



APPLICABILITY OF A NEW WATER-CPC FOR AMBIENT MONITORING IN COMPARISON TO A BUTANOL-CPC



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A.J. Tiwari¹, T. Tritscher², S.H. Schmitt², J.H.T. Scheckman¹,
J. Spielvogel², A.F. Zerrath¹

¹ TSI Inc., 500 Cardigan Road, 55126 Shoreview, MN, USA

² TSI GmbH, Neuköllner Str. 4, 52068 Aachen, Germany

Contact: andrea.tiwari@tsi.com

Introduction

Two European standards for ambient monitoring of particle number concentration (CEN/TS 16976) and size distribution (CEN/TS 17434) require butanol-based Condensation Particle Counters (CPCs). Water-based CPCs have, however, been used in ambient monitoring for years. The performance of the Versatile Water CPC (V-WCPC Model 3789, TSI Inc. USA) is compared to that of a butanol-based CPC, Model 3750, when presented with both laboratory-generated sucrose aerosol and ambient aerosol. Ambient measurements were conducted in two locations: Shoreview, MN, US (aged aerosol); and Aachen, Germany (fresh aerosol).

Laboratory-generated aerosol

- Sucrose aerosol was generated using a Constant Output Atomizer and Diffusion Drier, at mode sizes ~30, ~50, and ~100 nm. These polydisperse distributions, as well as monodisperse distributions classified from them (at 30, 50, and 100 nm), were used as challenge aerosols.
- Concentration was varied using a dilution bridge and ranged from $1 \times 10^2 - 9.2 \times 10^4$ #/cm³. An aerosol mixer and a flow splitter delivered the concentration-adjusted aerosol to the CPCs. Both CPC's had a D50 of 7 nm.
- The ratio of measurements made by the 3789 and 3750 was calculated for monodisperse tests and polydisperse tests. These values serve two purposes:
 - Confirm that the 3789 is performing as expected relative to the 3750 on a controlled aerosol
 - Permit the 'normalization' of ambient data by this unit-to-unit difference

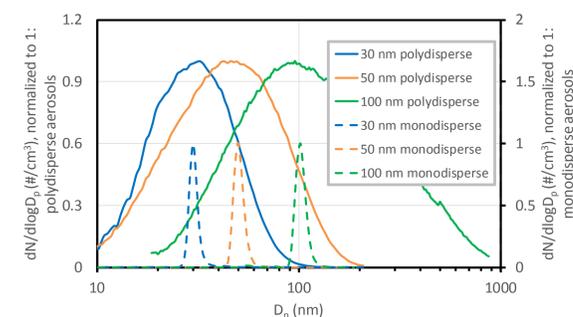


Fig. 1: Size distributions of polydisperse and monodisperse laboratory (sucrose) aerosol.

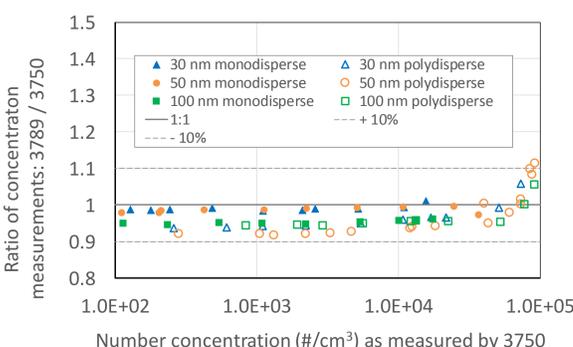


Fig. 2: Ratio of 3789 and 3750 measurements for laboratory aerosol.

Ambient aerosol

Following the laboratory characterization, the same individual 3750 and 3789 CPCs were used to measure particle number concentrations in ambient air at two locations: Shoreview, MN, US, and Aachen, Germany. The aerosol at the Shoreview US location is generally aged (suburban), while Aachen generally has fresh urban / industrial aerosol. An ambient aerosol sampling system – Model 3750200 – was used in both locations.



Fig. 3: Maps of ambient air sampling locations. Left: Shoreview (US); Right: Aachen (D).

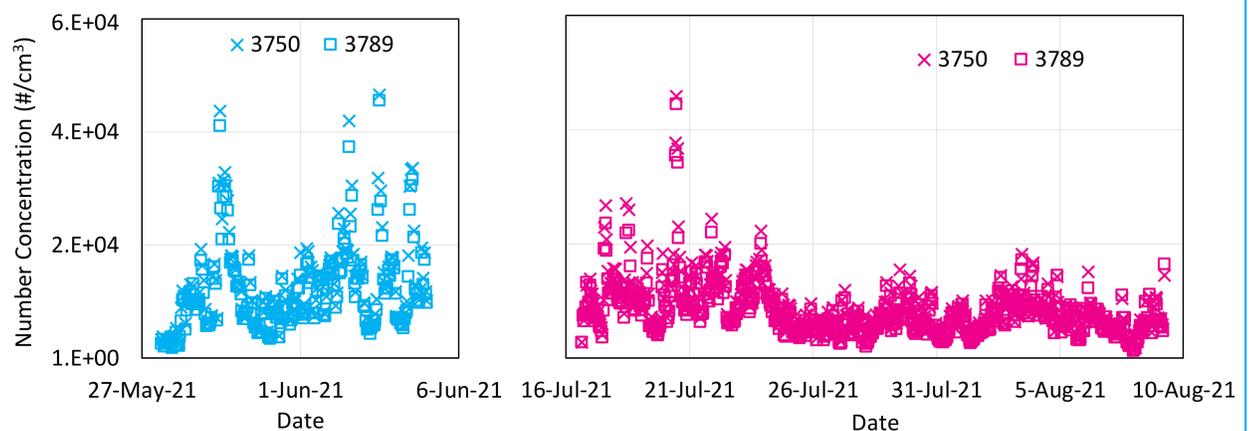


Fig. 4: Time series of ambient aerosol as measured by the 3750 and 3789 in Shoreview (left; blue) and Aachen (right, pink).

Fig. 5: Hourly averages of ambient measurements made by the 3750 and 3789, plotted against each other, for both sampling locations. Linear fits, forced through the origin, are shown.

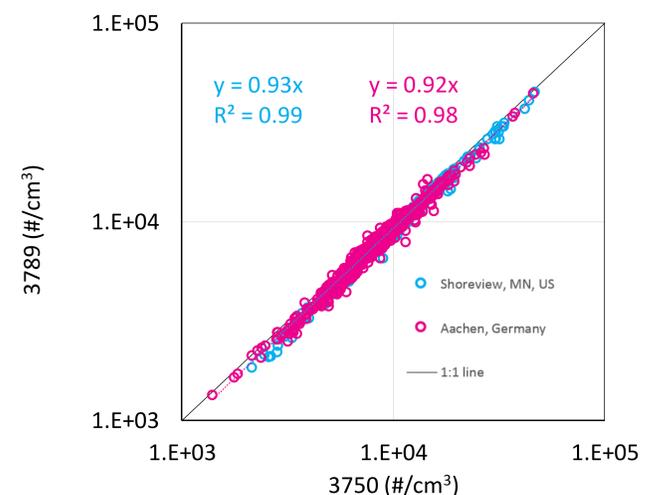


Table 1: Slopes of linear fits to ambient aerosol concentrations collected in Shoreview, MN, US and Aachen, Germany. Slopes are presented for data as collected (i.e., no correction is applied), and also after normalizing the 3789 ambient data to the laboratory data to correct for the unit-to-unit difference. Slopes of fits to data normalized using only the monodisperse tests, only the polydisperse tests, and all tests, are shown. The observed unit-to-unit difference meets the concentration accuracy specification for both models of CPC.

Ambient Air data slopes	Shoreview	Aachen
As-collected	0.93	0.92
Normalized to laboratory results	Monodisperse	0.95
	Polydisperse	0.98
	Combined	0.96

Conclusions The water-based 3789 compares positively to the butanol-based 3750 when measuring both laboratory-generated (polydisperse and monodisperse sucrose) and ambient aerosol. Correcting the ambient comparison for the performance of the CPCs on controlled, laboratory aerosol demonstrates that the 3789 performs very comparably to the 3750 for both fresh and aged ambient aerosol.

References

Hering *et al* 2014, *Aeros. Sci. Tech.*, 48:401-408.