

A Microwave-Based Hygrometer for Measuring Humidity in Gases

Xavier Paredes¹, David Vega-Maza¹, M. Carmen Martín^{2, C}, Jaime García-Gallegos³, Robert Benyon³ and José Juan Segovia^{2, S}

¹*Department of Energetic Engineering and Fluid Mechanics, University of Valladolid, Valladolid, Spain*

²*Research Institute on Bioeconomy, University of Valladolid, Valladolid, Spain*

³*National Institute of Aerospace Technology (INTA), Madrid, Spain*

mcarmen.martin@uva.es

Water vapor is a critical contaminant which influences thermophysical, electrical, chemical, and mechanical properties, and could lead to corrosion or degradation. Even in trace amounts, water is chemically active. Humidity measurements are lacking metrological traceability in the relevant ranges and matrix gases. Our research group, in collaboration with the metrology laboratory of the National Institute of Aerospace Technology (INTA), which is in charge of the national standard of humidity, aims to broaden the present knowledge of thermophysical data of real humid gas mixtures, in particular the water vapor enhancement factor focusing on selected ultra-pure gases, such as nitrogen or hydrogen, for which water is an inherent impurity in its production by electrolysis.

For this purpose, a new microwave resonant cavity was designed in our group in order to measure humidity and use it as a standard hygrometer. The physical principle of detection is based on the change in dielectric constant which occurs due to a phase transition that also involves a discontinuity in the resonance frequency of the cavity. The technique is validated by measuring mixtures of humid nitrogen whose humidity is controlled by using a generator and the amount of water is determined with the new technique and by means of a precision dew point hygrometer (MBW DP30), which provides traceability to national standards. The generator and the calibrated chilled mirror dew point hygrometer are provided by the INTA's laboratory. The technique and the results obtained with nitrogen and hydrogen will be presented.

Acknowledgments

This work is funded by Spanish State Research Agency project number PID2021-125749OB-I00; ERDF and Junta de Castilla y León project number CLU-2019-04; and EMPIR project number: 20IND06.