Definition of pH and pH Testing Tools

Definition

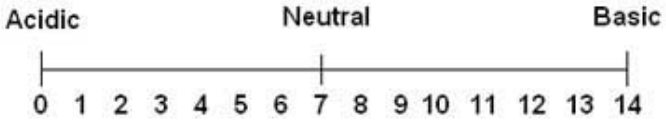
Hydrogen ion (H^+) concentration of a solution defines if a solution is "acidic" or "basic". Acidic solutions have higher H^+ concentrations and basic solutions have lower H^+ concentrations. The standard unit for this is called a "pH value".

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

$[H^+]$ = hydrogen ion concentration

This means that as the pH value decreases by 1, the hydrogen ion concentration increases by 10 times (ex. A pH value of 1 has an H^+ concentration of 0.1 M whereas a pH value of 2 has an H^+ concentration of .01 M).

Solutions with pH values between 0 and 7 are acidic (ex. orange juice, vinegar, battery acid, etc.) and liquids with pH values between 7 and 14 are basic (ex. lye, ammonia, bleach, etc.).



Maintaining and controlling proper pH levels is essential to many agricultural, industrial and environmental processes. In agriculture, proper pH of the soil ensures the best growing crop. For drinking water, processing plants have to control pH in order to produce safe drinking water. Environmentally, pH monitoring and control are critical to prevent damage or deterioration of the quality of all plant, animal and human life.

Several different testing methods are available for measuring pH values:

pH paper - Typically called litmus paper, these small strips of paper are impregnated with a chemical indicator. When the paper is immersed in a liquid solution, the paper will turn color which is then compared to a color chart showing pH values. The only problem with pH paper is limitation of accuracy and results can be skewed by colored or turbid solutions.

pH strips - pH strips are very similar to pH paper, but they typically use a plastic strip with a paper or cloth square impregnated with the same types of chemical indicators.

pH meters - When accurate measurements are needed, a pH meter should be used. There are a wide variety of pH meters ranging from small compact pen-style meters to larger bench top meters. Bench top meters are generally more accurate and have the ability to be used with a wide variety of different pH probes for different applications, while a compact pH pen is easier for taking quick measurements in the field. A meter will also be more accurate if it has **Automatic Temperature Compensation (ATC)**.

pH varies with temperature and a meter with ATC can automatically adjust for this. For example, a pH 4.01 buffer at 25°C is 4.01. However, if the same buffer is heated to 90°C, the pH meter would read 4.20 without ATC. If the meter had ATC it would still read 4.01. ATC is important because no matter what the temperature of your solution, the pH value would be the same as if it were at room temperature. This gives the user a reference point to compare different samples.

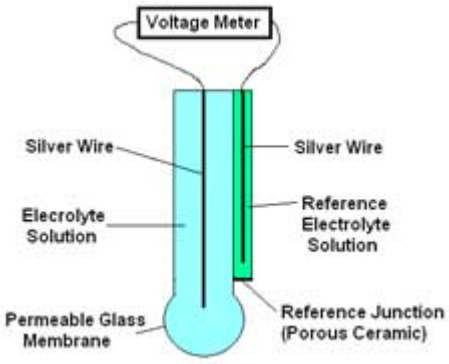
pH Probes

A pH probe has a very similar setup of a simple battery, using metals and salt solutions to create

electric potential. The only difference is the glass membrane separating the metal and salt solution from the unknown liquid. The structure of the porous glass membrane only allows for small hydrogen ions to interact, making the electrical potential associated with hydrogen ion concentration. Since pH is a measurement of hydrogen ion concentration, the voltage of the probe can be converted into a pH value.

Single-Junction Reference electrodes are considered as general use electrodes. They typically consist of a Silver/Silver Chloride (Ag/AgCl) reference and will work fine for use in most applications but cannot be used in solutions that include heavy metals (ex. silver, iron and lead), proteins, organics (ex. acetone), low ion concentrations (ex. distilled water), high ion concentrations and sulfides. If used with any of these solutions, the electrode can become contaminated and will need to be replaced.

Single Junction Reference

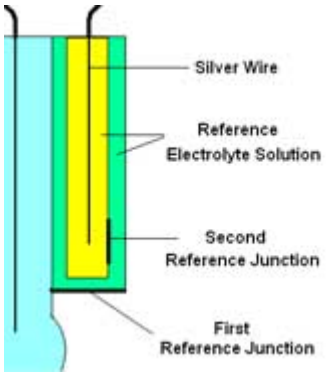


Calomel Reference electrodes consist of a Mercury/Mercury Chloride (Hg/Hg_2Cl_2) reference which allows them to work in solutions containing proteins, organics, low ion activity and heavy metals.

PTFE Resin Junction Reference electrodes are designed for applications where the solution to be measured can clog the reference of a standard electrode. These types are best for use with solutions such as paints, gels and pastes.

Double-Junction Reference electrodes are very similar to a single-junction reference electrode, but they have two reference junctions to filter out any potential contamination of the reference electrode. This allows it to work in the same applications as calomel reference electrodes as well as in highly concentrated solutions.

Double Junction Reference



Silicon Chip Sensor or ISFET sensors will still have a porous reference junction, but do not have a glass membrane. In place of the glass membrane is a silicon chip sensor. This means there is very little maintenance, they can be stored dry, are very easy to clean and will last much longer than glass membrane electrodes. Silicon chip sensors are used mostly in food, beverage, cosmetic and pharmaceutical applications where glass electrodes are prohibited.

For information on calibration, storage and maintenance of pH probes, see the Calibration and Maintenance of Water Quality Meters Tech Info Doc.