Reagecon

A CALIBRE SCIENTIFIC COMPANY

Conductivity Standards

A range of standards designed to optimise the confidence of analysts in their results


CONDUCTIVITY STANDARD 84µS/cm
Certified Traceable to N.I.S.T.
500ml
Keep tightly closed when not in use
TEMPERATURE COEFFICIENT OF VARIATION
T(°C) CONDUCTIVITY µS/cm
5 53.02
10 60.34
15 67.61
16 69.25
17 70.89
18 72.52
19 74.16
20 75.80
21 77.44
T(°C) CONDUCTIVITY µS/cm
22 79.08
23 80.72
24 82.36
25 84.00
30 92.19
35 100.92
40 109.21
45 118.05
50 126.80
Average Temperature Coefficient (0 - 50°C) = 1.949%/°C
Store in original, unopened
between 5°C and 30°C
atmospheric conditions
cap immediately after
fresh aliquot of conductivity
each use. Never pour
conductivity back into
When stored under
Laboratory practice
value is valid for the
the products shelf life
opened or unopened

Contents

About Reagecon

Reagecon, part of the Calibre Scientific Group of companies is one of the largest producers of Physical and Chemical Standards. The company is based in an 8,000 sq. metre facility that includes a large suite of manufacturing, quality control and research and development laboratories in Shannon, Ireland with sales offices in Shanghai and North America, Europe and the UK through our Calibre Scientific sister companies. Reagecon employs 100 people, 50% are chemistry or science graduates and most are involved in the development, production, testing, quality control and sales & marketing of over 10,000 product references that we currently produce. We have a very active R&D programme and develop and bring to market many hundreds of new standards, every year.

All Reagecon manufactured products are underpinned by and demonstrate our position as a centre of excellence in the science of Metrology. Product is manufactured, tested, and certified under the applicable ISO/IEC 17025 (A2LA Ref: 6739.03) or ISO/IEC 17034 (A2LA Ref: 6739.01) accreditation or ISO/IEC 17025 (A2LA Ref: 6739.02) for Calibration, in one of our 20 specially equipped laboratories.

The resulting product is classified within one of 54 product families, these families are then grouped and promoted under 7 main product headings, as listed below:-

- Electrochemistry Standards
- Cation and Anion Standards
- Pharmacopoeia Reagents and Standards
- Physicochemical Standards
- Total Organic and Inorganic Carbon Standards
- Volumetric Solutions for Titration
- Customised Standards and Reagents

Conductivity Standards

Summary of Features & Benefits

COMPREHENSIVE RANGE OF PRODUCTS
- Reagecon offers the widest range available on the market of aqueous standards from 1.3 µS/cm to 500,000 µS/cm

STABILITY
- Reagecon is the ONLY producer of low level, aqueous based, stable 1.3 µs/cm Conductivity Standard.

ACCURACY
- Accurate to ± 1% of target value, with the exception of 1.30 µS/cm which has a specification of ± 0.05 µS/cm from target value

QUALITY PRODUCTION
- Standards are tested using Accredited test methods to ISO17025

FULLY CHARACTERISED TEMPERATURE VALUES
- Fully characterised temperature coefficient of variation printed on all product labels.

NON-HAZARDOUS
- No shipping, storage or disposal issues

TRACEABILITY
- All directly traceable to N.I.S.T. standard reference materials. These products meet the specification requirements of all the major Pharmacopoeias

COMPREHENSIVE CERTS OF ANALYSIS
- Certificates of Analysis for all batches

Introduction

Reagecon is the largest producer of aqueous based Conductivity Standards and is credited with the invention of low level aqueous standards. The company is still the only producer with the capability to manufacture and stabilise these products at such low levels of conductivity.

The changing requirements and the increasing demands being placed on analysts have become more onerous in recent years than at any other time in the history of analytical science. Analysts measuring conductivity must meet demands for increased accuracy and for measurement of more varied and challenging sample types whilst also providing greater speed, efficiency and cost effectiveness for their analysis.

Compliance with this changing situation can be achieved through strict adherence to Good Laboratory Practice (GLP). High quality instrumentation, Validation, Calibration and Service coupled with Training, Method Validation and the use of high quality Standards and Control Materials are all major aspects of Good Laboratory Practice. Conductivity measurement is one of the key parameters for which Reagecon offer a comprehensive, turnkey solution to meet all these GLP requirements.

Extensive range of values

At the heart of Reagecon's approach to conductivity measurement is our comprehensive range of Conductivity Standards. The products are tested using our ISO 17025 accredited methods are fully characterised and certified for Accuracy, Measurement Uncertainty, Stability and Traceability. Not only do such Standards accommodate the technical requirements of a high quality analytical result, but they also provide the other major demands of modern analytical chemistry i.e. proof that the result is correct and fit for purpose.

Reagecon offer over 45 different values of Conductivity and Total Dissolved Solids (TDS) Standards, ranging from as low as 1.3 µS/cm to as high as 500,000 µS/cm.

Reagecon Standard Value range of Conductivity Standards cover the entire range of calibration values pre-programmed into modern conductivity meters.

Reagecon Premium Value range of Conductivity Standards offers the user the widest available range of conductivity control standards. Additional values within the range of 1.3µS/cm to 500,000µS/cm may also available upon request.

Matrix Matched

The matrix of a solution is defined as "the components of the sample other than the analyte". In all analytical measurements, it is of utmost importance that the matrix of the standard and the sample are the same. As conductivity measurement is, in the main, a water quality measurement, the standard used should also have an aqueous matrix. Reagecon Conductivity Standards are all aqueous based, thereby eliminating any errors attributable to matrix mismatch.

Non-Hazardous

All Reagecon Conductivity Standards are aqueous and therefore they are non-hazardous.

This means Reagecon Conductivity Standards offer the following benefits over solvent-based Conductivity Standards

- Ease and cost of shipping, without the need to provide hazardous goods' paperwork
- Reduced Health & Safety requirements for storage and use
- Ease and cost of disposal, solvent-based Conductivity Standards require expensive specialised disposal to comply with environmental regulations

Guaranteed Stability

As a result of the extensive Research and Development in our innovative manufacturing process, Reagecon can guarantee the stability of their complete range of Conductivity Standards over their entire shelf life. The stability offered by Reagecon conductivity standards varies from that of their competitors in one vital area. Reagecon can guarantee that their conductivity standards will remain within specification, (up to their expiry date), right through their working life, regardless of when the bottle was first opened. This eliminates the need to open a fresh bottle for every measurement thereby reducing both purchasing and disposal costs.

The shelf life of Reagecon conductivity standards from their date of manufacture is given below. Reagecon 1.30 µS/cm conductivity standard is packaged in single-dose bottles and so no guarantee can be given on the multiple use of this standard.

Conductivity Value (µS/cm)	Shelf Life
1.3	3 months
5 & 10	6 months
20 – 147	12 months
200 - 500,000	18 months

Accuracy

All standards have a specification of ± 1%, except 1.30µS/cm, which has a specification of 1.25 – 1.35 µS/cm. This high level of accuracy enables the standards to be used as calibrators and/or controls in fulfilment of the most exacting industrial statutory requirements, for example the United States Pharmacopoeia Monograph for Water for Injection.

Accreditation

Reagecon's conductivity measurement has been covered in the scope of our accreditation to ISO 17025 "General Requirements for Calibration and Testing Laboratories" and its predecessor, EN 45001, since 1990. In the case of our range of Conductivity Standards, over 90% of values are accredited to ISO 17025. Achieving accreditation involves fulfilling many highly technical criteria, including fully validating our test methods and instrumentation systems and characterising our measurement uncertainty.

Reagecon's accreditation proves the technical competence of our personnel, the technical validity of our test procedures and the traceability of our measurements. Therefore, in purchasing a Conductivity Standard from Reagecon, not only do you have transparent traceability to primary standards, but you also have confidence that the standards are of a well-defined and tightly controlled specification.

All values are certified and traceable

Comprehensive Certificates of Analysis are available for Reagecon's Conductivity Standards, including detailed information on:

- Product Number
- Lot Number
- Expiry Date
- Mean Specific Conductance
- Date of Measurement
- Assay Limits
- Test Method Used
- Uncertainty of Measurement and Traceability Data

The complete range is traceable to primary standards from the United States National Institute for Standards and Technology (NIST). The traceability of these standards is proven by the inclusion of conductivity testing in Reagecon's ISO 17025 accreditation. It is a fundamental requirement of ISO 17025 that traceability is proven.

Characterised Temperature Coefficient of Variation

The temperature coefficient of variation and a table of conductivity variation with temperature are printed on the label of each bottle of Conductivity Standard. This feature provides the user with all the information necessary to use Reagecon Conductivity Standards across the full range of measurement temperatures encountered for their application.

Unparalleled Technical Support

Reagecon have been manufacturing conductivity standards for over 25 years. In that time, we have built up a vast resource of technical expertise on all aspects of conductivity measurement.

The members of Reagecon's Technical Services Department have written a comprehensive series of papers covering all the practical requirements for accurate conductivity measurement.

These papers are available via Reagecon's website www.reagecon.com. Our Technical Services team is always on hand to answer any questions regarding the selection and use of conductivity instruments, sensors and standards.

Conductivity Standards for Pharmaceutical Applications

The measurement of conductivity of Water for Injection (WFI) and purified water are of fundamental importance to the quality of many pharmaceutical products. Compliance with the regulatory requirements set out in USP & EP requires the use of high quality Conductivity Standards. Reagecon have developed a series of Conductivity Standards that are designed specifically to meet these requirements. This range includes Conductivity Standards formulated in accordance with the current European Pharmacopoeia specifications, along with Reagecon's 1.30 µS/cm Conductivity Standard, which is ideal for use as a Control Standard for these demanding applications.

Proof of the Correct Result and Regulatory Compliance

Reagecon's ISO 17025 accreditation combined with the proven stability of our range of Conductivity Standards means that users of Reagecon's Conductivity Standards can fully comply with GMP, GLP, USP, EP, ISO 17025 & ISO 9000 requirements for their own conductivity measurements. They can also achieve full traceability, improve their measurement accuracy and characterise the uncertainty of measurement of their own conductivity measurements.

Reagecon

Certificate of Analysis

ACCREDITED
CERT #6739.03

Conductivity Standard Solution

5 µS/cm @ 25°C

Product No:	CSKC5	Date of Measurement:	20/02/2023
Lot No:	CS523B6	Date of Sample Receipt:	20/02/2023
Expiry Date*:	18/08/2023	Date of Manufacture*:	20/02/2023

Specification: 4.95 - 5.05 µS/cm @ 25°C

Mean Measured Value: 5.05 µS/cm @ 25°C

Method:
The result reported above was determined by analysis of a sample of this lot taken at time of manufacture. Test Method used was TPCOND. This certificate relates solely to the sample as received by the laboratory, bearing the product code and lot number given above. The uncertainty of measurement has been calculated not to exceed ± 1% at 95% confidence level, k=2.

Metrological Traceability:
Measurement taken by comparison with standard prepared from National Institute of Standards and Technology (USA), Standard Reference Material 999 (Potassium Chloride). Electrode used for measurement: Platinised Platinum Dip Cell. Reference: ASTM D-1125 Method A.

Accreditation:
Reagecon Diagnostics Ltd. is accredited by the American Association for Laboratory Accreditation, under scope 6739.03, for the test method, TPCOND, used to generate the above result. This accreditation deems Reagecon competent on a quality systems level and a technical level to perform the tests on the scope of accreditation. Reagecon has the Quality Management Systems in place to ensure that each individual test result generated using TPCOND is technically valid and is supported by appropriate uncertainty measurements.

Date of Issue of the Certificate: 21/02/2023

Senior QC Technician: MALONE Eileen

Eileen Malone

All raw materials used to prepare this product are of high purity.
*The data# above is based on information supplied in writing by Reagecon Manufacturing.
Tested by Reagecon Quality Control Laboratories for Reagecon Manufacturing
This Certificate must not be reproduced except in full. Rev-QL001

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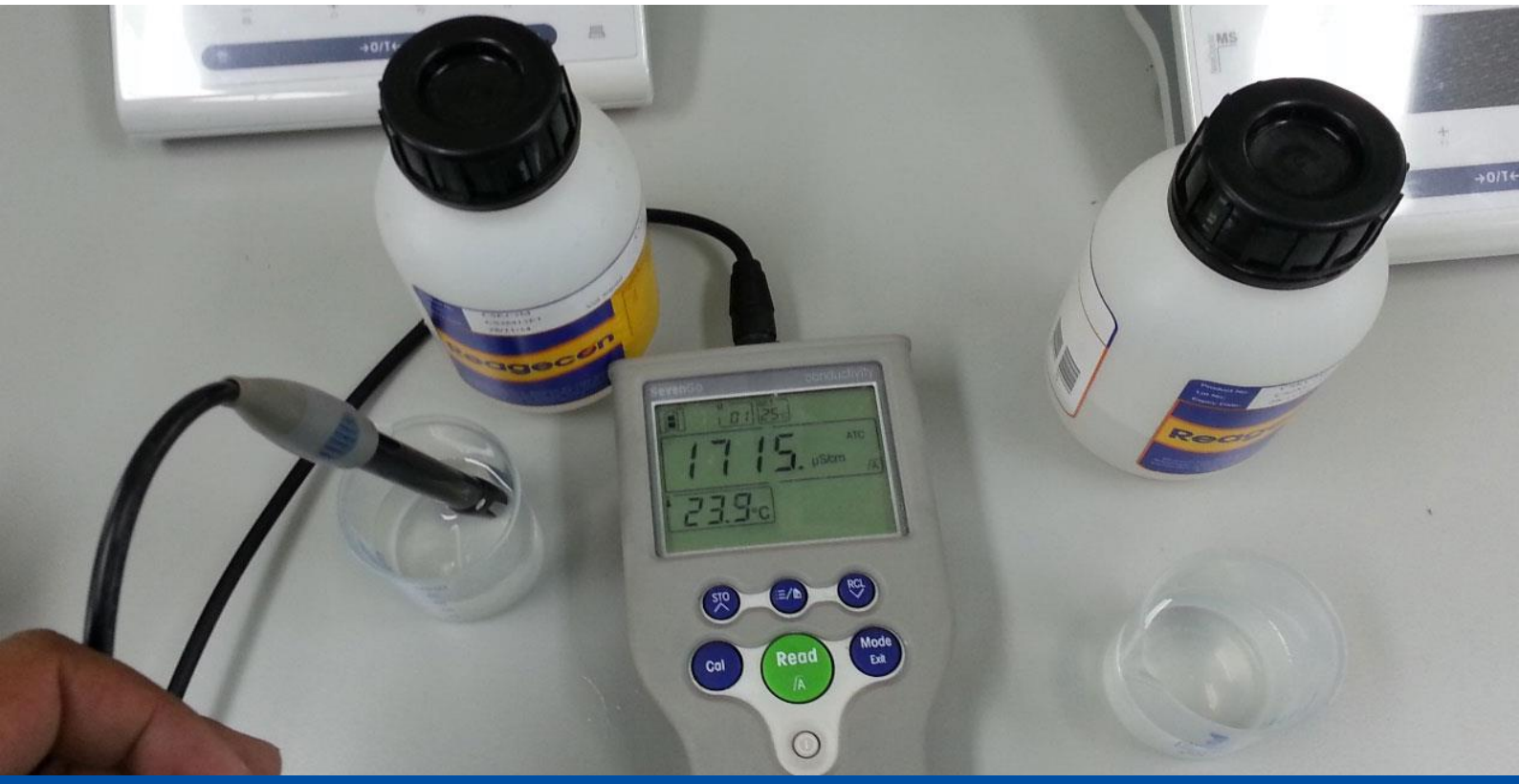
Reagecon's wide range of values of Conductivity Standards means that relevant control standards are available for all conductivity measurement applications, thus allowing users to validate their measurement systems and methods. This means that users of Reagecon Conductivity Standards can not only achieve the correct conductivity test result; but they can also prove that their test results are correct.



Conductivity Standards (Calibration Values)

Item No.	Description	Pack Size
CSKC84	84 µS/cm Conductivity Standard at 25°C	500ml
CSKCS	147 µS/cm Conductivity Standard at 25°C	500ml
CSKCL	1413 µS/cm Conductivity Standard at 25°C	500ml
CSKC12880	12,880 µS/cm Conductivity Standard at 25°C	500ml
CSKC111800	111,800 µS/cm Conductivity Standard at 25°C	500ml

Conductivity Premium Standards (Control Values)

Item No.	Description	Pack Size
CSKC13	1.30 µS/cm Conductivity Standard at 25°C	250ml
CSKC136	1.30 µS/cm Conductivity Standard at 25°C	6x250ml
CSKC5	5 µS/cm Conductivity Standard at 25°C	500ml
CSKC10	10 µS/cm Conductivity Standard at 25°C	500ml
CSKC1325	13.25 µS/cm Conductivity Standard at 25°C	500ml
CSKC15	15 µS/cm Conductivity Standard at 25°C	500ml
CSKC20	20 µS/cm Conductivity Standard at 25°C	500ml
CSKC238	23.8 µS/cm Conductivity Standard at 25°C	500ml
CSKC25	25 µS/cm Conductivity Standard at 25°C	500ml
CSKC50	50 µS/cm Conductivity Standard at 25°C	500ml
CSKC100	100 µS/cm Conductivity Standard at 25°C	500ml
CSKC150	150 µS/cm Conductivity Standard at 25°C	500ml
CSKC185	185 µS/cm Conductivity Standard at 25°C	500ml
CSKC200	200 µS/cm Conductivity Standard at 25°C	500ml
CSKC250	250 µS/cm Conductivity Standard at 25°C	500ml
CSKC300	300 µS/cm Conductivity Standard at 25°C	500ml
CSKC400	400 µS/cm Conductivity Standard at 25°C	500ml
CSKC500	500 µS/cm Conductivity Standard at 25°C	500ml
CSKC718	718 µS/cm Conductivity Standard at 25°C	500ml
CSKC1000	1000 µS/cm Conductivity Standard at 25°C	500ml
CSKC2M	2000 µS/cm Conductivity Standard at 25°C	500ml
CSKC2500	2500 µS/cm Conductivity Standard at 25°C	500ml
CSKC3M	3000 µS/cm Conductivity Standard at 25°C	500ml
CSKC5M	5000 µS/cm Conductivity Standard at 25°C	500ml
CSKC7M	7000 µS/cm Conductivity Standard at 25°C	500ml
CSKC8M	8000 µS/cm Conductivity Standard at 25°C	500ml
CSKC10M	10,000 µS/cm Conductivity Standard at 25°C	500ml
CSKC15M	15,000 µS/cm Conductivity Standard at 25°C	500ml
CSKC20M	20,000 µS/cm Conductivity Standard at 25°C	500ml
CSKC30M	30,000 µS/cm Conductivity Standard at 25°C	500ml
CSKC35M	35,000 µS/cm Conductivity Standard at 25°C	500ml
CSKC40M	40,000 µS/cm Conductivity Standard at 25°C	500ml
CSKC50M	50,000 µS/cm Conductivity Standard at 25°C	500ml
CSKC60M	60,000 µS/cm Conductivity Standard at 25°C	500ml
CSKC80M	80,000 µS/cm Conductivity Standard at 25°C	500ml
CSKC84M	84,000 µS/cm Conductivity Standard at 25°C	500ml
CSKC100M	100,000 µS/cm Conductivity Standard at 25°C	500ml
CSKC150M	150,000 µS/cm Conductivity Standard at 25°C	500ml

Item No.	Description	Pack Size
CSKC200M	200,000 µS/cm Conductivity Standard at 25°C	500ml
CS2513M	251.3 mS/cm Conductivity Standard at 25°C	500ml
CSKC300M	300,000 µS/cm Conductivity Standard at 25°C	500ml
CSKC350M	350,000 µS/cm Conductivity Standard at 25°C	500ml
CSKC400M	400,000 µS/cm Conductivity Standard at 25°C	500ml
CSKC450M	450,000 µS/cm Conductivity Standard at 25°C	500ml
CSKC500M	500,000 µS/cm Conductivity Standard at 25°C	500ml

Resistivity

Item No.	Description	Pack Size
RESNHCLA2	Resistivity A 0.1% Ammonium Chloride Solution at 25°C, acc. IEC 60112:2020	1L

TDS Standards

Item No.	Description	Pack Size
TDS10	Total Dissolved Solids (TDS) 10 mg/L Standard	1L
TDS50	Total Dissolved Solids (TDS) 50 mg/L Standard	1L
TDS100	Total Dissolved Solids (TDS) 100 mg/l Standard	1L
TDS250	Total Dissolved Solids (TDS) 250 mg/l Standard	1L
TDS500	Total Dissolved Solids (TDS) 500 mg/l Standard	1L
TDS1000	Total Dissolved Solids (TDS) 1000 mg/l Standard	1L
CS1382	Total Dissolved Solids (TDS) 1382 ppm NaCl at 25°C Standard	500ml
TDS1500	Total Dissolved Solids (TDS) 1500 mg/l Standard	1L
TDS2000	Total Dissolved Solids (TDS) 2000 mg/l Standard	1L

OBTAINING ACCURATE CONDUCTIVITY MEASUREMENTS

Authors: John J. Barron, Colin Ashton, Leo Geary & Bernard Gleeson – Reagecon Diagnostics Ltd, Shannon Free Zone, County Clare, Ireland

Reagecon
Delivering the Correct Result

Conductivity is an extremely common analytical technique. Due to the simplicity of the equipment required, it can be measured quickly and cheaply. However, there are a number of factors that need to be taken into account to ensure that these measurements are accurate and fit for purpose so that decisions made based upon conductivity test results are correct:

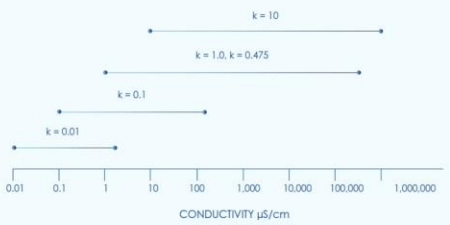
1 INSTRUMENT SELECTION

- Required accuracy of results is the overriding selection factor.
- Take account of the instrument's temperature measuring accuracy – this may be the biggest error source.
- Be aware of specifications stating the accuracy as "% f.s." – this means % of the full scale of the instrument's measuring range and not % of the measured value.

2 SENSOR SELECTION

Conductivity sensor selection is made based upon the conductivity range of the samples being measured. Modern conductivity sensors are capable of giving linear response over several decades; but it is not possible to cover the entire practical conductivity range with a single sensor. Figure 1(1) shows the linear ranges of sensors with different cell constants.

FIGURE 1 : TYPICAL MEASURING RANGES OF SENSORS WITH DIFFERENT CELL CONSTANTS (k)



NB. Ranges are k = 0.01 : 0.01 - µS/cm, k = 0.1: 0.02 - 200µS/cm, k = 1.0, 0.475 : 10.500, 000µS/cm, k = 10 : 1,000 - 1,000,000µS/cm

3 TEMPERATURE EFFECTS

Conductivity is a temperature dependent parameter. Table 1 gives the temperature dependency for a range of solutions.

SOLUTION	TEMPERATURE COEFFICIENT OF VARIATION %/ °C AT 25 °C
Ultrapure Water	5.5
NaOH 5%	2.01
NaOH 30%	4.50
HCl 5%	1.58
HCl 30%	1.52
KCl 5%	2.01
KCl 20%	1.68
Fresh water	~ 2.0

Conductivity instruments are equipped with a temperature compensation function. This has practical benefits, but also limitations:

- Comparisons of measurements made at different temperatures are possible, as the instrument reports an expected conductivity value at a reference temperature (usually 25°C).
- Field measurements are practical, particular with instruments equipped with non-linear temperature compensation specified in ISO 7888(3) (suitable for natural waters, such as groundwater and river water).
- Temperature compensation must be appropriate to the sample type.
- Temperature compensation relies on an assumed temperature effect and so is only an estimate.
- For high accuracy do not use temperature compensation; but ensure all the samples are at the same temperature.
- The Pharmacopoeias stipulate that temperature compensation cannot be used for the laboratory measurement of purified water samples(4,5).

4 SELECTION AND USE OF CALIBRATION STANDARDS

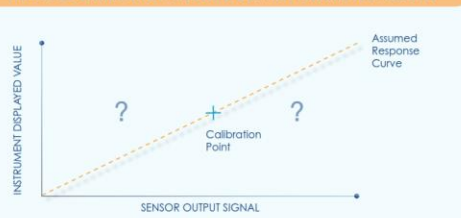
Conductivity instruments multiply the input signal from the sensor by the Cell Constant to give their reported value. The Cell Constant is assigned during calibration by measuring the response to a Calibration Standard. As all of the subsequent sample measurements will be affected by the calibration process, it is essential that the Calibration Standard is suitable and used correctly:

- It should be of high accuracy – your measurements cannot be more accurate than your Calibration Standard.
- It should be traceable to SI units (usually via traceability to primary standards, such as those produced by NIST). If this is not the case then your conductivity measurements are not traceable to SI units and so you are not entitled to quote your readings in SI units.
- Ideally, the manufacturer should hold ISO 17025(6) accreditation – this gives an independent guarantee of the traceability and validity of how its value was assigned.
- To ensure contamination does not occur, rinse the measuring container to drain before filling and rinse the sensor to drain with the Calibration Standard before placing it in the measurement aliquot. The same approach should be used when measuring samples.

5 PROOF OF THE CORRECT RESULT – THE ROLE OF CONTROL STANDARDS

Many analysts cover all of these previous points; but this does not give any proof that their sample measurements are correct. If the only standard used is the Calibration Standard then this assumes that the sensor and instrument give perfectly linear response. Apart from at the calibration value, this gives no knowledge of how your system performs:

FIGURE 2: CALIBRATION ALONE DOES NOT ASSURE TEST RESULTS



To give assurance of results requires the use of Control Standards and also an understanding that the role of the Calibration Standard is merely to accurately assign the Cell Constant. For the Calibration Standard selection:

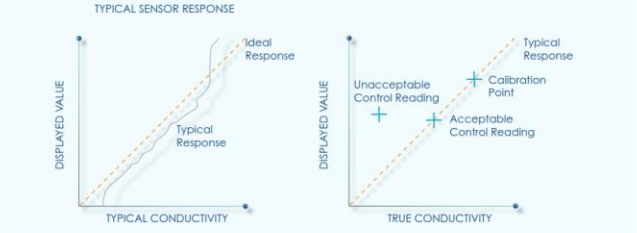
- If the instrument has pre-defined Calibration Standard values then use these values, as this will automate the calibration process.
- When measuring low conductivity then use a Calibration Standard near the upper end of the cell's linear response range (typically 200µS/cm for sensors with a nominal Cell Constant of 0.1cm-1) to limit errors from the instrument's resolution.
- Some instruments have a number of discreet overlapping measurement ranges that each use a separate Cell Constant and so each need a Calibration Standard.

If properly selected, the Control Standard gives full assurance of the correct result(7):

- The Control Standard should have similar properties to the samples – i.e. similar conductivity value and similar matrix (usually aqueous).
- If the samples have a wide range of conductivity values then a number of Control Standards will be required.
- The Control Standard should be handled as described above for Calibration Standards, to ensure contaminations does not occur.
- If an acceptable reading is obtained for the Control Standard then this not only proves that the instrument is functioning correctly; but also that the sensor gives linear response, the calibration process was performed correctly, temperature effects do not give significant errors, the operator has not contributed significant errors and that the entire measurement process yields valid results.

The Use Of Appropriate Control Standards Gives Full Confidence In The Complete Conductivity Measuring System And Method So That There Is Proof That The Conductivity Measurements Are Correct.

FIGURE 3: CONTROL STANDARDS ASSURE THE CORRECT RESULT



References

1. John J Barron & Colin Ashton, Reagecon Diagnostics ,"The Selection, Use, Care and Maintenance of Sensors for Accurate Conductivity Measurement" *
2. John J Barron & Colin Ashton, Reagecon Diagnostics, "The Effect of Temperature on Conductivity Measurement" *
3. ISO 7888 "Water Quality – Determination of Electrical Conductivity"
4. United States Pharmacopoeia, Monograph <645>: "Water Conductivity"
5. European Pharmacopoeia Monographs 0008, 0169 & 1927
6. ISO 17025 "General Requirements for the Competence of Testing and Calibration Laboratories"
7. John J Barron & Colin Ashton, Reagecon Diagnostics, "The Application of Good Laboratory Practice in the Selection and Use of Accurate, Traceable Conductivity Standards" *

* These papers form part of a comprehensive series of papers that the authors have written covering all of the practical requirements for accurate conductivity measurement. These papers are available via Reagecon's website at www.reagecon.com.

Reagecon

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