

3.056 Photochemical production of secondary organic aerosol from a non-road diesel engine: Influence of an alternative fuel and emissions control systems.

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Abstract:

Non-road diesels account for about a quarter of the nitrogen oxides and primary aerosol emissions from mobile sources in the United States. While a lot is understood about primary emissions, very little work has been done to characterize the atmospheric formation and evolution of secondary organic aerosol (SOA) from tailpipe emissions of non-road diesels. Further, little is understood about how SOA responds to the use of alternative fuels and emissions control systems. To address this gap, in the Summer of 2015, we performed photochemistry experiments on diluted emissions from a 4.5 L John Deere diesel engine using a potential aerosol mass (PAM) reactor. Aerosol size, mass and composition were measured using a scanning mobility particle sizer, photoacoustic extinctions, and high-resolution aerosol mass spectrometer (HR-AMS). After 1.5 days of simulated atmospheric aging, production of SOA dominated primary aerosol emissions by an order of magnitude. Efficient combustion at higher engine loads and removal of SOA precursors and particle emissions by emissions control systems (oxidation catalyst and particle filter respectively), significantly reduced emission factors for POA (factor of 10-50) and production factors for SOA (factor of 10). The only exception was that the SOA production was nearly identical for idle loads regardless of the use of emissions control systems. We hypothesize (and even validate using carbon monoxide measurements) that at idle loads the oxidation catalyst temperatures were too low to oxidize/remove any of the SOA precursors. Elemental analysis of the HR-AMS data shows a more oxygenated OA at idle than higher loads. Statistically, the use of soy-based biodiesel (B100) produced slightly lower POA emissions but nearly identical SOA levels as diesel. Work is under way to perform a positive matrix factorization using the HR-AMS data and understand compositional differences in OA produced across engine loads, fuels and use of emissions control systems.