Chamber Studies of Secondary Aerosol Formation from Light Duty Vehicle Exhausts

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Nordin[1], Erik, Z.[1], Nilsson[1], Patrik[1], Eriksson[1, 2], Axel[1,2], Kajos[3], Maija, K.[3], Rissler[1], Jenny[1], Svenningsson[2], Birgitta[2], Swietlicki[2], Erik[2], Bohgard[1], Mats[1], Kulmala[2,3], Markku[2,3] and Pagels[1], Joakim[1]

[1]Division of Ergonomics and Aerosol Technology, Lund University, P.O. Box 118 SE-221 00 Lund, Sweden
[2]Division of Nuclear Physics, Lund University, P.O. Box 118 SE-221 00 Lund, Sweden
[3]Department of Physic, University of Helsinki, P.O. Box 64, FIN-00014 University of Helsinki, Finland

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Particulate matter from anthropogenic combustion sources has been considered a health and environmental issue for a long time. Formation of secondary organic aerosol (SOA) from combustion processes is a subject that is not well known, because it involves a large number of complicated physical and chemical processes (Hallquist *et al.*, 2009). The aim of this study was to investigate secondary aerosol formation, by ageing light duty vehicle exhausts.

The campaign focused on secondary aerosol formation from idling gasoline (Volvo V40 1998), diesel (VW Passat 1998) and ethanol (Volvo V70 2009) fueled cars. Ammonium sulfate or primary particles from the diesel car are utilized as condensation seeds, with an initial concentration of about 20 µg/m^3. The experiments are monitored by several particle characterization instruments and gas analyzers (figure 1), including a HR-TOF Aerosol Mass Spectrometer. After extraction of the exhaust, it is left in the Teflon chamber for 30 minutes to allow mixing and to enable sampling of the fresh exhaust. The UV-lights are then turned on for 5h.

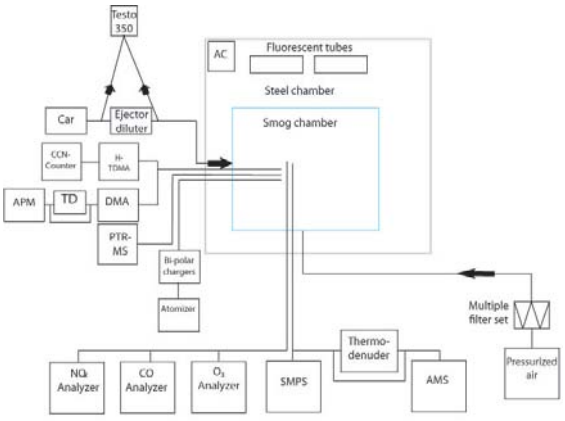

Figure 1: The measurement setup

The ageing experiments take place in a 6 m^3 fluorinated ethylene propylene chamber (Lindskog *et al.*, 2009). The chamber is placed in a 21 m^3 temperature controlled steel chamber. Exhaust is extracted from a car operating on idling load for about 15 minutes. The exhaust is injected via a heated stainless steel inlet (140 ^{0}C) with a flow rate of 0.0055m^3/s, the total dilution ratio in the chamber is about 200 times.

An example of an experiment involving the gasoline car is given in figure 2. The ratio between secondary organics and the sulfate seed increases almost four times during oxidation of the gasoline exhausts. The increase in organics/salt-ratio is due to condensation of the SOA on the salt seeds (figure 2). The ammonium sulfate particles are used to reduce vapor losses and to quantify particle wall losses.

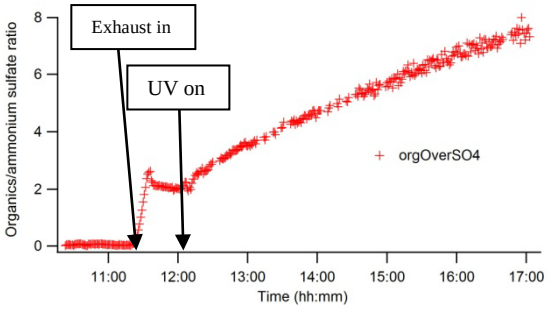

Figure 2: The ratio between organics and sulfate from gasoline exhausts (Volvo V40 1998), the UV-lights started at 12:00 and ended at 17:00.

The organic matter origins from unburned and partly oxidized hydrocarbons in the gasoline fuel, the hydrocarbons are then oxidized in reactions initiated by UV. The oxidation decreases the vapor pressure of the hydrocarbons, which causes them to partition to the particle phase (Robinson *et al.*, 2007).

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Hallquist *et al.* (2009) *The formation, properties and impact of secondary organic aerosol: current and emerging issues.* Atmos. Chem. Phys. Discuss., 9, 3555-3762

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