Getting pH Measurements Right

Small Cause, Large Effect: Webinar on October 9

The pH value is one of the most important and therefore also one of the most frequently measured quantities in analytical chemistry. Sometimes, a simple pH test strip is sufficient for making a rapid check; precise pH meters are, however, required whenever accurate measuring results are needed. Such a pH meter is available in practically every laboratory and is generally ready for use at a moment's notice. The measured pH value can be read off the pH meter directly and can also often be archived immediately in compliance with GLP. However, in order to verify the accuracy of the measured value, the following points should always be considered before taking a pH measurement.

The pH Measuring Instrument

A pH meter is a high-resistance voltage meter. It uses an electrochemical method involving a pH glass electrode to determine the pH value of a solution. The mathematical connection between the activity a_M of an ion in solution and the potential measured at the pH electrode is described in the Nernst equation. A pH meter must meet certain prerequisites for optimum accuracy and reproducibility.

- Calibration: Depending on the required accuracy, a pH meter should permit multipoint calibration across the pH range in which the samples are to be found.
- Temperature compensation: According to the Nernst equation, the pH value is dependent on the temperature of the samples. Modern pH meters can compensate for this temperature impact through simultaneous measurement of sample temperature.
- Test setup: Whether or not a sample is stirred, the best way to obtain reproducible results is to use a firmly installed setup (stand, stirrer, position of the electrode in the measuring vessel).

The pH Electrode

Selecting a suitable pH electrode is a crucial stage of the process of purchasing a pH meter. Selection of an electrode should be based on the characteristics of the sample (pH value, temperature, consistency, matrix). Particular attention should be paid to selecting a suitable reference electrolyte and diaphragm.

Calibrating the Measuring System

The quality of a pH measurement depends on the calibration of the measuring system (pH meter and pH electrode). The rule of thumb: the more exacting the accuracy requirements, the greater the amount of buffer solutions necessary for calibration. The pH value of the sample should be within the pH range covered by the buffer solutions.

External Actuating Variables

Both the measured pH value and the time required to obtain a stable value are dependent on many factors. If the temperature of the sample changes during the measurement, this can cause the pH value to drift if the measuring instrument used is not equipped with temperature compensation.

In order to obtain a pH value that is representative for the sample, nonhomogeneous solutions should be stirred in advance of (or ideally during) the measuring process. The stirring rate and the position of the pH electrode inside the measuring vessel can, however, also have an effect on the result.

Cleaning and Storage

Care of the pH glass electrode is the key to obtaining precise and reliable results when measuring pH values. Constant drift or a prolonged response time before a stable value is achieved can usually be attributed to contamination of the glass membrane or diaphragm, although in some cases the sensor may also have mechanical damage. The pH electrode should be cleaned at regular intervals with suitable cleaning solutions. This can significantly increase its service life. It is, however, also important to minimize contact while cleaning the sensor in order to avoid mechanical damage.

Contact
Dr. Christian Haider
Metrohm AG Herisau, Switzerland
hc@metrohm.com
www.metrohm.com