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LUND UNIVERSITY

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

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On-line Characterization of Biomass Aerosols from Different Combustion Conditions

E. Z. Nordin[1], J. Pagels[1], A. Eriksson[1,2], R. Nyström[3], E. Pettersson[3], E. Swietlicki[2], M. Bohgard[1] and C. Boman[3]

[1]Ergonomics and Aerosol Technology, Lund University, P.O. Box 118, SE-22100, Lund, Sweden
[2]Nuclear Physics, Lund University, P.O. Box 118, SE-22100, Lund, Sweden
[3]Energy Technology and Thermal Process Chemistry, Umeå University, SE-901 87, Umeå, Sweden

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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. $PM_{2.5}$, which is to a large extent comprised by combustion generated particle matter, co-varies with cardio vascular diseases (Kochbach *et al.* 2009). Soot and organic carbon which are produced under incomplete combustion conditions are considered to be more harmful to human health than ash particles produced under optimal combustion conditions (Kochbach *et al.* 2009). The aim of this paper is to study the change in aerosol properties due to different combustion conditions.

A total of five combustion cases were studied using three residential wood combustion appliances; *i*) a conventional wood stove operated with high load, *ii*) a conventional wood stove operated with low load, *iii*) a modern pellet burner operated under optimal conditions *iv*) a novel pellet reactor operating on optimal conditions *v*) a novel pellet reactor operating under air starved conditions. Conventional wood pellets or birch wood logs (14 % moisture content) was used. Gas concentrations and particle characteristics from the combustion cases are shown in table 1.

Table 1: Particle characteristics and gas concentrations from the five combustion cases.

Case	O_2 (%)	CO (mg/MJ)	Total conc. (#*10^7/cm^3)	Org (AMS) (mg/MJ)
i	9.3±5,4	3020	2.7±1.1	9.4
ii	11.8±2,4	2590	1.6±0.8	8.6
iii	8.2±1.0	110±38	8.4±0.4	0.32
iv	11.1±1.2	120±67	6.1±0.2	0.45
v	5.3±2.0	700± 1390	3.0±0.8	6.5

The aerosol from the combustion appliances was diluted 1000-3000 times to ambient concentrations, 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 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.

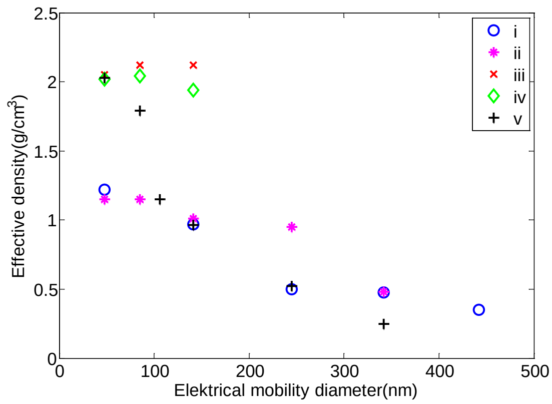

Figure 1: The effective density from the combustion cases.

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 particle on the other hand have a lower effective density which is decreasing with increased size, due to their agglomerated shape. The aerosol from case *iii* and *iv* consists of spherical alkali salt particles, with little organic contribution. When the novel pellet reactor is operated under air starved conditions (*v*) the aerosol consists of both salt and soot particles, which are produced during different stages of the combustion cycle. The aerosols from case *i and ii* is dominated by soot particles and organic carbon.

The present on-line characterisation study gives novel detailed information of the aerosol emission properties from different kinds of biomass combustion.

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Kocbach Bølling A., Pagels J., Yttri K-E., Barregard L., Sällsten G., Schwarze PE., Boman C. (2009) *Health effects of residential wood smoke particles: the importance of combustion conditions and physicochemical particle characteristics*. Particle & Fibre Toxicology, 6