

# Primary and Secondary Organic Emissions of a Pellet Boiler

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The combustion of biomass for domestic heating leads to environmental and financial benefits due to an approximately neutral CO<sub>2</sub> balance, subsidies in many countries and independence from growing prices of fossil fuels. In 2012, 6 mio tons of wood pellets were consumed in EU27 for residential heating (Thomson and Liddell 2015). Pellet boilers are one popular appliance for a controlled technique of burning wood and known to produce low amounts of pollutants, compared to wood combustion in stoves. Although permanent gases, such as CO<sub>2</sub>, CO, NO<sub>x</sub>, and particle-related emissions, such as organic and elemental carbon (OC, EC), have been subject of many emission studies of stoves, only few studies were carried out to investigate the composition of volatile emission and its conversion into secondary organic aerosol (SOA).

On that account, combustion experiment with a modern small-scale automatically-fired pellet boiler (Biotech, PZ25RL, Austria) fuelled with commercially available soft wood pellets and birch bark pellets were accomplished under different operation stadiums: ignition, stable combustion (SC), reduced secondary air (RSA) and shutdown. The pellet boiler covers a constant nominal load of 25 kW, a 200 kW heat exchanger and secondary air supply. Ageing experiments were performed in a Potential Aerosol Mass flow reactor (PAM) with UV-lights on (254 nm and 185 nm) for OH radical and ozone generation (Bruns 2015). Emissions of main permanent gases in the exhaust and VOC were analysed by ABB gas analysers and single-photon ionisation time-of-flight mass spectrometry (SPI-TOFMS) at 118 nm, respectively. Particles were examined by a soot-particle aerosol mass spectrometer (SP-AMS).

Typical wood combustion related species, such as phenol and furan derivatives, only occurred during the start phase to an appreciable extent. For both type of pellets, m/z of aliphatic and aromatic (poly)unsaturated hydrocarbons appear in the mass spectra, such as benzene, butadiene, vinylacetylene and propene. Compared to stable combustion condition, total intensities increased by 100 % for birch bark pellets and by 50 % for RSA. However, for the latter condition aromatic compounds increased by 1,000 %, whereas

polyenes raised only by 100 % and oxygenated species remained constant. Consequently, VOC of this combustion type are not only difficult to assign to wood combustion in source apportionment studies, but also lead to higher oxidised and functionalised secondary organic aerosol due to more double bonds in the precursors and possibilities for oxidative attack by atmospheric oxidising agents (Ng 2006). Finally, different yields of volatile secondary species were observed exposing the combustion aerosol to the PAM. For example, acetaldehyde (m/z 44), hydroxyacetone (m/z 72) and 2(5H)-furanone (m/z 84) showed distinctly higher abundances in the gas phase with UV lights switched on (Figure 1). From SP-AMS, a growth in particulate organic mass between 50 % and 90 % was observed for RSA, but only 3 % to 16 % for SC due to low VOC-to-NO<sub>x</sub> ratios.

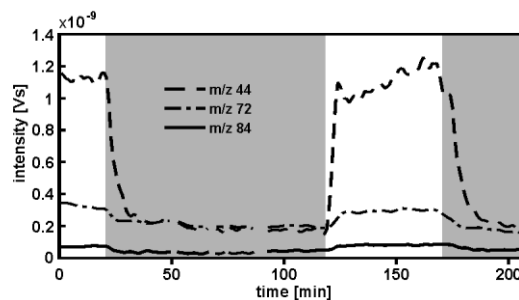


Figure 1. Time traces of secondary volatile species in PAM with UV lights on (white) and off (grey).

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