Characterization and Reduction of Particle Loss in Aerosol Diluters

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ABSTRACT

Accurate measurement of ultra-fine particles in high concentration is required in laboratory and industrial settings. Methods of measuring high concentrations are varied, but a common method is the use a single particle counting instrument. The Condensation Particle Counter(CPC) is a commonly used instrument to count particles in the ultra-fine size, however, are typically limited to concentrations limits of 10^4 particles/cc to remain in the higher accuracy single counting mode. One method to overcome this restriction is to accurately dilute the aerosol upstream of the CPC to reduce the concentration to below that of the upper limit of the CPC.

The objective of this study is to characterize the particle penetration of sub-100nm electrical mobility diameter particles in commercial diluters(TSI 3302, MSP 1100) and a commonly used laboratory "leaky filter". Furthermore, using the results of the characterization, the major loss mechanisms were identified and this information was used for development of a low loss orifice diluter that minimized sub-100nm losses. Using the penetration data collected, the accuracy of the size dependent dilution correction method was tested using a high-concentration diesel engine generated aerosol.

Sucrose particles were generated using a TSI Model 3480 Electrospray Aerosol Generator and where classified using a TSI 3085 Nano-DMA. Particle concentration measurements were made both upstream and downstream of the diluter using both the MSP 1100 and a TSI 3010. The laboratory "leaky filter" measurements were made using a MSP 1100 upstream and a TSI 3025A downstream. Penetration was determined using the particle dilution ratio determined from the CPC measurements and from volumetric dilution measurements.

As shown in Figure 1, the penetration of 9nm particles for all diluters is less than that at 100nm following a trend of decreasing penetration with decreasing particle diameter. This is driven by diffusional deposition on the walls of the diluter, with the resulting particle losses resulting in an artificially high dilution ratio when compared to the volumetric dilution ratio. Using the measured penetration then allows for corrections in concentration measurements if the size distribution of the aerosol is known allowing for accurate measurements of high concentration aerosols.

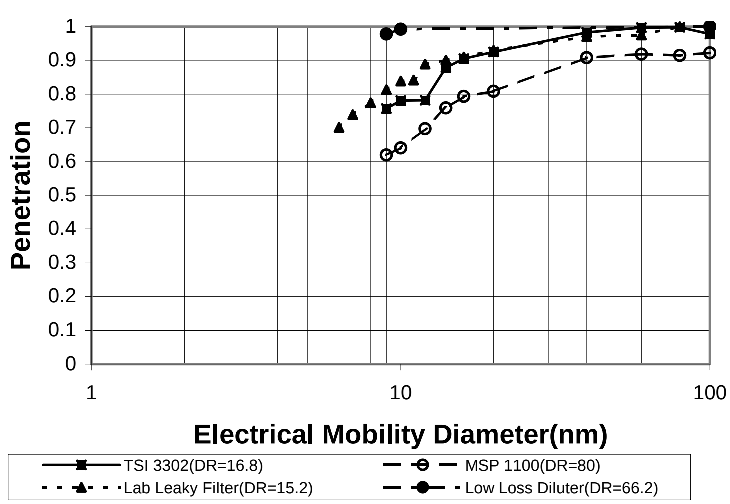

Figure 1. Penetration of Sub-100nm diameter particles in tested diluters