Ensuring maximum accuracy in pH measurement

Calibration, adjustment and verification

A variety of tests can be carried out in the laboratory to ensure the accuracy of pH sensors.

When it comes to pH measurements, a reliable measured value is essential. This is because fluctuating pH values or pH values outside of a specified range can have serious consequences for product and plant safety. Various procedures can be used to test and document whether the connected pH sensor is reliable at recording measured values. But which procedure is used when? When do you calibrate, when do you adjust and when is verification useful or even necessary?

Calibration

The purpose of calibration is to find out if the measured value of a pH sensor compares to that of another device. This calibration represents a snapshot, which explains why the procedure needs to be repeated at defined intervals. It requires the use of pH buffer solutions with a specific pH value. As a traceable standard, the pH buffer offers accredited reliability and safety. With regard to the calibration process itself, a distinction is made between a 1-point calibration and a 2-point calibration. With a 1-point calibration, the pH sensor is immersed in a buffer solution with a known pH value. A transmitter is then used to read the measured value. If, for example, a buffer solution with pH 7 is used and the transmitter displays a value of pH 7.2, this represents a clear deviation from the set point.
With a 2-point calibration, however, two different buffer solutions are used to record both the zero point and the slope. Depending on the requirements that need to be met within the plant, certain limit values may exist for the slope, for example. This is because the lower the slope of the sensor, the less accurate the measurement.
If no discrepancies are detected during calibration, the pH sensor can be reinstalled in the process and will provide reliable measured values. However, if there is a deviation from the set point or from the previous adjustment, a pH adjustment must be carried out in the second step.

Adjustment

The aim of adjustment is to compensate for the deviation established during calibration by entering an offset. The focus is on adjusting the pH measuring system so that it is as accurate as possible.
With a 1-point adjustment, as with calibration, the sensor is immersed in a buffer solution and the deviation from the set point is identified.
An offset, also called a pH buffer set point, is then stored in the transmitter, which corrects the value accordingly.
With a 2-point adjustment, the zero point and the slope are determined and the deviation from the previous adjustment is calculated. The newly recorded values for the slope and zero point are subsequently replaced.
Unlike calibration, adjustment involves direct intervention in the measuring system.

Verification

After the sensor has been adjusted, an optional verification can be performed. This is used to verify the result and prove that an adjustment was successful and that the pH values of the buffer solutions are recorded correctly. In some sectors, such as the pharmaceutical industry, verification is often included in the standard

Overview

Calibration

- Detects deviations
- Snapshot
- Can be performed using one or two buffer solutions
- 1-point calibration: detects deviation from set point
- 2-point calibration: records zero point and slope

Adjustment

- Direct intervention in the measuring system
- 1-point adjustment: compensates for deviation by entering an offset
- 2-point adjustment: zero point and slope values of previous adjustment are replaced

Verification

- Verifies an adjustment
- Checks if deviations are within specified limit values

An offset value is stored during adjustment to ensure that the measurement is accurate.

procedure and is part of the Standard Operating Procedure (SOP). Following a 1-point adjustment, the pH sensor is immersed in a buffer solution that is different from the adjustment buffer solution previously used. With the desired, optimal linear behavior, the deviation of the measured value should not exceed 0.02 pH (pH 2 – pH 9) or 0.05 pH (pH 10 – pH 12). If verification is carried out following a 2-point adjustment, the pH sensor is immersed in a buffer solution whose pH values are situated between the two adjustment buffers. With this type of verification, statistical error propagation based on the two pH buffer solutions is taken into account: In the pH 2 to pH 9 range, the deviation should not exceed 0.028 pH. In the pH 10 to pH 12 range, the value is 0.053 pH.

All three steps ensure the accuracy of the sensor and yet each has different objectives and results. Deviations are detected during calibration, which are rectified by means of adjustment and cross-checked during verification. These steps reliably ensure optimal recording and mapping of the measured value by the pH sensor.