Humidity effects on XEN-3880 and XEN-5320

The humidity has an unexpected effect on the transfer of the sensing element of the XEN-5320: the XEN-3880, compared to the influence reported in some literature. At first, for low humidity levels, the transfer decreases. Then it levels off at around 20 kPa (at 100 kPa total ambient pressure), and starts rising again at higher partial water vapor pressures. The ambient temperature has a small influence on this effect. The partial water vapor pressure at which the humidity effect is independent of the water vapor partial pressure, around 20 kPa, shifts a little bit to higher partial pressures as ambient temperature increases. See Fig. 1, which gives the normalized transfer of the XEN-3880 sensing element for air-H_2O concentrations, normalized to the value at 0 kPa partial water vapor pressure. The red striped curve is measured at temperatures up to 80 ºC, the blue curve is measured at ambient temperature of around 100 ºC. The graph shows that the transfer of the XEN-TCG3880 continues to rise above 20 kPa absolute humidity. It also indicates a slight shift to the right of the blue curve, compared to the red curve measured at up to 80 ºC.

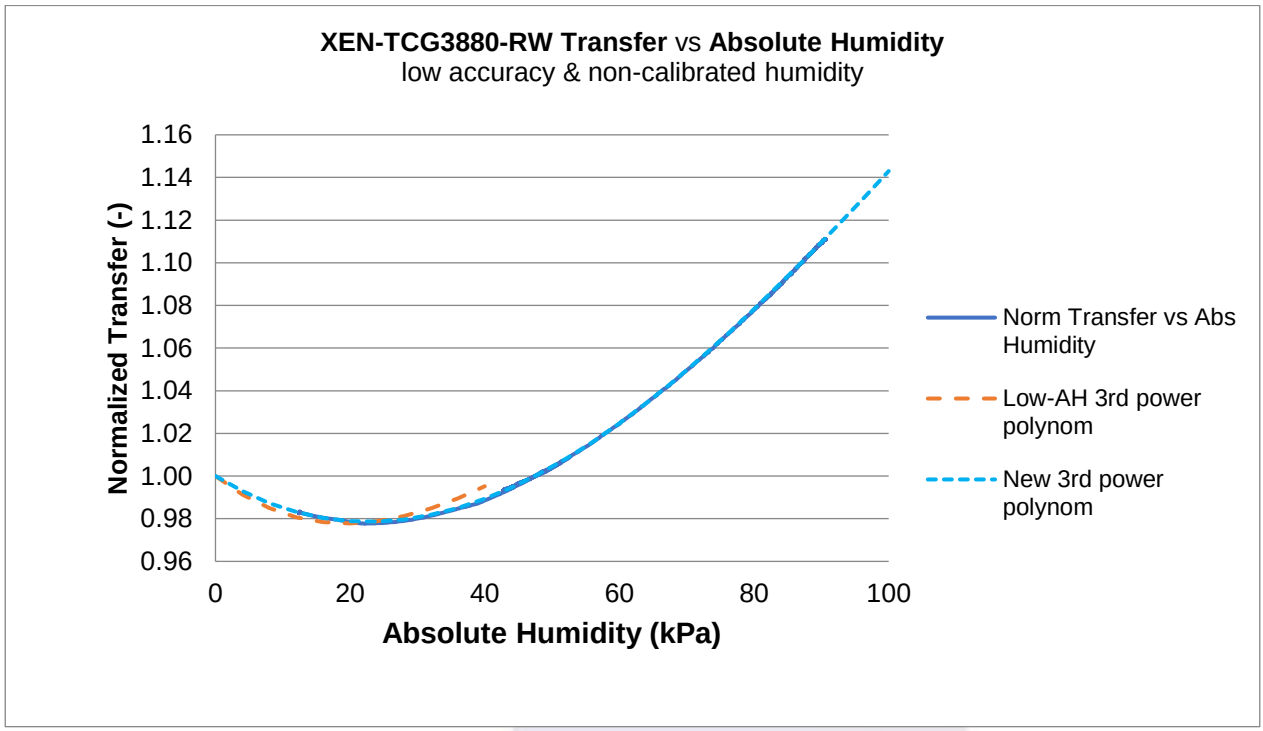

Figure 1: Typical XEN-TCG3880 normalized transfer as a function of partial pressure of water vapor (red curve measured at up to 80 ºC, blue curve measured at 100 ºC). The right part of the blue curve, striped, shows the extrapolated curve based on a 3rd power polynomial.

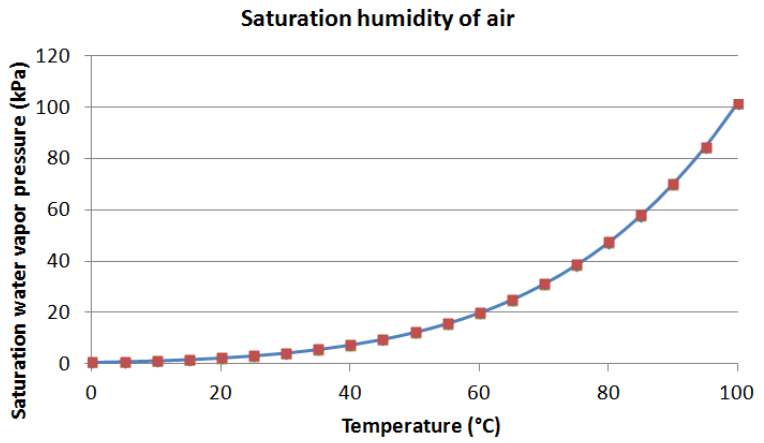

Figure 2: Saturation partial pressure of water vapor vs temperature.

Fig. 2 shows the water vapor maximum or saturation partial pressure as a function of ambient temperature. This clearly shows that at temperatures up to 40 ºC humidity will not influence the measurements very much, but at high temperatures, between 80 ºC and 100 ºC, humidity can cause up to 10 - 15% change in transfer, if we use Fig. 1 as reference. This is also because the water vapor starts to drive out other gases. At 80 ºC and 100 % RH, the partial pressure of water vapor is about 50 kPa, so there is only 50 kPa left for all other gases together (at sea level!). It may be expected that under these conditions, 1% of hydrogen in air is only 0.5% of hydrogen in total.

No data are available for water vapor pressures above 100 kPa. For data for some dry gases at elevated pressures, see the application note on pressure effects.

Fig. 3 nicely illustrates that the sensitivity of the transfer for water vapor has a minimum at about 20 kPa. This graph shows the transfer measured with the XEN-5320 in a climate chamber, with at measurement 1 no water vapor present, and then ever rising water vapor concentrations of 20 kPa and higher. The fluctuations in the climate chamber regulation of the humidity are not seen in the measurements 2000-3000, because there the water vapor partial pressure is around 20 kPa, where the transfer is insensitive to water vapor influence. But later measurements at higher humidity levels show increasing fluctuations in the transfer, where the transfer becomes more sensitive to the presence of water vapor.

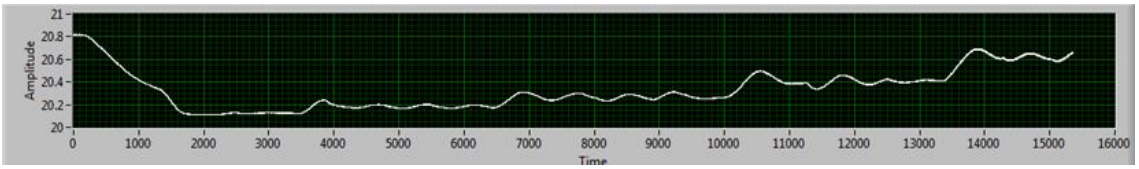

Figure 3: Transfer of the XEN-3880 for measurements at ever increasing absolute humidity in kPa. Transients in humidity do not show in the transfer of the XEN-5320 around 20 kPa partial water vapor pressure (measurement 2000-3000), but do show when the humidity levels are higher (later measurements), as indicated in Fig. 1. Also the absolute value of the transfer increases at higher measurement (= water vapor partial pressures) numbers, as indicated in Fig. 1.

It must be remarked that in the instrument XEN-5320 the transfer shows the performance of the sensing element XEN-3880, while the corrected transfer shows the performance after correction for the temperature and humidity. This is achieved by using a separate temperature/humidity sensor. This sensor has a time constant for humidity of about 8 s. Because the XEN-3880 reacts almost instantly to humidity, this can lead to transient signal when the humidity shows large sudden changes.