

Multichannel-PDMS-Denuders as a tool for SVOC aerosol sampling

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The use of denuders is a promising approach towards collection of semi-volatile vapours at workplaces (Kohlmeier *et al.*, 2015). Aerosols from semi-volatile organic compounds (SVOC) are very dynamic and can simultaneously be found as a particulate and gas phase. Therefore, vaporisation of droplets or condensation of vapours during sampling has to be taken into account in order to avoid sampling artefacts and toxicological misinterpretation. This can be achieved through differentiation and separate sampling of both phases. Previous studies (Forbes *et al.*, 2012) have shown that Multichannel-PDMS-Denuders (MCD) in combination with a filter, an adsorber cartridge and small portable personal sampling pump are well suitable as a sampling instrument for the measurement of SVOC.

The goal of the study was to characterize the annular MCD with regard to the size dependent particle transmission and vapour collection efficiencies. The experimental vapour collection efficiency was also compared with the theoretical collection efficiency calculated according to Possanzini *et al.*, 1983.

The denuders used in this study consisted of 22 parallel polydimethyl siloxane tubes (PDMS) (length 55 mm, ID 0.3 mm, OD 0.64 mm) housed in a glass liner (length 9 cm, ID 4 mm). The experimental setup used for analysing the vapour collection efficiency consisted of a vapour generating unit, a dilution and mixing unit, a denuder attached to a 150 cm long flow tube and a flame ionisation detector (FID). All experiments were performed with a flow rate of 0.5 l/min and *n*-hexadecane (C16), dimethyl phthalate (DMP) and diethylene glycol (DEG) as the test substances.

Figure 1 shows the vapour collection efficiency of one denuder over 135 min using the three substances. If C16 was applied, no change in the sorption capacity (96 %) was observed during 135 min. A similar behaviour was shown for DMP (99 %). In contrast, DEG showed a decrease of the sorption capacity from 94 % to 49 % over time. Because PDMS is a nonpolar polymer; C16 can be trapped with a better efficiency than polar DEG molecules.

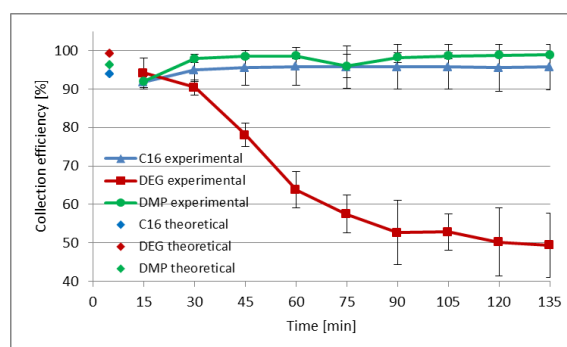


Figure 1. Time dependent vapour collection efficiency of one denuder using *n*-hexadecane (C16), diethylene glycol (DEG) and dimethyl phthalate (DMP) as test substances at a flow rate of 0.5 l/min.

The experimental sorption efficiency results of the nonpolar substances are in a good agreement with the theoretical ones (deviations $\leq 3\%$). Moreover, the calculations showed a strong dependence on the denuder length and sampling flow rate. For example, the collection efficiency was 83 % for one MCD, DEG and a flow rate of 1.5 l/min, while two denuders in series would yield 97 %.

Besides the high sorption capacity for nonpolar substances, the denuders showed transmission efficiencies from 93.3–86.7 % for polystyrene latex (PSL)-particles with diameters from 0.3–1.93 μm . Thus, MCD are well suitable for sampling aerosols of nonpolar substances with particle diameters $< 2\ \mu\text{m}$ and flow rates of 0.5–1 l/min.

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Kohlmeier, V., Dragan, G. C., Karg, E., Schnelle-Kreis, J., Breuer, D., Forbes, P. B. C., Rohwer, E. R. and Zimmermann, R. (2015) *Gefahrstoffe – Reinhalt. Luft* **75**, 383–389.

Forbes, P. B., Karg, E. W., Zimmermann, R. and Rohwer, E. R. (2012) *Anal. Chim. Acta* **730**, 71–79.

Possanzini, M., Febo, A. and Liberti, A. (1983) *Atmos. Environ.* **17**, 2605–2610.