SYNCHROTRON RADIATION INDUCED µ-X-RAY FLUORESCENCE AND ABSORPTION SPECTROSCOPY ON MUNICIPAL SOLID WASTE FLY ASHES

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The increasing amount of refuse has turned industrialised countries to choose incineration as a way to manage municipal and hazardous wastes. The advantages of incinerating waste are their volume reduction and the fact that the chemical energy stored in them is transformed into a usable form, usually electricity or heat. However, Municipal Solid Waste (MSW) fly ash may be a potential hazard due to enrichment of toxic trace metal compounds. An effective and safe handling of such ash requires a thorough knowledge of its chemical properties, in particular, their dissolution and leaching characteristics.

The aim of the present work was to gain a better understanding of the factors that determine the environmental mobility of trace elements and, in particular, the potential for their dissolution and leaching. Such detailed investigation of the content, distribution and chemical forms of toxic metals especially of Cd on/in individual particles is a valuable complement to the usual elemental analysis of bulk samples.

In the present study, Synchrotron Radiation induced µ-X-ray fluorescence and absorption spectrometry were used to investigate in situ metal ion distribution and the chemical state of Cd in micro-spots of individual MSW fly ash particles. These X-ray micro-beam techniques can be used to reveal spatially resolved information about structural and chemical properties of particles. By using an excitation energy of 27.0 keV, trace elements of environmental concern, like Cd, Pb and Zn can be detected at low concentrations (ppm) routinely. Changing the excitation energy in the vicinity of the absorption edge of Cd (26.71 keV), the absorption spectra of this element can be measured in a micro-spot of an individual fly-ash particle. Since most of the Cd compounds (CdO, CdSO\textsubscript{4}, CdS, CdCl\textsubscript{2}, CdBr\textsubscript{2}) whose abundances are the most likely in the fly ash material have identical oxidation states (+2), an energy range of 200-300 eV around the Cd absorption edge (NEXAFS) was scanned in order to get structural information about atoms in the local environment of Cd.

The measurements were performed on individual fly ash particles from a Bubbling Fluidised Bed (BFB) combustion unit of 2×15 MW fired with MSW. Twelve single particles of different dimensions (varying from ca. 30 to 200 µm in diameter) were selected and each of them was glued on a 100 µm diameter glass capillary before the µ-XRF analysis. Several micro-spots on a single particle containing relatively high amounts of Cd were chosen for the NEXAFS measurements. The measurements were performed at ID22 of the European Synchrotron Radiation Facility (ESRF, Grenoble, France) using compound refractive lenses (CRL) for the demagnification of the synchrotron source and creating the micro-beam.