- The actual colour of the indicator, which depends upon the ratio of the concentration of the ionized and unionized forms, is thus directly related to the hydrogen–ion concentration. Eq. (2) may be written as

$$pH = \log \frac{[In^-]}{[HIn]} + pKa \text{ .... (3)}$$

- In this equation [HIn] represents the concentration of the undissociated indicator molecule whose colour is called 'acid colour' while [In −] denotes the concentration of the indicator-anions, the colour of which is called 'alkaline colour'. Ka is the dissociation constant of the indicator- acid. The indicator base may be characterized similarly to the indicator acid

$$InOH \rightleftharpoons In^+ + OH^-$$

$$\frac{[In^+][OH^-]}{[InOH]} = Kb \text{ .... (4)}$$

- Taking the ionic product of water into consideration

$$\frac{[In^+]\, K_w}{[H^+][InOH]} = Kb \text{ .... (5)}$$

$$[H^+] = \frac{Kb}{KW} \cdot \frac{[In^+]}{[InOH]} \text{ .... (6)}$$

$$pH = PkW - Pkb + \log \frac{[InOH]}{[In^+]} \text{ .... (7)}$$