pH Metry

By- Dr. Ekta Khare

What is pH?

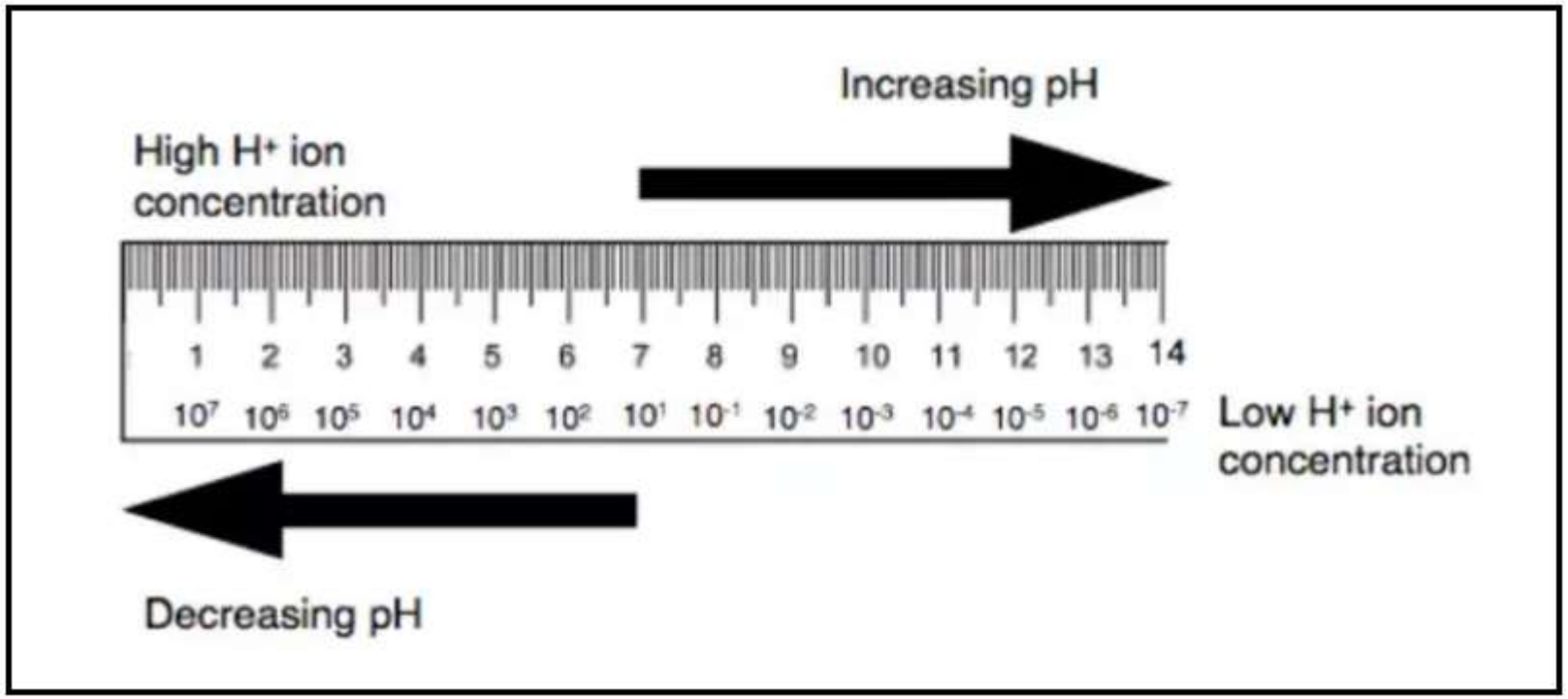
- pH indicates the concentration of Hydrogen ions in a solution.
- pH signify the power of hydrogen.
- The pH scale was formed from water's spontaneous dissociation.
- Water dissociates spontaneously into its H^+ and OH^- components.
- In pure water, the concentration of H+ ion is 1×10^{-7}.
- This H^+ ion concentration is neutral, meaning it is neither acidic nor alkaline.

… What is pH?

- When the concentration of H^+ ions is greater than 1×10^{-7}, the solution is acidic; when the concentration is less than 1×10^{-7}, the solution is alkaline.
- Low pH indicates a high concentration of H^+ ions; high pH indicates a low quantity of H^+ ions.
- Therefore, the pH scale is inversely proportional to the concentration of H^+ in any particular solution and proportional to the concentration of OH^- ions.

$$pH = -Log10\ [H+]$$

- Since pH can be affected by chemicals in the water, pH is an important indicator of water that is changing chemically.
- pH is reported in "logarithmic units".
- Each number represents a 10-fold change in the acidity/basicness of the water.
- Water with a pH of five is ten times more acidic than water having a pH of six.



- When the pH changes by 2 units, the concentration of hydrogen ions changes by a factor of 100. As a result of this relationship, the pH scale is logarithmic.

pH Meter

- The history of the pH meter can be traced back to the early 20th century. In 1909, German chemist Fritz Haber and his student Zygmunt Klemensiewicz proposed the concept of the glass electrode, which formed the basis for modern pH measurement.
- However, it was not until 1934 that an American chemist named Arnold Beckman introduced the first electronic pH meter.
- An instrument referred to as a pH metre is utilised for accurate pH measurement.
- The pH metre operates on a potentiometric basis.
- As the acidic solution has a bigger positive charge (H^+ ion) than the alkaline solution, the acidic solution has a greater capacity to generate current.
- The pH metre calculates the pH by measuring the potential difference (voltage) between a test solution and a standard or known solution.
- Hence, it works like a Voltmeter. In order to complete the circuit, two electrodes must be joined.
- The full circuit permits electric current to flow.

Principle

- The fundamental principle behind a pH meter lies in potentiometric measurement.
- It involves detecting the variation in electrical potential between two electrodes: a pH electrode and a reference electrode.
- The pH electrode is specifically designed to respond to changes in hydrogen-ion concentration, while the reference electrode provides a stable electrical potential.
- By comparing these two potentials, the pH meter can determine the acidity or alkalinity of the solution.

Definition of pH Meter

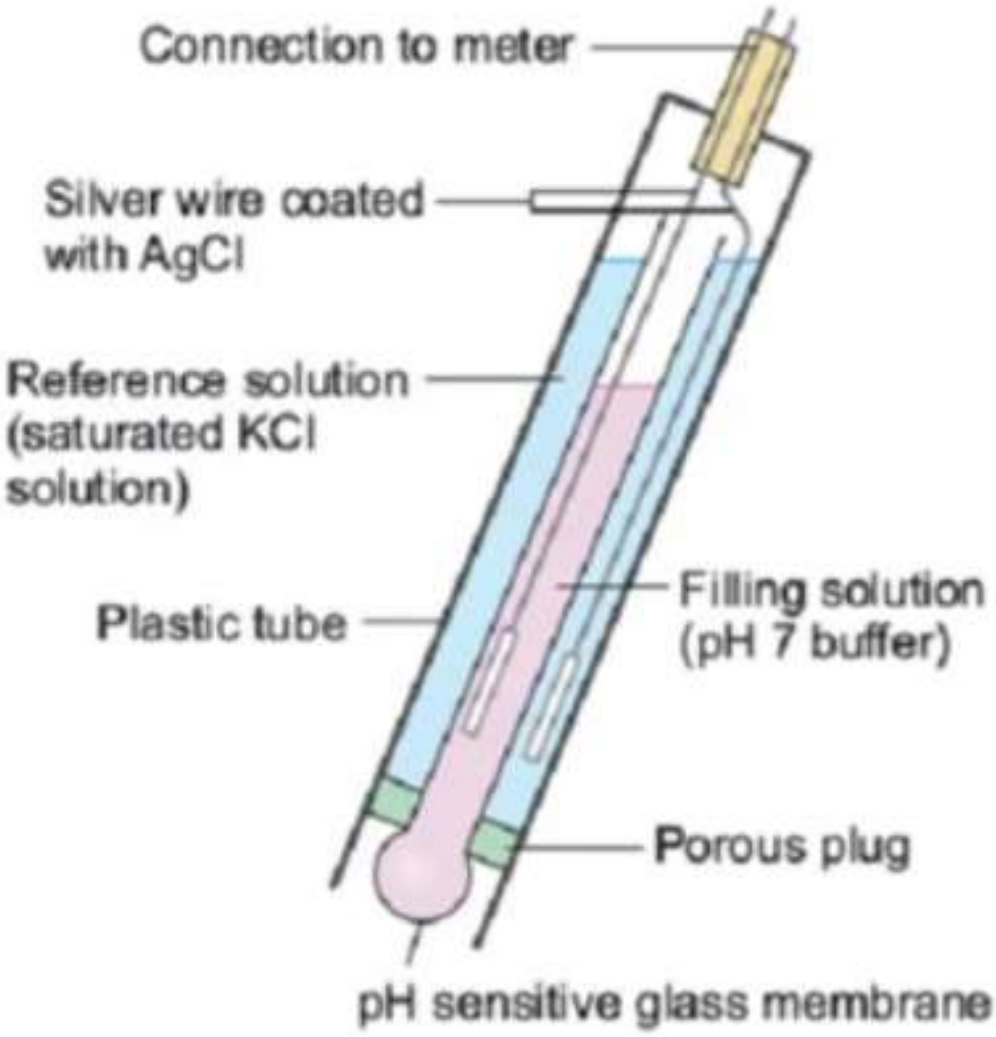
- **A pH meter is a scientific instrument that measures the acidity or alkalinity of water-based solutions by detecting the electrical potential difference between a pH electrode and a reference electrode. It provides precise pH measurements and is widely used in laboratories, quality control, and various scientific and industrial applications.**

pH Meter Working Principle

- The principle of operation for a pH meter is based on the exchange of ions between the sample solution and the inner solution of the glass electrode.
- This exchange occurs through the glass membrane, allowing the pH meter to measure the acidity or alkalinity of the solution.
- A pH meter consists of a pH probe that conducts electrical signals to the pH meter itself, which then displays the pH value of the solution.
- The pH probe comprises two electrodes: a sensor electrode and a reference electrode.
- The sensor electrode is filled with a pH 7 buffer, while the reference electrode is filled with saturated potassium chloride solution.
- The sensor electrode bulb is coated with metal salts and silica, forming a porous glass membrane.

… pH Meter Working Principle

- When the pH probe is immersed in a sample solution to measure the pH, hydrogen ions accumulate around the bulb and replace the metal ions within the electrode.
- At the same time, some metal ions from the glass electrode transfer to the sample solution.
- The reference electrode, which has low sensitivity or complete insensitivity to pH changes, provides a constant voltage.
- This voltage generates an electrical current that is captured by a silver wire, creating a potential difference related to the activity of hydrogen ions.
- The pH meter compares this voltage to the reference electrode and converts it into a pH value.
- An increase in acidity of the solution leads to a higher concentration of hydrogen ions, which in turn increases the voltage measured by the pH meter.
- Consequently, the pH reading on the pH meter decreases. Conversely, an increase in alkalinity or the concentration of hydroxyl ions reduces the voltage, resulting in an elevated pH reading on the pH meter.


Connection to meter
Silver wire coated with AgCl
Reference solution (saturated KCl solution)
Plastic tube
Filling solution (pH 7 buffer)
Porous plug
pH sensitive glass membrane