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Carbonaceous Monolithic Multi-Channel Denuders as a Gas-Particle Partitioning Tool for the Occupational Sampling of Aerosols from Semi-Volatile Organic Compounds

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Abstract : Aerosols from hazardous semi-volatile organic compounds (SVOC) may occur in workplace air and can simultaneously be found as particle and gas phase. For health risk assessment, it is necessary to collect particles and gases separately. This can be achieved by using a denuder for the gas phase collection, combined with a filter and an adsorber for particle collection. The study focused on the suitability of carbonaceous monolithic multi-channel denuders, so-called Novacarb™-Denuders (MastCarbon International Ltd., Guilford, UK), to achieve gas-particle separation. Particle transmission efficiency experiments were performed with polystyrene latex (PSL) particles (size range 0.51-3 µm), while the time dependent gas phase collection efficiency was analysed for polar and nonpolar SVOC (mass concentrations 7-10 mg/m3) over 2 h at 5 or 10 l/min. The experimental gas phase collection efficiency was also compared with theoretical predictions. For n-hexadecane (C16), the gas phase collection efficiency was max. 91 % for one denuder and max. 98 % for two denuders, while for diethylene glycol (DEG), a maximal gas phase collection efficiency of 93 % for one denuder and 97 % for two denuders was observed. At 5 l/min higher gas phase collection efficiencies were achieved than at 10 l/min. The deviations between the theoretical and experimental gas phase collection efficiencies were up to 5 % for C16 and 23 % for DEG. Since the theoretical efficiency depends on the geometric shape and length of the denuder, flow rate and diffusion coefficients of the tested substances, the obtained values define an upper limit which could be reached. Regarding the particle transmission through the denuders, the use of one denuder showed transmission efficiencies around 98 % for 1-3 µm particle diameters. The use of three denuders resulted in transmission efficiencies from 93-97 % for the same particle sizes. In summary, NovaCarb™-Denuders are well applicable for sampling aerosols of polar/nonpolar substances with particle diameters ≤3 µm and flow rates of 5 l/min or lower. These properties and their compact size make them suitable for use in personal aerosol samplers. This work is supported by the German Social Accident Insurance (DGUV), research contract FP371.

Keywords : gas phase collection efficiency, particle transmission, personal aerosol sampler, SVOC
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