



# LUND UNIVERSITY

## On-line Characterization of Aerosols from Transient Biomass Combustion

Nordin, Erik; Eriksson, Axel; Nyström, Robin; Pettersson, Esbjörn; Rissler, Jenny; Swietlicki, Erik; Bohgard, Mats; Boman, Christoffer; Pagels, Joakim

*Published in:*

Proceedings of the European Aerosol Conference (EAC)

2012

[Link to publication](#)

*Citation for published version (APA):*

Nordin, E., Eriksson, A., Nyström, R., Pettersson, E., Rissler, J., Swietlicki, E., Bohgard, M., Boman, C., & Pagels, J. (2012). On-line Characterization of Aerosols from Transient Biomass Combustion. *Proceedings of the European Aerosol Conference (EAC)*.

*Total number of authors:*

9

### General rights

Unless other specific re-use rights are stated the following general rights apply:

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

Read more about Creative commons licenses: <https://creativecommons.org/licenses/>

### Take down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

LUND UNIVERSITY

PO Box 117  
221 00 Lund  
+46 46-222 00 00

# On-line Characterization of Aerosols from Transient Biomass Combustion

E. Z. Nordin<sup>1</sup>, A. C. Eriksson<sup>2</sup>, R. Nyström<sup>3</sup>, E. Pettersson<sup>3,4</sup>, J. Rissler<sup>1</sup>, E. Swietlicki<sup>2</sup>, M. Bohgard<sup>1</sup>, C. Boman<sup>3</sup> and J. Pagels<sup>1</sup>

<sup>1</sup>Ergonomics and Aerosol Technology, Lund University, P.O. Box 118, SE-22100, Lund, Sweden

<sup>2</sup>Nuclear Physics, Lund University, P.O. Box 118, SE-22100, Lund, Sweden

<sup>3</sup>Energy Technology and Thermal Process Chemistry, Umeå University, SE-901 87, Umeå, Sweden

<sup>4</sup>Energy Engineering, Luleå University of Technology, SE-971 86 Luleå, Sweden

Keywords: APM, AMS, morphology, biomass combustion

Presenting author email: Erik.Nordin@design.lth.se

Combustion of biomass fuels for residential heating is considered to be a climate friendly option and is increasing globally. However, this implies potentially increased emissions of aerosol particles. PM<sub>2.5</sub>, which is to a large extent comprised by combustion generated particle matter, co-varies with cardio vascular diseases (Kocbach Bølling *et al.*, 2009). The composition of biomass combustion aerosol can be divided into three main components, soot, alkali salts/ash and organic aerosol and is determined by combustion conditions like oxygen supply and temperature as well as the fuel. Soot and organic aerosol are a result of poor combustion conditions and are considered to be more harmful to human health than ash particles produced under optimal combustion conditions (Kocbach Bølling *et al.*, 2009). A combustion cycle for example in a wood stove can emit episodes of poor combustion even when the overall combustion is relatively complete. The start-up phase is very sensitive to flash-over which results in air-starved conditions with emissions of soot and polycyclic hydrocarbons. The aim of this paper is to study the change in aerosol properties due to different combustion conditions and phases using on-line aerosol measurement techniques.

A total of five combustion cases were studied using three residential wood combustion appliances; *i*) a conventional wood stove operated with high burn rate *ii*) a conventional wood stove operated with nominal burn rate, *iii*) a modern pellet burner operated under optimal conditions *iv*) a novel pellet reactor operating under air starved conditions. Mean flue gas and particle characteristics from the combustion cases are shown in table 1.

Table 1: Particle characteristics and gas concentrations.

Case	O <sub>2</sub> (%)	CO (mg/MJ)	Total conc. (#*10 <sup>7</sup> /cm <sup>3</sup> )	Org (mg/MJ)
<i>i</i>	9.3±5.4	3020	2.7±1.1	9.4
<i>ii</i>	11.8±2.4	2590	1.6±0.8	8.6
<i>iii</i>	8.2±1.0	110±38	8.4±0.4	0.32
<i>iv</i>	11.1±1.2	120±67	6.1±0.2	0.45
<i>v</i>	5.3±2.0	700±1390	3.0±0.8	6.5

The aerosol from the combustion appliances was diluted 1000-3000 times to concentrations relevant for ambient air before sampling. A high resolution aerosol mass spectrometer (HR-TOF-AMS, Aerodyne research Inc.) was used for size resolved composition of

compounds vaporised at 600°C. A scanning mobility particle sizer (SMPS) was used for mobility size distributions (10-600 nm) and an aerosol particle mass analyser operated downstream a differential mobility analyser and an optional thermodenuder (DMA-TD-APM) was used to determine the mass mobility relationship and assess the size dependent organic mass fraction. Particles for TEM analysis were collected using an electrostatic precipitator. For highly transient conditions like the start-up phase the time-resolution of the APM is not sufficient. By utilizing a relationship in (DeCarlo *et al.*, 2004) that the effective density is the ratio between the vacuum aerodynamic diameter (AMS) and mobility diameter (SMPS), the effective density can be derived by from SMPS and AMS size distributions. Combining this method with APM measurements will give novel and detailed information about the aerosol composition in all phases of the combustion cycle.

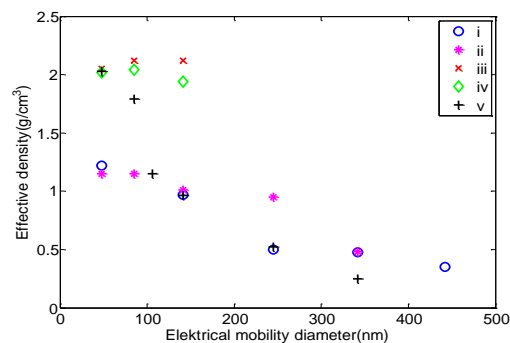


Figure 1: The effective density

The effective density from DMA-APM measurements (figure 1) gives an indication of the particle shape and composition. Salt aerosols have a relatively high effective density, which does not change with increasing mobility diameter, due to their spherical shape. Soot particles on the other hand have a lower effective density which is decreasing with increased size, due to their agglomerated shape.

This work was supported by the Swedish Energy Agency, the ERA-NET project Biohealth, FORMAS and METALUND.

DeCarlo P. *et al.*, (2004) *Aerosol Sci. Technol.* 38: 1185–1205

Kocbach Bølling A. *et al.*, (2009) *Particle & Fibre Toxicology*, 6:29