Physicochemical characterization of sewage sludge ashes in terms of phosphorus recovery

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Current global trends, population growth and environmental problems stimulate to rethink of the way of nutrient management. Ineffective use of nitrogen and phosphorus has resulted in high nutrient losses to the environment and consequently leaded to eutrophication process, soil and air pollution. And the same time, the huge problem with management of waste exists. According to the circular economy concept waste should be treated as resources (Kobza & Schuster, 2016). It gives a possibility of using nutrient-rich waste in fertilizers industry (Buckwell & Nadeu, 2016).

Sewage sludge ashes, thanks to the removal of organic matter and pathogens, and the concentration of phosphorus in the mineral residue after the incineration process, are a valuable source of phosphorus, the content of which ranges from approx. 7% to over 11%, which can be compared to poorer phosphorus ores (Gorazda et al., 2017). Due to the small pool of available phosphorus for plants, constituting only 30% of its total content, this material in its unprocessed form is not used as a fertilizer.

The aim of the study was to analysed 9 sewage sludge ashes in terms of phosphorus recovery. X-ray diffraction (XRD), attenuated total reflectance Fourier transform infrared spectroscopy (ATR-FTIR) and atomic absorption spectrometry (AAS) were used to determine the forms of occurrence of phosphorus compounds in sewage sludge ashes. The mobility of the phosphorus compounds was determined by sequential analysis. The ash samples were collected from industrial sewage sludge incineration plants in Poland.

The chemical composition of sludge ash varies depending on origin. The wastewater treatment method used, the type of chemical dewatering or precipitating agent used, as well as the degree of industrialization of the region have the greatest influence on the ash characteristics.

The analysed ashes are a valuable material in terms of the possibility of its use as an alternative phosphorus raw material. The average content of phosphorus in the investigated mineral residues after thermal treatment of sewage sludge was 8.9% P. However, according to the results of sequential analysis, this phosphorus was not available to plants.

In the context of phosphorus forms occurrence, the results of XRD analysis have shown that in most of the analysed ashes, phosphorus is present in the form of calcium iron phosphate and/or iron (III) phosphate. The berlinite and stanfieldyt phases have also been identified in some samples of sewage sludge ashes.

FTIR analysis confirmed the presence of calcium phosphates in all analysed sewage sludge ashes. In one ash, a peak derived from the Al-P bond was observed, which may indicate the presence of aluminium phosphate.

Identification of phosphorus forms is necessary to develop a method of phosphorus activation in ashes to increase phosphorus mobility and bioavailability for plants.

Reference

Buckwell, A., & Nadeu, E. (2016). *Nutrient Recovery and Reuse (NRR) in European agriculture. A review of the issues, opportunities, and actions*. RISE Foundation.

Gorazda, K., Tarko, B., Wzorek, Z., Kominko, H., Nowak, A. K., Kulczycka, J., Henclik, A., & Smol, M. (2017). Fertilisers production from ashes after sewage sludge combustion – A strategy towards sustainable development. *Environmental Research*, *154*, 171–180. https://doi.org/10.1016/j.envres.2017.01.002

Kobza, N., & Schuster, A. (2016). Building a responsible Europe - the value of circular economy. *IFAC-PapersOnLine*, *49*(29), 111–116. https://doi.org/10.1016/j.ifacol.2016.11.067