PPI personal thoracic aerosol sampler performance

P. Görner, A. Boivin, S. Bau

Laboratory of Aerosol Metrology, Institut National de Recherche et de Sécurité, 1 rue du Morvan, CS 60027, 54519 Vandœuvre-lès-Nancy, France
Keywords: aerosol, sampling, impactor, thoracic
Presenting author email: peter.gorner@inrs.fr

The Parallel Particle Impactor (PPI) manufactured by SKC® (863 Valley View Road, Eighty Four, PA 15330 USA) is designed to sample the respirable or thoracic health-related aerosol fraction for the assessment of workers' personal exposure to airborne particles. The thoracic fraction is relevant for substances with a local effect in the conductive respiratory airways, typically irritation, allergic reactions or other harmful manifestations including those involving a carcinogenic risk. Among other substances, this fraction can be considered in the case of cotton dust (OSHA 1978, ACGIH 1985), asbestos (Dement 1990, NF X43-050), sulphuric acid (EU Directive 2009) and white flour.

The PPI operates at the flow rate of 2 L/min, when sampling thoracic particulates. Four parallel nozzles draw in the ambient aerosol, causing particles to impact a pre-oiled porous plastic substrates. Selection of the thoracic aerosol fraction as conventionally defined by standards CEN 481 (1993) and ISO 7708 (1995) is achieved by simultaneously implementing four parallel impactor stages and a final collection filter.

In this study, the PPI sampler was laboratory tested along with other thoracic aerosol samplers. A low velocity wind tunnel (0.15 m/s) with a fluidised-bed aerosol generator was used to challenge the candidate sampler with a polydisperse aerosol of glass micro-spheres. Reference and sampled size-dependent aerosol concentrations were measured using a TSI Aerodynamic Particle Sizer (APS 3321). An iso-kinetic iso-axial reference probe operating at 2 L/min flow rate ensured 100% sampling efficiency within the aerosol size distribution range up to $D_{ae} \approx 20$ µm. (D_{ae} = particle aerodynamic diameter). Details of the complete experimental set-up are provided elsewhere (Görner et al 2001). Sampling efficiency E as a function of D_{ae} was determined from the ratio of number concentration at the PPI outlet C_{PPI} to the reference aerosol concentration C_R

$$E(D_{ae}) = C_{PPI}(D_{ae}) / C_R(D_{ae})$$

During the efficiency measurements, a Grimm 1.108 optical particle counter was used to check the ambient aerosol concentration in the wind tunnel working section before and after each run. The experimental data were only accepted when the particle number concentration in each size bin varied within a ± 5% interval.

Figure 1 shows the size-resolved sampling efficiency points for the PPI along with data provided by Trakumas and Salter (2009). Both experimental data sets were fitted together by a cumulative log-normal law multiplied by the Vincent & Armbruster (1981) inhalability. The resulting sampling efficiency curve is compared to the conventional CEN-ISO definition of thoracic particle penetration.

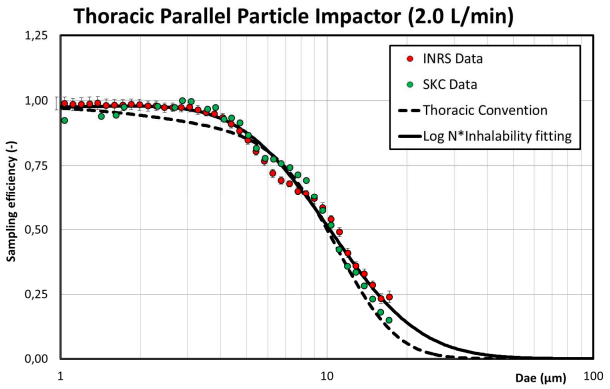

Figure 1. Thoracic PPI Sampling efficiency

A bias map for thoracic aerosol mass concentration measurement was then computed for a series of polydisperse aerosols (Figure 2).

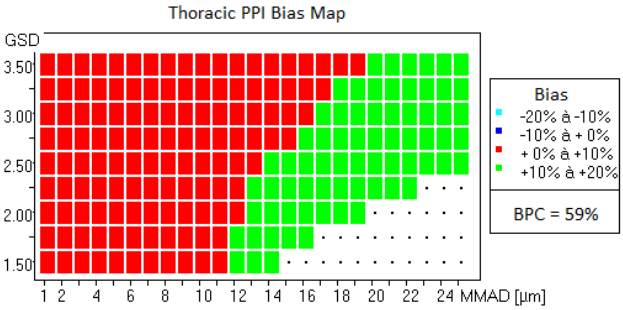

Figure 2. Thoracic PPI sampling performance

The bias map shows that the Bias Performance Criterion BPC (defined by Görner et al 2001) is 59%, representing fairly good sampling performance.

ACGIH (1985). *Report of the Technical Committee on Air Sampl. Procedures*, ACGIH, Cincinnati, Ohio.

Commission Directive (2009)/161/EU of 17 Dec. 2009, *Official Journal of the EU*, L 338/87, 19.12.2009.

Dement (1990). *Env. Health Perspect.*, **88**, 261-268.

Görner, P. et al (2001). *Ann. Occup. Hyg.*, **45**, 43-54.

OSHA (1987). *US Federal Register*, **43**, 27350.J.M.

Trakumas, and Salter, E. (2009) *J.Physics: Conf. Series* 151, doi: 10.1088/1742-6596/151/1/012060.

Vincent, J.H., and Armbruster, L. (1981) *Ann. Occup. Hyg.*, **24**, 245-248.