Response of Water-Based Condensation Particle Counters to Ambient and Vehicular Particulate Matter

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Concerns regarding the health effects of ultrafine particles and particulate emission from vehicular traffic is motivating the measurement of these particles in ambient air. Water-based condensation particle counting is an attractive approach for monitoring particle number concentration because it eliminates the need for toxic and costly working fluids.

Reported here is the response of a laminar-flow, water-based condensation particle counter (WCPC) to ambient and vehicular traffic aerosols. The WCPC is a continuous, thermally diffusive instrument that enlarges particles by water condensation to enable them to be counted by optical means. The WCPC uses a "growth tube" technology that explicitly takes into account the high diffusivity of water vapor wherein the supersaturation necessary for particle activation and growth is produced in a wetted tube whose walls are warmer than the entering flow (Hering and Stolzenburg, 2005).

Two types of WCPCs have been evaluated, the TSI Model 3785 and Model 3786. Model 3785, the first commercialized WCPC, has an unsheathed sample flow of 1 L/min with a lower size cutpoint of 4.5 nm (Hering *et al*., 2005). Model 3786 is an ultrafine particle counter that utilizes a 50% sheath flow with an aerosol flow of 0.3 L/min, with a lower size cutpoint of approximately 2.5 nm. The time response for both instruments is approximately 300 ms, excluding the flow-induced lag.

The WCPC response to traffic aerosols was evaluated by comparison to the butanol-based TSI Model 3025 ultrafine particle counter, which has a lower size limit of approximately 3 nm (Stolzenburg and McMurry, 1991). Side-by-side measurements were made from the exhaust duct of a freeway tunnel near Berkeley, CA and at freeway-influenced ambient sites in Berkeley, and Riverside, CA.

Figure 1 shows the size-dependent counting efficiency for traffic aerosol from the freeway tunnel, with comparison to the efficiency curve for the Model 3025 from Stolzenburg and McMurry that was used as reference. The cutpoint of the 3785 is around 4.5 nm, similar to that found for laboratory calibrations with inorganic salts (Hering *et al.,*2005). The ultrafine WCPC Model 3786 is somewhat more efficient than the Model 3025, with 70% greater counts at 2.5 nm. The data indicate that for the high water supersaturation ratios achieved in the WCPCs (of order 1.8 and 3, respectively) the ultrafine traffic aerosols are activated and counted efficiently.

Figure 2 shows a time series for total particle concentrations from the freeway tunnel. Over all concentration ranges the ultrafine WCPC detects somewhat more particles than the Model 3025, consistent with the difference in size cut noted in Figure 1.

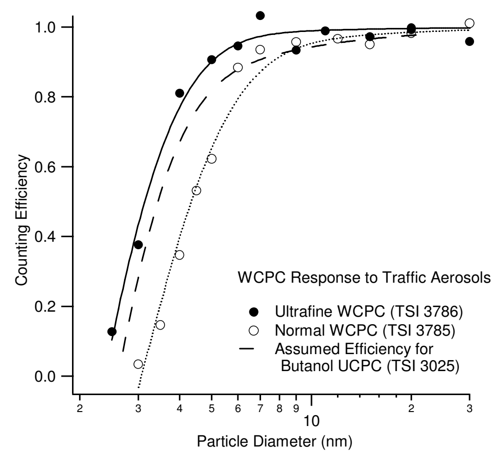

Figure 1. Response of the WCPC to traffic aerosol.

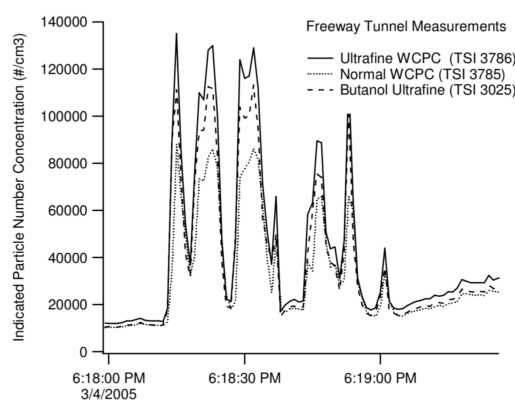

Figure 2. Comparison for vehicular emissions.

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