return

pH Theory

pH is a value for the acidity or alkalinity of a solution. In pure water the hydrogen ion (H^+) and hydroxyl ion (OH^-) concentrations are equal at 10^{-7} M (25°C). To provide a convenient and effective means of defining acidity and alkalinity, pH is defined as the negative logarithm of hydrogen activity:

$$pH = -\log [H^+]$$

Nernst Equation

The principle of the potentiometric pH measurement is rooted in Nernst's Law. Nernst found that when a metal object is immersed into a solution containing ions of the same metal, a potential difference occurs. Nernst defined this potential difference, E, generated by the exchange of metal ions between the metal and liquid, as:

$$E = E0 + [RT / nF] \cdot \ln [M+]$$

Where:

R = gas constant (R=8.314J/mole·K)
F = Faraday number (F = 96493 C/mole)
n = valency of the metal
[M+] = metal ion concentration
T = absolute temperature in Kelvin
E0 = normal potential

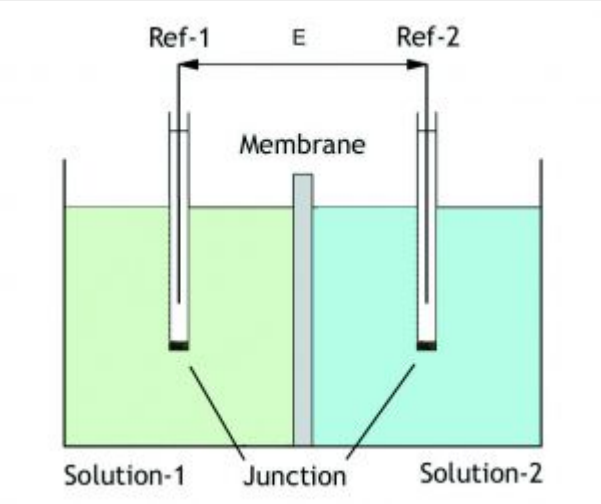
The “normal potential” is the potential difference arising between the metal and solution when the solution contains 1 mole M+/liter.

Because the hydrogen ion has similar properties to metal ions (both have a positive charge), Nernst's law can also be applied to a “Hydrogen Electrode” immersed into a solution containing hydrogen ions.

Nernst's original equation can be rewritten as:

$$E = E0 + [RT / nF] \cdot \ln [H+]$$

Measurement



Solution-1 sample to be measured
Solution-2 known buffer solution (7 pH)

Reference-1 silver wire in a salt-bridge (KCl)
Reference-2 silver wire in a salt-bridge (KCl)

The heart of a pH measurement system is a membrane made from special pH-selective glass on which a very thin layer of hydrogen ions is formed when dipped in water. At high pH values, this layer will have a low hydrogen concentration. However, at low pH values a large number of H^+ ions diffuse in the layer. By measuring the generated electrical potential (E) in the layer the corresponding pH can be computed.

The potential (E) between both wires will vary with the pH difference between sample and known buffer according the Nernst-equation (-59.2 mV/pH at 25°C). A salt-bridge around each wire prevents direct metal contact with the solutions by using a wet junction for a stable electrical behaviour.