On the emissions of wood-log fueled fireplaces: correlation of continuous gas sensor data with particle spectra analysis

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Wood-log fuelled fireplaces in domestic households are widespread. Biomass combustion saves fossil resources, but emissions from such stoves might affect human health. Especially fine dust emissions appear carcinogenic. Automatically controlled combustion might be a solution for future wood-use in heat generation. For that purpose, sensors installed in the flue gas should give continuous and reliable insights concerning gaseous and particulate matter emissions. Resistive particle sensors are known from automotive applications. Typically, they are operated discontinuously: As long as soot deposits on the electrodes, an increasing current signal can be measured. After a certain time, the sensor has to be regenerated at higher temperatures (soot oxidation). Figure 1 shows an initial test with a simple soot sensor (own development, details in [1-4]), installed in the flue gas of a single-room fireplace (LEDA Unica, Germany). Several slopes could be evaluated and correlated with data from a continuous particle analysis (DMS500, CAMBUSTION) – here the product of the "Aerosol Mode Concentration" (i.e. the particle number concentration, PNC) and the "Aerosol Mode" (i.e. count media diameter, CMD).

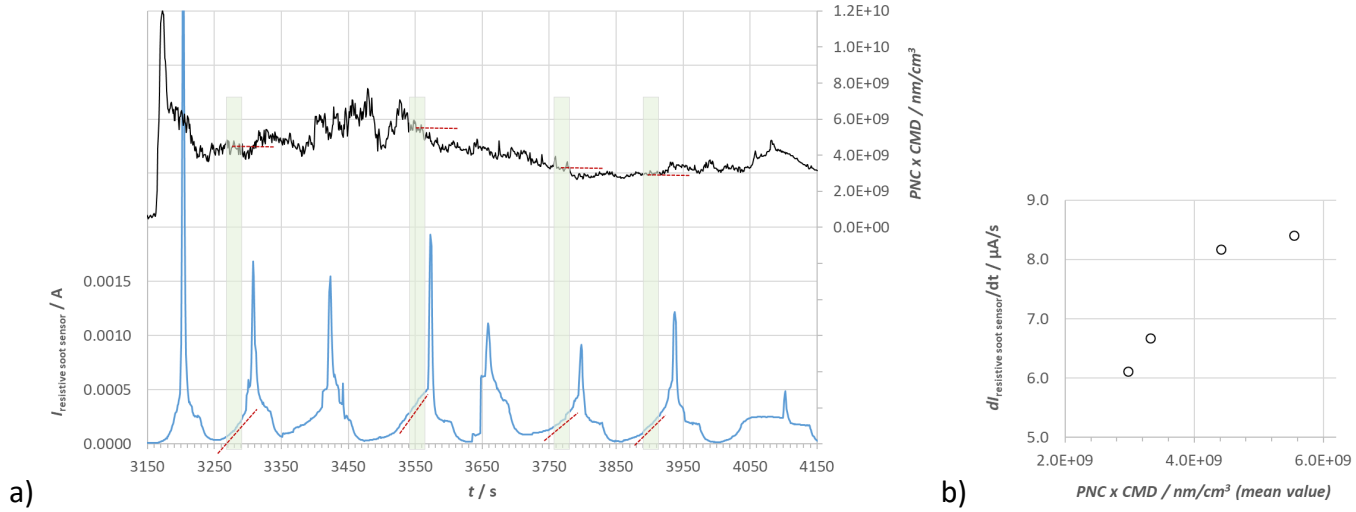

Figure 1a: Comparison of particle analysis (DMS500, CAMBUSTION, details see text, upper curve) and discontinuously operated resistive soot sensor (own development with Pt-electrodes on alumina substrate without protection cap) during wood combustion (starting after stoking with wood in the hot stove); **b**: Correlation of the sensors slope (i.e. increasing current over time during soot deposition on the electrodes) with mean-value of particle data at evaluated time intervals (20 s each, see Figure 1a).

More desirable and effective for controlling the stove operation [5] would be a continuous signal, corresponding to the emissions. For that purpose, a robust gas sensor was developed. It measures a sum of reducing gas components by means of exothermicity (details in [5]). The sensor signal is processed to a concentration value which fits well to data from FTIR gas analysis (MKS Multigas). Figure 2 shows that continuously measured gas data also correlate with particle data. Future work will focus on dependencies between particle formation, various gas sensor data and available operation parameters. A deeper understanding should enable efficient and environmentally friendly biomass use.

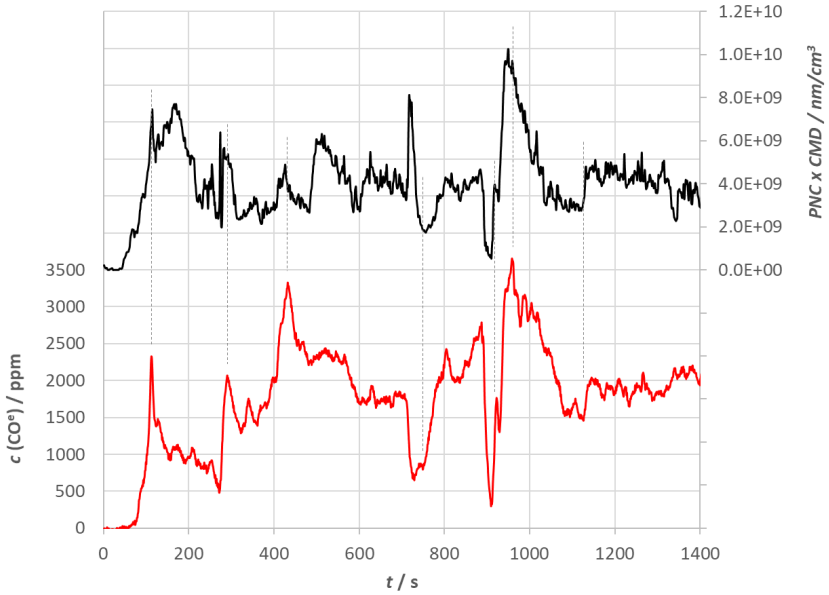

Figure 2: Comparison of particle analysis (DMS500, CAMBUSTION, details see text, upper curve) and sensor signal (SUM of reducing gases as CO-equivalent value by own developed CO/HC-thermoelectric gas sensor after [6], lower curve) during batch combustion of wood in a single room fireplace (cold start and one time stoking with additional wood at *t* = 900s).

References:

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