

Buffer Solutions

A buffer solution is defined as a solution which resists any change in its pH value on addition of small amount of strong acid or strong base to it.

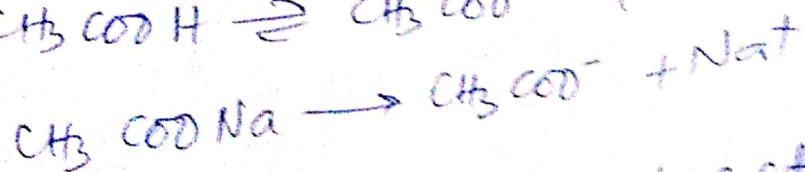
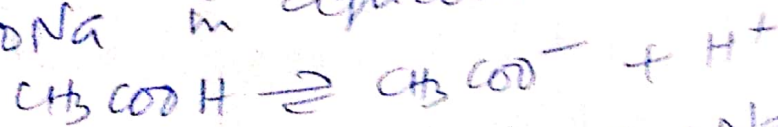
Types of Buffer Solutions

Acid Buffers = These solutions are the solution of weak acid and a salt of weak acid with strong base

- Example - $\text{CH}_3\text{COOH} + \text{CH}_3\text{COONa}$
 - $\text{HCN} + \text{NaCN}$
 - $\text{PhCOOH} + \text{PhCOONa}$

Buffer action of Acidic Buffer

Consider acidic buffer of CH_3COOH and CH_3COONa in aqueous solution



Due to common ion effect ionization of CH_3COOH is further suppressed \rightarrow

When small amount of strong acid (HCl) is added to the acidic Buffer solution Then H^+ ion of HCl combines with CH_3COO^- ion to form weakly ionized molecules CH_3COOH



Thus H^+ or H_3O^+ in aqeous solution or pH (which $-\log_{10} H^+$) remains constant or negligible change occurs.

(Henderson) Equation for Acidic Buffer - Hasselbalch

for weak acid CH_3COOH in

aq. solution $CH_3COOH \rightleftharpoons CH_3COO^- + H^+$

Hence in presence of salt

$$K_a = \frac{[CH_3COO^-][H^+]}{[CH_3COOH]}$$

$$\Rightarrow [H^+] = K_a \frac{[CH_3COOH]}{[CH_3COO^-]_{salt}}$$

Taking $-\log_{10}$ both sides

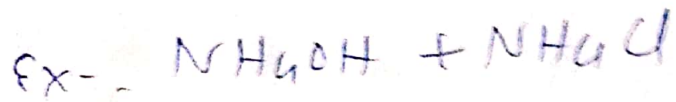
$$-\log [H^+] = -\log K_a - \log [CH_3COOH] + \log [CH_3COO^-]$$

$$pH = pK_a + \log \frac{[CH_3COO^-]_{salt}}{[CH_3COOH]}$$

$$pH = pK_a + \log \frac{[salt]}{[Acid]}$$

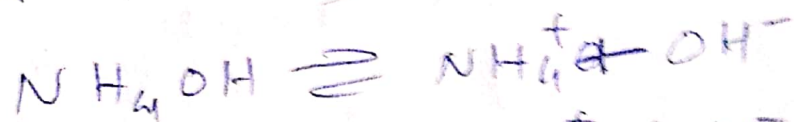
This Eqⁿ is known as Henderson Hasselbalch eqⁿ.

Basic Buffer \Rightarrow Such Solutions
are solutions of
mixture of ~~strong~~ weak base and its
salt with strong base.

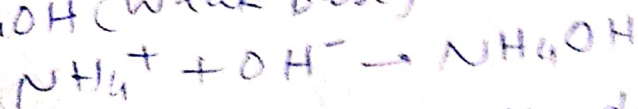


Buffer Action of Basic Buffer

Consider Basic Buffer of
($\text{NH}_4\text{OH} + \text{NH}_4\text{Cl}$) dissociate as



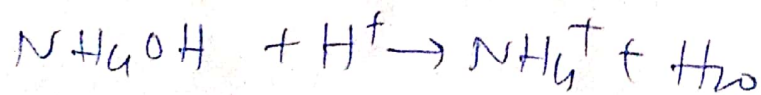
Addition of strong base in small amount,
 OH^- of sbase combines with NH_4^+ to
give NH_4OH (weak base)



Due to formation weakly dissociated
 NH_4OH , pH of solution does not
change effectively. New pH is
unchanged.

When H^+ from acid is added to
Basic Buffer, H^+ of acid combines

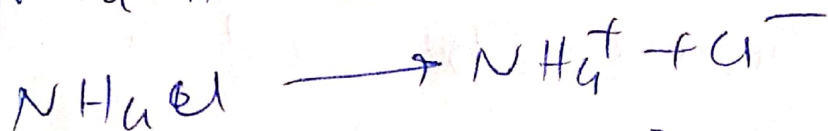
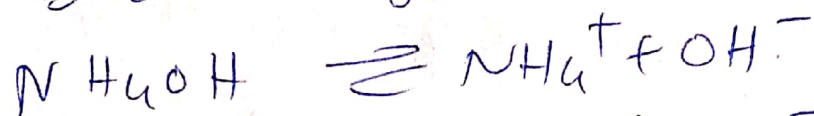
with NH_4OH to give NH_4^+ + H_2O



Due to formation of NH_4^+ ion, pH of solution does not change effectively.

Henderson Equation for Basic Buffer

For Basic Buffer



$$K_b = \frac{[\text{NH}_4^+][\text{OH}^-]}{[\text{NH}_4\text{OH}]}$$

In presence of common ion NH_4^+

$$[\text{OH}^-] = K_b \frac{[\text{NH}_4\text{OH}]}{[\text{NH}_4^+]_{\text{salt}}}$$

Taking $-\log_{10}$ both sides

$$-\log [\text{OH}^-] = -\log K_b - \log \frac{[\text{NH}_4\text{OH}]}{[\text{NH}_4^+]_{\text{salt}}}$$

$$\text{pOH} = \text{p}K_b + \log \frac{[\text{NH}_4^+]_{\text{salt}}}{[\text{NH}_4\text{OH}]}$$

$$\text{pOH} = \text{p}K_b + \log \frac{[\text{Salt}]}{[\text{Base}]}$$

Henderson
Eqn.

$$\text{pH} = 14 - \text{pOH}$$