

Conductivity Standard Solutions are just water and salt, or?

Aren't Conductivity Reference Solutions just water and salt?

Before pursuing the question in detail, some of the basic issues are listed below in order to comprehend the matters involved.

Primary, Secondary Standards and Working Solutions

All reference solutions used for dialysis must adhere to national standards. In the U.S.A. the NIST (National Institute of Standards and Technology) and for Germany the PTB (Physikalisch-Technische Bundesanstalt) is responsible for these standards.

Primary Standards are solutions that have been calibrated strictly according to the NIST or PTB standard measurement equipment.

Secondary Standards are solutions that have been calibrated with a measuring instrument adjusted with a Primary Standard.

Working Solutions are solutions that have been calibrated using a measuring instrument adjusted with a Secondary Standard.

Due to the error factors, measuring uncertainty will be continuously increased and with every step, the uncertainty of the current measuring system is added to the imprecision of the measured value. Thus, with each step further away from Primary Standards, less accuracy is achievable. By definition, the

Primary Standard achieves the highest possible accuracy whereas the Working Solution is the least accurate.

Uncertainty of Measurement

It is nowadays customary to claim an accuracy of 0.5% (for example) for a solution. The measuring accuracy is usually determined simply by taking a series of measurements from the solution and determining the accuracy from the deviation between the measurements.

What is uncertainty?

In ordinary use the word "uncertainty" does not inspire confidence. However, when used in a technical sense as in "measurement uncertainty" or 'uncertainty of a test result' it carries a specific meaning. It is a parameter, associated with the result of a measurement (e.g. a calibration or test) that defines the range of the values that could reasonably be attributed to the measured quantity. When uncertainty is evaluated and reported in a specified way it indicates the level of confidence that the value actually lies within the range defined by the uncertainty interval.

How does it arise?

Any measurement is subject to imperfections; some of these are due to random effects, such as short-term fluctuations in temperature, humidity and air-pressure or variability in the performance of the measurer. Repeated measurements will show variation because of these

random effects. Other imperfections are due to the practical limits to which correction can be made for systematic effects, such as offset of a measuring instrument, drift in its characteristics between calibrations, personal bias in reading an analog scale or the uncertainty of the value of a reference standard.

Why is it important?

The uncertainty is a quantitative indication of the quality of the result. It gives an answer to the question: How well does the result represent the value of the quantity being measured? It allows users of the result to assess its reliability, for example for the purposes of comparison of results from different sources or with reference values. Confidence in the comparability of results can help to reduce barriers to trade. Often, a result is compared with a limiting value defined in a specification or regulation. In this case, knowledge of the uncertainty shows whether the result is well within the the acceptable limits or only just makes it. Occasionally a result is so close to the limit that the risk associated with the possibility that the property that was measured may not fall within the limit, once the uncertainty has been allowed for, must be considered. Suppose that a customer has the same test done in more than one laboratory, perhaps on the same sample, more likely on what they may regard as an identical sample of the same product. Would we expect the laboratories to get identical results? Only within limits, we may answer, but when the

results are close to the specification limit it may be that one laboratory indicates failure whereas another indicates a pass. From time to time accreditation bodies have to investigate complaints concerning such differences. This can involve much time and effort for all parties, which in many cases could have been avoided if the uncertainty of the result had been known by the customer.

The explanation above is also available at: http://www.ukas.com/new_docs/technical-uncertain.htm.

More information on the subject of measuring uncertainty is available on the internet at following addresses: <http://physics.nist.gov/Pubs/guidelines/sec8.html>
<http://www.measurementuncertainty.org>

Why use the measuring uncertainty?

It's the standard. NIST, PTB and all international organizations only use this way to publish the "accuracy."

Too complicated?

To have a coarse approximation to the widely used "accuracy" divide the value of Uncertainty by 2.

Examples:

1. IBP Solution 14.00 mS/cm with a Combined Standard Uncertainty of $\pm 0.15\%$.

To get the "accuracy" divide the Uncertainty by two: Accuracy is about $\pm 0.075\%$

2. A solution has an accuracy of 0.5%: This leads to a Uncertainty of about $\pm 1\%$.

National Standards

The national standards for Conductivity Reference Solutions are defined by the different organizations and in some cases solutions are also available from them.

In the USA, NIST (<http://www.nist.gov>) and in Germany, PTB (<http://www.ptb.de>).

There is a multinational agreement between the national institutes for the mutual acknowledgement of measuring results, the CIPM Mutual Recognition Arrangement (CIPM-MRA). This agreement was signed in 2000 (<http://kcdb.bipm.fr>).



The quality of the measuring results must be proven by international comparison, the so-called key comparisons. After passing extensive international test procedures, the measurement methods/possibilities of the individual institutes are published on the internet at <http://kcdb.bipm.fr>.

The German PTB can give an absolute determination of the conductivity of solutions without calibration. The measurement uncertainty of these primary standards is better than $\pm 0.15\%$ and with a lower conductivity can even achieve values better than $\pm 0.1\%$.

The NIST offers primary standards only in very restricted values. The other NIST Conductivity-SRMs are measured with this primary SRM (Standard Reference Materials) calibrated measuring cells and are, as a result, Secondary Standards. In the NIST calibration certificate papers, the value 10000 $\mu\text{S}/\text{cm}$ is declared as having a measurement uncertainty of 0.27%.

Reference Solutions are just water and salt?

Correct, but to be precise, de-ionized water and depending on the solution either NaCl or KCl, too. NaCl is useful with reference-solution values from 2 mS/cm as the temperature-coefficient approaches that of the dialysate. KCl is used with low conductivity values. In order to guarantee the stability of the solution, the solutions must have the same carbon dioxide content as the ambient air.

Make no mistake, solutions with the unparalleled low measuring uncertainty offered by IBP are high tech, high precision products backed by years of careful research and international standards.