The potential of waste from wastewater treatment plants in fertilizer industry

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Current global trends, population growth and environmental problems stimulate to rethink of the way of nutrient management. As part of the European Green Deal, Biodiversity Strategy (BDS), the Farm to Fork (F2F) Strategy and the Zero Pollution Action Plan (ZPAP), the European Union has set a target to manage 50% of biogenic nutrient losses in the environment by 2030, thus reducing the use of artificial fertilizers by at least 20% while maintaining soil fertility. This goal is to be achieved through full implementation and enforcement of relevant environmental and climate regulations, identifying nutrient load reductions with Member States, using sustainable fertilization and sustainable management of nutrients and better management of nitrogen and phosphorus throughout their life cycle.

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. According to the circular economy concept waste should be treated as resources (Kobza and Schuster, 2016). It gives a possibility of using nutrient-rich waste in fertilizers industry. (Buckwell and Nadeu, 2016).

At May 21, 2019 the European Commission has adopted a new fertilizer regulation, which harmonises the requirements for fertilizers produced from conventional and secondary raw materials (European Parliament and the Council, 2019). The regulation introduces 15 Component Material Categories (CMC), which can be used for production of different types of fertilizers, growing medias, soil improvers, biostimulants, liming materials, etc. Despite high fertilizer potential waste from wastewater treatment plants and ashes after its treatment are not included in the list of CMC. This is related to the threats that sewage sludge introduced into the soil without appropriate processing may pose like organic pollutants, pathogenic microorganisms or heavy metals.

This study focuses on possibilities and limits of waste from wastewater treatment plants for using in fertilizer industry. The potential of nutrient recovery from this type of waste are discussed and the available technologies are presented.

Wastewater treatment plants provide one of the largest possibilities for nutrient recovery, mainly phosphorus and nitrogen due to the relatively high and constant content of nutrients in sewage and sewage sludge. The estimated annual load of nitrogen (N) and phosphorus (P) in wastewater in the European Union is 2.3-3.1 million tonnes and 0.5 million tonnes, respectively, that potentially can be recovered. Approximately 0.227 million tonnes of phosphorus remains in the sewage sludge after wastewater treatment processes (Huygens et al., 2018). Bearing in mind fact, that phosphorus fertilizer consumption in the EU accounts for 1.3 million tonnes ("Fertilizer consumption in European Union,"), the recycling of sewage sludge will reduce the amount of used phosphorus fertilizers by 17%. It is estimated, that near 20-30% of nitrogen remain in sewage sludge after nitrification/denitrification process (Diaz-Elsayed et al., 2019), which allows for recycling 0,62-0,93 million tonnes of N from sewage sludge.

More than 50% of sewage sludge are already recycled in European Union by direct application of digested or composted sewage sludge ("Sewage sludge management in European Union,"). However, there is some technical problems associated with lack of surface, where sewage sludge can be applied and the fact, that sewage sludge are generated throughout the year, but can be used 2-3 times a year (Alvarenga et al., 2015). Taking into account fertilizers properties of sewage sludge their using for organo-mineral fertilizers production seems to be a promising solution (Kominko et al., 2017). The main advantages of such approach is transformation of waste into a valuable product.

Except organic recycling, the second most preferred option for the disposal of sewage sludge in the European Union is incineration. Produced sewage sludge ash can contain 10.0-25.7% P_2O_5 (Fang et al., 2018). In order to recover phosphorus two ways of dealing with ash from incineration of sewage sludge may be distinguished: wet chemical extraction methods and thermochemical methods. Thermochemical methods include the process of phosphorus production in an electric furnace and ash calcination with a chlorine donor. The main idea behind extraction methods is carrying out the extraction of ash with the application of solutions of acids, alkalis or their sequence, or water in its supercritical state, as leaching agent. The most frequently encountered solution is the extraction of ash with the application of the following acid solutions: H_2SO_4, HCl, HNO_3, H_3PO_4 with pH below 2 (Egle et al., 2016; Gorazda et al., 2016).

Waste from wastewater treatment plants is an attractive secondary raw materials with a huge potential for fertilizer production. However, it is worth considering the availability of nutrients in waste, the potential presence of contaminants and the lack of adequate marketing and distribution infrastructure, as well as public acceptation.

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