Aerosol particle penetration efficiency through a carbon honeycomb denuder

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One of the objectives of the EUSAAR (EUropean Supersites for Atmospheric Aerosol Research) project is to improve sampling configuration for collecting carbonaceous aerosol particles and their subsequent analysis for organic (OC) and elemental carbon (EC). Carbon honeycomb denuder has been developed by Thermo Electron Corporation to minimize positive artifacts resulting from adsorption of gaseous OC on quartz fibre filters. The denuder was tested for collection efficiency of gaseous OC and penetration efficiency of particulate matter. This paper describes the measurement procedure and consequent data evaluation of particle losses.

In order to determine particle losses within the denuder, measuring system depicted in Figure 1 was built. Two measuring configurations were used in dependence on desired particle size. The first configuration measuring penetration efficiency of particles in the size range 0.02 - 0.4 µm included AGK-2000 (Palas GmbH, Germany), EC 3080 provided with long DMA 3081 (TSI Inc., USA) and aerosol neutralizer 241Am as the aerosol generating system and two counters, CPC 3022 and CPC 3025 (TSI Inc., USA), as the instruments monitoring particle number concentration. Penetration efficiency of larger particles with diameter from 0.6 to 5 µm was measured by the second system comprising MAG-3000 (Palas GmbH, Germany) and home-made aerosol diluter as the aerosol generating system and two particle sizers, APS 3021 (TSI Inc., USA).

Figure 1. Aerosol particle penetration efficiency measuring system

The measurement procedure was designed to compensate the differences in readings of two instruments (two CPC or two APS). Furthermore, sampling lines were identical to eliminate differences of particle losses in sampling lines upstream and downstream of denuder (Baron & Willeke, 2001).

Particle penetration efficiency in dependence on particle diameter is presented in Figure 2. It is obvious that for particles of 0.02, 0.1, 1 and 5 µm, approximately 25%, 5%, 0.5% and 4%, respectively, of particles entering the denuder are lost. Mader at al. (2003) published similar results that losses of particles with diameter of 0.1 and 1, were 2% and 0.2%, respectively, through denuder-filter sampler. Since the denuders are operated vertically the gravitational losses of large particles (> 1 µm) can be neglected comparing to losses of small particles (< 0.1 µm) caused primarily by diffusion to the denuder walls. Losses of coarse particles were caused by inertial impaction.

Figure 2. Aerosol particle penetration (Δ: AGK - CPC system, ○: MAG - APS system)

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