e-newsletter n°6

August 31st, 2018

New calibration facility developed at PTB for relative humidity, associated to dTDLAS transfer standard

PTB has developed a test facility to characterize humidity sensors at elevated relative humidity levels and temperatures up to 100 °C. With this set-up and by means of a humidity generator a relative humidity in the range of 0 % RH up to 98 % RH can be realized in a Ød 0.6 m*L 1 m chamber at temperatures between 40 and 100 °C. In terms of absolute humidity, water amount fractions of 3000 µmol/mol to 280 mmol/mol were generated and controlled by means of dew point mirror (DPM). The traceable reference values of this dew point mirror can be compared to measurement values produced by a device under test inside the chamber. Previously, the DPM was qualified as a secondary standard at the national humidity standard.

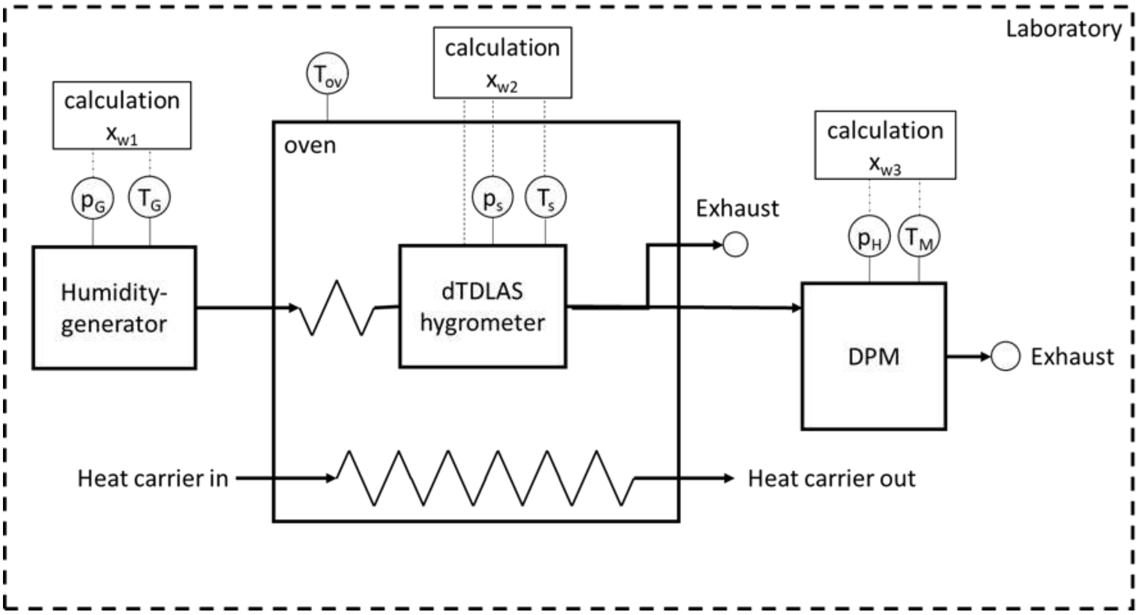

Figure 1 – Block flowchart of the validation set-up

The setup shown in Figure 1 was used to validate a dTDLAS-based hygrometer developed by TU Darmstadt which is capable to be operated as a humidity transfer standard. Validation measurement were successfully performed at ambient pressure and temperatures between 40°C to 100°C. This validation was established at PTB in cooperation with TU-Darmstadt (Figure 2).

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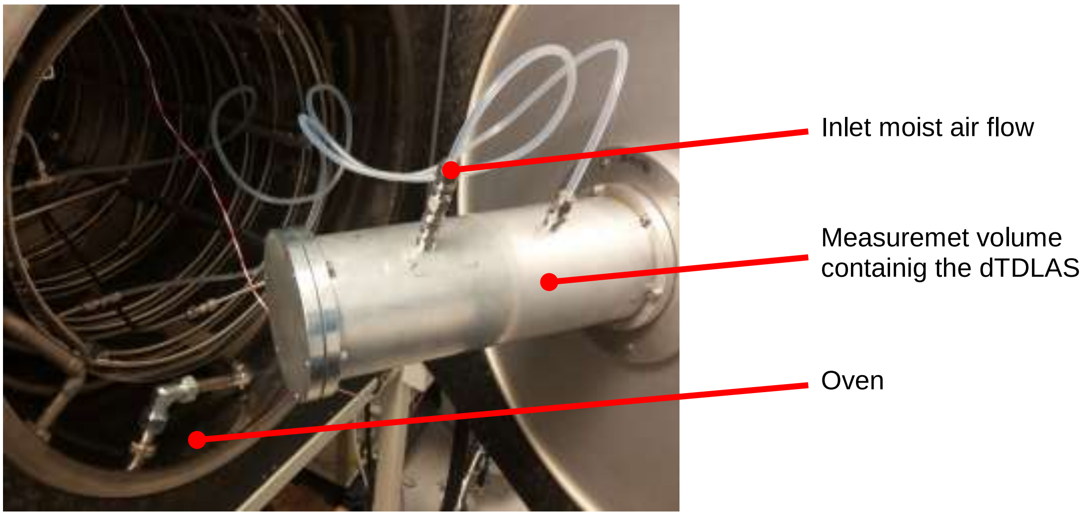

Figure 2 – Look inside the oven used at PTB including the measurement volume housing the dTDLAS

The developed dTDLAS hygrometer has shown relative deviations of less than 5 % compared to the reference value nicely confirming its capability to be used as a transfer standard. Based on this validation and on another one above 100 °C at INRIM, the dTDLAS hygrometer could subsequently be applied at an industrial site within the project. Results will be published soon.

The use of lambda sensor for measuring humidity

LNE-CETIAT had the opportunity to collaborate with the working group CLC/TC/59X/WG18 “Electric ovens for commercial use”. One of the purpose of the working group was to measure the humidity inside a professional oven. It is an appliance that cooks and processes foods, in which one or more of the following methods are undertaken: baking, blanching, frying, steaming, proofing, roasting, re-thermalizing, toasting…
In order to overcome the issue of an arch environment in terms of temperature, typically above 100 °C, humidity, typically very close to saturation, with a relatively low-cost instrument, the idea of the use of lambda sensor has been proposed.
A lambda sensor may be described, roughly like a sensor equipped with ZrO2 cell with integrated heater and is often originally designed to measure the proportion of oxygen in exhaust gases of automotive engines.

a)

b)

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Figure 3 – a) classical calibration of lambda sensors, b) new calibration method

The calibration, in humidity, of several sensors have been performed within the HIT project. It has showed interesting results in terms of repatability, reproductibility and interchangeability. In addition an original calibration method, prosed by the working group, has been tested and compared to a classical calibration in humidity.
Further details about this work are available here.

Relative humidity comparison at high temperature involving VSL, INRiM, LNE-CETIAT

In the frame of the EMPIR project "HIT", three European institutes implemented their relative humidity calibration facilities at temperatures above 100 ºC.
An informal comparison between the three facilities was organized in the last months of the project. The three facilities were compared according to the following comparison scheme:

- Four Vaisala sensors, suited for high temperatures, were selected and calibrated at Vaisala
  - The four sensors were calibrated at VSL (April 2018)
  - Two of the four sensors were calibrated at INRiM (May 2018) and the other two sensors were calibrated at LNE-CETIAT (May 2018).
  - All sensor were finally re-calibrated at VSL (June 2018).

The results showed that:

- the used sensors have appropriate stability to be used at such high-temperatures and humidities.
- the VSL and CETIAT facilities agree within their claimed uncertainties (≤ 03 %rh)
- the discrepancies between VSL and INRiM facilities amounted up to 3 %rh.

Figure 4 – Travelling standards used for the comparison

Further details about the facilities and the data analysis are available here.
This work will be also presented at the next TempMeko 2019

VTT humidity calibration facility for non-static conditions and field humidity calibrator development at VTT MIKES

VTT MIKES has developed a calibration method for relative humidity hygrometers based on a non-static calibration method. The method was shown to provide equivalent calibration results compared to the typical method based on calibrations at stable humidity points. The main advantage of this new method is that the calibration can be performed faster and more data on the sensor behavior can be attained than with the conventional point-wise calibration. For example, a typical 5 point static calibration with 1 h stabilization time at each calibration point, will take up to 10 hours (each point is measured twice) compared to a dynamic calibration of 6 hours (two 1 h static points and two 2 h ramps). In the case of more than five measurement points, the benefit will be even larger.

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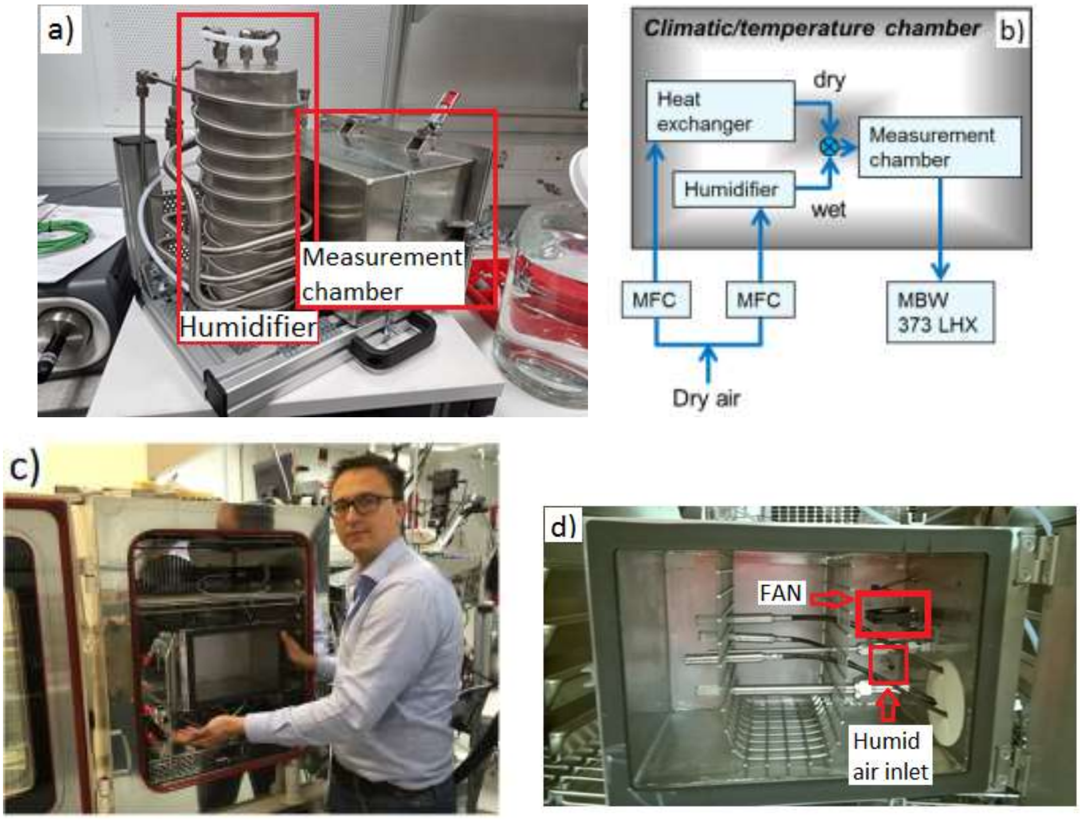

Figure 5 – VTT MIKES measurement setup. a) Humidifier and measurement chamber. b) Schematic of humidity generation principle. c) The modular system in figure a) inside a climatic chamber. d) Humidity sensors fitted inside the measurement chamber.

A prototype of a field humidity calibrator based on dynamic humidity control and with an operating range 10 %rh to 90 %rh was developed. The size of calibrator is 30 x 25 x 15 cm. The humidity in the calibrator can be controlled within ±0.5 %rh. Besides humidity control, different kind of calibration cycles such as staircase, triangle wave, ramp or some specific humidity excitation scheme can be chosen. Current prototype is only operating at ambient temperature, which is sufficient for most humidity calibrations on site. However, extension to simultaneous temperature calibrations is under development to address customer needs.

Figure 6 – Field calibrator developed at VTT MIKES

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Inline sampling at production facility and DTI laboratory investigations

DTI has developed a setup that allows the water content and the water activity (equilibrium relative humidity) of a sample to be correlated. In this way sorption isotherms can be measured, and it is also possible to record transient water content during ad- or desorption processes. A particular characteristic of the setup is that the measurements are traceable, and data thus can be traced back all the way to the definitions of the SI-units. Besides, the design includes large sample chambers. The latter can be used to take representative samples inline at production facilities and transport them isolated to DTI for further analysis.

In the example shown in the figure below, cat-food samples were collected inline at the production facility of Vital Petfood Group (VPG) in Ølgod, Denmark. While inline sampling and analysis are essential for optimising drying processes, the additional subsequent analysis at DTI allowed for a much more comprehensive characterisation of the samples. To mention certain aspects, the influence of the temperature on the water activity was investigated, and the effect of overdrying was quantified. Such data represent important steps towards improving the product quality and reducing the energy consumption.

Figure 7. Left: A sample of cat food from VPG in the DTI sample chamber. Right: The same sample chamber mounted in the setup at DTI.

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