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## Improving emerging European NMIs' capabilities in humidity measurement

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**Abstract.** The control and measurement of humidity is important for many industrial applications and to ensure the appropriate storage of materials and products. Humidity measurement techniques are diverse and each presents different challenges for use and calibration for a range of pressures and gases. Over the past few years, the development of humidity sensors and apparatus has matured to a level where traceable calibration is beneficial to all industries in which humidity and moisture measurement and control are important. This paper deals with a European project in which the overall objective is to develop or extend the measurement and research capabilities of the participating emerging NMI/DIs' countries in the field of humidity measurements, where access to these types of facilities is currently limited.

### 1. Introduction

This paper presents the current status of a European project for enhancing infrastructure for humidity measurements in both developed and emerging NMI/DIs. The improvement of humidity measurement capabilities is a precondition to engaging in related research, including the grand challenges (health, environment and energy) and closely associated with quality of life measures, many industrial processes and implementation of specific EU legislation.

The overall objective of the project is to develop measurement and research capabilities in humidity measurements of participating emerging NMI countries, based on stakeholder's needs. Specific



objectives are: identifying existing and future needs, transfer of knowledge, developing measurement methods and sharing procedures as best practice, narrowing the gap in the offered calibration services, performing an inter-comparison, building research potential and strengthening co-operation between NMIs.

## 2. Consortium overview

The consortium consists of leading European NMI/DIs and emerging NMIs in the field of humidity in a complementary metrology structure. The leading NMI/DIs of the consortium (INRIM-Italy, CMI-Czech Republic, TUBITAK-Turkey, FSB-Croatia and UL-Slovenia) have significant experience and excellence in the area of humidity measurements and research. On the other hand, the emerging NMIs (IMBiH-Bosnia and Herzegovina, MoE-Serbia, NSAI-Ireland, ME-BoM- The Former Yugoslav Republic of Macedonia and MER- Montenegro) have adequate equipment to carry out the project, but limited capabilities and experience in humidity related research. Collaboration between leading, and emerging NMIs will improve the latter's metrology capabilities and infrastructure for traceable humidity measurements, which will support their participation in future research projects.

## 3. Technical Objectives

The project is performed within the framework of EURAMET/EMPIR (European Metrology Programme for Innovation and Research) and is divided into five work packages (WPs), three technical and scientific WPs, and one WP each for impact and management [1].

## 4. Objectives overview

The project addresses the following scientific and technical objectives

### 4.1 WP1: Improvements in the field of relative humidity measurements

The aim of this WP is to improve measurement capabilities of participating NMI/DIs in the field of relative humidity (RH). It also provides an opportunity for networking with industrial stakeholders in Europe, in order to exchange knowledge, improve traceability, and build capacities.

The following activities were agreed among the partners for achieving the main WP goals:

1. To conduct a survey addressing the stakeholders' needs related to the RH measurements within each emerging NMI/DI country. The results of the survey will be used as an input to the strategy for development in the field of humidity measurements in the particular country.
2. To develop a small chamber for RH calibrations, which will be a cheap and simple tool available to any interested laboratory, enabling the improvement in uncertainties of related calibrations
3. To carry out an inter-comparison to confirm the improved measurement capabilities developed by the project partners in the field of RH measurement.

### 4.2 WP2: Improvements in the field of dew point measurements

The key challenge in this WP is to improve the capabilities of participating NMI/DIs (knowledge, skills and capacity building), which will lead to an improvement in the accuracy of dew point temperature measurement.

The aims of this WP are:

1. To obtain information about the dew point measurement related needs of stakeholders in each country with an emerging NMI/DI.
2. To obtain information about the existing level of knowledge and capabilities of partners and to identify gaps in the capabilities for dew point temperature measurement of the emerging NMI/DIs with regard to stakeholder needs.
3. To improve the capabilities to enable emerging NMI/DIs to perform dew point temperature measurements in the temperature range from -70 °C to 90 °C.

#### 4.3 WP3: Strategy development

The key challenge in this WP is to prepare individual strategy documents for humidity research and development of the associated capabilities in Serbia, Bosnia and Herzegovina, Montenegro, Ireland, FYR Macedonia and Croatia (MoE, IMBiH, MER, NSAI, ME-BoM and FSB).

The aims of this WP are:

1. To ensure that emerging countries engage in further development of humidity metrology infrastructure to support industrial needs, competitiveness and international trade and show commitment to sustainable growth in the partner's country after the lifetime of the project.
2. To ensure that emerging countries engage in future collaboration and co-operation, especially in future joint research and collaborative projects with European NMI/Dis.
3. To identify future trends toward smart specialisation in humidity metrology based on identified trends and needs for metrology research and services.

#### 4.4 WP4: Impact

Through the development of training courses in humidity measurement, the project outcomes, as well as general humidity training will be delivered effectively to industrial stakeholders, thereby improving understanding and skills within the European Union. Knowledge transfer in the field of humidity measurement from experienced NMI/DIs to those less experienced will help to enhance their measurement and research capabilities and will promote standardisation within humidity metrology.

By highlighting the importance of humidity to processes, and to human comfort levels, this project will lead to a better understanding of humidity among stakeholders.

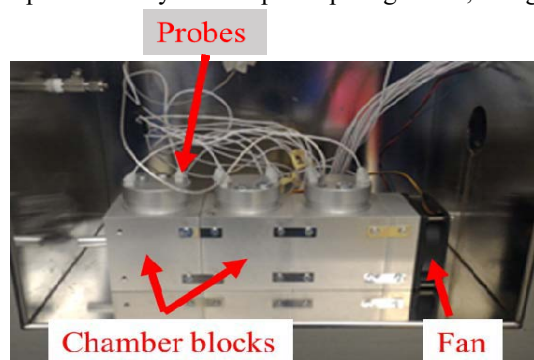
### 5 Research Highlights

In recent years, the development of humidity sensors and equipment has matured to a level where traceable calibration is beneficial to all industries in which humidity, moisture measurement and control are important. Based on the extensive experience of the leading NMIs participating in this project, the consortium members cooperate intensively, according to a tight timeline. The following examples give an overview of work planned over the lifetime of the project and the results to date.

#### 5.1. Relative humidity measurements

A new modular chamber for calibration of RH instruments was designed, manufactured and preliminarily characterised through extensive cooperation of all project partners.

The chamber blocks, instrument adapters and connecting rings are made of aluminium, making the assembly relatively lightweight and robust. A carrier gas can be supplied to the chamber using a fan (when supplied from the larger climatic chamber working volume) or using tube fittings (when supplied from dew/frost point generators). The preliminary characterisation was performed at INRIM, showing a significant improvement of temperature gradients, when used. Further characterisation will be performed by several participating NMIs, alongside an inter-comparison of RH realizations.



**Figure 1.** The modular RH chamber consisting of three chamber blocks connected in the in-line configuration. The whole setup is placed inside the larger volume climatic chamber.

Existing knowledge and expertise was shared among the partners during the design, manufacture and preliminary characterisation of the modular chamber. The chamber is appropriate for use in combination with a larger temperature controlled enclosure. By implementing the new chamber in their facilities, partners and other interested parties will improve their capabilities by expanding their RH and temperature ranges, achieving lower uncertainties and reducing calibration times.

### *5.2 Dew point temperature standards*

In order to meet the objectives, two tasks were planned. Firstly, a survey was undertaken to identify the dew point measurement needs of stakeholders in participating countries (parameters to be investigated include temperature and pressure ranges and measurement media used). The second task builds upon knowledge obtained about stakeholders' needs in order to improve the capacity of participating countries to perform high-accuracy dew/frost point measurements in the selected temperature range. Gaps in the individual NMI/DIs' capabilities will be identified and areas targeted to achieve an improvement of dew point measurement setups. The individual NMI/DIs will implement and test the designed solution with respect to the factors which could influence the measurement (flow rate, pressure, temperature, tubing, bath, media, etc.). A report detailing the influence of the different generator components on the uncertainty for dew point measurement using the improved setups will be prepared.

### *5.3 Strategy development*

The key challenge in this work package was to prepare individual strategy documents for humidity research and development of the associated capabilities in Serbia, Bosnia and Herzegovina, Montenegro, Ireland, FYR Macedonia and Croatia (MoE, IMBiH, MER, NSAI, ME-BoM and FSB). Each individual strategy document will be the long term strategy, over the next 15 years, taking into account future humidity measurement capability requirements and the need for developments linked with environmental, health and energy topics.

## **6 Results**

Establishing traceable measurements in humidity at the level needed by each participating country will enable research, innovation and patenting in this field in future EMPIR projects. An important aspect of this project is the collaboration of less experienced NMI/DIs with leading NMI/DIs. The latter will assist the emerging institutes in establishing their metrology capabilities in the field of humidity and will provide an appropriate internal knowledge transfer in humidity traceability at the primary and secondary level. An expansion of the capabilities in humidity measurements at the European level will be established through this project, meaning that more EURAMET member countries will be able to participate in inter-comparisons in the field of humidity and ensure smooth progression of approval of CMCs. It will widen the availability of traceability and services for humidity related measurements to more countries. All EURAMET members could be included in the roadmap for humidity and moisture measurement. At the same time, traceable calibration and measurement services will be provided to regional industry at a higher level than previously possible

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