pH Indicators

For water and wastewater

Introduction

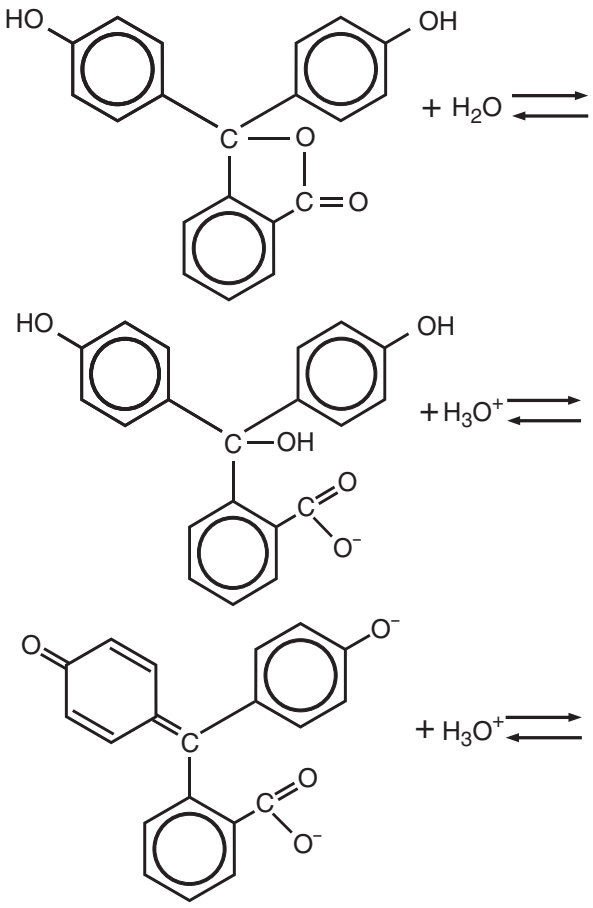
Acid-base indicators behave as weak acids or bases in water or solvents. An equilibrium established between the hydronium ion $(H_3O)^+$ and the indicator ion (In^-) can be represented as follows for an aqueous medium:

$H_2O + HIn \rightleftharpoons H_3O^+ + In^-$ (In as a weak acid)
(acid color) (base color)

$In^- + H_2O \rightleftharpoons InH^+ + OH^-$ (In as a weak base)
(base color) (acid color)

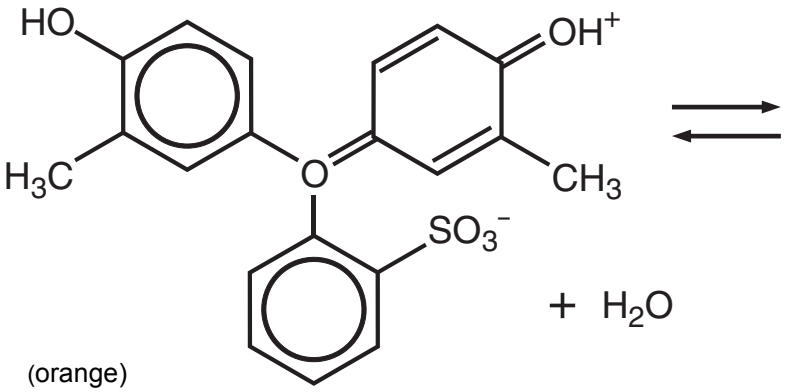
The ratio of HIn to In^- or In to InH^+ varies as a function of pH. However, the human eye cannot detect all the color changes as result of the varying concentrations of In in the solution. The color change between the predominately acid form of the indicator and the predominately base form is clearly visible, and therefore suitable for visual acid-base titration.

Most of the Hach Acid-Base Indicators can be divided into three classes based on the structure. The phthalein indicators are sparingly soluble in water but are quite soluble in alcohols. Alcohol is the preferred solvent for indicator solution preparation. Equilibrium of the phthalein-type indicators is exemplified by phenolphthalein represented as follows:

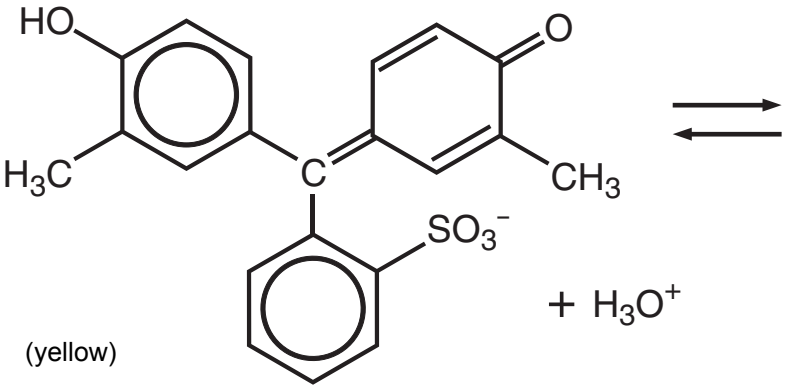


Many of the sulfonphthalein indicators exhibit two useful visual transition ranges. These indicators exhibit good stability toward strong alkali solution. Indicator solutions are usually prepared in 20% alcohol solution. The equilibria of this type of indicator are exemplified by cresol red, which is represented as follows:

Acidic transition range

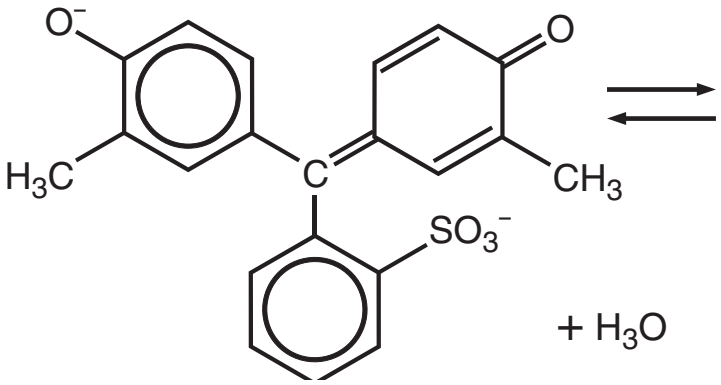


(orange)

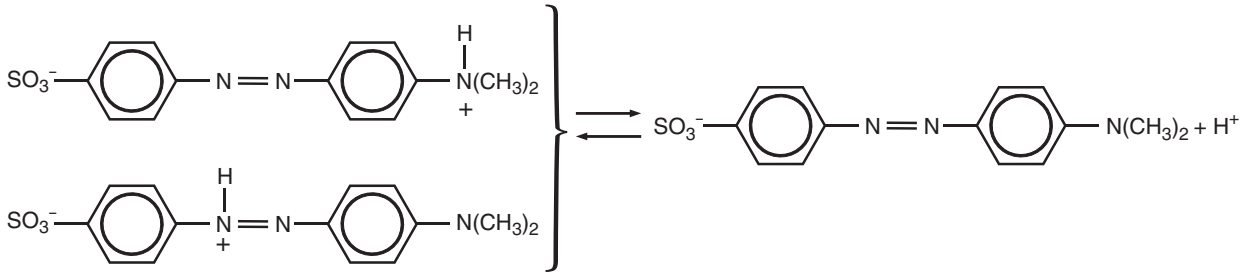


(yellow)

Basic transition range



Most of the azo indicators exhibit a color change from red to yellow. The equilibrium for azo-type indicators is exemplified by methyl orange, as shown below:



Indicator choice

The visual transition range is the main factor in selection of pH indicator. Indicator solubility also is important. When using the indicator for an acid-base titration, ease of identifying the color change and slope of the titration curve must be considered.

Figure 1 illustrates titration of a strong acid with a strong base. Any of the three indicators would be used with satisfactory results in the appropriate pH ranges. However, as the slope of the curve decreases, the selection of an indicator with the proper transition range is more important.

In Figure 2, titration of a weak acid with a strong base; only phenolphthalein would be satisfactory. Use of methyl red would give an incorrect result because the transition range of the indicator does not correspond with the actual titration equivalence point.

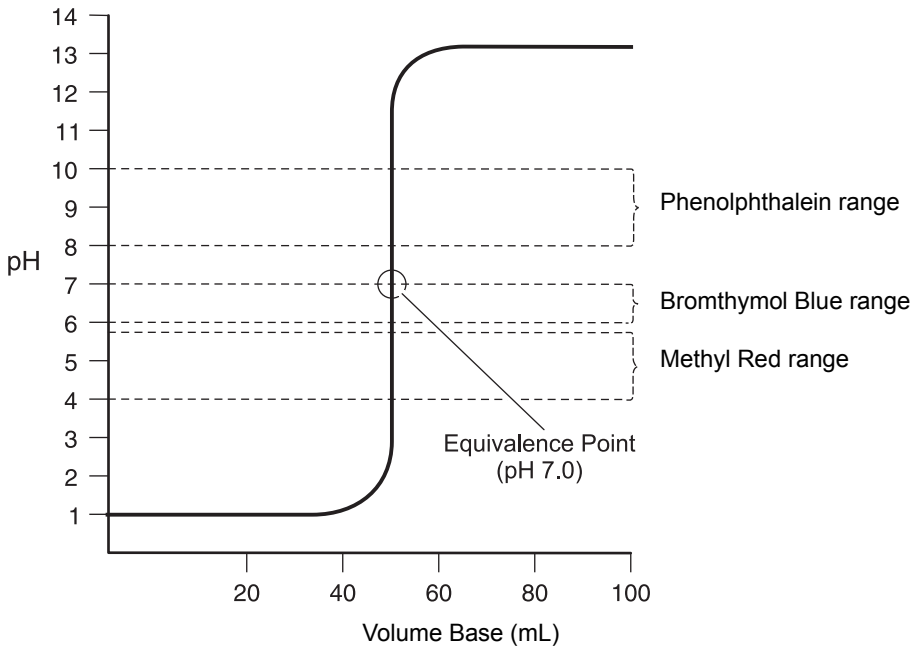


Figure 1 Titration of a strong acid with a strong base

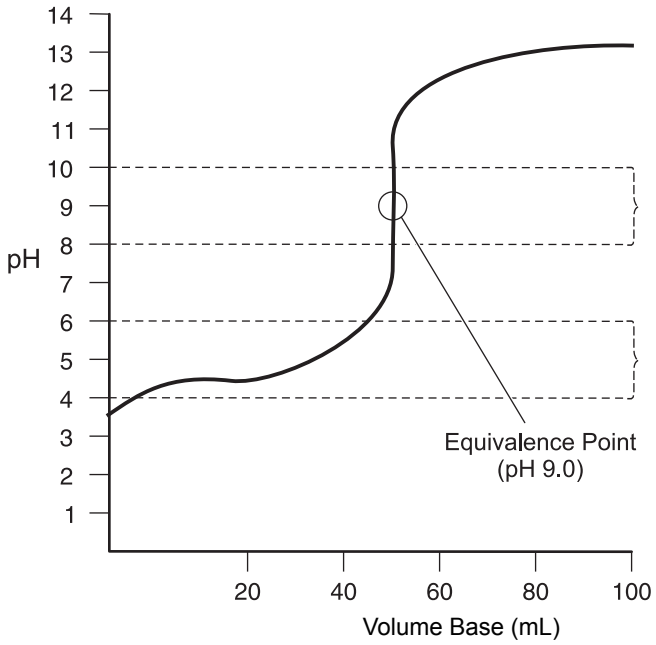


Figure 2 Titration of weak acid with a strong base

The chart below shows the ranges of some pH indicators available from Hach Company.