

EPA PM Chemistry Studies

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Extended Abstract

Although PM_{2.5} can be directly introduced into the atmosphere through primary emissions, the mass concentration of PM_{2.5} is also affected by secondary processes such as nucleation or condensation of nonvolatile and semivolatile compounds on pre-existing PM_{2.5}. To address these issues, a laboratory research program was developed at EPA to investigate the key chemical processes that determine the contributions of secondary processes to the overall mass concentrations of PM_{2.5}. The program consists of experiments to (1) measure the secondary organic aerosol (SOA) yields of atmospherically relevant hydrocarbons under ambient concentration and relative humidities; (2) determine the chemical composition of the multi-functional compounds in the SOA chamber samples and compare those findings with field study results; (3) measure the partitioning coefficients of semivolatile compounds in SOA; and (4) evaluate methods for collecting semivolatile SOA.

As part of the program a series of chamber experiments was carried out to determine to what extent photochemical oxidation products of aromatic hydrocarbons contribute to SOA aerosol formation through uptake on pre-existing inorganic aerosols in the absence of liquid water films⁽¹⁾. The irradiation experiments were conducted with toluene, *p*-xylene, and 1,3,5-trimethylbenzene in the presence of NO_x and ammonium sulfate aerosol, with propylene added to enhance the production of radicals in the system. The mass concentration of the organic fraction was obtained by multiplying the measured organic carbon concentration by 2.0, a correction factor that takes into account the presence of hydrogen, nitrogen, and oxygen atoms in the organic species. In addition, mass concentrations of ammonium, nitrate, and sulfate as well as total gravimetric mass concentrations were measured. The reconstructed mass concentrations were in reasonable agreement with the gravimetrically determined values. The largest secondary organic aerosol yield of $1.59 \pm 0.40\%$ was found for toluene at an organic aerosol concentration of $8.2 \mu\text{g m}^{-3}$, followed by $1.09 \pm 0.27\%$ for *p*-xylene at $6.4 \mu\text{g m}^{-3}$, and $0.41 \pm 0.10\%$ for 1,3,5-trimethylbenzene at $2.0 \mu\text{g m}^{-3}$. In general, these results agreed with those reported by Odum et al.,⁽²⁾ and support the gas-aerosol partitioning theory developed by Pankow⁽³⁾. The presence of organics in the aerosol did not affect significantly the hygroscopic properties of the aerosol for relative humidities between 35% and 80%.

References:

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