Scientific Papers. Series E. Land Reclamation, Earth Observation & Surveying, Environmental Engineering. Vol. V, 2016
Print ISSN 2285-6064, CD-ROM ISSN 2285-6072, Online ISSN 2393-5138, ISSN-L 2285-6064

AERATION LAGOON AS ADVANCED SOLUTION FOR LEACHATE EPURATION - A STUDY CASE IN GLINA PURGE UNIT

Zamfir PANTER[1], Mugur BOBE[2], Gabriela ROSU[3], Florentina MATEI[1]

[1] University of Agronomic Sciences and Veterinary Medicine of Bucharest, Faculty of Biotechnologies, 59 Marasti Blvd, District 1, Bucharest, Romania
[2] SC ECOREC SA Bucharest
[3] University of Agronomic Sciences and Veterinary Medicine of Bucharest, Faculty of Land Reclamation& Environmental Engineering, 59 Marasti Blvd, District 1, Bucharest, Romania

Corresponding author email: zamfirpanter@yahoo.com

Abstract

Leachate is a liquid waste product of the processes in solid waste landfills with meteoric waters seeping. A number of substances are dissolved by washing with meteoric water and other substances resulting from the processes of fermentation of organic waste components. Leachate treatment is essential to reduce mainly the organic and nitrogen content in the leachate. The initial solution applied to the purge unit-Glina was a biologic reverse osmosis in two steps (osmosis layout). An aeration lagoon has been designed and proposed to be installed as pilot in Glina. The leachate provides the food for the bacteria and the aeration system provides the oxygen. The results are suggesting that this lagoon technology can be economic to install and simple to run.

Key words*: aeration lagoon, leachate landfill.*

INTRODUCTION

In correlation with environmental protection requirements, characteristics of the deposit and weather conditions are necessary measures regarding: control of water in the body of the deposit, leachate collection through a proper drainage system, as well as its appropriate treatment.
Constraints in terms of management are specific to each site and refer to: the conditions of discharge in the receiver natural system leachate treatment, availability of space for the installation of leachate treatment in the warehouse, as those relating to performance of the treatment plant (Cretu, 2015).
The main objective of the step is the removal of biological treatment of organic solid substances undeposited (dissolved or colloidal) and the stabilization of organic materials in the sludge. At the same time it is proposed to reduce nutrients based on nitrogen and phosphorus. It is a flexible process that can easily adapt to the variability characteristics leachate concentrations and composition. (Jascau, 2015).
Factors influencing biological processes are time of contact, or during the crossing of the target technology in which the biological process takes place, temperature, pH level, and oxygen level, loading the technological object with waste waters (dilution) with the slurry nutrients, the presence of the inhibitors process hydrodynamic conditions of the process - mixing and blending.

MATERIALS AND METHODS

Leachate is nothing more but a waste liquid, a waste, highly polluted water coming from the humidity ceded garbage, and water ceded the fermentation process and most of the precipitation falling on the surface of the deposit.
Levigates' composition will vary over time depending on

- composition of the waste deposited and the degree of their decomposition;
- humidity mass of waste from storage;
- evolutionary age of the deposit defined by the phase in which the (acid metanogenic);
- storage system and technological solutions: compacting, laminating, coating, time (period) execution;
- environmental temperature.

In experimental determinations there were used samples of leachate coming from the evacuation outlet of Cell 2 from Glina waste landfill.

Samples were collected during October 2014 - December 2015 on beginning of each month. The determinations were performed according to specific standards of each component.

Detention facilities discharge pollutants into water and consist of:

1. The drainage pipes made of HDPE with Dn = 200 mm, total length of 758 m and 0.05% longitudinal slope to drain
2. leachate pre-treatment station consists of:

• underground basin for leachate collection, made of polyester reinforced fiberglass, having a capacity of 25 m^3;

• aboveground pool for collecting leachate mounted on metallic supports, made of fiberglass reinforced polyester, with capacity 25 m^3 ensuring gravitational leachate flow to the treatment plant through a pipeline from PHED Pn 4 Dn = 325 mm;

• settling tank, concrete, above ground, two-compartment with a volume of 140 m^3

3. Aeration Lagoon is approximately = 500 m^3 volume, dimensions: B x W x H = 15 x 10 x 3.3 m. The role of the lagoon system for treatment and purification of leachate is to ensure oxidation of organic matter. Demand for oxygen is provided through a battery of aeration, which includes a submersible pump mounted on a frame aeration float with a variable power as needed between 3.5 - 30 kW. Oxygen transfer rate is as Sotra (ANSI/ASCE 2-91) 1.2 kg O_2/ kWh. Suction maximum depth 21 m.
4. The metal Eurocontainer equipped with specific modules for the method of reverse osmosis treatment in two stages: pre-filtration segment, segment leaching stage E I, E II segment phase permeate system wells;
5. Outdoor storage and disposal of the resulting permeate treatment module constructed of concrete, with a volume of 35m^3.

Treated (permeated) leachate together with wastewater from the toilets at the entrance of the administrative building inside the objective and processed water from the municipal results are taken from the wash basin and clarified with three compartments 32 m^3 and discharged in the Dambovita River's cased collector.

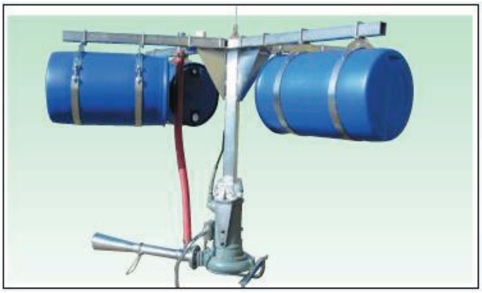

Figure 1 Aeration battery
(pumps aeration, float frame, supply air)

In their research, Schiopu et all showed that the method of treating leachate from the landfill through the process of reverse osmosis is increasingly used due to the economic, technical and environmental advantages of the removal efficiency of organic contaminants which were nearly 90% for the COD, $NH4^+$, and the electrical conductivity (Schiopu, 2012).

But this method has also got some disadvantages, such as poor retention passage of small molecules through small molecules that pass through the membrane and deposition of unwanted solutes on the outer surface of the membrane (Smith, 2012).

At the beginning of 2015 on economic and especially environmental technology leachate treatment of urban waste landfill Glina was introduced an aeration lagoon for biological treatment of leachate.

The goal is the elimination of biological treatment of colloidal and dissolved organic matter undeposited and stabilization. Microorganisms convert organic materials into cellular tissue, liquids and gases.

Determination of quality parameters (pH, nitrates and nitrites suspended matter, ammonia, phosphates, BOD, COD) of leachate was done in the laboratory using standard methods whose measurement principle is given in Table 1.

Table 1. Analytical methods used in the laboratory to determine the pollutant content of the leachate from the landfill Glina

Nr crt	Quality Indicator	U/M	The method of determination	The method principle	Standard
0	1	2	3	4	5
1	pH, to 20.6^0C		Electro prosody 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.	SR EN ISO 10532-2012
2	Suspended matters	mg/l	Filtration and drying	The separation of suspended particles by filtration and drying in a vacuum oven at 1050C and then weighing	STAS 6953-81
3	Nitrate NO_3^-	mg/l	Sulfosalicylic acid spectrometric method	t is based on determining the intensity of yellow coloration complex, sodium nitrosalicilatul formed between salicylic acid and nitrate. Absorption maximum at λ = 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.	SR ISO 7890-1998
4	Nitrite 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.	SR EN 26777-2002
5	Ammonium NH_4^+	mg/l	Manual spectrometric method	Spectrometric method is based on analysis of a light beam passing through a solution. The more particles are present in solution, the light will be increasingly more subdued - its intensity decreases.	SR ISO 7150-1-2001
6	Sum Phosphor	mg/l	Ammonium molybdate spectrophotometric method	The phosphate ion is 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.	SR EN ISO 6878-2005
8	BOD5	mgO_2 /l	Dilution 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 API test immediately after 5 days after harvest	SR EN 1899-1-2003
9	COD-Cr	mgO_2 /l	The method with potassium dichromate	Oxidizable substances in the leachate are oxidized by potassium dichromate in sulfuric acid medium, hot, and the excess dichromate is titrated with the Mohr salt in the presence as an indicator fenioinei	SR ISO 6060-1996

Figure 2. Aeration lagoon of the landfill Glina

RESULTS AND DISCUSSIONS

Characteristics of leachate from municipal landfills can be best represented by several parameters of which the most important for introduced an aeration lagoon for biological treatment of leachate.

The goal is the elimination of biological treatment of colloidal and dissolved organic matter undeposited and stabilization. Microorganisms convert organic materials into cellular tissue, liquids and gases.

Biological treatment is: COD, BOD, the ratio BOD/COD, pH, suspended matter, ammonia, nitrates and nitrites, bacteria and turbidity (Foo K. Y., 2009).

Leachate composition and properties depend on environmental conditions (temperature, precipitation), the age and maturity of the landfill, waste characteristics and composition, operating warehouse technology.

In the process of aging, deposits pass through various stages of degradation of organic waste, from aerobic to anaerobic dissolution stage. Therefore, leachate properties such as Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD), ammonia (NH_3) or pH changes depending on the stage of decomposition of waste (Amor C., 2015).

Biodegradability can be estimated by the ratio BOD/COD, environmental conditions; temperature, pH and the absence of inhibitors have major effects on the bacteria. The following links can be broken down biologically: carbon bonds, bonds nitrogen (including ammonia NH_4-N) AOX bonds. (Clarke, 2015).

Table 2. Composition of leachate from the landfill Glina from October 2014 to December 2015
Sampling point two-compartment tank leachate

No	No quality indicator	U/M	Oct 2014	Dec 2014	Febr 2015	Apr 2015	Jun 2015	Oct 2015	Dec 2015
0	1	2	3	4	5	6	7	8	9
1	pH, to 20.6^0C		9.1	9.2	8.4	7.4	7.6	7.1	7.3
2	Suspended matters	mg/l	12212	13122	11056	10836	10498	10216	10115
3	Nitrate NO_3^-	mg/l	90.12	83.16	85.25	74.9	80.01	78.25	80.30
4	Nitrite NO_2^-	mg/l	16.98	18.2	17.7	11.3	10.3	9.60	12.25
5	Ammonium NH_4^+	mg/l	902	801	862	749	605	594	660
6	Sum Phosphor	mg/l	85.12	95	78	87.2	103	116	120
7	Substances- extract with solvents	mg/l	38.61	53	48	64.7	54	57	56
8	BOD_5	mgO_2/l	22961	21630	22736	18712	20033	17864	20103
9	CODCr	mgO_2/l	45760	43206	45484	34706	37904	31672	36176
10	BOD_5/CODCr		0.508	0.50	0.511	0.542	0.541	0.560	0.564

Biological processes for treatment of leachate is based on the biochemical reactions in the metabolism of bacteria, fungi and other lower organisms - in particular protozoa which are organic load in waste water, which form biomass.

From the results shown in Table 2 and in the following graphs it can be clearly seen that since April 2015 the quantities of pollutants in the leachate decreased except for total phosphorus and substances extracted with solvents.

Biochemical activity of microorganisms present in the aeration lagoon have as first observed effect in experimental measurements, a change in pH that has achieved a

Scientific Papers. Series E. Land Reclamation, Earth Observation & Surveying, Environmental Engineering. Vol. V, 2016
Print ISSN 2285-6064, CD-ROM ISSN 2285-6072, Online ISSN 2393-5138, ISSN-L 2285-6064

decrease of 2.5 units from 9.2 in December 2014 to 7.1 in October 2015 (Figure 3).
The final result of the biological process the treatment is reflected in the degradation of the organic substance, to the various stages of the relevant technology and equipment, and increase of biomass (estimated at 40 ... 60%) in the form of cellular material insoluble sediment, and some products of metabolism, easier to remove

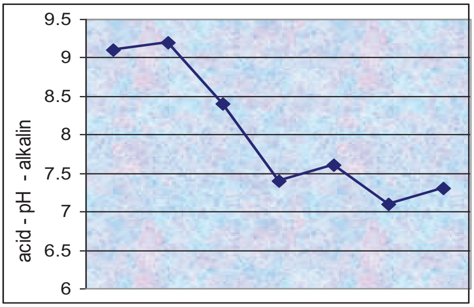

Figure 3. Changes in pH leachate from ecological landfill Glina (October 2014 to December 2015)

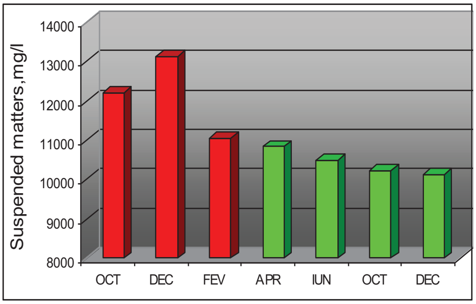

Figure 4. Suspended solids content of leachate from landfill ecological Glina (October 2014 to December 2015)

The amount of suspended solids (Figure 4) ranged from October 2014 - February 2015 between 11.06 and 13.13 g/l leachate values that are within the existing literature for deposits less than 5 years. (Jascau, 2015 Foo K.Y. 2009).
After introducing it in the lagoon aeration technology there can be observed a decrease of materials in suspension having values between 10.11 and 10.84 g/l decrease recorded an increase of 10% in the first month of operation of the lagoon and 29% after the first 8 months (Figure 4).

Biological processes for reducing the organic materials are affected by a number of specific factors such as contact time or during the crossing of the target technology in which the biological process takes place, temperature, pH, oxygen loading lagoon wastewater (dilution), the slurry nutrients, the presence of inhibitors of the process, the hydrodynamic conditions of the process - mixing and blending, as the use of the aeration system.
Considerable reductions were recorded between April-December 2015 regarding the composition of in nitrogen compounds (nitrates, nitrites and ammonia).

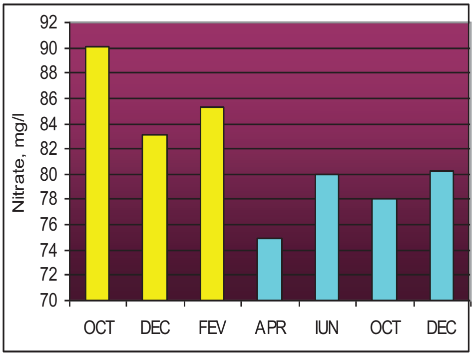

Figure 5. Content of nitrate leaching from Glina ecological deposit (October 2014 to December 2015)

The nitrate content in laboratory determinations revealed ranged between 83.16 and 90.12 mg/l before the construction of the lagoon and between 74.9 and 80.3 mg/l (Figure 5) after commissioning of the lagoon aeration.
The same effect was found in the content of nitrite, which were originally recorded values between 16.98 and 18.2 mg/l (Figure 6) and after building the lagoon have been reported very low with about 50% (9.6- 12.5 mg/l).
Renou et al. used anaerobic and aerobic lagoons situated near the landfill leachate biological treatment constructed warehouse.
Overall modifications of N, P and Fe were obtained in this system of over 70% for diluted leachate (Renoua, 2008).

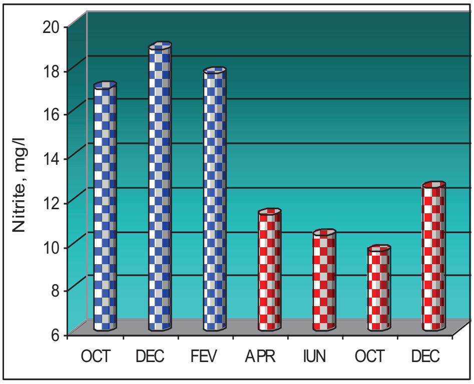

Figure 6. The nitrate content of leachate from Glina ecological deposit (October 2014 to December 2015)

Biological Cleaning lagoon aeration used to store Glina builds on the work of two groups of microorganisms: aerobic or anaerobic.
Aerobic microorganisms are commonly used in wastewater treatment with the predominant majority of organic - carbon-based compounds, nitrogen or phosphorus - and for certain categories of sludge stabilization.
Biochemical activity of microorganisms which degrade organic matter content leachate led to a decrease in Ammonium between 10% in the first month of operation of the lagoon and 30% in October (6 months of operation).
In December 2015 there can be seen an increase of the ammonium perhaps because of the reduction of biomass activity, due to the fall in temperature (Figure 7).
Some applications of biological processes in lixiviate treatment are: the removal of organic substances measured BOD, COD, BOD/COD report, nitrification, denitrification, phosphorus removal, sludge stabilization. Organic nitrogen is converted to ammonia and phosphates and phosphate. (Menyk, 2014).
From the graph shown in Figure 8 we can see an increase of the total phosphorus content of 78 mg/l up to 120 mg/l in December 2015 so to 8 months after the construction of the aeration lagoon.
Results on landfill leachate from Glina are consistent with the data presented by Zhang, G. et al (2013).

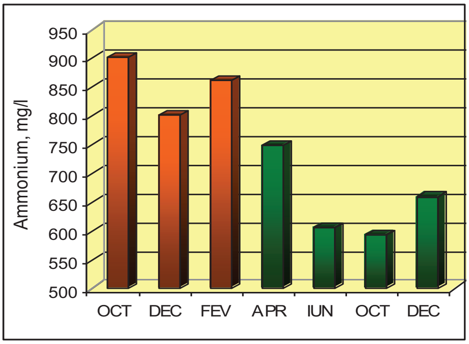

Figure 7. Ammonium content of leachate from landfill ecological Glina (October 2014 to December 2015)

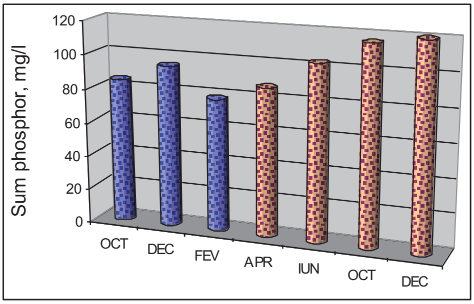

Figure 8. Change in total leachability of phosphorous the ecological deposit Glina (October 2014 to December 2015)

As shown in the graph in Figure 9 Biochemical Oxygen dropped from 22.961 mg/l (October 2014) to 17.864 mg/l (October 2015) representing a 26% reduction.
Regarding Chemical Oxygen Demand the decline is much more consistent, reaching a maximum of 38% after the start of the lagoon aeration.

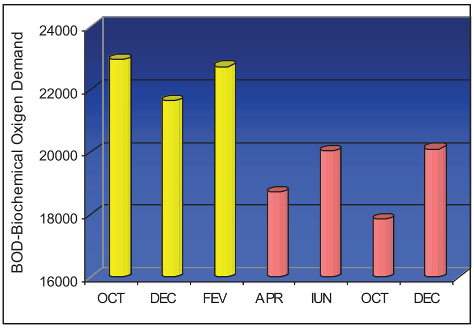

Figure 9. Changes in Biochemical Oxygen Demand BOD of leachate the ecological deposit Glina (October 2014 to December 2015)

From Figure 10 we can observe that in the months of October - Feb. 2014 COD ranged between 43 200 and 45 760 mg/l April 2015 and after that period values ranged between 31 672 and 36 900 mg/l.
During storage, waste passes through various stages of degradation of the organic constituents, from aerobic to anaerobic digestion stage. Therefore, properties such as Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD), total oxygen consumption (TOC), pH and other characteristics change depending on the stage of decomposition of fermentable waste.

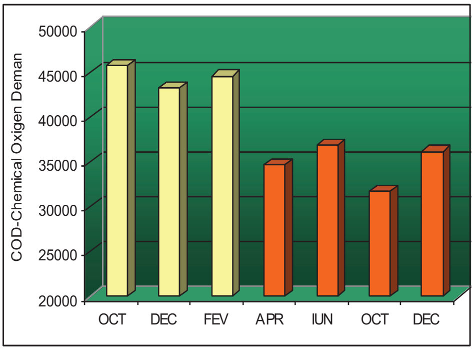

Figure 10. Changes in Chemical Oxygen Demand COD of leachate the ecological deposit Glina (October 2014 to December 2015)

Zhang and his collaborators studied the feasibility of the lagoon to treat phenolic compounds and organic matter; they have achieved a reduction of 55-64% and 80-88% of COD of phenol (Zhang, G., 2013).
When leachate from landfills presents BOD/COD report of more than 0.25, they may be subject to a standard biological treatment processes (Amor, C 2015).
Renou says that biological processes have proven to be very effective in removing organic matter and nitrogen from immature levigates when the ratio BOD/COD has a high value > 0.5 (Renoua 2008).
The analyzes presented in the graph in Figure 11 leachate from the landfill Glina the ratio BOD/COD of more than 0.5 is well suited to biological treatment.

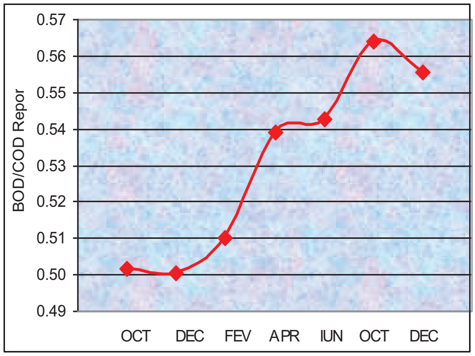

Figure 11. Variation of the BOD/COD report in leachate from Glina ecological deposit (October 2014 to December 2015)

CONCLUSIONS

Biological treatment of leachate is a simple and is particularly viable in terms of cost-effectiveness. Advantages of this method consist mainly of leachate treatment efficiency with high concentrations of organic matter, nitrogen or BOD, where a high ratio BOD/COD report, usually encountered in young leachate.
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.
By entering the aeration lagoon we yielded reductions of leachate organic pollutant content in particular is reduced content of nitrates, nitrites and ammoniac. There were also recorded reductions in terms of Biochemical Oxygen Demand, Chemical Oxygen Demand and the pH decreases as confirmed by the presence of the biochemical decomposition process of organic matter in the leachate, accordingly the efficiency of the introduction of aeration lagoon.
Although there are some advantages, the implications of anaerobic processes are limited mainly because of the low growth rate of anaerobic microorganisms and weak retention of biomass.
The trial is biologically dependent on maintaining stable parameters at the entry wastewater lagoon aeration.

Because biological treatment processes are conducted under natural conditions the occurrence of temporary shocks parameters is frequent and it will reduce sedimentation sludge, sludge disintegration, increase in effluent suspended solids concentration and finally to partial or complete blocking of the process.

The approach of combining biological process of reverse osmosis is recommended as a feasible method in removing organic substances, nitrogen and other pollutants in the leachate generated by the landfill of municipal waste.

REFERENCES

Amor C., De Torres-Socias E., Peres J., Maldonado M., Oller I., Malato S., Lucas M., 2015, *Mature landfill leachate treatment by coagulation/flocculation combined with Fenton and solar photo-Fenton Processes*, Journal of Hazardous Materials, Vol 286, pp. 261-268.

Clarke, B.O., Anumol, T., Barlaz, M., Snyder A.S., 2015, *Investigating landfill leachate as a source of trace organic pollutants*, Chemosphere Journal, Vol. 127, pp. 269-275.

Cretu Ana Maria Giorgiana, Scurtu C 2015, *.Sisteme de control si gestiune a levigatului* Revista Constructiilor nr. 111 – ianuarie-februarie 2015, pp. 60 - 62

Foo K. Y., Hameed B. H., 2009, *An overview of landfill leachate treatment via activated carbon adsorption process*, Journal of Hazardous Materials, Vol. 171, pp. 54-60.

Jascau Dan-Vlad , Boroş Melania, Gabor Timea, Sur Ioana Monica, Pica Elena Maria, 2015, *Efficient Methods of trating the leachate generated from municipalwaste landfills* Ingineria Mediului şi Antreprenoriatul Dezvoltarii Durabile – Vol. 4, Nr. 1 (2015) pp 41-50

Menyk, A., Kuklinska, K., Wolska, L., Namiesnik, J., 2014, *Chemical pollution and toxicity of water samples from stream receiving leachate from controlled municipal solid waste (MSW) landfill*, Environmental Research, Vol 135, pp. 253-261

Renoua S., J.G. Givaudan a, S. Poulain a, F. Dirassouyan b, P. Moulin, 2008, *Landfill leachate treatment: Review and opportunity* Journal of Hazardous Materials Vol 150 (2008) pp. 468–493

Schiopu, A.M., Piuleacm G.C., Cojocaru, C., Apostol, I., Mamaliga, I., Gavrilescu, M., 2012, *Reducing environmental risk of landfills: Leachate treatment by reverse osmosis*, Environmental Engineering and Management Journal, Vol. 11, Nr 12, pp. 2319-2331.

Smith, A., Stadler, L., Love N.G., Skerlos, S.J., Raskin, L., 2012, *Perspectives on anaerobic membrane bioreactor treatment of domestic wastewater: A critical review,* Bioresource Technology, Vol. 122, pp. 149-159.

Zhang, G., Qin, L., Meng, Q., Fan, Z., Wu, D., 2013, *Aerobic SMBR/reverse osmosis system enhanced by Fenton oxidation for advanced treatment of old municipal landfill leachate,* Bioresource Technology, Vol. 142, pp. 261-268.