Experimental Determination of the Transmission Efficiency of the Aerodynamic Lens in the Aerodyne Aerosol Mass Spectrometer (AMS)

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One of the key issues for successful quantification of AMS data is knowledge of the overall collection efficiency of the AMS, CE_{AMS}. Until recently, analysis of AMS data has usually been performed with an overall collection efficiency of 0.5 obtained by comparing mass loading measured with an AMS to Particle into Liquid Sampler (PILS). This CE of 0.5 is not size dependent and so is not able to account correctly for mass loading for different modes in the ambient aerosol. From laboratory and field studies, three factors have been identified which influence the CE_{AMS}. They are the lens transmission efficiency of the inlet system, E_L, the efficiency due to particle bounce at the vaporizer, E_B and the efficiency due to particle shape, E_S. Determining E_L as a function of particle size is the object of the work presented here.

Numerical (Fluent) calculations of E_L have been performed on the AMS lens system, but measurements to verify the numerical calculations have been limited to date. Presented here are new results which extend E_L measurements to larger and smaller particle sizes using three different types of aerosols NH_4NO_3, $NaNO_3$ and di-ethyl hexyl sebacate (DEHS). These measurements of E_L of the AMS inlet system cover the vacuum aerodynamic diameter, d_{va} range of 44 – 777 nm. The lens system used in these measurements and in the model is known as the ARI standard lens (1/2" OD x 7" length).

To investigate E_L as a function of size experimentally, it is essential that particle size, composition and concentration be accurately known. Here we used an atomizer-classifier system to generate near monodisperse aerosol. The size distribution of the classified aerosol was determined using a scanning mobility particle sizer (SMPS). For concentration reference, a TSI condensation particle counter (CPC 3010) was used. The effective ionization efficiency, EIE must also be determined for each aerosol type. This was done at a particle size that can be collected with full efficiency. Once the reference EIE was obtained, experiments were then performed to determine E_L at other sizes.

The combined E_L results for the DEHS and $NaNO_3$ are shown in Figure 1 and are consistent with each other. The model over predicts E_L below 160 nm and under predicts E_L above 350 nm d_{va}. The $NaNO_3$ experiments were performed with a higher vaporizer temperature of 800 °C.

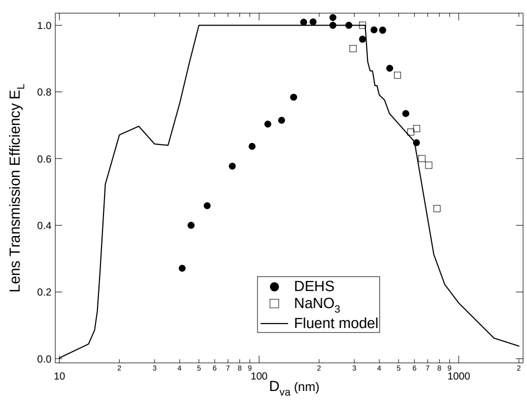

Figure 1. Lens transmission efficiency of the AMS inlet system with 100 µm orifice and 780 mb ambient pressure.

The results obtained with NH_4NO_3 were mixed as they were complicated by a small-end tail in front of the singly charged particles in the AMS, but this tail was not observed with the SMPS.

The results of DEHS using a nominal vaporizer temperature of 560 °C revealed evidence of bounce for the larger particles causing the particle distribution to be smeared between the singly and multiply charged particles. By systematically reducing the temperature of the vaporizer down to 380 °C, the bounce effect was eliminated.

The effect of particle vaporization temperature on particle bounce and the NH_4NO_3 results will also be discussed.

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