

# Primary particles and marker compounds from wood combustion in household stoves

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Biomass combustion is a major global source of fine particulate matter (PM) in the atmosphere with significant impacts on regional air quality, visibility, ecosystems, human health, and global climate (Hobbs, 1997). Once released to the atmosphere, biomass smoke is mixed with the particulate matter emitted from many other natural and anthropogenic pollution sources, in many cases becoming difficult to recognize and quantify (Simoneit et al., 1999). In Estonia wood and wood chips account > 90% of the fuel used for residential heating (Loosaar et al., 2008). Source apportionment studies as well as emission inventories depend on reliable data about emission sources. There is, however, lack of information concerning the characterisation of particulate emissions from small scale biomass combustion systems in North-East Europe. Molecular markers have been used extensively in source apportionment studies and to evaluate the transport, transformation, and fate of atmospheric species (Engling et al., 2006).

Three different combustion facilities were tested: a masonry stove, a cooking stove and a fireplace, as those combustion facilities are typically used in Estonian households. Measurements were carried out in EERC stove test laboratory and they included both filter sampling (PM<sub>10</sub>, PM<sub>2.5</sub>, PM<sub>1</sub>, PM<sub><1</sub>) and online methods. Conifer and hardwood logwood with different humidity was used. Each log batch was weighed, heating value was measured and the RH of each log was measured separately. All samples were taken from the hot flue gas. For the particle measurements Dekati® PM<sub>10</sub> Impactor (10 l/min, Dekati Ltd) was used. The Dekati® PM<sub>10</sub> Impactor classifies airborne particles into four size fractions (PM<sub>10</sub>, PM<sub>2.5</sub>, PM<sub>1</sub>, PM<sub><1</sub>). Samples were taken through an insulated, externally heated (up to 180 °C) sample line. Samples were taken during the start-up phase (up to 20 min) and during the constant flaming process (up to 30 min). For the removal of larger particles the Dekati® Cyclone (10 l/min, Dekati Ltd.) with the nominal cutpoint D<sub>50</sub> 10 µm, was used. From the filter samples organic carbon (OC), elemental carbon (EC), levoglucosan and ionic composition (Na<sup>+</sup>, K<sup>+</sup>, Ca<sup>2+</sup>, Mg<sup>2+</sup>, NH<sub>4</sub><sup>+</sup>, SO<sub>4</sub><sup>2-</sup>, Cl<sup>-</sup>) were analysed. The organic (OC) and elemental carbon (EC) fractions were determined from quartz filter samples with a thermal optical method using a carbon analyzer constructed by Sunset Laboratories (Model-3 Semi-Continuous OC-EC Field Analyzer, Sunset Laboratory). The analyses were performed according to the NIOSH method 5040. Levoglucosane was detected with the gas chromatograph-mass spectrometry (GC-MS) after

chemical derivatization. Ionic composition of the particles fractions were analyzed by ion chromatography (Dionex DX2000 and DX2100). Simultaneously gas samples (O<sub>2</sub>, SO<sub>2</sub>, NO, NO<sub>2</sub>, CO, CO<sub>2</sub>, VOC), temperature (°C), relative humidity (%) and gas flow (m/s) were measured during the whole burning process. Samples for the gas analyses were taken through an insulated, externally heated (up to 180 °C) sample line and through the filter units to the gas analyser (Testo 360, Testo AG).

## Results

OC and levoglucosane content in smaller PM fractions was higher. The average levoglucosane content in PM<sub>10</sub> fraction was in average 50.083 µg per filter and in PM<sub><1</sub> fraction in average 1127.400 µg per filter. Potassium content in PM<sub>10</sub> fraction was smaller compared with other PM fractions. Taken into account that the combustion equipment type and other relevant flue gas and wood parameters (temperature, RH, heating value) play an important role in PM<sub>x</sub> and marker compound formation, this should be considered in further emission inventories.

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