Performances of the CIP 10-M personal sampler: new laboratory and field investigations

X. Simon[1], S. Bau[1], A. Boivin[1], P. Duquenne[1], O. Witschger[1] and P. Görner[1]

[1]Department of Pollutant Metrology, Institut National de Recherche et de Sécurité (INRS), Vandœuvre-lès Nancy, 54500, France

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Presenting author email: xavier.simon@inrs.fr

The CIP 10-M personal sampler is used to assess worker exposure to airborne particles by collecting them in a rotating metal cup containing a few milliliters of a collection fluid. The sampling cup is equipped with radial blades on its upper part and rotates inside its housing at a speed close to 7000 rpm to induce a 10 L/min sampling airflow through an annular omnidirectional aerosol inlet orifice and a particle-size selector (Görner *et al*, 2006). This device is mainly used to sample bioaerosols in various occupational environments; it has also been used to sample airborne chemical components in particulate form. Aqueous liquids are generally used as collection fluid, but their rapid evaporation limits the sampling duration; alternative viscous collection fluids could help overcome this problem. Although used by many teams in the world, the particle-collection efficiency of the rotating cup has not been extensively studied, and the only data available relate to a discontinued model (Görner *et al*, 2006). Field-based comparisons of CIP 10-M measurements with other samplers are also limited.

The main objectives of this work were: (1) to measure the kinetics of evaporation of different collection liquids as a function of the duration of use of the CIP 10-M; (2) to measure the collection efficiency of the current rotating cup containing an aqueous (water) or viscous (ViaTrap mineral oil) collection fluid; (3) to compare bioaerosol concentrations obtained with four samplers (CIP 10-M, closed-face cassette, Frit-Bubbler, BioSampler) in different workplaces.

Regarding objective (1), our results indicated that unlike aqueous liquids such as water or PBS, which completely evaporate after a few hours of sampling (Figure 1), viscous liquids such as mineral oil do not evaporate, making 8-h sampling campaigns in constant volumes feasible.

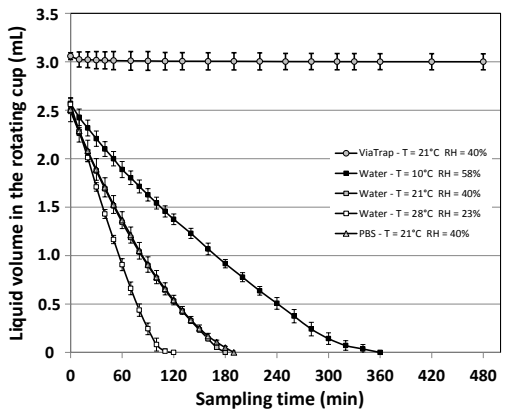

Figure 1. Kinetics of evaporation for water, PBS and ViaTrap present in the rotating cup of the CIP 10-M.

Concerning objective (2), particles with a wide range of aerodynamic diameters (d_{ae} between 0.1 and 10 µm) were produced using various test rigs and mono- or poly-disperse test aerosols (glass beads, DEHS droplets, bacteria cells). For a given d_{ae}, the collection efficiency was calculated by comparing the number concentrations measured upstream and downstream of the rotating cup using several real-time instruments (TSI APS 3321, Grimm SMPS, TSI CPC 3007). Both new and older cup models performed similarly, with a collection efficiency of > 80% for larger particles (d_{ae} > 2.8 µm), progressively decreasing to around 50% for d_{ae} of 2.1 µm, falling below 10% for d_{ae} < 1 µm. Besides, collection efficiency was unaffected by the type (aqueous or viscous) or volume (between 0 and 3 mL) of collection fluid used. Bias maps indicated that the inhalable fraction may be underestimated, particularly with aerosols mainly composed of particles with d_{ae} of less than around 3 µm (Figure 2).

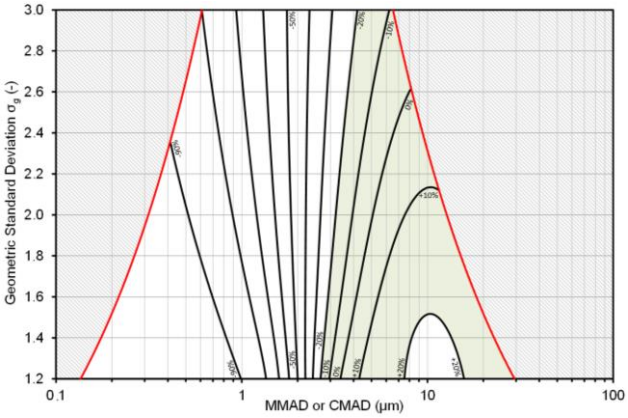

Figure 2. Mass-based (vs. MMAD) or number-based (vs. CMAD) bias map of CIP 10-M for log-normal aerosol size distributions.

To address the third objective of this work, side-by-side comparisons of four bioaerosol samplers (CIP 10-M, closed-face cassette, Frit-Bubbler, BioSampler) were performed in different occupational atmospheres (composting, waste sorting, water treatment, piggery). Static samplings were carried out in front of aerosol sources or workstations and the samples analysed using culture and molecular methods. The performances of the CIP 10-M and its capacity to ensure preservation of the biological properties of the particles sampled mainly depended on the aerosol size distribution and the type of airborne microorganisms (bacteria, fungi, species, etc.).

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