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A review of sludge characteristics in Lithuania's wastewater treatment plants and perspectives of its usage in thermal processes

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ABSTRACT

Wastewater collection and treatment, as well as the effective utilization of sewage sludge, are tasks of great importance for growing populations, rapidly developing industry and pollution reduction efforts aimed at curbing the harmful by-products generated by such processes.

In this study, the current status and theory behind municipal sewage sludge disposal in Lithuania is presented. Since 2004, the country has rapidly developed its wastewater treatment system by applying contemporary technologies used in other European countries. According to statistical data, the amount of accumulated sewage sludge in the country will reach 82,000 t/year dry weight in 2016. Of that, approximately 60% is stored in storage plants and landfills, 14% is used in agriculture, and 26% is composted. Storing such a large percentage of waste is not viable from an environmental or an economic perspective. Thermal utilization of sewage sludge is considered a promising alternative to storage, and there is strong demand for more reliable data on accruing quantities of sewage sludge and its properties, including heavy metals concentrations, at separate wastewater treatment plants.

Sludge samples were collected from seven wastewater treatment plants in the cities of Vilnius, Kaunas, Klaipeda, Siauliai, Panevezys, Alytus and Silute which had populations of 528, 307, 159, 107, 97, 57 and 17 thousand inhabitants, respectively, in 2013. These cities utilized different waste water treatment technologies, and the primary industrial activities in the places selected varied. Heavy metal concentrations and ash melting temperatures were determined based on an analysis of the sludge content, and conclusions for agricultural application and energy production were made. For energy production, co-incineration with municipal waste or wood and gasification are the most reliable ways to utilize sewage sludge. Implementation of such technologies is beginning and further research into these methods is occurring at both the local and international levels.

Contents

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1. Introduction

Wastewater collection and treatment, as well as the effective utilization of sewage sludge are tasks of great importance for growing populations, rapidly developing industry and pollution reduction efforts aimed at curbing the harmful by-products generated by such processes. The increase in the sewage sludge waste stream is a global problem that is being tackled by EU countries both in relation to national legislative requirements and general directives and indicators.

An evaluation of the extent of the problem shows that, from 1992–2005, the amount of sewage sludge increased by 50%, from 6.5 million tons of dry matter (DM) in 1992–9.8 million tons DM in 2005. According to the 2005 data, the amount of accumulated sewage sludge from the new Member States (EU-12) accounted for an additional 1.1 million tons DM. Thus, the total amount of sewage sludge produced in all EU countries (EU-27) in 2005 was 10.9 million tons DM [1–3]. From 2007–2009, the accumulated sewage sludge produced by the EU-27 declined only slightly ($<1\%$) [4].

According to the EU and other countries' demographic projections [5], the amount of non-processed sewage sludge will only increase in the future. Increasing populations and more stringent requirements for wastewater treatment quality will spur this increase.

To solve this problem, many EU countries have implemented various primary, secondary and tertiary wastewater treatment processes and have intensively developed new sludge processing technologies (Fig. 1), and new wastewater treatment requirements have prompted additional EU countries to implement full-cycle wastewater treatment..

An analysis of the existing experience utilizing sewage sludge [8,9] clearly reveals for ways of disposing of the substance: use as a fertilizer, accumulation in storage plants and landfills (an option that is currently neither acceptable nor desirable in Member States) [10], incineration or utilization of its thermal potential through anaerobic digestion, pyrolysis, etc..

Accumulated sewage sludge in wastewater treatment plants is a mixture of various organic and inorganic materials containing substances and microorganisms of different origins [11,12]. The composition of the sludge, which includes a wide range of organic and inorganic compounds that affect the environment in positive and negative ways, determines its application possibilities and technologies.

Data from the EU [1,13] show that in 2012, a significant amount of sewage sludge was used in agriculture. Sewage sludge is useful in agricultural production because it contains essential nutrients such as nitrogen, phosphorus and potassium. Lower quantities of calcium, sulfur, magnesium and other inorganic elements are also important nutrients for soil [14]. Sewage sludge can improve the quality of unproductive soils and restore degraded soils by increasing the materials necessary for plant growth.

However, sewage sludge accumulates year-round, while soils are only fertilized once or twice a year. As a result, the sludge must be stored appropriately until needed, which creates many environmental problems [8,9,15]. In addition, the use of sewage sludge in agriculture incites negative public opinion. Consequently, sewage sludge usage in agriculture has declined or even stopped in European countries such as Finland, Slovenia, Sweden, the Netherlands, Greece and Belgium during the last few years [10].

Other countries such as Bulgaria, Romania, Italy, Malta, Greece and Iceland dispose of their sewage sludge in landfills. Malta, Greece and Iceland use this approach for almost all of their sludge. Slovakia, Estonia, France, Hungary, the Czech Republic and Sweden compost the majority of their sludge.

Regardless of public opinion, however, the presence of harmful elements and compounds in sewage sludge is the primary barrier

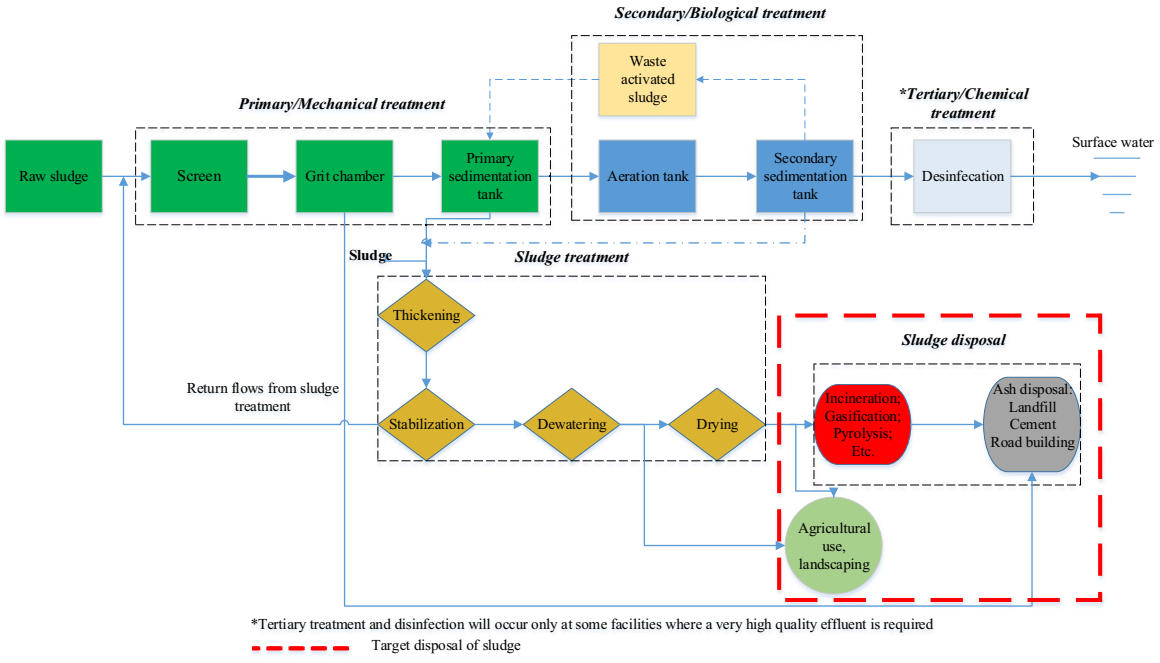

Fig. 1. Main wastewater and sewage sludge processing technologies in the EU [6,7].