Release of critical elements from biomass combustion

[a]Ruppert H, [a]Seidel T

In many countries with temperate forests wood and straw combustion is increasingly used to reduce the emission of greenhouse gases as well as the dependency from countries delivering fossil fuels and to stabilize or reduce the energy prices. In the industrialized countries of the northern Hemisphere the forest soils are often polluted by element such as Pb, Cd, Sb, Bi etc. and strongly acidified (pH-values of 3 to 4) facilitating the transfer of critical elements into trees. The behavior of critical elements during biomass combustion is very poorly known.

We did some systematic combustion experiments in small and larger wood burning units and sampled the fuel (wood pellets, chips and logs), the bottom ash, the internal heat exchanger ash, the electrostatic precipitator ash, and the fly ash during and after wood burning. The samples were digested totally with a mixture of concentrated HF-$HClO_3$-HNO_3 in closed PTFE vessels and analysed by ICP-OES and -MS.

As preliminary balance calculations show, variable portions of the elements stay in the different ash fractions, but considerable portions of some elements leave the chimneys as aerosols and are only partially retainable by filters or electrostatic precipitators. Compared to the element amounts contained in the fuel the following harmful element portions are released into the atmosphere in decreasing order: Cd (>90%), Pb, Tl, Mo, Cr, Zn, Sn, Sb, Co, S, Cu, and Ni (~40%). It means that more than 90 % of Cd or about 40 % of Ni contained originally in the wood are not retained in the bottom and heat exchanger ashes but enter the air mainly in the form of aerosols or molecules. The aerosols are smaller than 1 µm and show a pronounced water solubility for the different elements. This facilitates the transfer of the aerosol into the lung alveoli and the transition of critical elements into the blood. Appreciable amounts of the pollutants contaminate the surroundings of wood burning facilities and significantly increase the atmospheric deposition. The implementation of electrostatic precipitators reduces the emitted portion only up to 20 % depending on the element.

Our results should activate a further improvement of flue gas purification techniques. Such emission findings must also be incorporated into upcoming national and international emission compilations for different harmful elements, if wood and straw burning will become an essential part of our future energy supply.

Parallel to harmful metals we also measured the release of critical organic compounds. Their formation depends on the burning conditions in the ovens and the water content of the fuel. Furnaces feed by wood pellets show the best burning conditions and the lowest emissions of organic pollutants, while burning of wood chips and logs leads to higher undesirable emissions.

[a] *Geoscience Centre, University of Goettingen, Goldschmidtstrasse 3, 37077 Goettingen, Germany (hrupper@gwdg.de)*