

Methanol: Trace- to Toxic-Level Detection in Human Breath

Methanol is commonly found in human breath at trace concentrations. Main sources are consumption of fruits, vegetables, fermented drinks, alcoholic beverages and the sweetener aspartam released through metabolism. Furthermore microbiota may be a source as well.

Methanol itself is not toxic, yet its metabolites formaldehyde and formate are. The treatment threshold for methanol poisoning is reported to be 20mg/dL in blood.^[1]

Methanol can directly be analyzed in human breath as well as from saliva (via gas phase sampling in mouth cavity) using G.A.S. GC-IMS systems. For direct breath analysis the BreathSpec® is equipped with a medical spirometer, so that the breath sampling can be triggered by the CO₂ concentration to ensure end-tidal breath sampling. Alternatively a GC-IMS can be equipped with a luer port to accept gaseous samples from any standard luer tip syringe. This enables a very flexible sampling of e.g. breath exhaled from mouth or even nose. Furthermore sampling in the mouth cavity may overcome sampling issues were probands are incapable or unwilling (e.g. forensic application).

The GC-IMS separates gas mixtures based on two compound specific physical properties, the gas chromatographic retention times and the specific ion mobilities. This results in a 2-dimensional separation enabling the individual analysis of single compounds. Figure 1 displays the GC-IMS chromatogram of

i) human breath and

ii) gas phase of methanol (2.5mmol/l) in water (physiological salt solution). This concentration represents the treatment threshold for methanol poisoning. Monomer and dimer peaks are highlighted, the respective maxima are plotted on the GC retention times in figure 2.

The methanol spiked water exhibits significant monomer and dimer signals. Even in human breath the monomer ion of methanol is distinct, enabling the monitoring of methanol in normal breath.

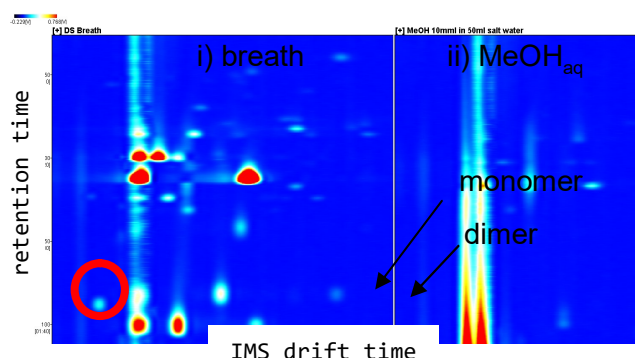


Fig.1: GC-IMS chromatogram of i) human breath and ii) static gas phase (20°C) over methanol (2.5mmol/l) in water (physiological salt solution)

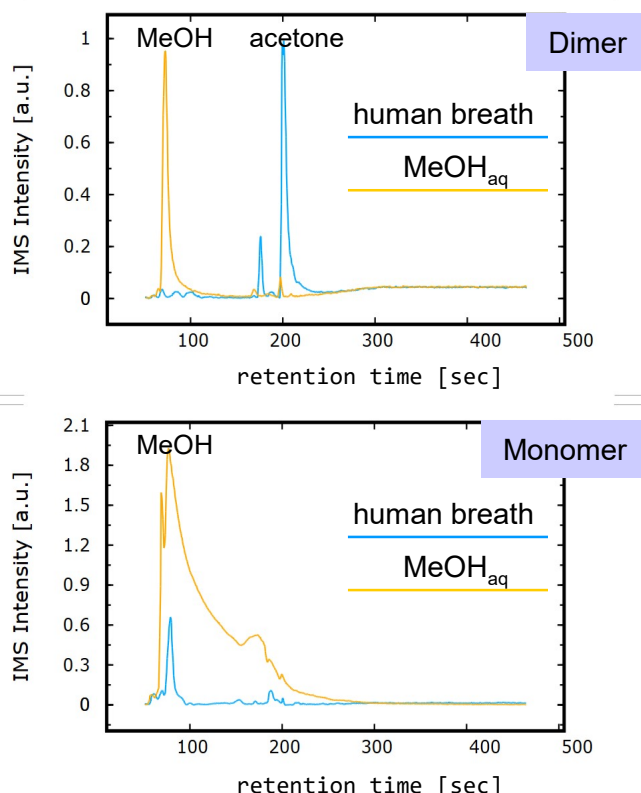


Fig.2: IMS signal at maximum intensity of methanol monomer and dimer peaks versus retention times

Device Setup:

Ion-Mobility-Spectrometer:

- GAS ³H-IMS TOF-design
- Driftgas: N₂

GC:

- 30m OV-201 type phase 1µm, d: 0.53mm
- Carrier gas: N₂
- Carrier gas flow ramp (150sec@3SCCM > linear ramp to 300sec@75SCCM > 75SCCM)
- runtime: 11min



Fig.3: BreathSpec® device

[1] Kostic MA, Dart RC, J Toxicol Clin Toxicol. 2003;41(6):793-800.