POSSIBILITIES OF SLUDGE RECOVERY FROM WASTEWATER TREATMENT PLANT

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ABSTRACT

The aim of this study is to focus on environmental benefits, or eventual loads of sludge life cycle in the wastewater treatment process. Life Cycle Assessment was used to evaluate the environmental impacts associated with the treatment of wastewater in a wastewater treatment plant (WWTP) in Vráble, based on the general standard EN ISO 14040. From the measured experimental data, the environmental impacts of the sludge management are quantified using the LCA method. For impact assessment is using the OpenLCA program, together with the available databases and assessment methods. The LCA results of Vráble WWTP taking renewable energy as the energy source proposed that enhancing the effluent quality will decrease the environmental impacts.

Key words: *life cycle assessment, wastewater treatment plant, environmental impacts, sludge*

Introduction

With the increasing world population, as well as industrial and agriculture activities, countries worldwide face growing global water stress. Sustainability is one of the main concerns in many sectors, which is especially true when concerning water (Beery and Repke, 2010). There is many methods of environmental sustanability. Generally, the choice of "best" water treatment system is based first and foremost on economic and technical constraints (Bonton et al., 2012).

The essence of the application of the LCA study is to avoid increasing the quality of individual products and services at the expense of environmental degradation. LCA is regarded as a universal method that is useful for any organization, regardless of the nature and scope of business. LCA is defined in the international standard EN ISO 14040. The implementation of the method requires processing procedures are formalized, using exact methods, allowing to identify the environmental impacts on the environment. LCA is in industrialized and environmentally conscious states among ordinary tool of environmental management.

The main idea of the application of LCA methods for wastewater treatment, namely sludge produced by the wastewater treatment plant, is to assess the effectiveness and the possibility of treating sludge with a focus on possible negative environmental aspects and a potential use of biogas energy.

1.1 Objectives, goals and phases of LCA

LCA is in standard EN ISO 14040 is defined as the collection and evaluation of the inputs, outputs and impacts on the environment, product-system throughout the life cycle (ISO14040, 2006). Life Cycle Assessment consists of defining the objectives and scope, inventory, impact assessment and interpretation of results. From the structure of the LCA concludes that findings from one phase may affect the basis of the previous phase, which should be reviewed and then go over to the next phase.

1.1.1 *Objective and scope of the study*

The objective and scope of the study set out the context in which the LCA analysis processed while helping to further identify the boundaries with which they will be considered in the analysis. The aim of LCA analysis in this case is to assess the impact of the WWTP to individual components of the environment with an emphasis on human health and the impact on the ecosystem and water system environment.

Very important is to focus on:

- a feature of the product
- functional unit
- examination system product
- system boundaries
- the type and form of assessment
- the use of interpretation
- assumptions
- restrictions
- data requirements and data quality
- choice of values and options (ISO14040, 2006)

Functional unit is a measure of performance of the function outputs (Kudláček, 2004). Sludge management can be evaluated in relation to their weight with respect to the production of sludge at WWTP. Within the sludge management and biogas sludge they may also be evaluated with respect to the energy / kg, or in relation to a number of features that their use complies with (the amount of energy produced). The last type of evaluation permits to LCA studies also include the cost and inputs to operate the equipment (Kočí, 2009).

System boundaries are used to determine the process units that must be included in the LCA system. They depend on factors such as; the goal of applying the study, reduction of costs, or the amount of data used [4]. To the border system was selected operating and consumption costs. To compare the environmental impact has not been considered with the construction of facilities with regard to the content and objectives of the study. An important component of borders constitutes the composition of the sludge with an emphasis on nitrogen and phosphorus content, serving for the subsequent quantification of the effects of eutrophication on the environment (Kočí, 2009).

Life cycle inventory phase - LCI is used to determine the amount of elementary streams discharged into the environment during the life cycle of a product. Inventory analysis focuses on data collection process, data and methods used to quantify relevant inputs and outputs of the process under consideration (Cashman, 2014; Stajanča,2011).

2.1 LCA analysis of sludge from WWTP Vráble

2.1.1 *Data collection*

As part of WWTP sludge management Vráble, excess sludge stored in the storage tank, which also serves as a digester. Subsequently, the sludge is pumped to sludge fields. Within the inventory phase was followed sludge production in each month focusing on the production of raw sludge, sludge water, digested sludge and solids. The measured data are processed in the table 1.

Month	1	2	3	4	5	6	7
Raw sludge [kg]	1322	1250	860	840	1320	1025	1160
Sludge water [m^3]	550	144	420	120	120	660	180
Digested sludge [kg]	0	240	720	600	880	1040	680
Solids [kg]	18	11	18	12	22	19	68
Month	**8**	**9**	**10**	**11**	**12**	**In total**	
Raw sludge [kg]	1170	1170	1190	1150	1280	13762	
Sludge water [m^3]	560	270	490	800	610	5014	
Digested sludge [kg]	450	560	710	610	520	18776	
Solids [kg]	18	11	32	32	0	213	

Tab. 1 inventory data of sludge

2.1.2 *Potential of sludge for bioenergy*

The potential of biogas production is quantified by calculating the sludge generated and optimizing biogas production in the digester. Biogas production in heated anaerobic stabilization tanks at 33-40 °C is 750 liters of biogas from 1 kg of organic dry extract of mixed primary and excess sludge. Approximate stabilization time is 11 to 20 days depending on temperature (Drtil, 2007).

Furthermore, the biogas is 23 MJ / m3. Production of biogas is also dependent on the sludge composition and on the substances released during stabilization. It contains 60-70% of CH_4 methane, 35% of CO_2, 0.1% of H_2S and small amounts of N_2, H_2, ammonia, fatty acids, etc. (Hlavínek, 2006).

Natural gas heating .... 34.25 MJ / m^3 = approx. 9.51 kWh
Biogas heat ....23 MJ / m^3 = approx. 6.38 kWh

The WWTP in Vráble does not produce biogas. The potential of biogas production at the WWTP was calculated from the available measured data based on the conversion of the sludge to 1023.03 MWh.

3.1 Impact assessment

Impact assessment of sewage sludge Vráble is based on assigning the corresponding characterization factors for each elementary stream. We used the values from the inventory phase, namely the inflow of sewage, effluent treatment plants, power consumption, and sludge management of data such as the amount of raw sludge, sludge water, digested sludge and solids. Inventory results were processed using free software OpenLCA using available databases and for evaluating the results.

Results from the first chart shows the possible impact of sludge management to individual components of human health. The greatest negative impact was reflected in constituents human toxicity (45%) and respiratory effects (53%). Minimal impact was reflected in parts of the ozone layer depletion, photochemical oxidation and ionising radiation.

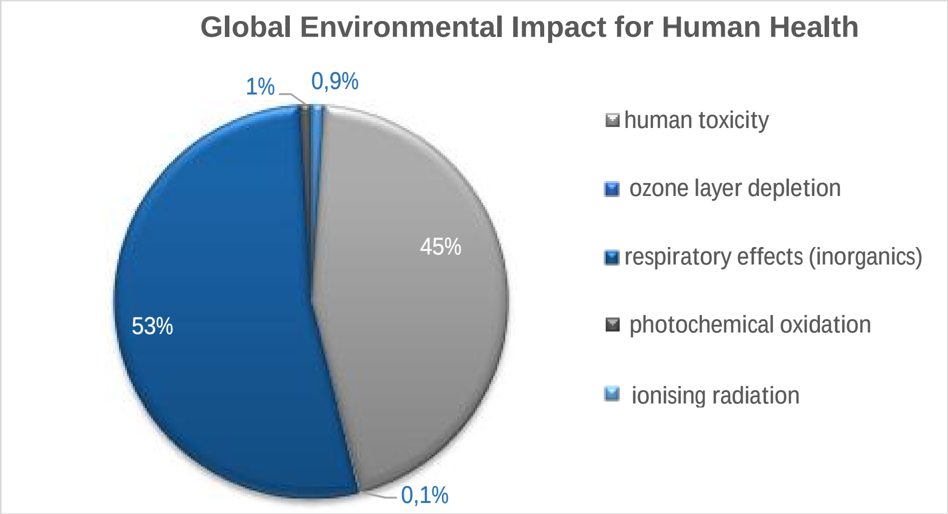

Fig. 1 Global environmental impact for human health

In the second method of evaluation, we focused on the potential impact of sludge management on the different quality of the ecosystem quality. The greatest negative impact was reflected in parts of the climate change (50%) and terrestrial ecotoxicity (42%).

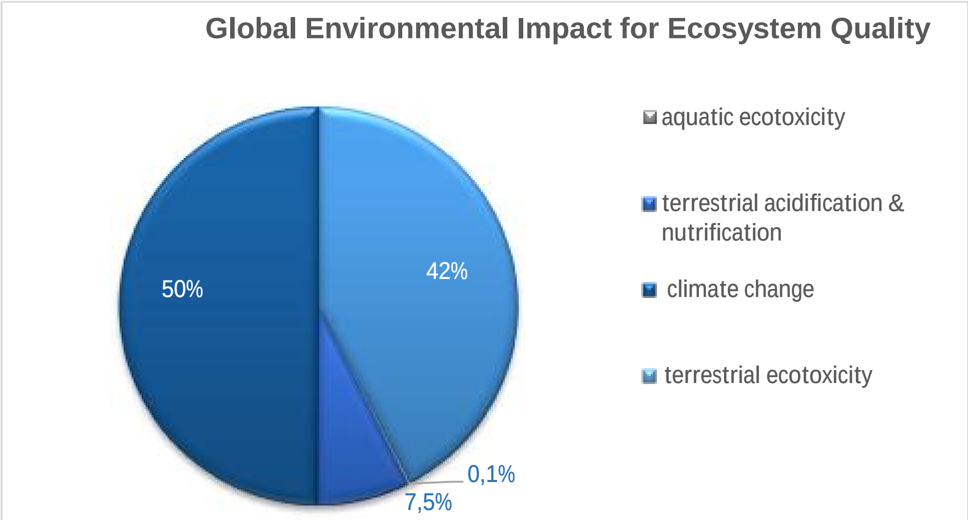

Fig. 2 Global environmental impact for ecosystem quality

4.1 Conclusion

The goal of this paper was to introduce the issue of the application of LCA and implement methods of sludge from wastewater treatment plant in Vráble. The essence of the method of applying the LCA was to evaluate the potential hazardous effects on the individual components of the environment and the subsequent percentage of the impact.

The key to proper implementation of the understanding of the life cycle of sewage sludge in connection with EN ISO 14040. The assessment is based on correct identification study objectives, scope, system boundaries and functional unit. A significant part of the assessment is based on the legislative limits of individual indicators.

In the sludge management is important to focus on the potential use and disposal of sludge, from which subsequently impact on the environment. The challenge is the determination and analysis of elements which are not provided with sufficient legislation and, therefore, the monitoring is not sufficient.

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