Inventory of waste generated in water and wastewater sector that can be utilized for the fertilizers production

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Introduction

Water and wastewater management is one of the biggest challenges for the circular economy (CE) as many kinds of industries depend on water (Mauchauffee et al., 2012) and a limited access to clean water resources can limit both production capacity and profits. Moreover, a disposal of wastewater, which can cause environmental damage, is an inherent element of water management as more than half of the global freshwater (2,212 km³ per year) is released into the environment as wastewater in the form of municipal and industrial effluent and agricultural drainage water. The remaining 44% of global freshwater (1,716 km³ per year) is mainly consumed by agriculture through evaporation in irrigated cropland (UNWWDR, 2017). In order to prevent contamination of the environment by insufficiently treated wastewater introduced into natural receivers, the European Union (EU) introduces systematic changes in the structure of water-based waste disposal practices, which are important elements of both water and waste management. Water and wastewater aspects in the European waste management hierarchy is presented in Figure 1.

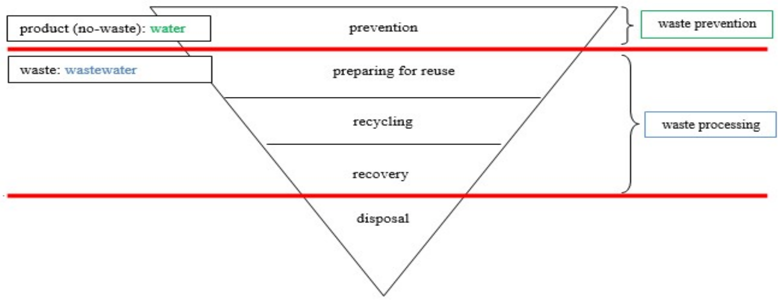

Figure 1 Water and wastewater aspects in the waste management hierarchy [own diagram based on the Waste Framework Directive 2008/98/EC]

One of the most important waste generated in water and wastewater sector are streams of waste generated in the wastewater treatment plants (WWTPs) as wastewater and sewage sludge (SS). In some WWTPs there is also sewage sludge ash (SSA), which is a product of the thermal conversion of sewage sludge. Anyway, the largest amounts of waste are wastewater and SS. These waste streams have a good fertilizer value, as high content of nutrients (phosphorus and nitrogen), therefore they should be use for the fertilizer purposes. This solution is in the line with the current economic policy of the EU - the CE model. The paper presents the characteristic of the selected waste generated in municipal WWTPs, as wastewater and sewage sludge, in the context of their possible usage as a source of nutrients directed to the fertilizer production.

Research framework

The paper presents a summary of the current state of knowledge in the research area showing the possible sources of waste generated in water and wastewater sector that can be utilized for the fertilizers production. Special attention is paid to the waste generated in the WWTPs since water is an important carrier of the raw materials (e.g. phosphorus) which can be used in the fertilizer sector. An analyzed waste streams are municipal wastewater and sewage sludge. The literature review has been done with the use of comprehensive analysis of existing data. The selection of primary literature items was proposed based on full-text databases (Elsevier, Scopus, ScienceDirect, Google Scholar, BazTech, EUR-lex) and scientific articles available in a range of peer reviewed journals. An important source of literature are European and national documents, legal regulations, and statistics. The choice of literature was associated with the use of a few keywords: "circular economy", "CE", "waste", "wastewater", "raw materials", "resources", "sewage sludge", "phosphorus", "fertilizer".

Results

In the following sections, the characteristic of the two waste streams generated in municipal WWTPs – wastewater and sewage sludge is presented.

a) Wastewater

Wastewaters, along with municipal wastes, are identified as the largest stream of nutrients within the modern anthropogenic systems. Due to the specific function, wastewaters are the final collection point to which most of physiological wastes generated by developed cities are subjected. In practice, this means that this type of streams are an excellent source for the possible recovery of valuable compounds such as nitrogen or phosphorus. In addition, the implementation of this objective has also an environmental implication. Therefore the effective removal of nitrogen and phosphorus from the wastewater is one of the key tasks of all existing and functioning sewage installations around the world. In specific the mentioned process is carried out at the final stage of the wastewater collection procedure. From technological perspective this process is conducted in wastewater treatment plants – location to which all liquid waste streams from the area affected by infrastructure are directed.

Most of the currently used wastewater treatment systems are based on an advanced biological process, supported with the use of activated sludge as an active medium. Therefore, the removal of nitrogen and phosphorus substances, takes place through the sedimentation or coagulation. The direct effect of described procedure is the production of sewage sludge. The effective recovery of nutrients, directly from the wastewater stream can be also conducted by other techniques. As an example the innovative approaches to increase the efficiency of the P recycling is based on the crystallization of the struvite on dedicated system incorporated with sewage treatment plant. As a result, this process allows the selective isolation of phosphorus compounds in the form, that can be easily adapted to fertilizers production purposes (Stolzenburg et al. 2015).

b) Sewage sludge

Sewage sludge is a specific group of municipal wastes. This material is generated as an intermediate product during the biological wastewater treatment process. Due to the specific place and nature of this type of waste, it is considered as rich source of organic matter, including phosphorus and nitrogen compounds. In recent years, the total content of those elements in the generated sewage sludge has increased. This phenomenon was a consequence of striving for a greater degree of biogenic elements removal from purified water, directed to the receiver. Unfortunately, the diverse composition and properties of sewage subjected to treatment cause, that in many cases the load of sewage sludge, despite nutrients is also burdened by the presence of dangerous pollutants. This phenomenon inflicts the necessity to provide a specific legal conditions, that should be meet before the introduction of this material into soil systems. Therefore the use of raw, unprocessed form of sewage sludge is regulated in terms of the pollutants content within used material, the amount of material that can be used, the frequency of its usage and the quality of the soil to which the application can be allowed (Wikarek-Paluch et al., 2016).

In order to increase the safety of the sewage sludge use and change the waste classification of this material, the current state of law allows the use of so-called "advanced processing" technology followed with the registration of the final product as a fertilizer, e.g. organic or organo-mineral fertilizer. The technologies that are most commonly used for those purposes are based on chemical stabilization using lime (CaO), thermal stabilization, composting, vermicomposting, fermentation and even pyrolysis (biochar production).

Discussion and conclusions

The use of waste as a source of raw materials in the fertilizer products and an implementation of nutrient recovery technologies are important parts of the transition process from linear economy into a sustainable and therefore well-balanced circular economy. In 2016 "*Proposal laying down rules on the making available on the market of CE marked fertilizing products*" has been published. Fertilizer produced from waste meeting quality, safety and labelling requirements and limits of organic, microbiological and physical contaminants will be able to be traded freely within the EU and receive the CE marking. The main policy objective of the proposal is to incentivize large scale fertilizer production in the EU from domestic organic or secondary raw materials, according to the assumptions of the CE model, in which waste is transformed into nutrients for crops. The proposal includes the new measures to facilitate the EU-wide recognition of organic and waste-based fertilizer, thus stimulating the sustainable development of an EU-wide market. In 2019, the "*Regulation laying down rules on the making available on the market of EU fertilizing products*" has been adopted. The conversion of waste into a valuable raw material or product is an important issue from the legal perspective. The newest regulation specifies the conditions when waste, as wastewater and sewage sludge, ceases to be waste, if it is contained in a compliant EU fertilizing product.

References

Mauchauffee, S., Denieul, M. P., & Coste, M. (2012). Industrial wastewater re-use: closure of water cycle in the main water consuming industries–the example of paper mills. Environmental technology, 33(19), 2257-2262.

Stolzenburg, P., Capdevielle, A., Teychené, S., & Biscans, B. (2015). Struvite precipitation with MgO as a precursor: Application to wastewater treatment. Chemical Engineering Science, 133, 9-15.

Regulation (EU) 2019/1009 of the European Parliament and of the Council of 5 June 2019 laying down rules on the making available on the market of EU fertilising products and amending Regulations (EC) No 1069/2009 and (EC) No 1107/2009 and repealing Regulation (EC) No 2003/2003.

The United Nations World Water Development Report 2017 (UNWWDR, 2017), unesdoc.unesco.org/images/0024/002475/247553e.pdf. (UNWWDR, 2017), assessed on 22.08.2019.

Wikarek-Paluch, E., Rosik-Dulewska, C., & Karwaczynska, U. (2016). Mobility of selected heavy metals in municipal sewage sludge. Annual Set Environ Protect, Rocznik Ochrona Srodowiska, 18, 181-192.