EMPIR Call 2014 – Industry and Research Potential

Selected Research Topic number: **SRT-i02**
Version: 1.0

Title: Metrology for industrial pure water applications

Abstract

Water purity must be verified in the pharmaceutical, microelectronic and power plant industries in order to guarantee safety and operational reliability. Conductivity measurements are the preferred choice for monitoring water purity with respect to ionic impurities, as it is relatively cheap and easy compared to chemical analysis. However, conductivity measurements in pure water applications are currently only used to detect impurities in general. Therefore, a system is needed to determine the type of ionic impurity in pure water applications using conductivity measurements so that impurities can be monitored in-line and without intensive chemical analysis. Existing calibration facilities also require extending to a wider temperature range, in order to support the development of a traceable conductivity sensor for pure water.

Keywords

Pure water, impurities, conductivity, ionic impurities, temperature

Background to the Metrological Challenges

Conductivity measurements are commonly used to monitor water purity with respect to ionic impurities, and to guarantee safety and functionality in industrial applications, such as: water for cleaning the surfaces of semiconductor wafers and liquid crystal panels; water for photovoltaic cell processing; water for steam generators for power turbines; refined and injection water for the medical and pharmaceutical industries; and water for blanks in analytical chemistry. The New York Times has estimated water purification and services as 10% of the overall $450 billion revenue generated by the global water industry, and the market for ultrapure water is expected to grow by 32 % to nearly $4.9 billion by 2015.

The International Conference on Harmonisation states in its ‘Good Manufacturing Practice Guide for Active Pharmaceutical Ingredients’ (issued 2000) [1]: that “Equipment calibrations should be performed using standards traceable to certified standards, if existing”. National and international standards and guidelines also specify the criteria and conductivity measurements for water purity in the ultrapure and pure water range, e.g. ISO 3696 Water for Analytical Laboratory Use [2] and ASTM 5127 Standard Guide for Ultra-Pure Water used in the electronics and semiconductor Industries [3]. Therefore, a metrological infrastructure for SI traceable measurements for impurities in pure water is needed.

Currently, conductivity cannot be used to determine the type of ionic impurity in pure water. However, it is often the type of contamination that is of most relevance and thus, further (costly and time consuming) chemical analysis is required to gain this information. The temperature dependence of conductivity in pure water is known to depend on the type of dissolved salt, therefore conductivity and temperature measurements could be used to determine the type of impurities in pure water.

Existing conductivity-temperature relations are calculated from semi-empirical theories. However, such theories are based on conductivity measurements that are orders of magnitude larger than the actual application range (i.e. low and sub mS/m instead of µS/m) and have therefore not been experimentally validated. Currently, the most reliable measurements have been achieved with sensor calibration, but only a few European NMIs can provide such a calibration service and their service is limited to room temperature.

Objectives

Proposers should address the objectives stated below, which are based on the PRT submissions. Proposers may identify amendments to the objectives or choose to address a subset of them in order to maximise the overall impact, or address budgetary or scientific / technical constraints, but the reasons for this should be clearly stated in the proposal.

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The JRP shall focus on the traceable measurement and characterisation of ionic impurities in pure water using conductivity and temperature measurements.

The specific objectives are

1. To develop measurement systems that allow the determination of the type of salt dissolved in pure water. The objective is to demonstrate the feasibility of methods for improving in-line water purity control in industrial pure water applications.
2. To determine the conductivity-temperature relation of pure water from measurement results traceable to the SI in the conductivity range from 5.5 µS/m (ultrapure water) to 5 mS/m (pure water), at temperatures 5 °C to 50 °C and with a variety of salts dissolved at trace levels (ppb range). The results should be used to provide metrological input to international standards and SI traceable data for pure water.
3. To establish a primary conductivity measurement setup for SI traceable conductivity measurements and conductivity sensor calibration in the ultrapure and pure water range and in the temperature range from 5 °C to 50 °C. The expanded relative target uncertainty is 0.5 %. To increase the reliability measurements two different primary cell types should be used.
4. To propose calibration methodologies to support the development of new conductivity sensors based on electrodes able to provide alternative measurement techniques.
5. To harmonise calibration facilities for pure water in European metrology institutes. This objective includes knowledge exchange and transfer, comparison measurements and, in particular, to link the measurements results of institutes to the SI, which have non SI traceability routes.

Proposers shall give priority to work that meets documented industrial needs and include measures to support transfer into industry by cooperation and by standardisation. An active involvement of industrial stakeholders is expected in order to align the project with their needs – both through project steering boards and participation in the research activities.

Proposers should establish the current state of the art, and explain how their proposed project goes beyond this.

In particular, proposers should outline the achievements of the iMERA-Plus JRP T2.J10 ‘Traceable measurements for biospecies and ion activity in clinical chemistry’ (TRACEBIOACTIVITY) and how their proposal will build on this.

EURAMET expects the average EU Contribution for the selected JRPs to be 1.5 M€, and has defined an upper limit of 1.8 M€ for any project.

EURAMET also expects the EU Contribution to the external funded partners to not exceed 30 % of the total EU Contribution to the project. Any deviation from this must be justified.

Any industrial partners that will receive significant benefit from the results of the proposed project are expected to be unfunded partners.

Potential Impact

Proposals must demonstrate adequate and appropriate participation/links to the “end user” community, describing how the project partners will engage with relevant communities during the project to facilitate knowledge transfer and accelerate the uptake of project outputs. Evidence of support from the “end user” community (e.g. letters of support) is also encouraged.

You should detail how your JRP results are going to:

- Address the SRT objectives and deliver solutions to the documented needs,
- Drive innovation in industrial production and facilitate new or significantly improved products through exploiting top-level metrological technology,
- Improve the competitiveness of EU industry,
- Feed into the development of urgent documentary standards through appropriate standards bodies,
- Transfer knowledge to the water purification sector.

You should detail other impacts of your proposed JRP as specified in the document “Guide 4: Writing Joint Research Projects”

You should also detail how your approach to realising the objectives will further the aim of EMPIR to develop a coherent approach at the European level in the field of metrology and include the best available contributions from across the metrology community. Specifically the opportunities for:

- improvement of the efficiency of use of available resources to better meet metrological needs and to assure the traceability of national standards
- the metrology capacity of EURAMET Member States whose metrology programmes are at an early stage of development to be increased
- organisations other than NMIs and DIs to be involved in the work

Time-scale

The project should be of up to 3 years duration.

Additional information

The references were provided by PRT submitters; proposers should therefore establish the relevance of any references.

[1] http://www.ich.org/fileadmin/Public_Web_Site/ICH_Products/Guidelines/Quality/Q7/Step4/Q7_Guideline.pdf

[2] http://www.iso.org/iso/home/store/catalogue_tc/catalogue_detail.htm?csnumber=9169

[3] http://www.astm.org/Standards/D5127.htm