Geophysical Research Abstracts
Vol. 19, EGU2017-19164, 2017
EGU General Assembly 2017

Calibration of Relative Humidity Devices in Low-pressure, Low-temperature CO_2 Environment

Maria Genzer, Jouni Polkko, Timo Nikkanen, Maria Hieta, and Ari-Matti Harri
Finnish Meteorological Institute, Helsinki, Finland (maria.genzer@fmi.fi)

Calibration of relative humidity devices requires in minimum two humidity points - dry (0%RH) and (near)saturation (95-100%RH) - over the expected operational temperature and pressure range of the device. In terrestrial applications these are relatively easy to achieve using for example N2 gas as dry medium, and water vapor saturation chambers for producing saturation and intermediate humidity points. But for example in applications intended for meteorological measurements on Mars there is a need to achieve at least dry and saturation points in low-temperature, low-pressure CO_2 environment.

We have developed a custom-made, small, relatively low-cost calibration chamber able to produce both dry points and saturation points in Martian range pressure CO_2, in temperatures down to -70°C. The system utilizes a commercially available temperature chamber for temperature control, vacuum vessels and pumps. The main pressure vessel with the devices under test inside is placed inside the temperature chamber, and the pressure inside is controlled by pumps and manual valves and monitored with a commercial pressure reference with calibration traceable to national standards. Air, CO_2, or if needed another gas like N2, is used for filling the vessel until the desired pressure is achieved. Another pressure vessel with a dedicated pressure pump is used as the saturation chamber. This vessel is placed in the room outside the temperature chamber, partly filled with water and used for achieving saturated water vapor in room-temperature low-pressure environment. The saturation chamber is connected to the main pressure vessel via valves.

In this system dry point, low-pressure CO_2 environment is achieved by filling the main pressure vessel with dry CO_2 gas until the desired pressure is achieved. A constant flow of gas is maintained with the pump and valves and monitored with the pressure reference. The saturation point is then achieved by adding some water vapor from the saturation chamber to the main pressure vessel. The amount of water vapor added is also monitored with the pressure reference. For example in -70°C, very small absolute amount of water vapor corresponding to $\sim$1 Pa [1][2] pressure rise in the main chamber results in humidity saturation. As the flow of both CO_2 and water vapor is kept constant, the main chamber is served with water vapor all the time, keeping the uniform saturation conditions inside the vessel even if some of the water freezes on the vessel and pipe walls.

[1] Goff, J. A., and S. Gratch (1946) Low-pressure properties of water from -160 to 212 °F, Transactions of the American Society of Heating and Ventilating Engineers
[2] Goff, J. A. (1957) Saturation pressure of water on the new Kelvin temperature scale, Transactions of the American Society of Heating and Ventilating Engineers