BUFFER SOLUTIONS:

For several purposes, we need solutions which should have constant pH. Many reactions, particularly the biochemical reactions, are to be carried out at a constant pH. But it is observed that solutions and even pure water (pH = 7) cannot retain the constant pH for long. If the solution comes in contact with air, it will absorb CO_2 and becomes more acidic. If the solution is stored in a glass bottle, alkaline impurities dissolve from glass and the solution becomes alkaline.

A solution whose pH is not altered to any great extent by the addition of small quantities of either an acid (H^+ ions) or a base (OH^- ions) is called the **buffer solution.** It can also be defined as a solution of **reserve acidity** or **alkalinity** which resists change of pH upon the addition of small amount of acid or alkali.

General characteristics of a buffer solution

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

(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 small quantity of an acid or a base.

Buffer solutions can be obtained:

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

eg;

(a) $CH_3COOH + CH_3COONa$

(b) Boric acid + Borax

(c) Phthalic acid + Potassium acid phthalate

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

e.g;

(a) $PNH_4OH + NH_4Cl$

(b) 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 weak acid and a weak base, such as CH_3COONH_4.

The first and second type are also called acidic and basic buffers respectively.

Explanation of buffer action

(i) Acidic buffer:

Consider the case of the solution of acetic acid containing sodium acetate. Acetic acid is feebly ionised while sodium acetate is almost completely ionised. The mixture thus contains CH_3COOH molecules, CH_3COO^- ions, Na^+ ions, H^+ ions and OH^- ions. Thus, we have the following equilibria in solution:

$CH_3COOH \leftrightarrow H^+ + CH_3COO^-$ (Feebly ionised)

$CH_3COONa \leftrightarrow Na^+ + CH_3COC^-$ (Completely ionised)

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

When a drop of strong acid, say HCl, is added, the H^+ ions furnished by HCl combine with CH_3COO^- ions to form feebly ionised CH_3COOH whose ionisation is further suppressed due to common ion effect. Thus, there will be a very slight effect in the overall H^+ ion concentration or pH value.

When a drop of NaOH is added, it will react with free acid to form undissociated water molecules.

$$CH_3COOH + OH^- \leftrightarrow CH_3COO^- + H_2O$$

Thus, OH^- ions furnished by a base are removed and pH of the solution is practically unaltered.