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Published in:
European Aerosol Conference 2009

2009

[Link to publication](#)

Citation for published version (APA):

Pagels, J., Lindskog, M., Nilsson, E., Swietlicki, E., Bilde, M., & Bohgard, M. (2009). Ozone Initiated SOA Formation of Combustion Aerosols. *European Aerosol Conference 2009*, T108A18.

Total number of authors:
6

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OZONE INITIATED SOA FORMATION OF COMBUSTION AEROSOLS

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Keywords: INDOOR AIR, OZONE, AEROSOL MASS SPECTROMETRY, SOA FORMATION

Recently it has been shown that organic aerosols from incomplete combustion such as emissions from diesel engines are significantly transformed upon atmospheric ageing (Robinson et al. 2007). The particle mass emission factors increases due to gas-to-particle conversion upon exposure to UV-light. We hypothesize that these effects are generic also for other types of combustion aerosols and oxidants. The aim of this work is to test this hypothesis by investigating processing of indoor combustion aerosols upon exposure to elevated ozone concentrations.

Incenses and sidestream cigarette smoke of market leading brands were generated in a controlled manner in the Lund aerosol chamber (22 m³, stainless steel chamber). After a desired particle concentration (30, 60 or 100 µg/m³) was established, the chamber was sealed. Two types of experiments (each 2-5 hours long) were performed, reference experiments with no added ozone and experiments where 100 or 400 ppb ozone was added after 20 min using an ozone generator (Ozone Technology). The ozone level was monitored using a UV spectrophotometric ozone monitor (model 49, Thermo Andersen). The particle size distribution and number concentration was determined using a scanning mobility particle sizer (model 3934, TSI Inc.). The chemical composition of fresh and aged aerosol particles was studied using a High-Resolution Time-of-Fight Aerosol Mass Spectrometer (HR-TOF-AMS; Aerodyne Research Inc.). The total mass concentration (PM1) was determined from the SMPS number size distribution using particle effective densities, which were empirically determined by comparing mobility (SMPS) and vacuum aerodynamic diameters (AMS).

Decrease in mass concentration over time in reference experiments were due to wall losses and some evaporation during the initial part of the experiment. As ozone was introduced into the chamber a rapid increase in mass concentration took place. For sidestream cigarette smoke the mass increase relative to the reference measurement is about 70% at 400 ppb ozone, and about 40% at 100 ppb ozone. Similar effects were found for incenses. It was found that concentrations of oxidised fragments detected with the AMS increased rapidly as ozone

was added (fig 1). This shows that the condensed material is highly oxidised, compared to the hydrocarbon dominated primary particles. The elemental composition showed increased oxygen to carbon ratio and increased nitrogen concentration after ozone addition.

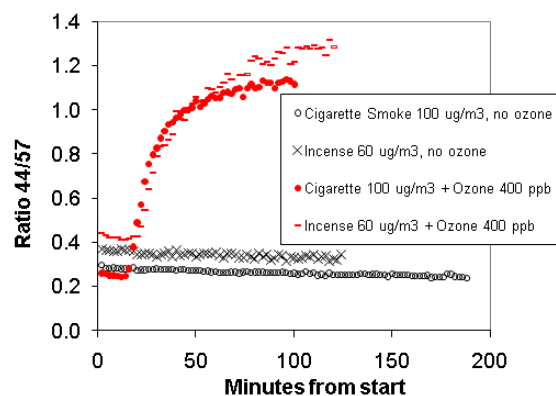


Figure 1. Time dependence of the ratio of two major fragments detected with AMS. m/z 44 (mainly CO₂⁺) is a marker for oxidised organics, m/z 57 (mainly C₄H₉⁺) is a marker for hydrocarbon like organics.

These effects are rapid enough to be relevant for indoor air (10-15 min). Health effects of aged particles are almost certainly different from those of fresh particles. Future experiments are planned to involve other combustion aerosols, such as wood smoke and traffic emissions and other oxidants, for example UV-light.

This study was financed by the Swedish Research Council FORMAS

Robinson AL, Donahue NM, Shrivastava MK, et al. (2007) SCIENCE 315, 1259-1262