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ON-ROAD NANOPARTICLE MEASUREMENTS

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EXTENDED ASTRACT

The University of Minnesota (UMN) has had extensive experience collecting real world, on-road data. Data have been collected during chase experiments in which plumes from Diesel and spark ignition vehicles were captured, and during extensive periods while driving at highway speeds on urban, city and interstate roadways. In-use evaluations of aftertreatment devices have also been conducted. This research was conducted to determine the effect of real world dilution and driving conditions on particle emissions, in particular nanoparticle emissions. This presentation will present overview our work and emphasize measurements of nanoparticles < 50 nm in size produced by mixed on-road vehicle fleets.

The UMN Mobile Emissions Laboratory (MEL) was used to collect all the on-road data. The MEL has a suite of aerosol instrumentation capable of physically characterizing on-road aerosol from < 10 nm to 1 μm in near real-time. Included in the instrument suite are a Scanning Mobility Particle Sizer (SMPS) that determines the aerosol size distribution from 10 to 300 nm, and an ultrafine condensation particle counter (UCPC) used to obtain total number concentration of particles from 3 nm to 1 μm. Gas analyzers measure CO, CO_2 and NO_x.

Real-time, on-road measurements show that on-road exhaust aerosol number concentrations range between about 10^4 to 10^6 part/cm^3 with the majority of the particles by number being < 50 nm in diameter. The geometric number mean diameters, DGN, typically range from 15 to 30 nm. The highest particle number concentrations and smallest particle size are associated with high-speed traffic. Average emission factors for mainly gasoline vehicle traffic were determined and ranged from 1.9 to 9.9×10^{14} part/km and 2.2×10^{15} to 1.1×10^{16} part/kg fuel. These emission factors are in the upper range of reported values. Our work differs from previous studies in that the data were collected while moving on the roadway in traffic, particles were measured with a UCPC that could detect smaller particles than the instruments used in most other studies, and the ambient temperatures during these tests were lower.

In order to determine the volatility of roadway particles, simultaneous measurements in mixed Diesel and spark ignition traffic at highway speeds were made using two SMPS instruments, one with and one without a thermal denuder. The thermal denuder operated at 300 ºC, reduced the average number concentration between 87 and 95 % and the volume concentration between 54 and 83 % suggesting that most of the particle mass consisted of volatile material and that the smallest particles that comprised most of the particle number were nearly entirely composed of volatile material.

Key words: nanoparticles, nuclei mode, Diesel, spark ignition, emissions, on-road, SMPS, UCPC, particle size, size distribution