THE ANNALS OF "DUNAREA DE JOS" UNIVERSITY OF GALATI
FASCICLE IX. METALLURGY AND MATERIALS SCIENCE
N°. 3 - 2018, ISSN 2668-4748; e-ISSN 2668-4756
Article DOI: https://doi.org/10.35219/mms.2018.3.07

THE ENVIRONMENTAL IMPACT ASSESSMENT OF A MUNICIPAL LANDFILL - A STUDY ON THE LEACHATE

Andrada Gabriela ALEXANDRU, Mădălina Gabriela PÎRVU, Marius BODOR*
"Dunarea de Jos" University of Galati, Faculty of Engineering
*email: marius.bodor@ugal.ro

ABSTRACT

The increase in consumption draws the need to quickly assess the problem of the municipal solid wastes. On the short term, the easiest way to deal with this stringent problem seems to be landfilling. This method was always a controversial one. Thus, making it more environmentally friendly was the logical next step. The recovery and utilization of methane gas, the recovery and treatment of the liquid generated by the landfill and, finally, the sealing of the landfill by the end of its utilization made it possible to deal the waste problem more environmentally friendly. However, no matter how "green" a landfill might be, every time such type of site is planned, a thoroughly environmental impact assessment must be conducted to anticipate, avoid and ameliorate the impact on the environment. This paper presents some aspects regarding an environmental impact assessment of a landfill, focusing mainly on the possible impact on water, the effect of leachate treatment and, finally, the future alternatives to landfilling.

KEYWORDS: environmental impact; leachate; municipal landfill

1. Introduction

The problem with waste management keeps getting more severe due to the alarming increasing of quantity and their impact on the environment. The increase of human population induces resource consumption due to higher production creating a significant environmental impact through wastes. In Romania, final disposal of municipal waste represents the primary option. Almost 98% of this kind of wastes are disposed yearly in specially arranged places named municipal landfills [1].

Any landfill that is about to be constructed or existent must be subject to a rigorous analysis ant also has to adopt the best measures regarding the environmental protection reducing thus its impact.

Although municipal solid waste landfilling might be easier and more frequent due to low costs during construction, operation and closing, compared to recycling costs, it can impact greatly the environment in time. Badly designed or exploited landfills can create almost always more serious consequences to the environment than non-complying ones and the areas surrounding the landfill might become heavily polluted. Landfills might pollute the air, water or soil since in such a badly designed or exploited construction the dangerous chemical substances present the risk to infiltrate in the environment. Also, frequently, the fauna is attracted to landfills and can spread dangerous diseases endangering the population around the site [2].

The methane gas, the leachate and the bulk municipal waste are the three main challenges of landfilling. The methane gas is produced in a landfill through anaerobic decomposing and can be collected with the existing technology then used to generate electricity in the landfill site or elsewhere or can be purified and then used as fuel for power generators. The leachate is a thick liquid, formed during waste decomposition. In the best-case scenario, the leachate is similar to residual waters and in the worst-case scenario it can transport dangerous materials dissolved from the wastes situated in the landfill. Landfills are equipped with synthetic liners placed on a layer of clay soil that helps to prevent leachate drain in underground water, preventing contamination [3, 4].

A municipal waste landfill also comes with some advantages. The first would be the possibility to obtain energy through methane gas conversion. Landfilling all non-recycling wastes in the same, controlled and monitored place, avoiding the non-

THE ANNALS OF "DUNAREA DE JOS" UNIVERSITY OF GALATI
FASCICLE IX. METALLURGY AND MATERIALS SCIENCE
N°. 3 - 2018, ISSN 2668-4748; e-ISSN 2668-4756
Article DOI: https://doi.org/10.35219/mms.2018.3.07

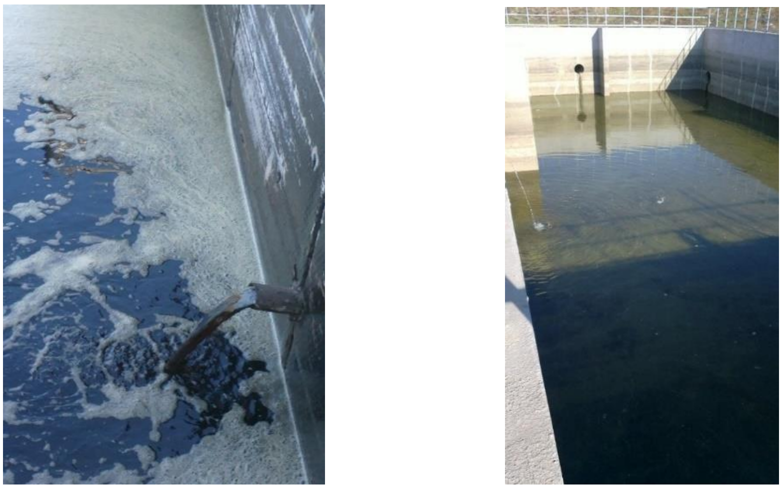
complying methods would be another advantage of this procedure. Also, the construction of a landfill creates new jobs during and after its activity [5, 6].

Leachate collection from a landfill is done using a system consisting in a web of perforated pipes from the base of the landfill, situated in a layer of sand under the deposited waste [7, 8]. The purpose of the present work is to assess the environmental impact of a landfill, from the point of view of the possible transmission of pollution through leachate generation.

2. Materials and methods

The leachate is created in landfills through leaching of wastes in different putrefaction states and the precipitation water. Water is infiltrating in the waste layers, dissolving and engaging a wide range of compounds. The leachate is usually collected in a basin, treated in a treatment plant for phosphorus and heavy metals retaining then is pumped in the sewage system or in a water-body if all the norms are met. According to the actual legislation, leachate treatment can be realized using two types of systems: i) using a treatment plant owned by the landfill that will permit the leachate evacuation directly into a natural receiver in compliance with the relevant legislation; ii) using a leachate pre-treatment facility prior to discharging into a municipal waste water treatment plant, respecting the values of the effluent quality indicators. Unfortunately, presently in Romania, there are still some non-complying landfills that do not has neither of the two leachate treatment systems mentioned above. Part of the European Union legislation was assumed by Romanian national legislation. Thus, the leachate collection methods refer only on the complying landfills. There is no method describing the leachate collection for non-complying landfills [9].

To start the experiment, an untreated leachate sample and a treated leachate sample were taken to determine their chemical and physical composition. Figure 1 presents the two basins used to contain the abovementioned sample types.



a b

Fig. 1. *Leachate collection basins: a - before and b – after treatment*

The equipment used consisted of: sample collection recipients, laboratory glassware, portable multiparameter model Aquatest +MO (HACH-LANGE), for pH values determination; UV-VIZ/VIZ spectrophotometer, model: DR 5000 (HACH-LANGE), for chemical factors determinants and an incubator for CBO_5 determination.

3. Results and discussions

For the leachate to be evacuated in the nature its chemical composition must be followed some maximum values established through corresponding legislation. The most important typical limits are found in Table 1, together with values for leachate samples before and after treatment. The treatment plant is owned by the landfill and is based on the reverse osmosis principle.

In Table 1 the most dangerous concentrations of the untreated leachate can be observed. These values must be reduced through whatever methods and brought as close as possible to the admissible values before safely discharging in the environment. After the treatment process some concentrations decreased consistently, even more than the maximum admissible values. The concentrations for suspended matters, CCO-Cr, Ammoniacal nitrogen, Phosphorus and Heavy metals (Pb, Cd, Cr, Cu and Zn) suffered

Article DOI: https://doi.org/10.35219/mms.2018.3.07

major transformations, reaching extremely low concentrations. To further highlight the difference between the two types of samples and between the two and the maximum admissible values, several graphs were drawn for the pollutants considered the most harmful for the environment.

Table 1. *Parameters values for leachate before and after treatment compared to maximum admitted values*

Nr. crt.	Indicator	Measuring unit	Untreated leachate	Treated leachate	Maximum admissible value
1	pH	pH units	8.28	6.94	6.5
2	Suspended matter	mg/L	215	17	60
3	CBO_5	mg/L	327	20	30
4	CCO-Cr	mg/L	2102	72.7	500
5	Ammoniacal nitrogen	mg/L	58	0.6	30
6	Phosphor total	mg/L	4.95	0.3	5.0
7	Pb	mg/L	0.44	0.06	0.5
8	Cd	mg/L	0.65	0.02	0.3
9	Cr total	mg/L	1.79	0.05	1.5
10	Cu	mg/L	2.19	0.05	0.2
11	Zn	mg/L	1.73	0.09	1.0

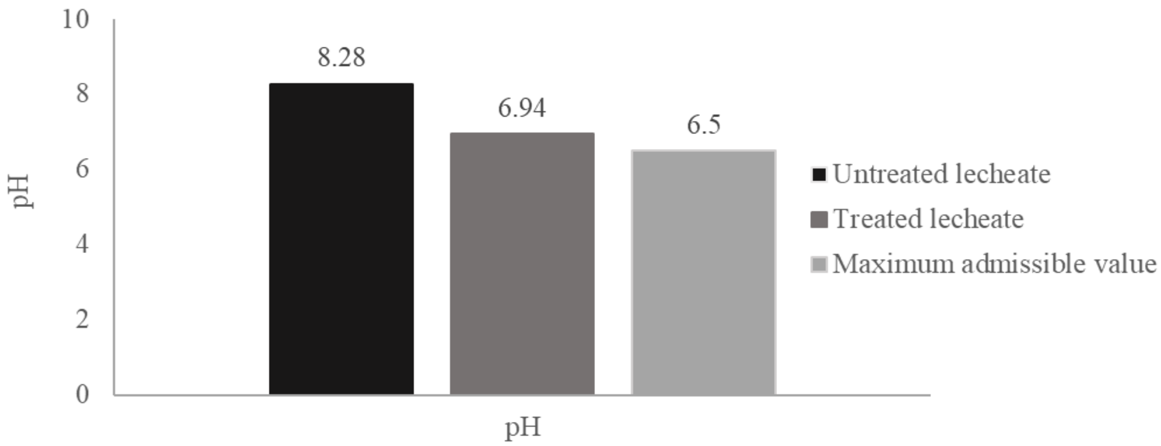


Fig. 2. *pH values of the leachate samples before and after treatment compared to the admitted value*

Figure 2 represents the modification of pH value after leachate treatment by a reduction with 1.34 pH units from the initial state. In the present case, after treatment, the leachate reaches a value close to the maximum admissible limit of 6.5 pH units, however even after treatment this limit is exceeded. In such situations, when the values after treatment do not comply with the maximum admitted values, the leachate should not be discharged directly into nature and further treated.

Article DOI: https://doi.org/10.35219/mms.2018.3.07

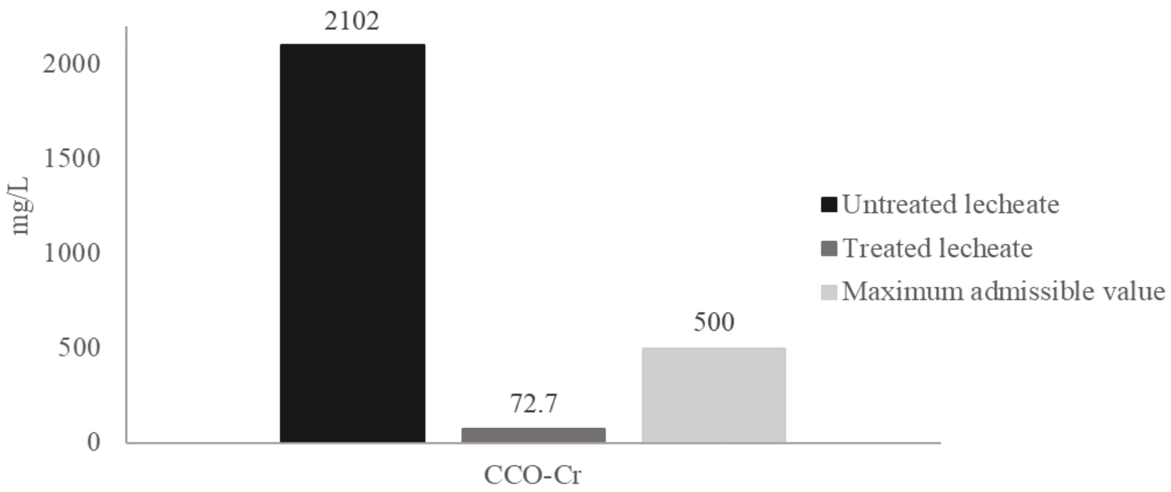


Fig. 3. *The amount of chemical oxygen demand for leachate samples before and after treatment compared to the admitted value*

The biggest difference between samples (treated and untreated) is that regarding CCO-Cr. In this case, the untreated leachate presents a value of 2102 mg/L and after treating this value falls with 2029.3 mg/L, reaching a value of 72.7 mg/L. Compared to the maximum admissible value (500 mg/L), after treatment, the CCO-Cr value for the leachate gets to decrease almost seven times. Thus, from this point of view the leachate might be discharged in nature without a major risk.

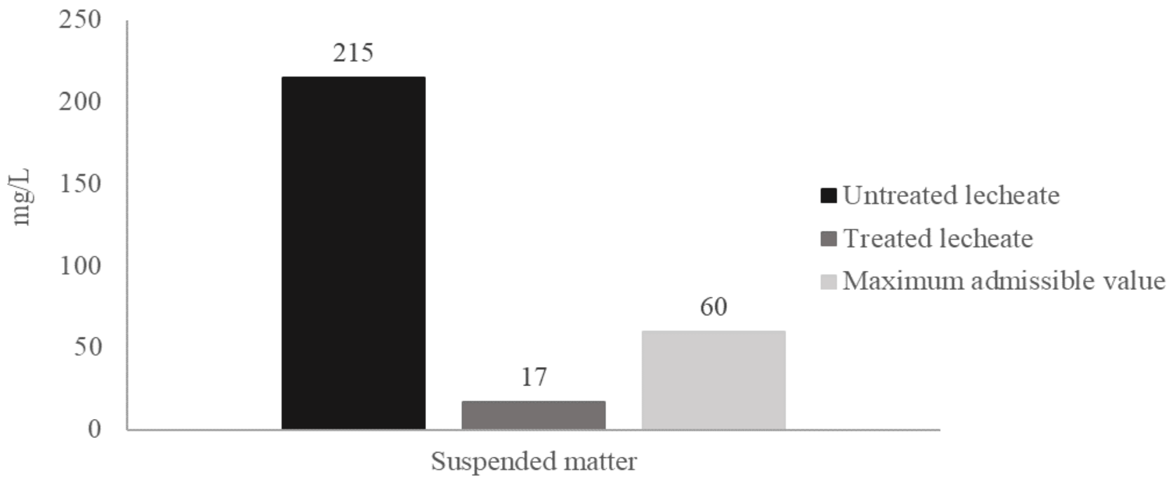


Fig. 4. *The value of suspended matter for leachate samples before and after treatment compared to the admissible value*

The suspended mater (Figure 4) represents the insoluble substances in the leachate. These are found in a very high concentration in the untreated leachate. After treatment, the suspended mater decreases considerably with 198 mg/L, which represents a big advantage for the environment.

The CBO_5 parameter (Figure 5) represents a measure of organic impurification of residual waters and is the quantity of oxygen (mg/L) needed to oxidize the organic substances through bacteria. Before leachate treatment, the CBO_5 content is significant, decreasing with 307 mg/L, reaching a value of 20 mg/L, a value smaller than the admissible one.

Regarding the heavy metals content of the leachate, from the examples abovementioned it is shown that after treatment the leachate has a lower content, compared to the admissible value. Out of the three examples, the largest content for the untreated leachate belongs to Copper, with a 2319 mg/L content. After treatment, this value decreases with 2.19 mg/L reaching the lowest value, namely 0.2

THE ANNALS OF "DUNAREA DE JOS" UNIVERSITY OF GALATI
FASCICLE IX. METALLURGY AND MATERIALS SCIENCE
N°. 3 - 2018, ISSN 2668-4748; e-ISSN 2668-4756
Article DOI: https://doi.org/10.35219/mms.2018.3.07

mg/L. The content of Zinc and Lead after treatment has also decreased considerably. Thus, the value for Lead decreased with 0.38 mg/L reaching under the admissible value and the Zinc value decreased by 1.64 mg/L.

The leachate is a liquid that cannot be discharged in nature without treatment. Its toxicity is detrimental to the health of the creatures with which it comes into contact, from the infiltration site to where it is spread through the groundwater. The leaching treatment should be based on an optimal solution, considering the actual conditions on the ground, the composition of the leachate, the climatic conditions, the available surface, and the impact of the technology on the environment [10-13].

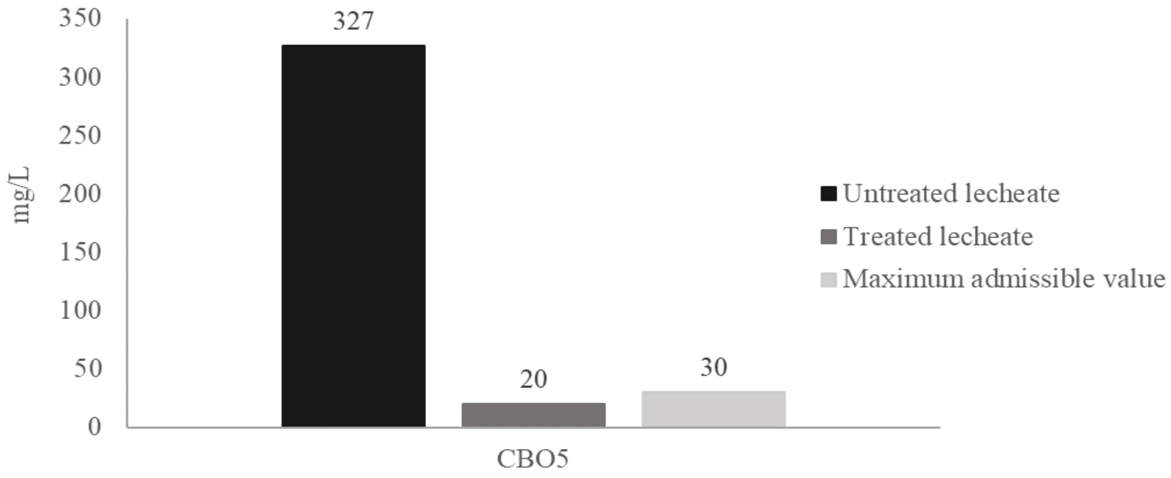


***Fig. 5.** Biochemical oxygen consumption value for leachate samples before and after treatment compared to the admissible value*

Following the leachate treatment, it was found that almost all concentrations decreased considerably. For example, concentrations of CBO, total nitrogen, ammoniacal nitrogen, total Cr, Cd, Cu, decreased by over 90%. A major advantage of leachate treatment is that certain substances can be completely removed depending on the nature and quantity of the leachate. For example, Sodium, Potassium, Calcium, Magnesium and Sulphate have been totally removed. Components found in untreated leachate appear after treatment in a lower or no concentration, which proves that the eventual impact after treatment is low. Concentration decreasing rates are different for different chemicals. The readily soluble and biodegradable substances reach the highest maximum concentrations, the moment when reaching the maximum value being closer to the start of the landfill operation.

4. Conclusions

From the beginning of the construction to its closure and even after, a municipal solid waste landfill may have a negative impact on the environment. Firstly, it affects the landscape with visual discomfort and creates new forms of relief by excavation and deforestation. The equipment used for different processes during the landfill construction also has harmful effects on the environment through oil, fuel and even some construction materials. At the same time, the air might be polluted by generating dust and traffic emissions on the site. Also, flora and fauna can be endangered because once the work starts, their habitat can be removed, fragmented or separated. During operation, the landfill might become a favorable habitat for different birds and animal species, considered harmful and dangerous to the community near the deposit. The environment is disturbed by the equipment noise, the mud on the roads, and the smell characteristic of a landfill due to decomposing organic materials.

The main environmental impacts can be attributed to gas emissions and leachate resulting from the storage of waste in landfills, both of which can be managed through engineering. The leachate generated is a major environmental problem, therefore it must be collected and subjected to proper treatment before it is released into the environment or sewage. This study has shown the beneficial effect that a treatment plant can have on the resulting leachate. Excepting the pH, which has been slightly higher than the maximum admissible value, the other values for pollutants that can be found in the leachate corresponded to the norms after the treatment process and thus, it was demonstrated the possibility that this

Nº. 3 - 2018, ISSN 2668-4748; e-ISSN 2668-4756
Article DOI: https://doi.org/10.35219/mms.2018.3.07

liquid could be eliminated directly in nature without the need for further treatment.

On the short term, landfills appear to be the cheapest and easiest option to solve the municipal waste problem, but in the long run they are a huge financial burden. This is due to the need to monitor gas from the storage site and the potential for contamination of nearby land, watercourses and groundwater for several decades after the landfill being disposed of. Taking these drawbacks into consideration, the diminishing utilization of landfills must be seriously taken into consideration in the near future and if used, landfilling should always function in parallel with a recycling program. The declared purpose of the Romanian Ministry of Environment is to stop all landfilling until 2050 and replacing it with performant programs of recycling, the only disposal being permitted in the end only to low quantities of nonrecyclable materials.

References

[1]. ***, http://ec.europa.eu/environment/waste/landfill_index.htm, accessed in 3.03.2016.

[2]. ***, http://www.edurite.com/kbase/advantages-and-disadvantages-of-landfills, accessed in 16.01.2016.

[3]. ***, http://events.awma.org/enviro_edu/fact_sheets, accessed in 3.05.2016.

[4]. ***, http://www.ecotic.ro/wp-content/uploads/2015/11/Studiu-DEEE-Generate-2015.pdf, accessed in 30.04.2016.

[5]. Emma Rawson, *Rotherham GA Living Geography Project My Waste Story (Rotherham)*.

[6]. T.F. Fwa, *Environmental Impact Assessment of Highway Development. The Handbook of Highway Engineering*, Ed. Teylor and Francis, CRC Press, 2005.

[7]. ***, https://www.teachengineering.org/curriculum, accessed in 18.01.2016.

[8]. ***, http://livelifegreen.com/landfills-and-th-environmental-effects/, accessed in 22.04.2016.

[9]. ***, http://www.agir.ro/buletine/910.pdf, accessed in data de 26.06.2016.

[10]. ***, http://documents.tips/documents/levigatul-formare-si-tratare.html, accessed in 26.06.2016.

[11]. ***, https://www.eionet.europa.eu/, accessed in 26.06.2016.

[12]. Francesco Cherubini, Silvia Bargigli, Sergio Ulgiati, *Life cycle assessment (LCA) of waste management strategies: Landfilling, sorting plant and incineration*, Energy, vol. 34, issue 12, p. 2116-2123, 2009.

[13]. ***, http://www.galati.insse.ro/main.php?id=405, accessed in 1.05.2016.