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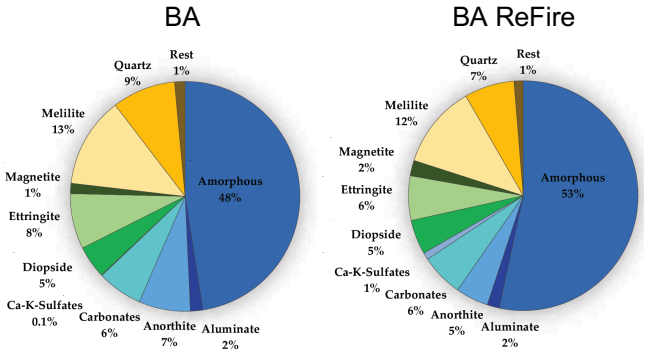
Dioxin Destruction in Residues from Waste Incineration Plants in Switzerland: Impact on Bottom Ash Quality

After the waste incineration process, bottom ash and fly ash remain, which contain ahigh content of heavy metals. As natural ore resources on Earth are limited, circulareconomy becomes more and more important. Waste incineration plants can contributeto sustainability by serving as urban mines. Metals from bottom ash can be recovered by mechanical separation and from fly ash by acid leaching (FLUWA). After the FLUWA, which will be required by the Swiss Waste Ordinance (VVEA) Swiss wide from 2021 on, the washed fly ash, also called filter cake, remains and has to be deposited together with the bottom ash in landfills. The filter cake contains beside remaining heavy metals also highly toxic substances, particularly dioxins and furans, which exceed in some cases the legally permitted threshold value for landfills. Here, the project named ReFire comes into play with the aim to destroy dioxins and furans by re-incineration of the leached filter cake on an industrial scale at two Swiss waste incineration plants. During several weeks, leached filter cake was transferred back into one of the furnace lines. ReFire bottom ash was sampled seamlessly parallel to a Reference bottom ash as well as fly ashes and filter cake.

The Master project focuses on the influence of ReFire on the chemical-mineralogical composition and on the leaching-behaviour of the bottom ash as risk assessment for deposition. Gas chromatography-mass spectrometry of the Reference bottom ash, ReFire bottom ash, leached filter cake and fly ashes shows that dioxins and furans were destroyed efficiently and that they were not transferred into the ReFire bottom ash. XRF and total digestion-ICP-OES analyses reveal that the main chemical composition of the bottom ash was not changed significantly due to ReFire as well as the linked mineralogy, which was determined by PXRD and accompanied by light microscope and scanning electron microscope observations. However, ReFire bottom ash show a slight increase in Pb, Sb and Sn. The increase in Pb is associated with a less effective FLUWA process due to the higher sulfur input through the feedback of the filter cake as it contains a relative high amount of sulfate phases. This may lead to precipitation of anglesite ($PbSO_4$), which remains in the filter cake. Thus, it has implications on the Pb recovery from the fly ash, but determination of particulate ferrous and non-ferrous residual metal content shows that ReFire does not have negative effects on the metal recovery.

So, ReFire can represent a good option to avoid high PCDD/F contents on landfills and to simplify the material flow as just bottom ash has to be deposited. Thus, it is fundamental to understand the behavior of bottom ash material within the wet and alkaline landfill conditions such as the mobilization of heavy metals and the stability of phases within the bottom ash. Implemented 24h-batch leaching tests, a dynamic column test and titration experiments to determine the acidic neutralizing capacity demonstrates that Reference and ReFire bottom ashes behave very similar and that the mobilization of heavy metals is generally very limited due to the high pH-conditions at a low level of between 0.01 mg/l and 1 mg/l for the most relevant heavy metals like Cu, Pb, Sb for example. Cr, Cd, Mn and Fe concentration in the bottom ash eluates lie even <0.01 mg/l as well as the Sb concentration of the column eluate. This may be due the interaction of Sb with the bottom ash mineralogy, but as Sb is very poorly understood under wet and very alkaline environments, future studies should focus on this issue more in detail.

Column test experimental set up. The three columns are filled with Reference bottom ash (BA), ReFire bottom ash (BA ReFire) and a bottom ash-filter cake mixture (BA + FC).



Mineralogical composition of the bottom ash residue remaining in the columns after approx. four weeks leaching experiment. In general, the remaining material from the columns looks very similar.

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