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INFLUENCE OF ENVIRONMENTAL CONDITIONS ON LEACHATE BIOSCRUBBERS

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Abstract

The study targeted the establishment of optimal conditions for biological treatment of leachate from Glina landfill waste. A change in the composition of leachate was analysed in correlation with temperature, precipitation and biodegradable material to highlight the work of microorganisms in various environmental conditions. The experimental results have shown that the highest efficiency has been registered over the temperature range of 10 – 25oC, while microbiological activity was not observed in the aeration lagoon at negative air temperature. The higher content in biodegradable waste (obtained by separating plastics, paper, metal and glass) had a positive influence on biological purge expressed by decreasing the nitrates, nitrites, ammonia content and biological oxygen demand between 12% and 28%.

Key words: *COD, BOD, biological epuration, leachate landfill, temperature.*

INTRODUCTION

High concentrations of pollutants in the leachate has become one of the most important problems of landfill site operators, especially given the strict regulations imposed by environmental protection legislation.

Biodegradation is performed by microorganisms that break down that organic compounds in carbon dioxide and sludge under aerobic conditions and lead to the formation of biogas (a mixture containing mainly CO_2 and CH_4) under anaerobic conditions (Ghasimi et al., 2010). Kamaruddin M.A. (2015) has shown that anaerobic organisms have played a significant role in the removal efficiency of pollutants in the leachate parameters.

According to research conducted by Syafalni (2012) reducing CCO may be due to the resistance of organic substances of the leachate, which is affected by the activity of methanogenic bacteria.

The decrease of the leachate's pH reduced the amount of dissolved oxygen needed by the aerobic biological organisms to decompose the present organic material, which was known as a poor state of the survival of anaerobic organisms. In contrast, the normal pH of the leachate lead to more efficient removal of COD of between 76.8% -77.4%. (Syafalni, 2012).

Factors influencing biological processes are: contact time or during the crossing of the target technology in which takes place the biological process, temperature, pH, oxygen loading of object technology mud (dilution) containing nutrients, the presence of inhibitors of the process, hydrodynamic conditions of the process - mixing and blending.

A municipal waste repository is not homogeneous, since there is waste which are water absorbent such as cardboard or paper, and at the other extreme waste such as plastics, glass or construction waste.

Qualitative analysis conducted by different researchers (Umar, 2010; Ghose & Gupta, 2015) have revealed the presence of very different groups of compounds: halogenated aliphatic, aromatic compounds, polycyclic aromatic hydrocarbons, esters, and other compounds.

Location deposits in areas characterized by predominantly rainy weather generates a quantity and quality leachate higher if the coverage is not adequate. Climatic conditions lead to significant seasonal variations of microbial activity and consequently the effects of biological purge is harder to be appreciate.

The temperature affects biological processes and chemical reactions taking place in the deposit

mass and subsequently in the aeration lagoon. In the case of high heights deposits, depths of over 15m are not influenced by seasonal temperature variations.

In the lagoon case, which is situated at relatively small depth, the temperature influence is much higher. Each bacterial species has an optimum temperature for growth. Values below 40^{o}C the temperature does not kill bacteria, but reduce growth rate and yield degradation decreases (Bashir & al., 2010).

MATERIALS AND METHODS

In the experiments samples of leachate were used coming from the electrical discharge leachate from Cell 2 waste landfill Glina, namely the settling tank located around the lagoon aeration, to highlight the effect of the lagoon on organic compounds from leachate. Samples were collected in the period December 2015 - November 2016 at the beginning of each month.

Measurements were carried out according to specific standards of each component

a. Determination of **materials in suspension** (mg/l) content was carried out by the method filtration and drying. The separation of suspended particles by filtration and drying in a vacuum oven at 105^{o}C and then weighting.

b. Determination of **Nitrate NO_3^-** (mg/l), was carried out by the sulfurosalicylic acid spectrometric method. It is based on determining the intensity of yellow coloration complex, sodium nitrosalicilyc formed between salicylic acid and nitrate. Absorption maximum at λ = 415 nm is. The sulfuric acid interacts with nitrate ions of sodium salicylate, 3-nitrosalicylic forming acids and 5-nitrosalicylic whose salts have a yellow coloration. Nitrate ions can be determined within the range 0.1-20 mg/l, without dilution or concentration of the sample analysed.

c. Analysis of the **nitrite NO_2^-** (mg/l) content was carried out by molecular absorption spectrometric method. The measurements are usually compared to a reference sample, by comparison, contained in a cell of the same size as that in which the sample to be analysed. The reference sample typically contains solvent and sample constituents, except a species whose absorbance measurements. With such a reference solution in the cell, the intensity of the incident radiation transmitted is less than that lost by diffusion, reflection, and absorption due to any other components.

d. Determination of **Ammonia NH_4^+** (mg/l) was carried out by the manual spectrometric method. The principle of the method consists in the reaction of ammonium ions, in a basic medium, with tetraiodomercurat of potassium (K2 [HgI4]) which form a complex (iodide oximercuramoniu) of yellow-brown color.

e. Analysis of the **total Phosphorus** (mg/l) content was carried out by Ammonium molybdate spectrophotometric method. Phosphate anion was reacted with ammonium molybdate in acidic medium and the formed ammonium phosphomolybdate form under the action of reducing compunds a blue complex known as molybdenum blue complex. The color intensity is proportional to the phosphate concentration.

f. In this work, the **pH** was determined using the electrometric method.

g. Determination of **biochemical oxygen demand** (**CBO**, mg O_2/l) was carried out by the dillution and seeding method, input aliltiouree. Oxygen consumed is determined for 5 days by microorganisms in the water by the difference between the amount of oxygen found in the sample of water immediately and 5 days after harvest

h. Analysis of the **chemical oxygen demand** (**COD**) content was carried out by the method with potassium dichromate. COD value is determined directly from the wavelength of a control sample prepared and treated as the test sample but containing only distilled water and oxidant mixture in the same proportions in a laboratory spectrophotometer.

RESULTS AND DISCUSSIONS

The general figures of the leachate content during December 2016 - November 2016 are provided in Table 1. Different contents of the leachate compounds are in the normal range described previously by our research (Panter et al., 2016). Applying an aeration lagoon had lead in that area to different modification and evolution of the compounds content.

The experimental results described in this paper (Figure 1) show a maximum activity of

microorganisms in the temperature range of 15 – 20°C while the amounts in nitrate and nitrite are the highest (117 g/l).

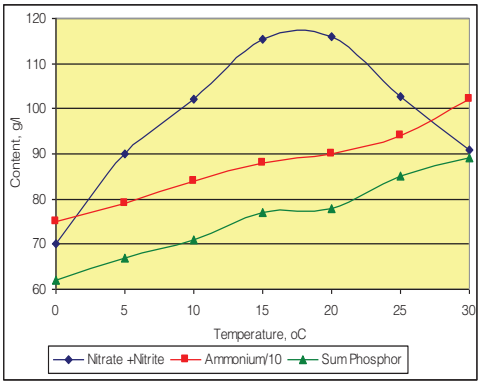

Figure 1. Variation of nitrate, ammonium and phosphate content in the leachate against air temperature variation

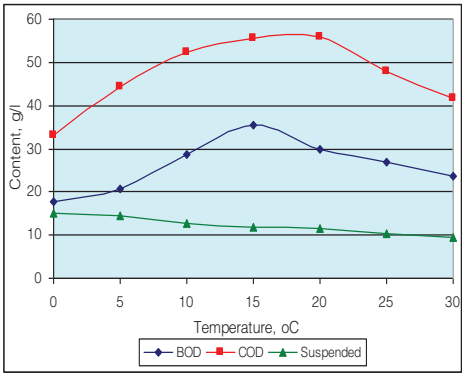

Figure 2. Changes in BOD, COD and suspended matter in the leachate against air temperature variation

Increasing the accumulation of ammonia and phosphorus is of course explained by the increased activity of bacteria with increasing environmental temperature and by increasing the intensity of biochemical reactions correlated with the temperature increase.

Microbiological treatment of leachate may be feasible solution for pre-treatment of the leachate, in particular between March and November, when the temperature is generally above 10°C.

The growth from 47 g/l to 70 g/l at a temperature of 0°C to 117 g/l at 18°C, is an increase in the efficiency of biocleaning 68% (Figure 2), which leads to the increase of BOD by 51% and the COD by 59.3%

Waste decomposition and release of chemicals occur differently under aerobic or anaerobic waste resulting coverage made with inert material. Anaerobic conditions are favoured at deposits with thicker layers of waste and aerated lagoons process is dependent on the efficiency of the aeration system.

Rainfall is the main factor of formation of leachate and influences the quantity and intensity of biodegradation of pollutants in the leachate. Under small or medium quantities of monthly rainfall (under 60 mm) there are significant concentrations of substances raging between 106.8 and 116.4 g/l of nitrite plus nitrate amount, between 90.2 and 102.1 g/l ammonium and between 81.5 and 86.9 g/l phosphate content amounting (Figure 3).

At higher amounts of rainfall of 60 mm per month, the concentrations of the compounds of sodium, ammonium and phosphorus decreases the extent and relatively uniform, so it can be considered that these values they affect insignificant rainfall biodegradation processes.

Table 1. Leachate composition in Cell 2 waste landfill Glina between December 2015 - November 2016

Months	Nitrat	Nitrit	Ammo-nium	Total phosphor	Suspended	BOD	COD
	g/l	g/l	g/l	g/l	g/l	gO_2/l	gO_2/l
December	62.16	8.2	78.4	62.2	15.12	17.63	33.2
February	85.4	29.5	88.1	76.9	11.68	35.34	51.2
April	75.1	15.3	75.9	67.5	14.5	23.7	44.3
June	84.6	18.2	89.9	77.1	10.2	22.9	47.9
August	79.3	12.1	102.3	87.9	9.5	23.6	41.7
October	80.9	20.8	84.2	71.3	12.8	28.8	52.3
November	89.1	26.3	90.1	75.3	11.4	29.96	45.76

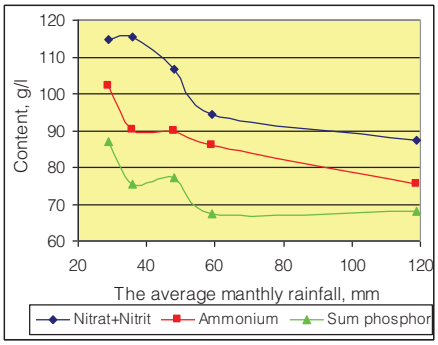

Figure 3. Variation of nitrates, nitrites, ammonia and phosphates in the leachate against rainfall

Regarding the biochemical oxygen demand and chemical oxygen demand of the experimental results we see the same variation as in the case of the chemical compounds of sodium, nitrogen and phosphorus, but with uniform variations. To increase the average monthly rainfall of 25 mm to 120 mm (Figure 4) biochemical oxygen demand decreased by 33.2% from 35.34 to 23.6 g O_2/l, chemical oxygen demand and has undergone a decrease of 17.7% from 52.2 to 41.7 g O_2/l.

Analysis of BOD/COD ratio reveals that there is quite small variations, between 0.56 and 0.69 so leaching are well suited for a microbiological treatment. It has been shown that anaerobic organisms have played an important role in the effective removal of pollutants in the leachate.

From the tests carried out it has been found that the change of climatic factors has led to different values of the constituents in the leachate means the activity of microorganisms and therefore differences in the changes in the biodegradation of leachate. The results may lead to the set up the optimum conditions for a maximum of microbial activity.

For this experiment we used samples of leachate collected from the cell 2, Section 3 of the Glina deposit where the waste came from the sorting station (sorting is done for metals, plastics, paper and textile). Table 3 presents the average composition of the waste prior sorting (2014) and after sorting (2016).

The higher content in biodegradable waste (obtained by separating plastics, paper, metal and glass) had a positive influence on biological purge expressed by a drop content of nitrates, nitrites, ammonia, chemical content and biological oxygen demand by between 12 and 29%.

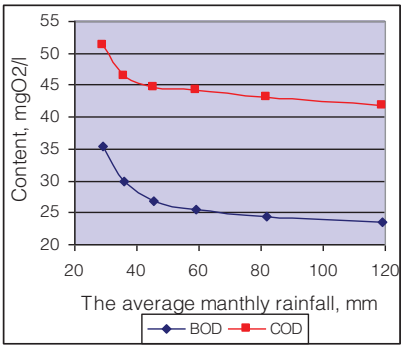

Figure 4. Variation, BOD and COD in the leachate against the rainfall

Most sorting efficiency was recorded in the case of nitrate content (growth of 29%), while the smallest increase was the amount of phosphates and the less in the case of the total phosphorus content (Figure 5).

Table 3. Composition of waste before and after sorting in cell 2, Section 3 of the Glina deposit

Nr crt.	Component	Content, %	
		Before sorting	After sorting
1	Metal	1.93	1.16
2	Mixed plastic	17.96	10.88
3	Paper and cardboard	18.61	9.15
4	Glass, ceramic	7.26	5.18
5	Textiles	4.64	3,20
6	Wood	1.24	1.22
7	Biodegradable	48.36	69.26

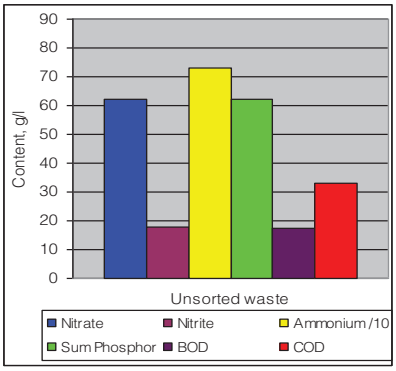

Figure 5. Unsorted waste leachate compositions

The rest of the components content have increased between 20.5% and 24.3%; biochemical oxygen demand and chemical oxygen demand recorded an increase of 24% for sorted waste (Figure 6).

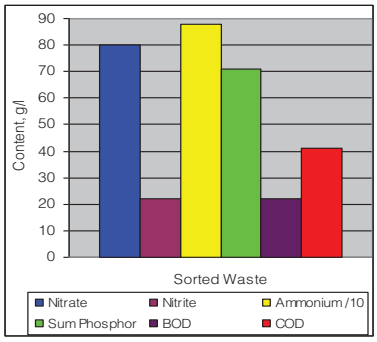

Figure 6. Sorted waste leachate composition

The presence of certain substances in waste or leachate can affect in a negative way the activity of microorganisms that produce germicides degradation of organic pollutants.
Germicides are substances that kill bacteria by contact and bacteriostatic agents are chemical compounds that prevent cell reproduction. Their presence in the aqueous environment may even lead to extinction of the metabolic process. Also anti-metabolites are chemicals that destroy or alter metabolic agents or growth - factors essential for normal life of bacterial cells.
These aspects will be further aspects to be examined.

CONCLUSIONS

Microbiological treatment of leachate is an effective method because of technical and economic advantages, consisting of leachate treatment efficiency with high concentrations of organic matter with high nitrogen content and a high ratio COD/BOD.
Anaerobic treatment is one of the biological treatment process is especially suited for pre-treatment.
The lagoon, which is relatively small in depth, the influence of temperature is much higher. The experimental results highlighted that the maximum activity of microorganisms is noticed in the temperature range 15 – 20°C; in this range the amounts in nitrate and nitrite are the highest.
Rainfall is the main factor of formation of leachate and influences the quantity and intensity of biodegradation of pollutants in the leachate.
The higher content in biodegradable waste (obtained by separating plastics, paper, metal and glass) had a positive influence on biological purge expressed by a drop in the content of nitrates, nitrites, ammonia, chemical content and biological oxygen demand by between 12- 29%.
Among the advantages of the method we could mention: reducing sludge, it doesn't require oxygen, the occupied area is not large, it produces biogas and does not consume much power. In general, the biological process is one of the most successful and effective methods of treating leachate.

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