

Introduction

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.

pH is a numeric scale used to express a solution's acidity or alkalinity. Acidity or alkalinity are terms that refer to a solution's concentration of hydrogen ions. The greater the concentration of hydrogen ions the more acidic the solution; fewer hydrogen ions and a solution is considered alkaline.

The pH scale ranges from 0 to 14. Seven is the midpoint at which a solution (such as distilled water) is neither acid or alkaline. A pH lower than seven indicates more acidic solutions like vinegar (3.0 pH), sulfuric acid (1.2 pH) or orange juice (3.7 pH). pH values higher than seven represent alkaline or "basic" solutions such as sodium hydroxide (pH 13), ammonia base household cleaners (pH 12), and potassium hydroxide (pH 14).

Testing Tools

The first step in controlling pH is measuring it. Today pH can be measured by various methods including pH paper, digital readout pocket testers, portable and bench top meters.

pH paper is an inexpensive and quick way to check pH. Strips of paper are impregnated with a chemical indicator. This indicator, when immersed in a sample liquid, turns the paper test strip a specific color. The pH of the sample liquid is determined by visually comparing the color of the test strip to a standard chart that is provided. These indicators are available for every pH range but have limitations to their accuracy. They can be particularly difficult to interpret when dealing with colored or turbid samples.

An alternative to pH paper is the pocket tester. Convenient and easy to carry, these testers are ideal for field use. pH tests can be made quickly without having to take a sample back to the laboratory. Pocket testers provide enough accuracy for general applications and are relatively inexpensive.

When more accuracy is required, portable meters are a good choice over the pocket tester. Most portable meters are larger in size than pocket pH testers. They are durable and well suited for accurate pH readings in the field. They use a wide variety of replaceable pH electrodes for individual applications and conditions.

Bench top meters are found mainly in testing or research laboratories. They are generally more expensive but offer

increased accuracy and more testing options. Bench top meters also use a wide variety of replaceable pH electrodes.

Types of Electrodes

pH electrodes consist of a general purpose glass electrode (measuring electrode) and a reference electrode. They are built into one electrode and referred to as a combination pH electrode. Combination pH electrodes are filled with a salt solution: a mixture made up of Potassium Chloride (KCl) saturated with a silver/silver chloride (Ag/AgCl) reference solution. The combination electrode is ideal for general purpose applications.

Because standard electrodes have silver in the reference solution inside of the electrode, there are a number of applications where this type of electrode cannot be used. The following are solutions which cannot be measured with general purpose electrodes.

- Heavy metals such as silver, iron and lead.
- Proteins.
- Organics such as acetone.
- Low ion solutions such as distilled water.
- High sodium concentrations such as solutions containing large amounts of salts.
- Sulfides.

If a sample contains any of these contaminants, the pH electrode may work for only a short period of time before it fails.

To check the pH of the above mentioned solutions, the following electrodes can be used:

Colomel Reference electrodes are designed to work in solutions containing proteins, organics, low ion activity and heavy metals. They are filled with Mercury/Mercury Chloride (Hg/Hg₂Cl₂) reference solution.

Double-Junction Reference electrodes are designed to work in the same applications as the colomel electrode as well as work in highly concentrated solutions. This is due to the presence of two reference junctions to filter out any potential contamination of the reference electrode.

Teflon Junction Reference electrodes are designed for applications where the solutions to be measured can clog the reference of a standard electrode. Teflon Junction Reference electrodes are recommended when dealing with solutions like paints, gels and pastes.

Electrode Care-Preparing the pH Electrode to Measure Solutions

The pH electrodes are shipped moist with storage solution. On occasion, after an electrode has been sitting in storage for a period of time, white crystals may appear near the

bulb of the electrode or around the electrode cap. These crystals result from the potassium chloride solution (KCl) that has evaporated and crystallized. Prior to using the electrode for the first time, rinse the electrode with some distilled water, and condition it in a buffer solution for about 10–20 minutes.

Electrode Conditioning

1. Remove the protective cap from the bottom of the sensor and rinse the electrode with distilled or deionized water.
2. Place the electrode in a beaker of one of the following liquids for one hour to rehydrate the electrode.
 - a) Potassium Chloride (KCl), 3.8 or 4.0 molar concentration.
 - b) 4.01 Buffer Solution.
 - c) 7.00 Buffer Solution.
 - d) Tap water.
3. After one hour, rinse the electrode with distilled water. You are now ready to calibrate the meter and take measurements.

Calibration

How do you calibrate? To properly calibrate a pH meter, you must choose a minimum of two buffers for a two point calibration*, one always being pH 7, and a second point that covers the expected pH of your sample. For example, if you are measuring an acidic solution (pH below 7), you would choose the pH 4.01 and 7.00 buffers to calibrate the meter. Likewise, if you were measuring mostly basic samples (pH above 7), you would choose pH 7.00 and pH 10.00 buffers for calibration.

Some meters refer to calibration as standardized and slope. To standardize a pH meter means to calibrate at a pH of 7.00. After doing this, you slope the meter to either the pH 4.01 or 10.00 buffers.

**Except pH meters that have only a 1-point calibration feature.*

Electrode Storage

After measurements have been made, the electrode should be stored in a manner which will keep the bulb of the electrode moist or hydrated.

All electrodes are shipped with a protective cap, also called a “rubber boot”. This cap can be used to hold a small amount of liquid. Add a few drops of potassium chloride (KCl) or 4.01 buffer solution to the cap. Then place the cap back on the electrode. This method works for long or short term storage.

The electrode can be placed in a beaker or an electrode saver bottle filled with KCl solution. Buffers with a pH of 4.01 or 7.00 are also good for storage. For short term storage regular tap water can be used. Do not use distilled or deionized water.

Commonly Asked Questions

- Q.** What is ATC?
- A.** ATC (Automatic Temperature Compensation) is a option found on pocket testers and handheld and benchtop meters.
- Q.** Why is it used?
- A.** pH is affected by the temperature of the solution that is being measured. 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 it 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.
- Q.** How is this done?
- A.** Meters with ATC accept one of several types of temperature probes or have a temperature sensor built into the electrode. These probes or electrodes measure the temperature of the sample and determine the pH value at that temperature.
- Q.** Do pH meters need calibration?
- A.** Yes. Before taking the pH measurement of your solution, you must calibrate the pH meter. Particularly if it has been stored or used to test a pH range that vastly differs from the one you currently need to test. When you calibrate a meter, you are simply checking and fixing the pH meter and probe ensuring that it reads pH correctly.

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