

Review of: Silicone tube humidity generator by Berg et al.

Content

This manuscript describes a two-flow humidity generator based on a silicone tube humidifier. The basic principle, the design and realization of this generator is described in detail. Its ability as primary calibration standard for water vapor is shown by comparing with a reference frost point hygrometer. In addition, a comprehensive error analysis including impact of various effect is examined in detail.

Overall impression and rating

The overall impression of the manuscript is good. The manuscript is written in a balanced way and all aspects important for an instrument manuscript are considered. The presentation of the manuscript is excellent and nicely to read. It is well organized and the analysis and results are clearly structured and communicated in a very detailed way. However, the authors do not really show groundbreaking new results and findings, as similar techniques for humidity generators are already used and published by others. For example Hubert et al. 2016 used also polymeric material to saturate air and developed a cheap and small humidity generator. Nevertheless, I think this manuscript is still a good contribution to the scientific community as it summarize comprehensively all the effects important for a precise humidity generation. For these reasons, I recommend publication in AMT.

I have only very few comments/questions which should be considered before preparing the final/revised version.

Specific comments/questions:

- Page 5, lines 120-123, I do not agree with the statement that the uncertainties of the individual flow meters will cancel out by using just the ratio of both flows in the mixing ratio formular. An uncertainty estimate is always positive and negativ and both MFC have an uncorrelated uncertainty (as you write also later in Section 5). Thus, the ratio leads on to even larger total uncertainties of slightly more than 2% by using Gaussian error propagation, if you assume an uncertainty of 2% for each flow.
- page 6, formular 8, Can you quickly explain the derivation of the right part of the formular. The left part is clear but I don't see directly were the right part comes from.
- page 7/8, lines 170-172, It is not really clear why you use capillaries for the connection within and outside of the generator. It is clear as you also wrote, that the surface of a capillary is smaller compared to a thicker tubing. But for the effect of the walls (adsorption and desorption) it should be rather the ratio between air volume and surface. The volumen of the tube scales with $1/r^2$ and the surface just with $1/r$. I would assume a tubing with a thicker diameter would be better. Can you please comment that.
- page 10, lines 225-226, Where do you get the enhancement factors for $f_w(Ar)$ and $f_w(air)$ from? Maybe you can put a reference here.

- Page 15/16, lines 349-361, Did you apply any gas correction factor (GCF), if you take the standard output of the factory calibrated MFC ? Usually, the MFC are calibrated using pure N₂ and if you use another carrier gas (in your Ar) you have to apply the specific GCF. This method is not described in the manuscript and can also account partially for the discrepancies between calculated water vapor mixing ratios and the measured ones.

Technical comments/suggestions:

- Page 3, lines 83-84, It would be good if you could state which formula you are using for calculation of saturation water vapor pressure P_v .
- Page 5, Figure 1, I suggest to add the word "dry" to the label "carrier gas" in the figure.
- Page 6, lines 145-146: The sentence seems to be not complete after the word kelvin.#
- Page 10, line 237, The saturator temperature was rather 28.5°C instead of 28°C as you write later in the manuscript. You should directly mention the right number here.
- Page 11, Figure 4: I would recommend to add error bars to the measurement points. In addition, the reference hygrometer from which the measured points are coming from should be mentioned in the figure caption.
- Page 12, lines 282: I recommend to add the wording "bypass the saturator" in this sentence, because you named this flow path "bypass" in Figure 2.
- Page 13, Figure 5: Figure 5 is not mentioned in the text at all. Please add at least one sentence or a reference somewhere in Section 4.3.
- Page 15, Figure 6: Please use consistent unit brackets in all the figures. In Figure 4 you used curved brackets and in this and Fig. 7/8 you use square brackets.
- Page 20, Section 5/6, It would be nice, if you can state your total uncertainty estimate in the text of Section 5 and the conclusion section. That would help the reader directly get this important piece of information without going deeply through your detailed uncertainty estimate in Section 5.

References

- Hubert, T.; Tiebe, C.; Detjens, M. & Majewski, J. On-site calibration system for trace humidity sensors Measurement, 2016, 91, 251-257