Monitoring Strategy for Characterization of Airborne Nanoparticles

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ABSTRACT

In this study, a variety of portable and non-portable direct-reading instruments, including scanning mobility particle sizers (SMPS), condensation particle counters (CPC), aerodynamic particle sizers (APS), diffusion chargers (DC) and aerosol mass monitors, were deployed simultaneously. Instrument performance was evaluated in a room-sized environmentally-controlled chamber with the goal of recommending a suite of instruments to provide particle number, surface area, mass concentrations and particle size distributions with an acceptable level of uncertainty. The suite of instruments was applied to monitoring background aerosols in a typical work-place setting, where laser printers provided a point source for monitoring response time and comparing peak-to-background signals. The study also explored filter-based methods for collecting nanoparticles (NPs) for subsequent elemental analysis using inductively coupled plasma-mass spectroscopy (ICP-MS).

Keywords: nanoparticle exposures, sampling, instrument comparison, background characterization, size distribution, SMPS, CPC, ICP-MS.

INTRODUCTION

A major challenge in monitoring indoor exposures to nanoparticles (NPs, <100 nanometer) is the selection and effective use of suitable instrumentation. Comparability, portability, response time, and reliability are important selection criteria in addition to reasonable cost. Amongst these criteria, instrument comparability is especially critical due to the requirement for multiple instruments in a single exposure assessment and the lack of reference standards for instrument calibration. Testing and verifying instrument comparability, therefore, is essential to ensure the reliability of exposure assessment data. Also, the sampling strategy must be able to capture the spatial and temporal variability of NPs.

RESULTS

Results are shown for instrument comparisons in a workplace setting where the background aerosol is dominated by incidental nanoparticles (Figure 1), and in

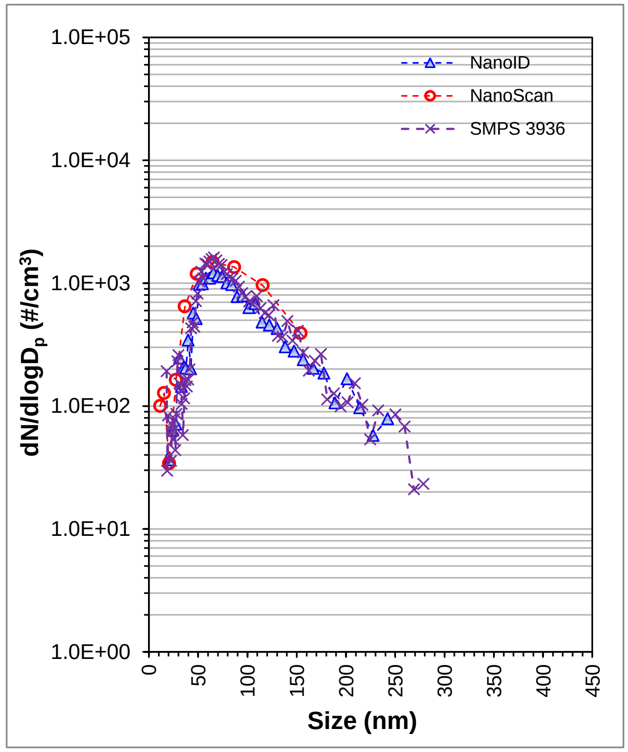

Figure1. Comparison of particle size distributions of typical indoor background aerosol using NanoID, NanoScan and TSI 3936NL87.

the full-scale environmental chamber using aerosolized NaCl nanoparticles (Table 1). Figure 1 indicates that measurements of background NPs by two newly available portable SMPS instruments (NanoID by Particle Measuring Systems and NanoScan by TSI) compare well with the stationary TSI SMPS3936 system. Table 1 shows that measurements of NaCl aerosol by various SMPS instruments correlate strongly (R^2 = 0.95 – 0.98). Differences amongst the instruments are within 3% to 22%. Good agreement was also observed amongst the various particle counters evaluated in this study (not shown), with R^2 = 0.81 for both NanoID *vs* TSI 3787 CPC and NanoID *vs* NanoTracer, and R^2 > 0.98 for P-Trak *vs* TSI 3787 CPC.

CONCLUSIONS

We concluded that a combination of instruments is required to fully characterize exposures to nanoparticles, due to the fact that no one instrument can provide all the required information. A drawback of direct reading instruments is that they are non-specific. Particles must be collected for subsequent chemical characterization (*e.g.* metals, VOCs) and morphological characterization (*e.g.* SEM/TEM) for identifying and distinguishing emission sources.

Table 1. Correlation coefficients (***R^2***) and slopes (***b,*** in bracket) for comparison of three SMPSs monitoring NaCl aerosol in the full-scale chamber

	SMPS 3936NL87	NanoScan	NanoID
SMPS 3936NL86	0.98 (0.79)		
NanoScan	0.97 (1.03)	x	
NanoID	0.95 (1.18)	0.97 (1.22)	x

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