Publishable Summary for 15RPT03 HUMEA
Expansion of European research capabilities in humidity measurement

Overview

The control and measurement of humidity is important for many industrial applications and to ensure the appropriate storage of materials and products. The overall objective of this project is to develop or extend the measurement and research capabilities of the participating emerging NMI/DIs' countries in the field of humidity measurements. The extent of improvements will be based on stakeholder needs, with the effort optimised thus avoiding duplication of resources, where applicable. Individual NMI/DIs' strategies for humidity metrology development will be prepared by participants and then discussed within the EURAMET community, ensuring a coordinated and optimised approach.

Need

Humidity is a vital parameter in the control of indoor climate and ventilation, the storage of food products, industrial and medical gases, textile, paper and many other products. Humidity affects many properties of air, and of materials in contact with air. Water vapour is a key agent in both weather and climate, and it is a key atmospheric greenhouse gas. Air-conditioning systems in buildings often control humidity, and significant energy may go into cooling the air to remove water vapour. Humidity measurements contribute both to achieving correct environmental conditions and to minimising the energy cost of this. A huge variety of manufacturing, storage and testing processes are humidity-critical. Humidity measurements are used wherever there is a need to prevent condensation, corrosion, mould, warping or other spoilage of products. Air humidity is also a crucial parameter due to the enormous heat capacity of gaseous water and its key role in atmospheric processes. Traceable measurements of air humidity from the ground level up to the stratosphere are required. Numerous energy technologies – established and novel – need reliable humidity measurements in a range of gases, at a range of pressures.

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. Measurement of humidity is complex and vitally important to a huge range of industries, as well as in healthcare and in terms of climate change and global warming.

The NMI/DIs in the consortium often receive feedback from their clients, indicating a desire for improved uncertainties in humidity measurement. Due to the tightness of manufacturer's specifications and the difficulty in achieving the uncertainties necessary to verify these specifications, there is an urgent need to improve the uncertainty of relative humidity and dew point measurements in most emerging NMI/DIs.

Establishing the infrastructure for humidity measurements, assuring traceability and providing dissemination are important concepts in both developed and emerging NMI/DIs as well as a precondition to related research, industrial applications and quality standards as well as support for various services, including the grand challenges (health, environment and energy) and closely associated with quality of life measures and implementation of specific EU legislation.

Objectives

The specific scientific and technical objectives of this project are:

1. To identify existing and future needs in the field of humidity measurement in the participating emerging NMI/DIs' countries.
2. To improve measurement methods in the field of humidity via the development and characterisation of an inner chamber for calibration of relative humidity instruments. The target uncertainties are

between 0.3 %rh and 2 %rh for a relative humidity range of 2 %rh to 95 %rh at temperatures from -60 °C to 100 °C. To implement the improved relative humidity capability into the national/regional traceability infrastructure.

3. To organise and undertake an intercomparison of relative humidity measurements using the small chamber to underpin and validate the procedures developed and measurement capabilities of the participants.
4. To improve research capacity in the field of dew point measurements by systematic review and improvement of dew point generators. The target uncertainties are between 0.05 °C and 0.1 °C for a temperature range of -70 °C to 90 °C. To implement the improved dewpoint capability into the national/regional traceability infrastructure.
5. To develop individual strategies for the long-term development of research capabilities in humidity traceability including a strategy for offering calibration services from the facilities established to customers in their own country and neighbouring countries, through questionnaires and workshops organised in the local language, which will involve the broadest spectrum of stakeholders. The individual strategies will be discussed within the consortium and will lead to an overall strategy document to be presented to the EURAMET TC-T, to ensure that a coordinated and optimised approach to the development of traceability in this field is developed for Europe as a whole.

Progress beyond the state of the art

This project will design, construct and characterise a chamber within a chamber system for the calibration of relative humidity instruments. The smaller chamber should lead to reduced spatial variation of the parameters (temperature, humidity etc.), a more rapid stabilisation of the conditions within the chamber, and therefore a faster turnaround time for calibrations. An intercomparison of relative humidity measurements using the small chamber will be carried out to underpin and validate the procedures and measurement capabilities of participants developed during the project.

The project will also address research capacity in the field of dew point measurements by the undertaking of a systematic review and improvement of dew point generators at each of the emerging NMI/DIs. This will establish a methodological approach to building of new dew point generators and allow for the development of traceability in dew point measurements in these countries.

This will lead to improved capabilities in the measurement of humidity and therefore a higher quality calibration service for industrial and research stakeholders.

Results

Identification of existing and future needs in the field of humidity measurement

The needs of stakeholders in the emerging countries with regards to relative humidity measurements and dew point measurements will be identified by engagement with stakeholders.

Two surveys have been performed, the first to collect data about the measurement setups in each partner's laboratory and the second to determine stakeholder needs. The results of these questionnaires represent the basis for an assessment of the need for relative humidity measurements and dew point measurements. This information will inform the activities in the rest of the project and the training required for partners in those countries. The first training course was held in Ljubljana for the consortium members and interested parties on the 24th and 25th of January 2017.

Improvement of measurement methods via the development and characterisation of an inner chamber for calibration of relative humidity instruments

After determining existing capabilities in each member institute, the consortium has designed an inner chamber for humidity measurements to be used within the existing humidity chambers. The inner chamber will provide a more stable environment with reduced temperature gradients, thus allowing an improvement in RH measurement uncertainty to between 0.3 %rh and 2 %rh for a relative humidity range of 2 %rh to 95 %rh at temperatures from -60 °C to 100 °C.

The chamber has been manufactured and the preliminary performance evaluation was carried out. In this preliminary research, the process of designing, producing and characterising the calibration sub-chamber was studied. Experimental work was carried out on a copy of the calibration sub-chamber developed in the project, to increase the practical understanding and to learn and apply good practices and methodologies to future characterisations.

Other research has focused on a technical device (humidity chamber) created in the scope of EMRP JRP SIB64 METefnet. The research included characterisation and testing of this small humidity chamber before and after the use of a new design, as well as investigating the behaviour of the different humidity sensor types. The uncertainty budget for the small chamber and for selected humidity sensors has been evaluated.

Prior to starting the characterisation of the small chamber, partners were trained on the installation, set-up, and fine tuning of the chamber within a chamber system for humidity measurements.

Organisation of an intercomparison of relative humidity measurements using the small chamber

An interlaboratory comparison using different sensors and testing the new small chamber will be carried out to enhance the design and provide a standard approach for its use in humidity calibrations. The chamber and the transfer standards will be circulated among the all participants of the project. The main goal is to check and quantify the decrease of the calibration uncertainties achieved by use of the new small chamber in comparison to previous uncertainties achievable in each participating laboratory.

Two protocols have been prepared, one describing the characterisation of the RH chamber to be followed by the participants of the intercomparison while the other one describes the intercomparison procedure itself. The transfer standards for the intercomparison were obtained from Rotronic and Alius grupa companies.

The outcomes, including guidelines on the standardised design will be promoted and disseminated to the relevant industrial stakeholders, thereby improving confidence in humidity calibrations throughout Europe.

Improvements in the field of dew point measurements by improving dew point generators

The current state of dew point measurement was determined within each partner institute and technical documentation on how to improve their respective measurement uncertainties will be prepared. This will be achieved by modifying factors of influence, such as flow rate, pressure, temperature range, bath performance and tubing type. Each partner will then report the improvements achieved in temperature range and uncertainty. The target uncertainties are between 0.05 °C and 0.1 °C for a temperature range of -70 °C to 90 °C.

A survey regarding dew point measurements has been performed to find out needs and requirements of stakeholders and capability of the partners. The results have enabled optimal solutions for dew point setups to be suggested for each individual partner. Individual requirements and needs have been discussed with each partner separately to find out the optimal solution for each of them and to meet the needs of their national stakeholders.

Development of individual strategies for the long-term development of research capabilities in humidity traceability

An overview of the experienced partners' individual strategy documents in metrology or the humidity subfield was presented at the beginning of the project. This has led to the development of a draft template for individual long-term strategy documents for the participating emerging countries.

Individual strategy documents for humidity research and development of the associated capabilities in Serbia, Bosnia and Herzegovina, Montenegro, Ireland, FYR Macedonia, and Croatia have been prepared and adopted by the respective NMIs.

Each individual strategy document proposes a long term strategy, over the next five to 15 years, taking into account future humidity measurement capability requirements and the need for developments linked with environmental, health and energy topics.

The individual strategy documents will be summarised in one strategy document, which will report an overview of future requirements and developments in the humidity subfield for NMI/DIs from emerging countries. The strategy document will be prepared within the scope of regional coordination with the aim of promoting small specialisations, taking care to avoid duplication of humidity resources.

Impact

A project website has been created and is updated regularly with news of the project, along with an associated LinkedIn profile.

A training course in humidity was held for consortium members and interested parties in January 2017. This course covered all aspects of humidity measurement and allowed for extensive discussion of the regional measurement requirements and capabilities. The training had a significant impact on the knowledge of each consortium member.

The second training course was held for consortium members in October 2017. The focus was on the installation, set-up, and fine tuning of the chamber within a chamber system for humidity measurements. After this training each partner will be able to perform a separate characterisation of the chamber. During the meeting, the inner chamber characterisation protocol was presented and discussed by the partners. The final version of this document will coordinate the characterisations in each partner country when the inner chamber is circulated in 2018.

A stakeholder training working group has been set up by the consortium members with the aim of preparing training material to assist in training of stakeholders within each member region.

Impact on industrial and other user communities

The small chamber within a chamber approach should reduce the time needed for a calibration and so will increase the time that each instrument is available to the owner for measurements at their facility reducing operation and maintenance costs.

Through the development of training courses in humidity measurement, the outcomes of the project, as well as general humidity measurement training will be delivered effectively to industrial stakeholders, thereby improving understanding and skills among industry within the European Union.

In the area of relative humidity and dew point measurement knowledge, transfer from experienced NMI/DIs to those less experienced in how to use new types of humidity instruments and facilities will be very beneficial. It will help to raise the knowledge, measurement and research capabilities and will promote consistency within humidity metrology.

Through highlighting the importance of humidity to processes, and to human comfort levels, this project will lead to a better understanding of humidity among stakeholders and therefore to an improvement of environments with climate control, as well as humidity or moisture dependant industrial processes. A better understanding of humidity measurement and control will also allow the development of optimal storage conditions for produce, leading to a reduction in waste and spoilage throughout Europe.

Impact on the metrology and scientific communities

The validated calibration techniques and associated uncertainty formulation developed in the project at emerging NMI/DIs will be used directly by calibration laboratories, which will assure traceability of measurements performed using different humidity sensors. Measurement results will be reported with the associated measurement uncertainty, which will enable their transparent comparison and comparison of the performance of various humidity sensors. Dissemination of traceability amongst NMI/DIs will provide access to improved capabilities for national and accredited laboratories and support consistency in measurement capabilities. Harmonised and traceable calibration, usually based on accreditation, is a basic requirement for mutual recognition of calibration results, offering a cost saving to European exporters. The recognised traceability of calibration results will also provide an important contribution to consumer protection.

The RMG researchers' work will bring increased technical skills in the humidity fields and also increasing capacity in research in their countries, it is a good opportunity for further growth and development of NMIs.

The improved capabilities developed at the participating laboratories will result in better uncertainties in the calibration of humidity instrumentation and hence will provide customers with a clearer picture of how their equipment is performing year on year thereby allowing better control of their processes.

Impact on relevant standards

By identifying relevant standards which involve humidity measurements, it will be possible to determine the range and accuracy requirements which would permit industry to comply with these standards. Where the humidity measurement expectations are considered unachievable or unrealistic by the consortium, this information will be communicated to the relevant standards committee with a view to influencing future drafts of the standards.

IEC TC 82, CEN, TC 346, IEC TC 47 and IEC TC 50 have been identified as the most relevant Technical committees to this project. These committees have been contacted and informed of the aims of the project. Once the results and conclusions have been compiled, these will be sent to the convenors for dissemination among the committee members. Where deemed relevant, the results will be considered when compiling future drafts of the standards.

List of publications

Project start date and duration:	01 June 2016, 36 months	
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