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Seasonal changes in chemical and mineralogical composition of sewage sludge incineration residues and their potential for metallic elements and valuable components recovery

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Increasing energy needs, the implementation of the circular economy principles and rising environmental awareness caused that waste management is becoming a major social and economic issue. The EU Member States have committed to a significant reduction in the amount of waste produced and landfilled and to use their inherent energy and raw materials potential. One of the most reasonable option to fulfil these commitments is waste incineration. The aim of the waste incineration is to reduce their volume and toxicity by disinfection and detoxification at high temperatures. Thermal process and reduction of volume allows the recovery of minerals and metallic elements from residues as well as the energy production (waste-to-energy strategy) during incineration. As a result of waste incineration a variety of solid residues (bottom ash, fly ash, air pollution control residues) and technological waste (gas waste, wastewater) are produced.

The goal of this study is to characterize fly ash and air pollution control (APC) residues formed as a result of municipal sewage sludge incineration in terms of their chemical and mineral composition and their extractive potential. Residues were sampled quarterly to study their seasonal changes in composition.

The fly ash was a Si-P-C-Fe-Al dominated material, whereas the APC residues composition was dominated by Na-rich soluble phases. The removal of soluble phase (∼98% of the material) from the APC residues by dissolution in deionised water caused significant mass reduction and concentration of non-soluble elements. The main mineral phases in fly ash were quartz, hematite, Fe-PO4, whitlockite and feldspar, while in APC thenardite, and in lower amount calcite, apatite and quartz were present.

The chemical composition of fly ash was practically invariable in different seasons, but significant differences were observed in APC residues. The lowest concentrations of all elements and the highest TOC content were measured in the samples collected in the spring 2016. The highest concentrations for most of the elements were measured in summer 2016 except for the Ca, Sn, Zn, Cd, Sb, and Ag which concentrations were the highest in the winter time 2015. Even though the seasonal changes in metallic and/or potentially valuable elements concentrations are visible their overall content is low. In addition they are dispersed within crystalline and amorphous phase, therefore it seems to be inappropriate to consider this material as a source of valuable elements. Due to high phosphorus content in the fly ash, equal to the low grade phosphorus ore, both in the form of phosphate minerals as well as dispersed within minerals can be treated as a potential source of this critical raw material.

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