Anomalous Humidity Dependence in Photoacoustic Spectroscopy of CO Explained by Kinetic Cooling

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Gas Mixing and Conditioning Rig [1]

For the preparation of the calibration gas mixtures with defined pressure, flow and humidity, a LabVIEW software controlled gas mixing and conditioning rig was used (Figure E1-a). By combination of 4 mass flow controllers (MFCs) with different flow ranges (refer to Table E1), up to 4 gas inputs can be joined and a large dynamic mixing ratio of up to 1:1000 is achieved. A powerful membrane vacuum pump is installed downstream the gas mixing and condition rig and ensures maintaining the desired pressure conditions in the range of 5 mbar up to 4 bar (Table E1).

Together with several path configurations, which are activated by magnetic valve action, transient pressure, concentration, temperature, flow level and saturation scenarios can be programmed, followed and logged via the LabVIEW graphical user interface (Figure E1-c).

The total flux set in the experiments was 1200 sccm. MFC 4 was used to define the humidified gas flux, MFC 3 kept a constant flux of 240 sccm of 100 ppm CO in N_2 test gas and MFC 2 defined the dry gas flux. The combined flux of MFC 4 and MFC 2 was 960 sccm, and the ratio of the fluxes was varied to achieve different humidity. The accuracy of the MFCs is specified to ±0.3 % of the full scale of the gas flow range.

Table 1. List of the main components of the gas mixing and conditioning rig and the according parameters.

Component	Item #	Manufacturer	Model	Parameter	Value
Mass flow controller	1	Voegtlin AG	GSC-C9TS-BB26	flow range (l/min)	0.1–10
	2		GSC-B9TS-BB26		0.05–5
	3		GSC-B9TS-BB23		0.01–1
	4		GSC-B9TS-BB23		0.01–1
Magnetic valve	5	END-Automation	MEAG2D Series	operating pressure (bar)	0–40
				operating voltage (V)	24

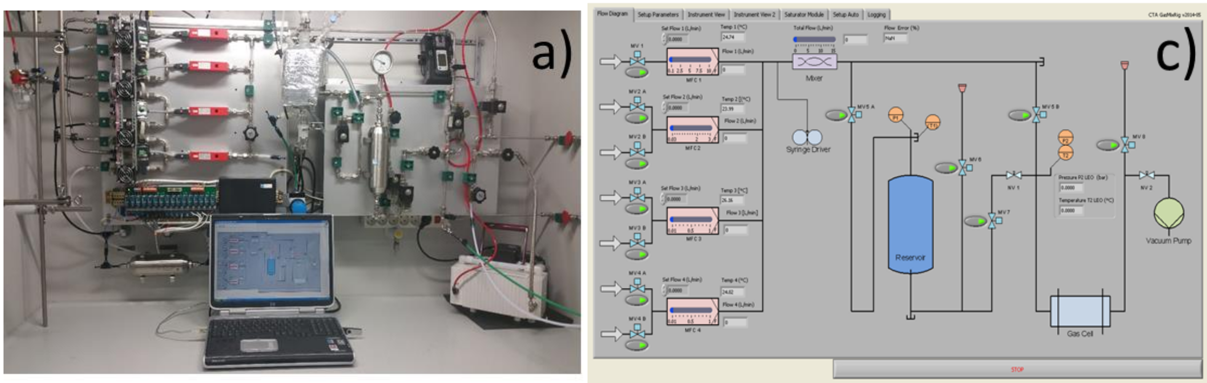

Figure E1. **a**) Gas mixing and conditioning rig (without the saturator module installed). **c**) LabVIEW graphical user interface.

Humidity dependence of the resonance frequency and quality factor of the T-shaped quartz tuning fork

The resonance frequency and quality factor of the T-shaped quartz tuning fork measured for every data-point in Figure 2 of the manuscript is shown in Figure E2.

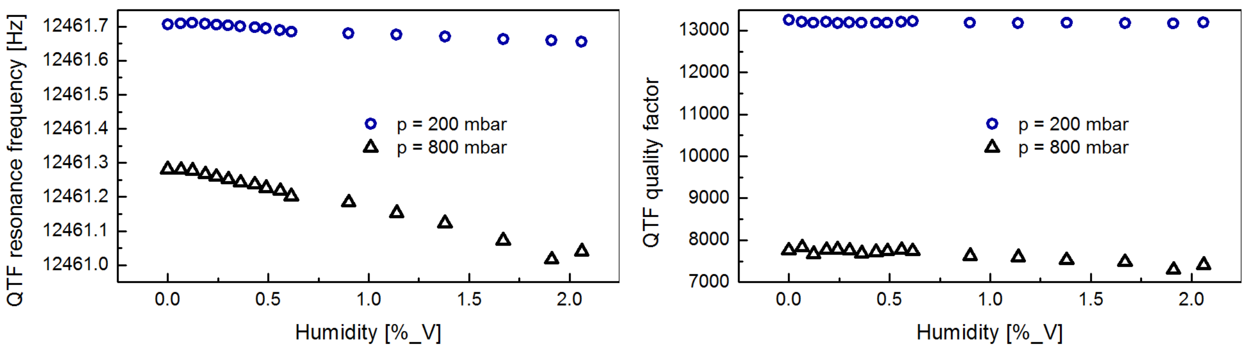

Figure E2. Resonance frequency and quality factor of the T-shaped quartz tuning fork measured at varying humidity for p = 200 mbar and p = 800 mbar.

Reference

1. Moser, H. Development and implementation of an industrial process gas monitoring system for H2S based on mid-infrared quantum cascade laser spectroscopy, Technische Univerisät Wien, 2016.