EMPIR Call 2017 – Industry, Fundamental, Normative and Research Potential

Selected Research Topic number: **SRT-f09**
Version: 1.0

Title: Realisation of a Unified pH Scale

Abstract

Unified pH (pH_{abs}) is a new concept for expressing the acidity of any medium, including non-aqueous solutions, colloids, etc. The acidities of different solvents and media expressed as pH_{abs} values are mutually comparable, in contrast with the conventional "single-solvent" pH scales (e.g. pH 7 in water is neutral, pH 7 in acetonitrile is strongly acidic). No reliable and universally applicable measurement approach of pH_{abs} is currently available. The objectives in this topic would address that deficiency.

Keywords

pH; non-aqueous solutions; thermodynamic solution acidity; comparability; chemical potential; differential potentiometry

Background to the Metrological Challenges

The concept of pH is very well defined and routinely used in (dilute) aqueous solutions, as well as a few organic solvents and mixed media. Acidity also plays a very important role in many biological (biological fluids, cell membranes, etc.), environmental (soils, sludge, etc.), and research applications (catalysis, electrochemical power sources, coatings and corrosion, etc.) but it requires a more accurate measurement.

Different solvents (or solvent mixtures) where the pH scales exist, are linked to the standard states defined in the same solvent (usually via concentration of solvated protons in the solvent), making the measured pH values specific to each solvent. As a consequence, pH values of different solvents are fundamentally incomparable in terms of their effect on proton activity. For example, pH 7 in water is neutral, while pH 7 in acetonitrile is strongly acidic.

For these reasons, creating a reliable, practical method of measuring and expressing acidity of any medium on a universal scale (termed here as pH_{abs}), which will make pH values comparable between solvents/media, is needed.

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 protocol.

The JRP shall focus on defining a traceable, reliable and universally applicable measurement approach of pH.

The specific objectives are

1. To develop and validate a reliable and universally applicable measurement procedure that enables the measurement of pH_{abs} (expressed relative to the aqueous scale, as $pH_{abs}^{H_2O}$ values) in non-aqueous and mixed solvents, colloids, etc., thereby enabling their acidities to be compared to the conventional aqueous pH scale.
2. To create a reliable method for the experimental or computational evaluation of the liquid junction potential between aqueous and non-aqueous solutions, allowing correction of results from, for example, a glass electrode pH measurement setup calibrated with aqueous standards measuring non-aqueous samples.

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3. To develop a coherent and validated suite of calibration standards for standardising routine measurement systems in terms of pH_{abs} values for a variety of widespread systems (e.g., industrial mixtures, soils/waters, food products, biomaterials).
4. To estimate the measurement uncertainty budget for generalised pH_{abs} measurements.
5. Based on the outcome of the project contribute to the international specifications for bioethanol quality EN 15490 (e.g. by value assigning existing certified reference materials) and other relevant standards development organisations, and disseminate findings to the European measurement infrastructure.

Proposers shall give priority to work that aims at excellent science exploring new techniques or methods for metrology and novel primary measurement standards, and brings together the best scientists in Europe and beyond, whilst exploiting the unique capabilities of the National Metrology Institutes and Designated Institutes.

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

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

EURAMET also expects the EU Contribution to the external funded partners to not exceed 40 % of the total EU Contribution to the project.

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,

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

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.