# Hygroscopic and cloud-activation properties of aged exhaust aerosols

Wittbom, Cerina; Svenningsson, Birgitta; Rissler, Jenny; Fors, Erik; Swietlicki, Erik; Nordin, Erik; Eriksson, Axel; Nilsson, Patrik; Pagels, Joakim

2010

# Hygroscopic and cloud-activation properties of aged exhaust aerosols

Wittbom, Cerina[1], Svenningsson, Birgitta[1], Rissler, Jenny[2], Fors, Erik[1], Swietlicki, Erik[1], Nordin, Erik[2], Eriksson, Axel[2], Nilsson, Patrik[2] and Pagels, Joakim[2]

[1]Department of Physics, University of Lund, P.O. Box 118 SE 221 00, Lund, Sweden
[2]Division of Ergonomics and Aerosol Technology, Lund University, P.O. Box 118 SE-221 00 Lund, Sweden

Keywords: H-TDMA, CCNC, Aged exhaust aerosol, Growth Factor, Supersaturation.

Aerosol particles affect both climate and health. Primary particles affect the atmosphere directly, while secondary aerosol is formed in the atmosphere by complex gas-particle conversion processes. The processes and products of secondary organic aerosol (SOA) from volatile organic compounds (VOCs) and their effect on cloud droplet formation are of great interest for investigation. The supposed altered organic fraction in an aged particle is important when predicting the CCN-activation, e.g. organic compounds that are surface active, decrease the surface tension and lowers the supersaturation (SS). However, in general organic compounds contribute less to the water activity suppression compared to inorganic salts.

The focus of this study is to analyze the hygroscopic behaviour of aged exhaust aerosol and link it to the effect on cloud droplet activation dependence on the particle size as well as the organic fraction in the particles. The car exhaust was aged using ozone and UV-light in a Teflon bag (for experimental set-up see Nordin *et al.*, 2010).

Hygroscopic and cloud-activation properties of aged exhaust aerosols was analysed using a Hygroscopic Tandem Differential Mobility Analyser (H-TDMA) (Nilsson *et al.*, 2009) in conjunction with a Cloud Condensation Nucleus Counter (CCNC) (DMT 100). The H-TDMA provides measurements of hygroscopic properties of the aerosol as well as a particle mobility separation for the CCNC-analysis. For this work the SS in the CCNC was varied for a fixed particle size. From the H-TDMA data the diameter growth factor (GF) can be derived and used for predicting the critical SS ($SS_{50}$) for particles of a certain mobility diameter. Here we present two experiments included in a series of measurements: (1) ammoniumsulfate (AS) seeds coated with organic compounds, and (2) diesel soot particles.

The smaller growth of the coated AS, compared to pure AS, imply that the coating is a compound that does not influence the water activity as much as AS does (Fig.1). As for the diesel soot, the particles showed no growth at all with increasing RH. However, the H-TDMA provides the mobility diameter and might give misleading information because the agglomerated diesel soot particles are not spherical and could therefore have an unnoticed water uptake.

From the provided GF we used a simple model based on Köhler theory to predict the $SS_{50}$ (Rissler *et al.*, 2010), which agreed well for CCNC measurements of the coated AS particles ($D_{mob}$=70 nm), Fig.2.

In the calculations for predicting the $SS_{50}$ for soot particles only the Kelvin effect was taken into account, according to the mobility diameter, assuming wettable particles. Results show that soot particles need a higher SS than the predicted (Fig.2). Our hypothesis is that this is due to the agglomerated structure of the soot particles.

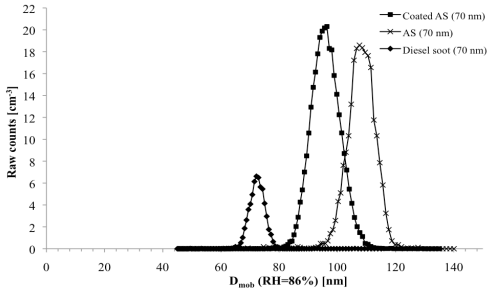


Figure 1. Particle diameters ($D_{dry}$=70 nm) at 86% RH, from the H-TDMA for soot (diamonds), coated AS (boxes), and pure AS (crosses).

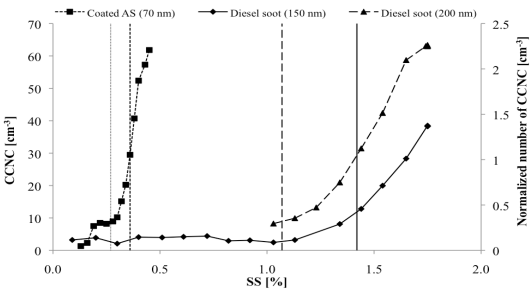


Figure 2. Raw data from CCNC (data points) and $SS_{50}$ predictions (vertical lines), discussed above. The solid grey line is the $SS_{50}$ for pure AS, dotted line correspond to coated AS (70 nm), dashed line to soot particles (150 nm), and solid black line to soot particles (200 nm). Data points for soot particles are normalized to the peak values from H-TDMA.

The Swedish Research Council supports this work.

Nilsson, E. *et al.* (2009). *Atmos. Meas. Tech.*, 2, 313-318.

Nordin, E. Z., Nilsson, P., Eriksson, A., Kajos, M.K., Rissler, J., Swietlicki, E., Bohgard, M., Kulmala, M., Pagels, J. (2010). *Submitted to IAC 2010.*

Rissler, J., Svenningsson, B., Fors, E., Bilde, M., Swietlicki, E. (2010). To be submitted to J. Geophys. Res.