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2005

Link to publication

Citation for published version (APA):

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ON-LINE CHARACTERISATION PARTICLE EMISSIONS FROM INDOOR COMBUSTION SOURCES — CHAMBER STUDIES OF PARTICLE VOLATILITY AND HYGROSCOPICITY

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Keywords: INDOOR AEROSOLS, COMBUSTION, VOLATILITY, HYGROSCOPICITY,

INTRODUCTION

People in industrialised countries spend ~ 90% of their time indoors and often indoor combustion sources give a significant contribution to the personal exposure of e.g. PM2.5 or the number of ultrafine particles.

We have characterised fine and ultrafine particles from indoor combustion sources in a 22 m³ steel chamber with controlled ventilation rate and relative humidity. The sources were sidestream cigarette smoke, incense and candles. Particle size distributions (5-1000 nm) and source strength were determined with an Electrical Mobility Spectrometer. Particle elemental composition was determined with PIXE (Z>12) and Evolving Gas Analysis (EC/OC). Different particle types from each source were separated using Tandem DMA-methods, where particles of well-defined size were conditioned to known RH (20-95%) or temperature (20-600 °C). These methods were also used to estimate the vapour pressures and solubility of particle constituents.

The initial concentration of the cigarette smoke for a single cigarette was around 120,000 particles per cm³. The particle size distribution of cigarette smoke and incense was unimodal with initial diameters of 100 and 200 nm, respectively. Particles were relatively volatile with a relatively large spread in vapour pressure. The most volatile components evaporated from the particle to the gas phase during storage in the chamber for 1 hour, with the majority of the effects happening during the first 10 minutes. All particles responded similar to thermal conditioning indicating that all particles have similar composition.

The candle size-distribution consisted of overlapping modes. A nucleation mode with concentrations higher than 10⁶ cm⁻³ with initial diameters of 10-20 nm. These particles took up water already at RH<40% and are therefore likely water-soluble. A soot mode of larger particles appeared already at low air-flows. These particles clearly dominated the mass concentration, when present. The nucleation mode candle particles distinctly decreased their diameters at around 150 °C, while the accumulation mode particles were almost stable up to 500 °C, as expected for elemental carbon. Smouldering particles appeared after the candles were