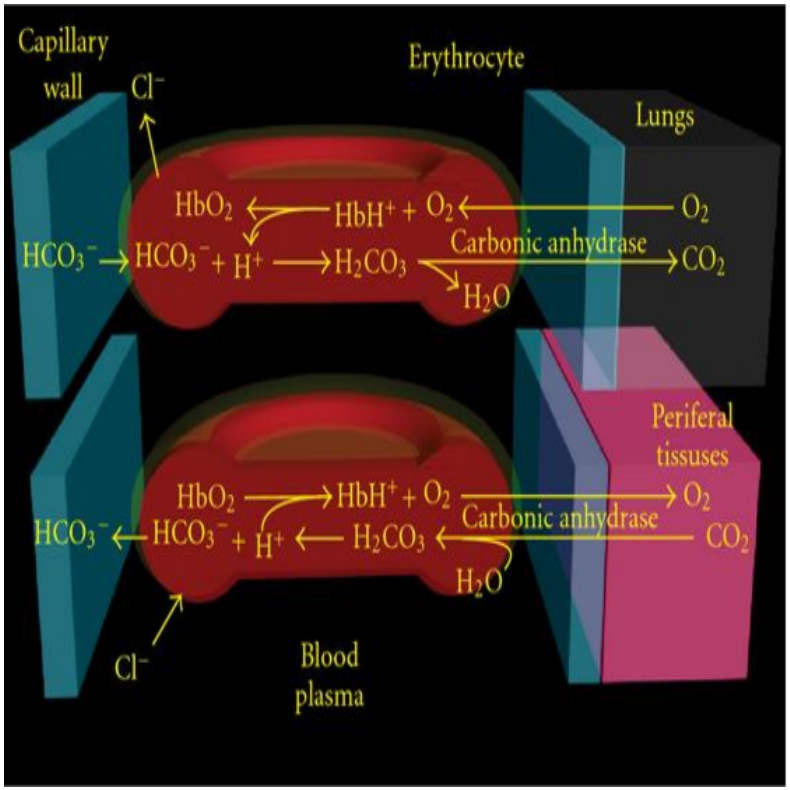
The buffer capacity of any buffer gives a measure of the amount of acid or alkali that the buffer can react with before changing the pH of the solution. The larger is the amounts of acid and its conjugate base or the base and its conjugate acid needed to change the pH of the buffer, the greater is the buffer capacity. Buffer capacity is high when, $\frac{[salt]}{[acid]} = 1$.

Application

There are many applications of buffer solutions. Some are -

- Many biological processes can only occur of very specific pH values. The reactions often take place in buffered environments. A buffer of **Carbonic acid(H_2CO_3)** and **bicarbonate(HCO_3^-)** is present in blood plasma, to maintain a pH between 7.35 and 7.45. Other fluids such as tear, salivary, urine, enzymes etc. has definite pH value. Eventhough the drugs that we take in our body has specific pH values.
- Industrially, buffer solutions are used in fermentation processes and in setting the correct conditions for dyes used in colouring fabrics. Also pH controlled in shampoo, soap, cosmetics etc.

Application



(a) Blood

(b) Dye

Thank You