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Investigation of alternative metrics to quantify PM mass emissions from light duty vehicles

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Abstract

We evaluated the performance of six alternative particulate matter (PM) metrics relative to the regulatory gravimetric method during chassis dynamometer testing of five light-duty vehicles over the Federal Test Procedure (FTP) and Supplemental FTP (US06) cycles. Alternative metrics included three mass-based metrics including black carbon (BC), two suspended PM mass using integrated particle size distribution (IPSD) method, and three number/surface-based metrics including total particle number (PN), solid particle number (SPN), and particle active surface area (PS). The results showed PM emissions over the FTP cycle were dominated by solid particles on a mass basis (BC to PM ratio = 0.6±0.5), whereas over the US06 cycle were dominated by semi-volatile particles (BC to PM ratio = 0.2±0.2). Moderate to strong correlations were reported between the gravimetric method and the six alternative metrics for FTP and US06 cycles separately (R^2=0.69-0.91), i.e. the best-fit lines were strongly dependent upon the cycle. On the other hand, the six alternative PM mass and number metrics exhibited moderate to strong correlations regardless of the test cycle (R^2=0.66-0.98). We attribute the observed cycle dependency between alternative metrics and the gravimetric mass method to the greater gravimetric sensitivity to organic and semi-volatile PM than for most alternative metrics.

Keywords: Solid particle number, total particle number, particle active surface area, aerosol surface area, black carbon, suspend particle mass, diffusion charger, and photoacoustic