INDUSTRIAL PILOT PROJECT

Synchrotron-based spectroscopy as analytical tool for improved zinc recovery processes from fly ash

THE INDUSTRIAL CHALLENGE

Waste-to-Energy through incineration is a common method to treat waste from households and commercial enterprises, and energy is recovered through production of heat and electricity. The fly ash formed as a by-product from the waste incineration is usually classified as hazardous, and is today typically deposited into specialized landfills. At the same time the ash could be used as a secondary source of metals and salts. Renova AB has recently built a facility for Zn recovery utilising fly ash from waste incineration. Better knowledge of the chemical form of Zn in the fly ash, before and after extraction, would enable a more efficiently designed extraction process.

WHY USING A LARGE SCALE FACILITY

The difficulty in determining speciation of trace metals in ashes lies not only in their relatively low concentrations (few % and below), but also in the complexity of the ash matrix with numerous elements in various chemical forms and commonly present amorphous phases. Therefore, traditional lab-methods such as X-ray diffraction (XRD) are not sufficient/suitable. A technique that has been proven successful to determine the speciation of these trace metals is synchrotron-based X-ray Absorption Spectroscopy (XAS), in which the chemical speciation of trace elements can be determined by analysing specific features on their X-ray absorption edges, and nano-resolved XRF could provide additional qualitative information about Zn-location.

HOW THE WORK WAS DONE

Three batches of both collected raw ash and residue after the Zn-extraction was investigated. Initial XAS measurements were performed at the P65 beam line of Petra III, Hamburg, and at Balder beamline of the MAXIV laboratory, Lund. Furthermore, combined nano-resolved XRF and XAS measurements were performed at beamline i14 of the Diamond Light source, Harwell UK. All XAS data were analyzed by Linear Combination Fitting (LCF) of the XANES spectra, and the nano-XRF data with statistical methods.

THE RESULTS AND EXPECTED IMPACT

From the LCF analysis of the XAS spectra we conclude that there are four main types of Zn-forms in the raw ash: salts, spinels (with Fe and Al), silicates, and Zn adsorbed onto or “dissolved” into the insoluble constituents of the ash particles (mainly composed by Ca). Another interesting finding is that the chemical form of Zn changes upon “dry” storage, and that the moisture present in air is sufficient to drives the transition. These results led to an investigation if other elements of importance (e.g. Cu, Pb and Sb) had a similar behaviour, but this was not observed. The finding shows the speciation of Zn is complex and put specific requirements for the sample preparation prior to any analysis of the chemical form of Zn in ash. The observation could potentially have implications for how the ash should be stored before the Zn-extraction process but needs to be investigated further.

The conclusions from the XAS analyses were supported by the nanoXRF and nanoXANES studies. Preliminary data further shows that the largest particles were containing the spinels and silicates, while the salts were mainly found in the smallest particle fraction.

Figure. Renovas’ new facility for Zn-extraction.

“This project has resulted in valuable knowledge about the zinc speciation in fly ash which can influence the recovery process.” ***/Karin Karlfeldt Fedje, Renova AB***

Contacts: Karin Karlfeldt Fedje – Renova AB, karin.karlfeldt.fedje@renova.se
Jenny Rissler – RISE, jenny.rissleer@ri.se

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