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Environmental assessment of the life cycle of sludge treatment systems of Ardabil and Khalkhal wastewater treatment plants

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ABSTRACT: With the increasing population growth and the importance of sustainable development, the need for wastewater treatment systems with less environmental load and therefore the economy is felt. The life cycle assessment method, is one of the methods of environmental assessment of products and services. in this study a comparison between two methods of sludge treatment systems, aerated lagoon (Ardabil wastewater treatment plant) and activated sludge (Khalkhal WWTP) were discussed. for this purpose, inputs (materials and energy) and outputs (related pollutants) of each system were determined. Based on the quality parameters data from the water and wastewater company in Ardabil province, the amount of CH4 and CO2 production gases in both systems were calculated, and analyzed with use of simapro 8.2.0 software and basic data of CML2001 and Eco-indicator 99. The results showed that, lagoon system had maximum effects in all impact categories and in contrast, activated sludge system had much less environmental impact than lagoon system. Thus, activated sludge system in the category of toxic effects for humans had the highest contribution (79 %) and in the global warming and photochemical oxidation impact categories had the lowest contribution (0.72 %). So, the results of this research showed that activated sludge system had lowest environmental load and introduced as an alternative method of aerated lagoon system in the development of Ardabil wastewater treatment plant (WWTP).

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impact categories.

1. Introduction

With a lack of water resources and the need for sewage treatment, a massive amount of sludge, which is a by-product of sewage treatment, needs to be disposed of in a way that is environmentally safe. in the field of sludge management, selecting the type of wastewater treatment systems is one of the most important issues before design and implementation [1]. sewage treatment that used to reduce or eliminate contaminants and impurities can also has an environmental impacts. these include increasing global warming due to increased greenhouse gas emissions, increasing the nutritional value of water resources due to the discharge of nutrient waste from recycled nutrients to water resources, etc. [2].

Since the early 1990s, the "Life Cycle Assessment" is a "cradle to grave" approach to assessing systems that has been widely used in many countries around the world and has been able to affect decision makers towards systems and processes [3].

Studies in this field and in Iran are often about waste management, and studies of (emerson et al.; dixon et al.; machado et al.; renou et al.; zhang et al.; changning et al.) are about sewage treatment and sludge management [4-9].

Considering that Ardabil wastewater treatment system is lagoon, due to climatic conditions in the area and frost in winter, its function is minimized and now, one of the problems is the production of high volumes of sludge and environmental impacts. so this study has been carried out to choose the appropriate system in the development of Ardabil WWTPs. in this study, two sludge filtration systems (Ardabil aerated lagoon and Khalkhal activated sludge) in terms of performance and environmental effects were compared and evaluated. finally, the system which has less productive sludge and eco-friendly with weather in Ardabil was selected.

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2. Methodology

There is a goal and scope, functional unit and boundary system in the life cycle assessments study [10]. the four steps of LCA study about Ardabil aerated lagoon system and activated sludge in Khalkhal were carried out as follows:

2.1. Definition of goal and scope

The scope of the life cycle assessment in this research was includes comparison of sludge treatment systems (aerated lagoon and activated sludge), which aims to identify outstanding of the life cycle points and also determined which system has the least environmental impact along with the lowest consumption of materials and energy.

2.2. Functional unit

In this research, functional unit for 1 m^3 of sludge was considered to compare different processes of sewage treatment.

2.3. System boundary

System boundaries are as shown in Figure 1 to be determined in a way that available data give allow to research.

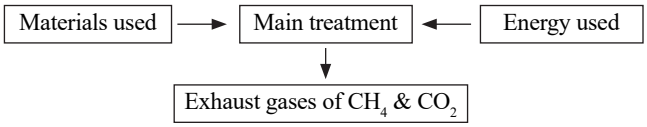

Figure 1. System boundary for LCA of sewage treatment systems (aerated lagoon and activated sludge)

2.4. Check list

Energy and raw materials consuming and amount of methane and carbon dioxide emissions per day calculated to treatment a cubic meter of sludge. information obtained was analyzed using simapro software and basic data of CML 2001 and Eco-indicator99.

Table 1. was modified

	Parameters	Unit	Input of ardabil	Input of khalkhal	Output of ardabil	Output of khalkhal
1	BOD	mg/l	321/17	248/85	80/63	28
2	COD	mg/l	592/65	344/62	186/82	55/92
3	TS	mg/l	1393/49	1202/24	1202/67	832/58
4	TOC	mg/l	-	-	53/75	18/66
5	TN - TP	mg/l	85-20	40-8	19/3-11	6/5-1
6	NO3	mg/l	-	-	2/68	18/75
7	NO2	mg/l	-	-	8	2/8
8	Ca	mg/l	-	-	96/75	76/33
9	Mg	mg/l	-	-	25/25	23/14
10	Na	mg/l	-	-	186/25	170
11	SAR	mg/l	-	-	4/37	4/39
12	VOC	mg/l	-	-	1/5	15
13	Electricity	mg/l	4576000	560600	-	-
14	Ca(OCl)2	mg/l	20	4	-	-
15	VCH4	Kg/d	-	-	69356/7	498/7
16	VCO2	Kg/d	-	-	37345/9	245/6

3. Results and Discussion

Results showed that, activated sludge system compared to the lagoon system had the lowest contribution in all impact categories including: abiotic depletion (13.1%), global warming (0.72%), ozone layer depletion (25%), human toxicity (79%), fresh water aquatic eco-toxicity (49.7%), marine aquatic eco-toxicity (34.7%), acidification (13.2%), photochemical oxidation (0.72%), eutrophication (15%).

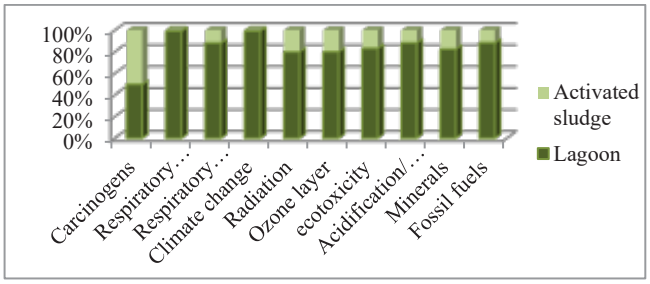

Figure 3. Comparison of lagoon and activated sludge systems by using the Eco-indicator99 method

In activated sludge system in impact categories of global warming and ozone layer depletion using the two evaluation methods listed, the same results were obtained (0.72% and 25% respectively). so that except in impact categories of acidification and eutrophication the results are (13.1% and 28.2% respectively). so, the aerated lagoon system can be evaluated ecologically, the worst type of sewage treatment system.

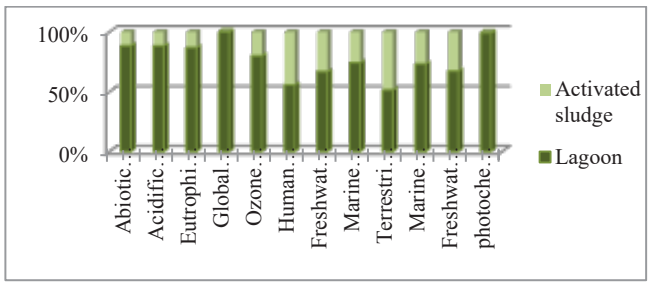

Figure 2. Comparison of lagoon and activated sludge systems by using the CML2001 method

4. Conclusions

As regards, studies in the field of the life cycle assessment in the country is often about waste management. Therefore, the need for studies on the life cycle assessment of systems in the water and wastewater sector is strongly felt. Because the study of the LCA creates the possibility that before the construction of the systems, managers consider the best decision on choosing a purification method with the lowest environmental and economic burden.

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