B.Sc. (Honours) Part-I

Paper-IA

Topic: Buffer Solutions

UG

Subject-Chemistry

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Buffer Solution

A solution which has reserve acidic nature or alkaline nature or a solution with reserve pH is buffer solution. A solution whose pH does not change significantly on addition of a small amount of acid or alkali.

Or

"Solutions which **resist** changes in pH when **small quantities** of acid or alkali are added."

(a) **General Characteristics of a Buffer Solution**

(i) It has a definite pH, i. e., it has reserve acidity or alkalinity.

(ii) Its pH does not change on standing for long.

(iii) Its pH does not change on dilution.

(iv) Its pH is slightly changed by the addition of a small quantity of an acid or a base.

(b) **Buffer solutions can be obtained by:**

(i) By mixing a weak acid with its salt with a strong base,

- $CH_3COOH + CH_3COONa$
- Boric acid + Borax
- Phthalic acid + Potassium acid phthalate

(ii) By mixing a weak base with its salt with a strong acid,

- NH_4OH + NH4Cl
- Glycine + Glycine hydrochloride

(iii) By a solution of ampholyte. The ampholytes or amphoteric electrolytes are the substances which show properties of both an acid and a base. Proteins and amino acids are the examples of such electrolytes.

(iv) By a mixture of an acid salt and a normal salt of a polybasic acid, e.g., $Na_2HPO_4 + Na_3PO_4$ or a salt of a weak acid and a weak base, such as CH_3COONH_4.

(c) **Basic buffer:** Consider the case of the solution containing NH_4OH and its salt NH_4Cl. The solution will have NH_4OH molecule. NH_4^+ ions, Cl^- ions. OH^- ions and H^+ ions.

NH_4OH $NH_4^+ + OH^-$ (Feebly ionised)

NH_4Cl $NH_4^+ + Cl^-$ (Completely ionised)

H_2O $H^+ + OH^-$ (Very feebly ionised)

When a drop of NaOH is added, the added OH^- ions combine with NH_4^+ ions to form feebly ionised NH_4OH whose ionization is further suppressed due to the common ion effect. Thus, pH is not disturbed considerably.

$NH_4^+ + OH^-$ NH_4OH

↑

(From strong base)

When a drop of HCl is added, the added H^+ ions combine with NH_4OH to form undissociated water molecules.

$NH_4OH + H^+$ $NH_4^+ + H_2O$

↑

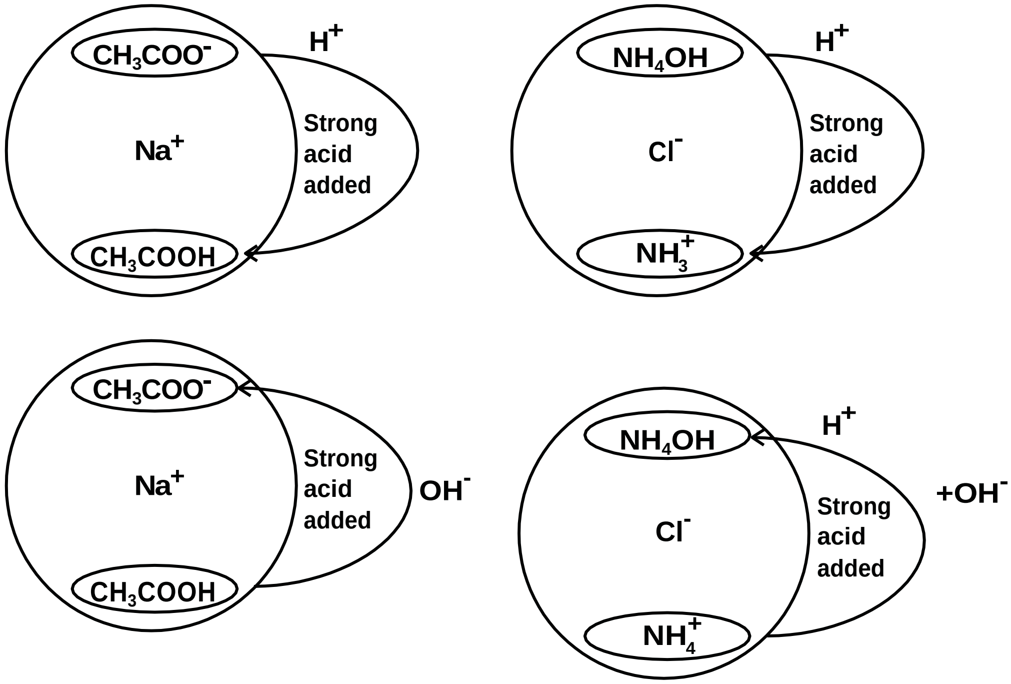
(From strong acid)

Thus, pH of the buffer is practically unaffected.

A similar thing will also happen in an Acidic Buffer. The overall picture is represented in the following diagram.

Acid Buffer ($CH_3COOH + CH_3COONa$)

Basic Buffer ($NH_4OH + NH_4Cl$)



Mechanism of buffer solution

Uses of Buffer Solutions

- There exists a few alternate names that are used to refer buffer solutions, such as pH buffers or hydrogen ion buffers.
- An example of the use of buffers in pH regulation is the use of bicarbonate and carbonic acid buffer system in order to regulate the pH of animal blood.
- Buffer solutions are also used to maintain an optimum pH for enzyme activity in many organisms.
- The absence of these buffers may lead to the slowing of the enzyme action, loss in enzyme properties, or even denature of the enzymes. This denaturation process can even permanently deactivate the catalytic action of the enzymes.