Salt hydrolysis

The reaction of cations or anions of the salt with water to produce acidic or basic medium is called salt hydrolysis. Let us consider the following four cases of salt hydrolysis.

(i) salt of strong acid and strong base :—

$$NaCl + H_2O \rightarrow Na^+ + Cl^-$$
$$H_2O \rightleftharpoons H^+ + OH^-$$

Here there is no hydrolysis because NaCl is only dissociated in Na^+ and Cl^- and there is no reaction of H_2O i.e formation of neutral medium solution.

(ii) salt of strong acid and weak base —

$$NH_4Cl \rightleftharpoons NH_4^+ + Cl^-$$
$$H_2O \rightleftharpoons H^+ + OH^-$$

or, ~~$NH_4Cl + H_2O \rightleftharpoons NH_4OH + H^+ + Cl^-$~~

overall reaction is $NH_4^+ + H_2O \rightleftharpoons NH_4OH + H^+$

this is called cationic hydrolysis because cation react with water.

(iii) Salt of Strong base and weak acid :—

$$CH_3COONa \rightleftharpoons CH_3CO^- + Na^+$$
$$H_2O \rightleftharpoons H^+ + OH^-$$

Overall Reaction $CH_3COO^- + H_2O = CH_3COOH + OH^-$

Here CH_3CO^- anion reacts with water to form CH_3COOH and resulting solution is basic in nature and hence this type of reaction is called anionic salt hydrolysis.

(iv) salt of weak acid and weak base :—

$$CH_3COONH_4 \rightleftharpoons CH_3CO^- + NH_4^+$$
$$H_2O \rightleftharpoons H^+ + OH^-$$

or, $CH_3COONH_4 + H_2O = CH_3COOH + NH_4OH$

This type of hydrolysis is called anionic and cationic hydrolysis. Because both anion (CH_3CO^-) and cation (NH_4) react with water to form acetic and basic solution.

Degree of hydrolysis :- The percentage or fraction of the total salt hydrolysed is called degree of hydrolysis of that salt.

Eg: 90% of a salt is hydrolysed then degree of hydrolysis is .9 or 90%.

If c moles/litre is the molar concentration and α is the degree of hydrolysis then we have.

	$A^- + H_2O \rightleftharpoons$	OH^- +	AH
initial	c	0	0
At. limit	$c(1-\alpha)$	$c\alpha$	$c\alpha$

Here, hydrolysis constant

$$K_h = \frac{c\alpha \cdot c\alpha}{c(1-\alpha)}$$

$$K_h = \frac{c\alpha^2}{1-\alpha}$$

As $K_h = \frac{[OH^-][AH]}{[A^-]}$

If $\alpha << 1$ then

$$K_h = C\alpha^2 \quad \text{---(i)}$$

$$\alpha^2 = \frac{K_h}{C}$$

$$\alpha = \sqrt{\frac{K_h}{C}} \quad \text{---(ii)}$$

$$\alpha \propto \sqrt{\frac{1}{C}} \quad \text{---(iii)}$$

Thus the degree of hydrolysis of a salt of weak acid and strong base is inversely proportional to the square root of its molar concentration.

If for one molar solution $C = \frac{1}{V}$ and therefore from eqn 1

$$\boxed{\alpha \propto \sqrt{K_h \cdot V}} \quad \text{---(iv)}$$

As $K_h = K_w / K_a$

equation (v) will be $\boxed{\alpha = \sqrt{\frac{K_w}{K_a} \cdot V}}$ (v)

or $\boxed{\alpha = \sqrt{\frac{K_w}{K_a \cdot C}}}$ (vi)

where K_w = ionic product of water and K_a is the dissociation constant of acid.