

# Real-time chemical composition analysis of particle emissions from woodchip combustion

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Residential wood combustion (RWC) produces high amounts of gaseous and particulate emissions into atmosphere. RWC for heat production has been and will be assessed to be one of the major sources of fine particle mass emissions as use of fossil fuels is predicted to be reduced in the future. Composition of crucial particulate emissions in wood combustion, ash, inorganic compounds, polycyclic aromatic hydrocarbons (PAH), alkali metals, elemental (soot) and organic carbon are depending on the combustion conditions (Tissari, 2008). Therefore it is important to study the variation of particulate emissions chemical composition during different burning processes.

In recent studies, the chemical composition of particulate emissions from residential wood combustion has been analyzed from the collected filter samples. However, conventional methods have poor temporal information from aerosol composition in rapidly changing circumstances. In this work aerosol chemical composition in near real-time from efficient to poor combustion conditions emissions of 40 kW grate fired burner was measured by Aerodyne high-resolution time-of-flight AMS (HR-ToF-AMS) (DeCarlo, 2006).

Table 1. Average mass concentrations and standard deviations (std) of compounds during and outside of gaseous CO peaks in poor combustion.

Compound	During peak, mass loading ( $\mu\text{g}/\text{m}^3$ )	Outside of the peak, mass loading ( $\mu\text{g}/\text{m}^3$ )
HOA	$1.9 \pm 1.5$	$0.5 \pm 1.0$
LV-OOA	$3.2 \pm 2.0$	$0.7 \pm 0.5$
Aromatic	$3.7 \pm 3.7$	$7.1 \pm 5.1$
PAH <sup>2+</sup>	$7.6 \pm 10.0$	$0.4 \pm 0.4$
PAH	$8.6 \pm 14.0$	$0.6 \pm 0.5$

It was found that particulate PAH compounds are formed during the constantly occurring short-period CO peaks shown in figure 1 and table 1, when combustion conditions changed temporarily because of grate movements of the burner. Organic species were split by positive matrix factorization (PMF) method (Ulbrich, 2009) into LV-OOA (Low-Volatile, highly Oxidized Organic Aerosol), HOA (Hydrocarbon-like Organic Aerosol), PAH and Aromatic factor. It was found that particulate PAHs split into once and doubly charged ion fragments in the instrument (Table 1). Aromatic factor was mainly composed of one aromatic ring containing

species, for example  $\text{C}_6\text{H}_5$ , and it was in the background throughout the combustion experiment in incomplete combustion circumstances. Hence it was noticed that aromatic ring containing organic species split into two factors where one ring containing species were in aromatic factor and several ring containing species were in PAHs. LV-OOA was likely oxalic acid, composed of  $\text{CO}_2^+$ ,  $\text{CO}^+$  and water ion fragments. Sulfate was originated from inorganic salts and was mainly in the background in the medium circumstances that were in between efficient and poor, combustion conditions.

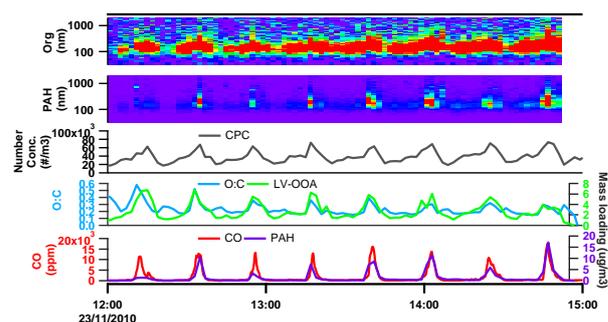


Figure 1. AMS organics and PAH size-resolved mass concentrations, CPC number concentration, O:C ratio, LV-OOA, gaseous CO and PAH double charge factor vs time during poor combustion.

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