On the detection limit of hydrophilic particles by a water CPC.

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The water-based condensation particle counter (WCPC) concept of Hering et al. (2004) has been turned by Quant Tecnhnologies into two commercial instruments. A first WCPC model was characterized by Kaufman and colleagues at the 2004 meeting of the AAAR. As expected from water's small Kelvin diameter at its critical supersaturation for homogeneous nucleation (Magnusson et al.), they noted a low size detection limit. This advantage is, however, offset by a surprising inability to detect hydrophobic particles. Quant's second WCPC model achieves a higher supersaturation than his first WCPC, and has a lower size detection limit (saturator 283K, growth tube 338K and optics 338K). It will be tested here with hydrophilic nanoparticles of polyethylene glycol (PEG).

The test particles were produced by charge-reduced (positive) electrospray of solutions of two relatively monodisperse samples PEG chain polymers with molecular weights chosen to cover the WCPC's expected lower size range (centered at 4.1 and 4.6 kDalton, respectively). Singly charged PEG is known to form spherical particles in the gas phase (Saucy et al. 2004). The charge-reduced electrospray generated particles were further selected by a high resolution DMA (Herrmann et al. 2000) before being introduced into the inlet port of the CPC and the electrometer in parallel. The electrometer used a flow rate of 10 lit/min (vs. 1 lit/min in the WCPC), so losses in its inlet line are negligible.

Figure 1 shows raw mobility spectra for PEG (particle concentration vs. DMA voltage) measured by both the CPC and the electrometer. Figure 2 shows the same data vs. mobility diameter for PEG 4.1k. Note the abrupt transition between 0 and full activation from 2.4 to 2.6 nm. This agrees with the 2.5 nm cutoff given in the commercial description of the instrument, distributed by TSI. The structure of the decay in counting efficiency is real, as the DMA was operated with high resolution. The rather small inlet losses of the WCPC at 2.6 nm are striking.

Herrmann, W.; Eichler, T.; Bernardo, N.; Fernandez de la Mora J. (2000). In Proc. of the annual meeting of the AAAR, St. Louis, MO, 6-10 October

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Saucy, D. et al. (2004), Anal. Chem**,** 76,1045

Magnusson, A. et al. (2003) J. Phys. Chem. Ref. Data, **32**, 1387-1409

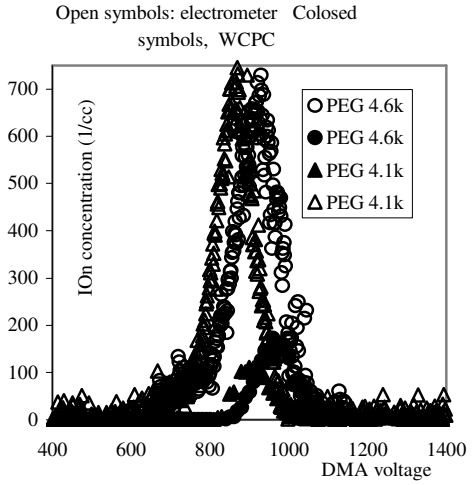

Fig.1
Ion concentration vs. DMA voltage measured with an electrometer (open circles) and the WCPC (filled symbols) for singly charged PEG particles

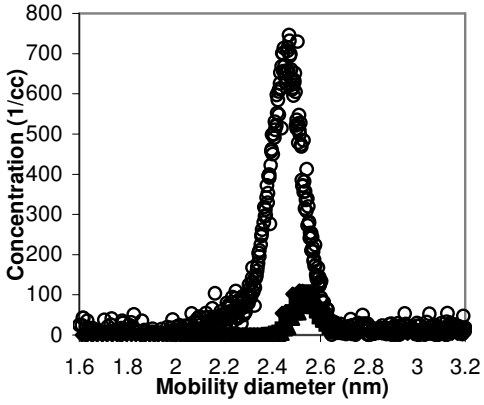

Fig. 2
Ion concentration vs. mobility diameter measured either with an electrometer (open circles) or with the WCPC (filled symbols) for singly charged PEG 4.1k particle

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