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PARTICULATE EMISSION FROM WOOD FIRING

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INTRODUCTION

An increase of the utilisation of biomass burning for energy production has been recognised recently, mostly in households and for the space heating of some public and agricultural buildings. Some of this wood is a by-product of furniture manufacturing, as a result during the combustion process various components with toxic effect might be emitted to the atmosphere. The majority of the wood combustion plants are not equipped with any flue gas filtering system, releasing all of the produced particles to the air. Others have simple fly ash collection usually cyclone and the collected ash is dumped on site so that resuspension of the giant particles have very significant contribution to air quality. The health effect of such inhaled aerosol particles depends on their aerodynamic behaviour and the heterogeneous distribution of toxic components in the particles. The environmental impact is most important in small settlements during winter periods with low inversion layer and moderate turbulence.

METHODS

Particulate and gaseous emission of a 150 kW heat plant was measured at Szödliget (small town at 30 km North form Budapest) during standard winter operation. The pant burned chipping from wood processing. Generated thermal power was calculated from the water temperature and flow rate measured on the secondary side of the boiler by ultrasonic flow meter. Below the gas flow duct a cyclone collected mostly large particles. Bottom ash, wood and ambient aerosol were also collected. The sampling of fly ash was isokinetic in the 1 m diameter vertical stack at flow rate of 7 m/s. Gas analysis of CO, O_2, CO_2, NO_X and THC was carried out by the measuring car that had a heated sampling tube. Since the generated heat is used for space heating the plant is regulated by a thermostat. The temporal resolution of the emitted gaseous compounds is presented in Figure 1. The measured CO concentration was over 600 mg/Nm^3 in the peaks. The unburned organic content as seen in Fig. 1 is striking.

For individual particle analysis one part of the filter was glued to a Cu-Zn sample holder and coated by a 25 nm carbon layer for Electron Probe Micro Analysis – EPMA – (Reed, 1975). 350 particles were measured in each sample. Morphological parameters such as diameter and shape factor were calculated by the image processing routine of the measuring program. The obtained characteristic X-ray spectra of the particles have been evaluated by the AXIL code (Van Espen *et al.*, 1986). The particles were classified using hierarchical cluster analysis. The determination of the elemental concentrations for each individual particle is possible, however, the final result of the classification based on the quantitative concentrations does not differ significantly from that based on normalised intensities (Bernard *et al.*, 1986).

Most particles emitted from the duct were in the respirable size range containing over 65 % of unburned organic substance. Particle classes obtained for the filter sample are presented in Figure 2. Potassium is the dominant element in each class. The two most abundant classes (51 % and 26 %) contain typical plant nutrients and trace elements. Class 4 obviously contains KCl particles with 2 μm average diameter. These particles were possibly originated from wood processing.

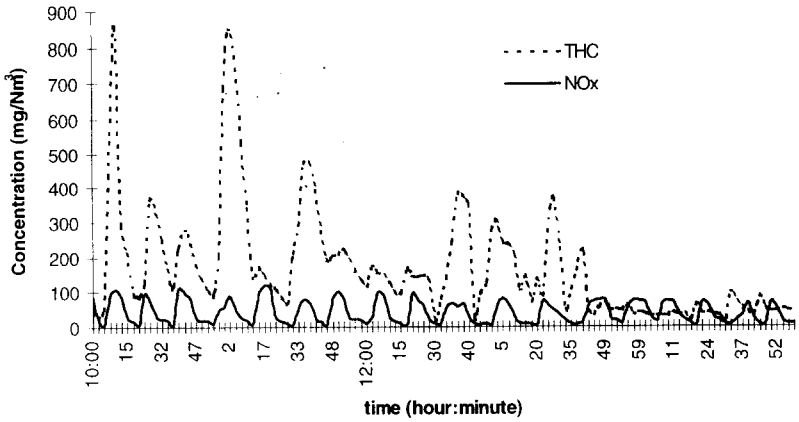

Figure 1. Temporal resolution of THC and NO_X components during a regular winter day.

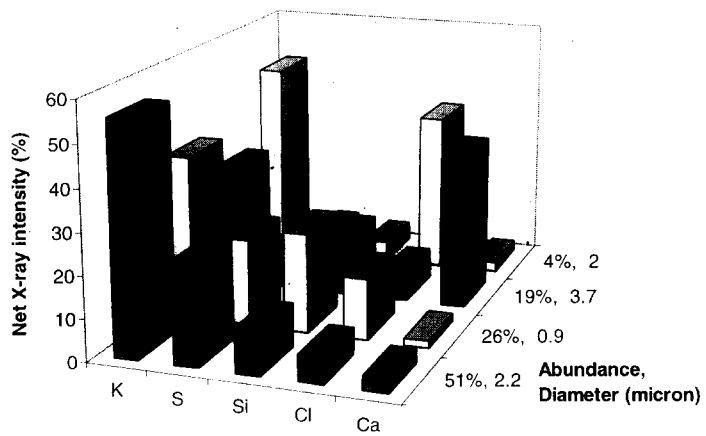

Figure 2. Particle classes of the fly ash sample from Szõdliget, obtained by single-particle EPMA and hierarchical cluster analysis.

CONCLUSIONS

The classification of the particles using single-particle EPMA is a useful tool to identify the origin of fly ash and to trace the emitted particles in the ambient air. Since the majority of the particles emitted from the wood burning plant was found to be in the respirable size range, they can cause significant effect to the human health. Therefore the extension of the studies by trace element and organic analysis combined with modelling the deposition in the human lung provides useful information to toxicological research.

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