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THE EFFECT OF THE TIME OF CONTACT ON THE MICROBIOLOGICAL TREATMENT OF LEACHATE

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Abstract

The study aimed to establish the optimum conditions for biological treatment of the leachate from the Glina household waste disposal site. The variation in nitrate, nitrite, phosphate, ammonium and suspended matter content in relation to contact time between microorganisms and leachate was analyzed to highlight the activity of microorganisms at different contact times. Experimental results have shown that the highest efficiency in the removal of nitrates and nitrites corresponds to the contact range of 16-24 hours, while the degradation efficiency is very low for contact time below 8 hours. The higher content of leachate suspensions was recorded over 5 days of contact, after which a continuous decrease was achieved by the end of the experiment. Positive inflection on biological purification by lowering the content of ammoniacal nitrogen, phosphorus, oxygen content and biochemical oxygen content between 16 and 32% after 20 hours of contact time

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

INTRODUCTION

Controlled storage in ecological landfill is the main method of processing waste in many countries in the world due to technical and economic advantages this method presents in comparison to other processing methods.

Leachate results from landfills, which if not treated properly and disposed of safely, can migrate into soil and groundwater basements with serious effects on eco-systems, as leachate contains many pollutants resulting from waste (Kamarud, 2013).

The presence of pollutants in high concentrations has become one of the major problems of landfill operators in particular in compliance with strict regulations regarding the safe disposal of leachate. Biological treatment is applied when the organic substances present in the leachate are degradable and are not accompanied by toxic substances. Bacteria use enzymes to get food in the form of hydrocarbons by breaking down substances in the leachate. levigat (Arpita, 2017).

In the microbiological treatment of leachate, biodegradation is performed by microorganisms that can degrade organic compounds and carbon dioxide under aerobic sludge and biogas (a mixture containing mainly CO_2 and CH_4) under anaerobic conditions (Ghasimi et al., 2010).

Under anaerobic conditions, Kamaruddin (2015) demonstrated that organisms played a significant role in the effective removal of leachate pollutants, their activity being strongly influenced by the pH of the leachate. By lowering the pH of the leachate sample, the percentage of COD removed increased from 39.7% to 43.7%.

Under these conditions, all organic compounds were completely oxidized to carbon dioxide. Increasing the pH in the range of 8 to 9 would lead to a slight (second) increase, from 49 to 51%. In this case, although anaerobic organisms are not an oxidizing agent, microorganisms in the leachate solution are responsible for the degradation of organic content (Kamaruddin, 2015).

Research by Mehmood MK et al. showed that anaerobic organisms would effectively activate neutral pH leachate; a similar finding being observed for the removal of NH3-N. Under acidic conditions, NH_3-N removal was observed below 29%, while a slight increase was recorded when the pH increased from 7.8 to 9.2 (Mehmood, 2009).

Among the factors influencing the biological process, the following were analyzed in the present study: the contact time or the crossing time of the aeration lagoon, the pH.

MATERIALS AND METHODS

In experimental determinations 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 (Table 1).

Tabel 1 Analysis method

Nr. crt	Quality indicator	U/M	Determination method	Method principle
1.	pH		Electrometric method	The method is based on measuring the potential difference of an electrochemical cell in which one half is the measurement electrode and the reference electrode is the other half. Measuring electrode potential is a function of hydrogen ion activity measurement solution.
2.	Materials in suspension	mg/l	Filtration and drying	The separation of suspended particles by filtration and drying in a vacuum oven at 105^0C and then weighing.
3.	Nitrate NO_3^-	mg/l	Sulfosalicylic acid spectrometric method	It is based on determining the intensity of yellow coloration complex, sodium nitrosalicilate formed between salicylic acid and nitrate. Absorption maximum at $\lambda = 415$ nm is. In 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 analyzed.
4.	Nitrogen NO_2^-	mg/l	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 analyzed. 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 intensity of the radiation transmitted is less than that lost by diffusion, reflection, and absorption due to any other components.
5.	Ammonia NH_4^+	mg/l	Manual spectrometric method	The principle of the method consists in the reaction of ammonium ions, in a basic medium, with tetraiodomercuratul potassium (K2 [HgI4]) which form a complex (iodide oximercuramoniu) of yellow-brown color.
6.	Phosphorus total	mg/l	Ammonium molybdate spectrophotometric method	Phosphate anion was reacted with ammonium molybdate in acidic medium and the formed ammonium phosphomolybdate, ammonium phosphomolybdate result form under the action of reducing a blue complex known as molybdenum blue complex The color intensity is proportional to the phosphate concentration.
7.	CBO_5	mgO_2/l	Dillution and seeding method with 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
8.	CCOCr	mgO_2/l	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

A municipal waste repository is not homogeneous, since there is waste which is water absorbent such as cardboard or paper, and at the other extreme waste such as plastic, glass or construction waste. Qualitative analysis conducted by researchers (Ghose Pooja and Gupta Asmita, 2015) have revealed the presence of numerous xenobiotics very different groups: 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 harder to appreciate (Pooja Ghos, Gupta Asmita, 2017).

Contact time

The contact time or the time of crossing of the technological objective in which the biological process takes place is one of the essential factors which determines the efficiency of the biological treatment. To carry out the process of decomposition, the concentration of the bacteria, the time to decomposition can vary.

The mechanism involved suggests that anaerobic metabolism involved a mixed culture of many species of microorganisms, some of which can convert NH_4^{++} to NO_3, thus lowering the potential for N-fraction (Javaid, 2010).

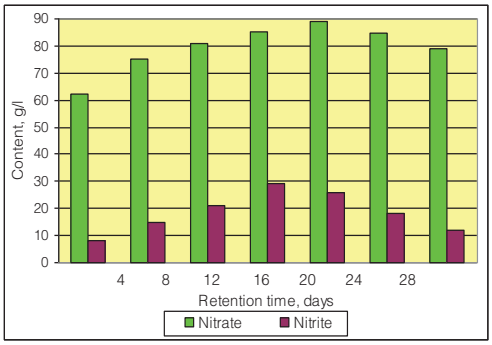

Figure 1. Content variation in nitrate and nitrite with contact time

Experimental determinations carried out on leachate samples in 2016 revealed an increase in concentrations over the first 20 days of nitrate treatment from 61.8 g/l to 89.1 g/l, and in the first 16 days of nitrate the increase was from 8.5 g/l to 28.9 g/l and 20.4 g/l respectively (Figure 1).

Increased contact time allowed leachate anaerobic microorganisms to adapt to the conditions of the aeration lagoon, harness the existing microorganisms in the lagoon sludge and enhance their biodegradation activity.

As the contact time was prolonged, a decrease in nitrogen content was observed.

In experiments we noticed that longer contact time between anaerobic organisms and the leachate sample will reduce the ability of microorganisms to react effectively with leachate pollutants because the oxygen content in the leachate pools is much lower.

The biological treatment process results in organic matter degradation, to various stages of technology and equipment and biomass growth (estimated at 40-60%) in the form of insoluble, sedimentable cell material, as well as in some metabolic products, more easily removed.

Concerning the concentrations in ammonium and phosphates, in figure 2 a constant increase of the concentration with the increase of the contact time can be seen, which shows that the nitrification processes - long-term denitrification are present.

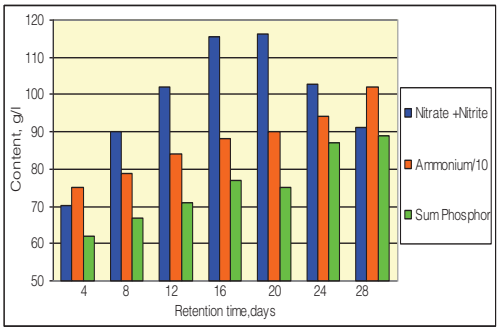

Figure 2. Change in total nitrate, ammonium and phosphate content with contact time

Higher ammonium concentration is generated by the biodegradation of the protein portion; also some nitrogen compounds were transferred as NH_3 after bioreaction.

These results suggest that bacteria produce enzymes whose optimal activity takes place at different research (Gabarro et al., 2012).

The presence of these compounds in a high proportion indicates a decrease in the biodegradation rate expressed by the reduction in oxygen consumption, thus decreasing the values of the biochemical oxygen content (BOD) and the chemical oxygen content (COD), the decrease also explained by the depletion of the dissolved oxygen content.

The refore, a slow biodegradation rate determined the increase in BOD and COD content over time to day 16, as shown in figure 3.

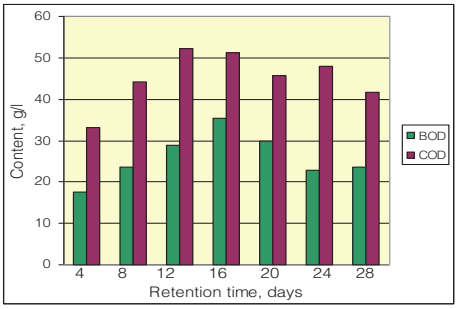

Figure 3. Variation of BOD, COD with contact time

In the period of time when the temperature is lower and consequently the activity of the microorganisms has a reduced intensity, the contact time required to achieve the leaching level required is higher.

Differences in pollutant reduction in leachate can also be attributed to bacteria of different species and variation in bacterial biomass concentration, as well as variation in the composition of the waste.

The continuous reduction of suspended matter, as can be seen from figure 4, can be explained not only by biodegradation processes but also by sedimentation in the aeration lagoon.

As previously shown, the biodegradable activity of the leachate microorganisms is strongly influenced by the pH of the leachate.

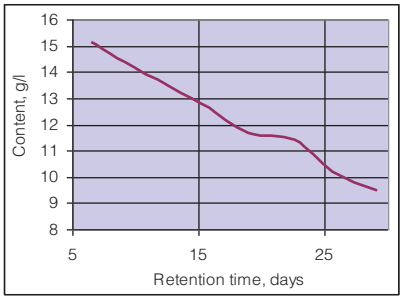

Figure 4. Variation of suspended material with contact time

The average pH of leachate samples for mature deposits is 7.52. According to Umar et al. (2010), the pH of a young leachate is less than 6.5, while for old waste landfills, leachate has a pH greater than 7.5. The low pH of the initial phase is caused by the high concentration of volatile fatty acids (VFAs). Similarly, stabilized leaching shows a fairly constant pH value with small variations ranging from 7.5 to 7.9. (Umar et al., 2010) From the research conducted in our country by Bold O.V. and collaborators, 2012, it was found that the pH of the leachate at the exit from the deposit is basically basic, with values greater than 9.2 (variations between 9.2 and 10.8). Also according to Rashid (2017), most microorganisms exhibit optimal growth at pH values between 6 and 8, and most microorganisms could not tolerate a pH above or below 4.

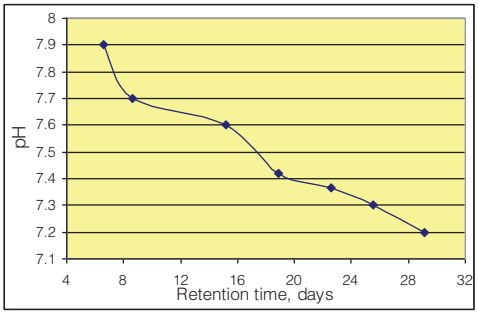

Figure 5. pH variation with contact time

The determinations made in this experiment showed a rather small variation of pH over the determination period (Figure 5), with pH values ranging from 7.2 to 7.9. However, a continuous and relatively uniform pH decrease with increasing contact time is observed.

It is observed in figure 6 that by increasing the pH of the leachate sample from 7.2 to 7.4, the BOD content increased from 23 g/l to 32 g/l and the COD content increased from 42 g/l to 53 g/l.

In these conditions, almost all organic compounds were completely degraded, a phenomenon due to leachate microorganisms.

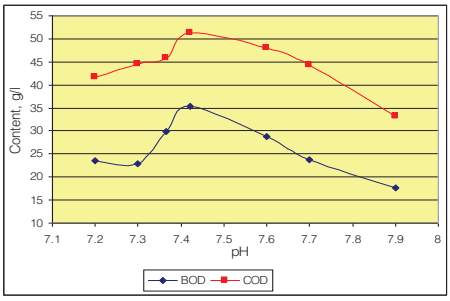

Figure 6. Variation of BOD and COD with leachate pH (2016)

Increasing the pH of the leachate samples over 7.4 has led to a decrease in chemical and biochemical oxygen consumption, which implies a decrease in bacterial activity and a slowing down of the biodegradation process

Over time, the concentrations of the compounds in the leachate decrease, the content being formed by water, dissolved gases and biomass. Quantitative levigate increases in the first 4 years, decreases until the 8th year and finally reaches a value representing about 1‰ of the maximum amount.

It is relevant to the efficiency of purification, first of all, the knowledge of the microorganisms present in the leachate, their activity and evolution and the interaction with other organisms present in the leachate (Fernandes, 2013).

The composition of waste by the high degree of diversification generates similarly a high degree of diversification of the composition of the leachate; thus waste with a high content of biodegradable materials influences its quality.

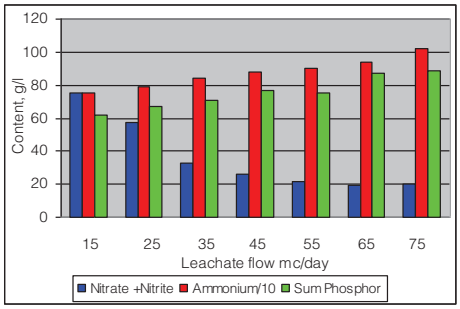

Figure 7. Variation in nitrate, ammonium and phosphate content with leachate rate

Due to the variation in the leachate flow rate and the very high concentrations of pollutants present in the leachate, there is a progressive decrease in the reaction rate until it is canceled; this phenomenon is called **substrate inhibition or product inhibition**. Figures 7 and 8, drawn from experimental determinations, evidence the dependence of various pollutants on leachate flow.

In this case, there are several processes which show the fixation of several substrate molecules, which produces the attenuation of the nitrification-denitrification reactions and thus the decrease of the chemical and biochemical oxygen content from 53.2g/l to 37.6g/l (COD) and 33.4 g/l to 17.2 g/l (BOD), respectively.

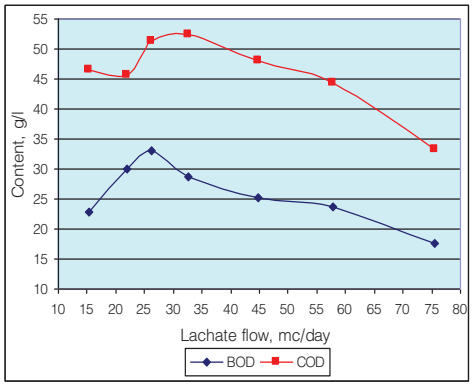

Figure 8. Variation of BOD, COD with leachate rate

The presence of certain substances in waste or leachate can negatively influence the activity of microorganisms that cause the degradation of organic pollutants. Germicides are substances that destroy bacteria by contact, and bacteriostatic agents are chemical compounds that inhibit the reproduction of cells.

Their presence in the aqueous environment can even lead to the extinction of the metabolic process.

Also, antimetabolites are chemicals that destroy or alter metabolic or growth factors - essential factors for the normal life of bacterial cells.

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.

Experimental determinations have shown an increase in the concentration in the first 16-20 days of treatment with nitrates and nitrites and, therefore, a slow rate of biodegradation of BOD and COD in time, up until the 16th day.

Increasing contact time allowed anaerobic microorganisms in samples of leachate to adjust to the conditions in the lagoon aeration to mix with existing microorganisms in the sludge in the lagoon and to intensify the work of biodegradation. As the contact time was

extended, there was a decrease in the nitrogen content components.

Increasing evidence of leachate pH above 7.4 resulted in the decrease of the chemical and biochemical oxygen demand which implies a decrease in bacterial activity and a slowdown between 7.2 and 7.8 revealed a pH value equal to 7.4 which is the maximum microbiological effectiveness of treatment.

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.

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