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Polycyclic Aromatic Hydrocarbon Emissions in Transient Wood Combustion

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Dynamic Changes in the Aerosol Composition and Concentration During Different Burning Phases of Wood Combustion. MICHAEL ELSASSER, Christian Busch, Jürgen Orasche, Hans Hartmann, Jürgen Schnelle-Kreis, Ralf Zimmermann, *Helmholtz Zentrum München*

Different on- and off-line mass spectrometry-based methods were applied to investigate changes in aerosol gas-phase and particle-phase composition during wood combustion in the different phases of the burning process. The experiments were carried out with a logwood boiler and a stove at the Technology and Support Centre (TFZ) for renewable resources in Straubing, Germany. Different fuel types (spruce and beech) and burning conditions (normal, overloaded feed, oxygen deficiency) were investigated. The aerosol particle phase of the non-refractory compounds was analysed by a High Resolution Time-of-Flight Aerosol Mass Spectrometer (HR-ToF-AMS, Aerodyne Research Inc.). Together with a Photo Ionisation (PI) Time-of-Flight Mass Spectrometer (ToF-MS), which detects selective aromatic organic compounds in the gas phase by Resonance Enhanced Multi Photon Ionisation (REMPI), it provides a useful tool to measure the dynamic of wood combustion.

This dynamic could be described and reflected in four different burning phases, during which the aerosol compounds and concentration changed strongly. For example, the first phase, which is of pyrolytic nature, shows the highest concentrations of organic mass, mass-to-charge ratio (m/z) 60 and guaiacol. The following "harsh combustion phase" provides an increase of the phenolic compounds in the flue gas, indicating the breakdown of the lignin backbone of the wood structure. Additionally, the contribution of organic mass to total non-refractory mass during these phases decreases from 99% to 91%. The wood combustion marker signal at m/z 60 also decreases. The subsequent "stable flaming phase" has the highest relative amount of sulphate and chloride, so the impact of inorganic compounds increases like in the second phase. The start of the char burnout is indicated by an increase of the carbon monoxide concentration in the gas phase. This contribution provides an overview of the impact of the dynamic phases of wood combustion. Additionally, it shows that burning conditions can significantly change the emission.

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Polycyclic Aromatic Hydrocarbon Emissions in Transient Wood Combustion. Axel Eriksson, Erik, Z Nordin, Robin Nyström, Esbjörn Pettersson, Christoffer Bergvall, Roger Westerholm, Erik Swietlicki, Christoffer Boman, JOAKIM PAGELS, *Lund University, Lund, Sweden*

Polycyclic aromatic hydrocarbons (PAHs) have been denoted key components in particle related toxicology. Emissions of PAHs can under certain circumstances be high in residential wood combustion. However, previous attempts to identify the combustion conditions favouring high PAH emissions have typically been limited to averages over one to several combustion cycles. In this work we applied Aerosol Mass Spectrometry for highly time-resolved direct measurements of PAHs and total organics in residential biomass combustion.

Emissions from a conventional wood stove and a novel pellet reactor with possibility to control fuel and air supply were studied. The flue gas was diluted with particle free air of ambient temperature, the total dilution factor was 1:2000. A high resolution aerosol mass spectrometer (HR-TOF-AMS, Aerodyne Inc.) was used for size resolved composition of compounds vaporised at 600°C. The results were compared with off-line speciated PAH analysis using GC-MS.

In the wood stove the highest emission factors of total particle phase organics and PAHs occurred during the first 1-5 minutes after addition of new batches of logs on glowing embers, although PAHs constituted less than 1% of the total organics. Elevated PAH-emissions also occurred at hot air starved combustion in both appliances, when O₂ levels in the flue gas were below 5%. In these cases, PAHs composed up to 30% of the total organics. A high burn rate under hot and air-starved combustion conditions, leads to thermal cracking of primary released oxygenated pyrolysis products (e.g. levoglucosan and methoxy-phenols). At higher temperatures mostly aromatic compounds and soot are stable enough to survive resulting in elevated PAH emissions.

It is well known that poorly insulated stoves, bad mixing and humid fuels lead to high organic emissions. This work illustrates the potential deterioration of emission levels caused by too high burn rates.