Comparison Between the Experimental and Theoretical Resolution of a Simple Three Outlet Differential Mobility Analyzer

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Measurement of particle size is required to understand the environmental impacts of aerosol particles (McMurry, 2000). The most effective and commonly used technique of measuring the size of aerosol particles is by employing Differential Mobility Analyzers (DMAs; Knutson and Whitby, 1975), which classify them according to their electrical mobility. DMAs have therefore become a standard component of aerosol size spectrometers, as well as of tandem systems (i.e., TDMAs) for determining some of the key physicochemical properties of aerosols such as hygroscopicity and volatility.

In TDMA systems, a monodisperse aerosol flow produced by the first DMA, is exposed to certain conditions (i.e., fixed relative humidity and/or temperature) before the size distribution of the particles is measured by a second DMA coupled with a Condensation Particle Counter (CPC). Despite the relative sort time of each size distribution measurement (ca. 3 min), a downside of these systems appears when the properties of monodisperse particles of different sizes from the same aerosol sample need to be determined. Chen *et al.* (2007), introduced a DMA with three outlets (3MO-DMA), having the ability of classifying three monodisperse particle populations, simultaneously and consequently increasing the time resolution. That DMA had the polydisperse aerosol flow introduced at the circumference of the central rod and the monodisperse particle outlets located along the outer electrode. As a result, when used as a first DMA in a TDMA system, it required three DMAs and an equal number of CPCs to measure potential changes in particle size at the 3 monodisperse particle outlets.

In this work we designed a simpler 3MO-DMA for use as DMA-1 in a TDMA system, without the use of additional equipement. In contrast to the 3MO-DMA developed by Chen *et al.* (2007), our classifier was constructed by modifying only the inner electrode of an existing single monodisperse outlet DMA. Its performance was experimentally evaluated using a TDMA configuration in which the size distribution of a monodisperse aerosol population provided by a custom-made conventional DMA was measured using the 3MO-DMA operated at different conditions. A software routine was employed for fitting lognormal distributions to the measured size distributions and for obtaining the geometric mean diameters of the sampled particles. The theoretical midpoint mobility diameters of particles classified by each outlet, at the operating flows and voltages of the 3MO-DMA, were then calculated using the generalized theoretical transfer function of multiple outlet DMAs (Giamarelou *et al.*, 2012). Figure 1 shows scatter plots of the measured versus the predicted geometrical mean diameters for 4 different sheath and aerosol flow rates. The solid lines stand for the 1:1 ratio, while the dashed lines depict a ±2% variation within which all the points fall.

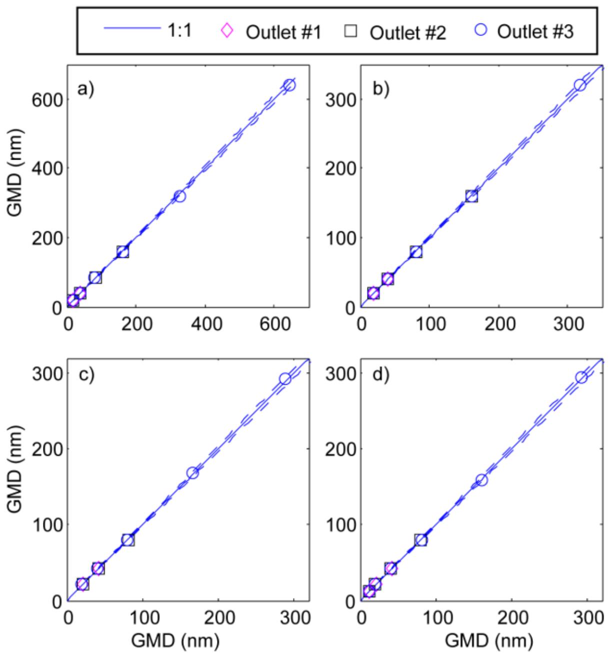

Fig. 1. Measured versus predicted (Giamarelou *et al.*, 2012) GMDs of the particles classified at each 3MO-DMA outlet, when the latter was operated with sheath and aerosol flows of (**a**) 3.0 and 0.3, (**b**) 6.0 and 0.6, (**c**) 8 and 0.3, (**d**) 8 and 1.5 lpm.

References

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