

A COMBINED XRF AND XANES STUDY ON BOTTOM ASHES FROM MUNICIPAL SOLID WASTE INCINERATOR

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The correct management of waste is a key aspect of the transition of our society to become as environmentally neutral as possible. Only in Italy, each year about 30 million tons of urban waste are produced, of which 5.3 million are disposed in incinerators; the incineration process then produces about one million tons of ashes [ISPRA, 2018].

In general, ashes from municipal solid waste incinerators (MSWI) are made by bottom ashes (BA), and fly ashes (FA), which corresponds to about 20% and 4% by weight of the original waste, respectively [Baalbaki et al., 2019]. Whereas FA are classified as dangerous waste, BA can be recycled and are the main secondary raw material from incinerators. Recycling BA as a secondary raw material represent an interesting, environmentally friendly, alternative solution to landfill disposal; indeed, several processes have been proposed, like inclusion in ceramics or in concrete [Bertolini et al., 2004].

Nevertheless, any form of recycling requires an assessment of the potential pollution for environment and health risk. This can be achieved through a detailed study of the chemical and mineralogical composition of BA and with specific tests to determine their eventual evolution following ageing, leaching and weathering [Alam et al., 2019]. BA are made by crystalline phases, i.e. silicate, carbonate, oxides, sulphates, amorphous glass and metallic inclusion. They are mainly composed by Si, Al, Fe, Ca, Mg, K, Na, S, Cl. However, they also contain potentially dangerous elements (PTE) such as Zn, Pb, Cu, Cr and Ni. The actual danger depends on the mineralogical environment in which they are found, which controls the potential release in the environment, so for any potential reuse it's important to determine their speciation.

For this reason, on few grains (sized 0.5 - 1 mm) of BA from a waste-to-energy plant, SEM-EDS, XRF mapping and XANES measurements were performed. The sample was embedded in epoxy resin and one side was polished. Then, XRF maps with a resolution of 50x50 μm^2 and an incident beam energy of 14 keV were collected in various areas.

Orienting on the basis of the elemental distribution, XANES spectra from different elements (Zn, Cu, Cr, Ni and Pb) were then collected on selected clasts.

XRF maps evidenced that PTE are present with different oxidation states and structures, like in metallic form, amorphous phases, silicates and carbonates. A preliminary look to the XANES data collected at the Cr K-edge permits to exclude the presence of Cr^{6+} , as all the collected spectra have features resembling that of Chromite (Cr^{3+}).

Also, all the XANES data collected at Pb L_3 -edge on various clasts are almost identical, and from the comparison with Pb metal foil and PbO standard compound spectra, we can qualitatively derive that Pb is oxidized in all the clasts. Cu appears to be present both in metal and oxidized form. The precise oxidation state and coordination geometry of all the investigated chemical elements will be determined through linear combination fit (LCF) analyses.

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