

Comprehensive analysis of Polish sewage sludge ash (SSA) and its possible disposal practices

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Keywords: sewage sludge (SS), sewage sludge ash (SSA), phosphorus (P), circular economy (CE)

Introduction

More sustainable waste management practices are an important element in the transformation towards a circular economy (CE) (COM no. 614, 2015). Activities in this area should be dedicated to all groups of waste, including those generated in the water and sewage sector, as wastewater, sewage sludge (SS) and sewage sludge ash (SSA). In the previous years, the special attention was paid to the SSA due to there is increase in the amount of this waste generation as a result of the construction of new or modernization of existing incineration plants. The SSA is characterized by a high content of minerals such as phosphorus (P), potassium (K), magnesium (Mg) and calcium (Ca) (Cieślik, Konieczka, 2017) and therefore is a valuable source of raw materials for the fertilizer industry (Herzcel et al., 2016). Despite the good fertilizing properties of the SSA, in selected cases the presence of heavy metals such as cadmium (Cd), lead (Pb), mercury (Hg), arsenic (As) and nickel (Ni) disqualifies this waste from direct application as a fertilizer. Furthermore, the bioavailability of P from SSA might be hampered. Therefore, it is necessary to conduct quantitative and qualitative analysis of the SSA generated. Currently, the installations for the incineration of sewage sludge are operating in the selected European countries, as Germany or Poland. This paper presents the quantitative and qualitative analysis of the SSA coming the Polish sludge mono-incineration plants (SMIPs). There are 11 mono-incineration facilities for sewage sludge in Poland, with the total capacity approx. 160,00 Mg SS/ year.

Material and methods

The research was divided into two parts (quantitative and qualitative analysis). The first part includes the quantitative analysis of the SSA generated in the Polish SMIPs. In the current study, 11 existing wastewater treatment plants (WWTPs) have been investigated. The selection of the WWTPs has been done based on the owning an installation to incinerate the sewage sludge. Among the presented WWTPs, only one did not agree to participate in the study, therefore in the current study the results are related to 10 Polish SMIPs.

The second part of the research presents the chemical characterization of the SSA generated in the selected Polish SMIPs, and an assessment of the use of studied waste samples in fertilizer products, in the aspects of legal regulations and CE implementation. Approximately, 0.5 kg of each sample was collected from the SMIPs and directed to the chemical characterization. The procedure of sample preparation has been done according to the generally accepted methodology (Krüger et al., 2016). The determination of the mass fractions of selected components and heavy metals present in the SSA has been done with the use of the inductively coupled plasma optical emission spectroscopy (ICP-OES) and inductively coupled plasma mass spectrometry (ICP-MS) after microwave-assisted acid digestion.

Results

The results of the survey analysis, are presented in Figure 1 and the results of the chemical characterization of the selected SSA are presented in Figure 2. As it can be seen from Figure 1, in the previous years, more and more SSA was generated in the Polish SMIPs. In 2018, approx.

27000 t/a of the SSA accrued in the Polish SMIPs. Most of the generated SSA is either landfilled or used for mine filling or construction purposes. According to the Polish legislation, the SSA can not be direct use as a fertilizer. Thus, all resources present in the SSA are removed from the economic cycle permanently. The results showed that the SSA has a good fertilizer potential, especially in terms of the content of phosphorus (Figure 2) which was equal to approx 13% in the SSA coming from SMIPs in Gdańsk.

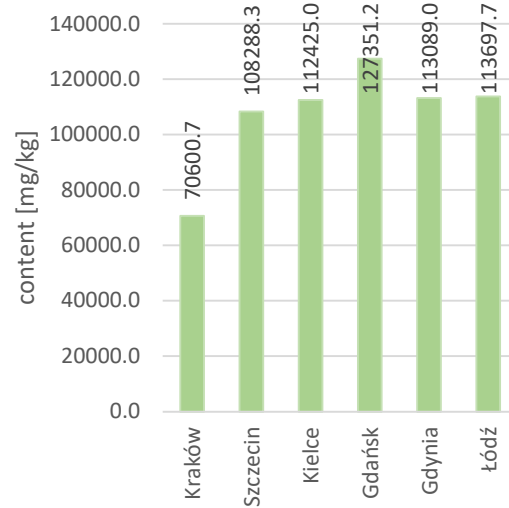
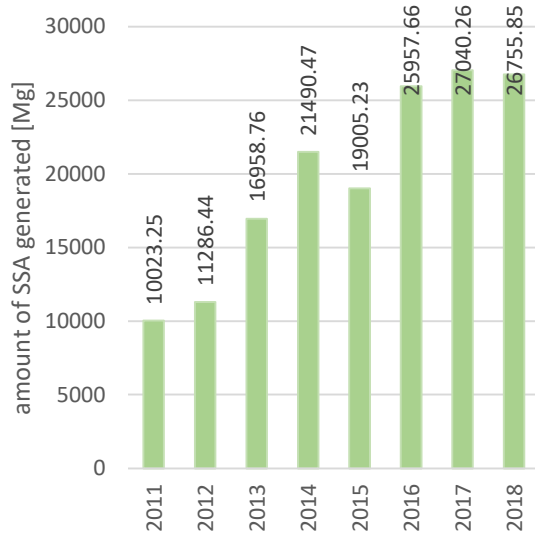


Figure 1 SSA generated in Polish mono-incineration plants

Figure 2 Content of phosphorus in Polish SSA

Conclusions

In the present paper, the quantitative and qualitative analysis of the SSA coming from a Polish SMIPs was conducted. The results show that the number of the SSA generated in Polish plants was increasing in recent years. It is caused by new construction and modernization of existing installations for thermal processing of sewage sludge. In 2018, approx. 27000 t/a of the SSA was generated in the Polish SMIPs.

In Poland, direct utilization of SSA as a phosphate fertilizer in agriculture is not possible due to the legal restrictions. Anyway, the analysed SSA could be a valuable source of the raw materials (RMs) for the substitution of primary resources in the phosphate, potassium and calcium fertilizer. The disposal of waste coming from wastewater sector as a source of biogenic RMs (phosphorus) is recommended direction in Poland. In this context, more rationale usage of water resources (which are under pressure) and more sustainable practices of water-based waste are expected, as a way toward the CE in the water and wastewater sector.

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