SUMMARY

Ph.D. thesis

METHODS AND TECHNOLOGIES FOR THE LOIVING OF LEACHATE FROM THE URBAN AND RURAL WASTE DEPOSITS

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Introduction

This thesis addresses a priority issue in the field of waste management, namely leachate treatment solutions resulting from waste deposits. A leachate treatment study comprises the processes of leachate formation, its collection, physical, chemical and biological phenomena taking place as well as the processes of treating it to remove pollutants.

The theme is indissolubly linked to the long-term objectives of waste management policies:

➢ the reduction of the quantities of waste generated by the producer itself;

➢ the significant increase in the percentage of recycled and recovered waste;

➢ the reuse of waste;

➢ the waste disposal safely;

➢ the promotion systems and solutions for the use of waste as raw material and energy resources.

In this context, there are constraints on the management of the landfill leachate that are specific to each site and refer to the conditions of discharge into the natural receiver, the leachate treatment system, the availability of space for the location of the leachate treatment facilities and the availability of installations treatment.

The main purpose of the paper is the Efficiency of leachate cleaning by finding and adopting the best and most ecological systems and technologies.

The concrete objectives of the thesis pursued during the research activity are:

- The study of the natural and technological conditions of leachate formation in the Glina Ecological Depositary, Ilfov County;
- The analysis of leachate treatment methods currently used in Europe and Romania;
- The introduction of a new aeration lagoon system - in the leachate treatment system at the Glina warehouse;
- The determination of the composition and characteristics of the leachate;
- Studies and analysis of the influence of the aeration lagoon on the composition and characteristics of the leachate;
- The analysis of the influence of environmental factors on the proposed system;
- Establishing the correlation between the composition of the waste and the characteristics of the leachate;
- The proposal of a leachate management system for the Glina waste repository.

To achieve these objectives, field studies and measurements were carried out, as well as laboratory analysis and determinations and last but not least, the study of bibliographic material in the field.

The thesis is structured in 8 chapters, general conclusions, and bibliography.

In the first chapter, Introduction, I presented the general context in which the theme, purpose, and objectives of the paper were approached and punctual problems such as the formation of leachate in the landfills, the composition and the characteristics of the leachate.

Chapter 2, The current state of advanced leachate treatment technologies, is geared towards the current state of knowledge and use of methods and techniques for leachate treatment at European level and in our country. Both classical wastewater treatment methods, in particular, leachate, and the latest leachate treatment methods for wet catalytic oxidation, ion flotation, nanofiltration, advanced biological treatment methods and reverse osmosis are presented. The analysis of the methods and purification systems used in the country and abroad aims at finding the most efficient and economical leachate treatment systems

When choosing the leachate treatment system, other economic or environmental aspects, energy and materials saving, and biodiversity conservation should be considered.

In chapter 3, Context and organizational conditions, the Glina waste disposal site in Ilfov County is presented in detail. This was the place where the practical activities necessary for the

realization of the thesis were performed and the place of implementation of new leaching treatment solutions.

Chapter 4, Aeration Lagoon - Design and Implementation, presents the technical design, implementation and exploitation elements, as well as deficiencies in lagoon exploitation and it ends with the positive effects of implementing this solution in leachate treatment. The physical and biological processes with a high degree of complexity that lead to the partial or total elimination of leachate pollutants are also presented.

Studies on aeration lagoons' influence on leachate physicochemical properties, which are the subject of Chapter 5, are based on analysis and laboratory tests performed on leachate samples taken from the dredged points of the drainage and treatment system. Concentrations in suspension, nitrate, nitrite, ammonium, phosphorus, and some characteristics such as pH, biochemical oxygen demand and chemical oxygen demand have been determined. The determinations were carried out in two stages: 2014-2015 on samples taken at the point of exit from the rectangular network and the 2016-2017 stage on samples taken at the entrance and exit of the aeration lagoon. In this way, the degree of leachate loading with pollutants and the EFF of the aeration lagoon was determined in the removal of these pollutants.

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The synthesis of the results in this chapter highlights the following:

➢ in June and August the highest yields of the lagoon were obtained for all pollutants investigated;

➢ the best response to this type of treatment is given by biochemical oxygen consumption, chemical oxygen demand, and nitrates;

➢ high yield for CBO5 - ranging from 51% to 72% - confirms the capacity of the microorganisms present in the pollutant decomposition leachate, the absorption of the decomposed material and ultimately the removal of the polysaccharides from the leachate in a high opacity;

➢ in terms of the chemical oxygen demand, there is also a high yield of between 49% and 68%, which evolves in the same way as the CBO variation.

Chapter 6, Studies on the influence of environmental factors on the biological treatment process, is based on the experimental results presented in the paper, which show a maximum activity of the microorganisms in the temperature range 15 - 20^0C in which the value of nitrates and nitrites is maximum. An increase in nitrate and nitrate concentrations in the first 16-20 days of leaching in the lagoon has also been noted, as well as the increase in BOD and COD over time up to day 16, processes determined by bacterial biodegradation.

In Chapter 7, Studies and Research on the Influence of the Aeration Lagoon on Content

of heavy metals in leachate, the main problems presented were the heavy metal concentrations of the leachate before and after the introduction of the aeration lagoon into the leachate treatment system.

Taking into account the difficulties in removing heavy metals and the risks they have on the environment and human health, the experimental values were compared with the normative limits. Synthetically, the results show that by staying in the suspended basin and by bio-cleaning the lagoon the concentrations can be reduced by between 53% and 89% depending on the season, the leachate dilution and the metal character. The results are satisfactory for the discharge of the effluent into the sewerage network.

Chapter 8, Studies on the Influence of the Aeration Lagoon on the Load

microbiological analysis of levigate, treats synthetically the problem of microbiological leaching of leachate, in the light of experimental results, compared with data from specialized publications.

GENERAL CONCLUSIONS

The use of modern advanced leachate cleaning technologies to eliminate pollutants and to reduce processing costs is part of the requirements and recommendations of the European Union, both in the field of environmental protection and in the reintroduction of permeate into the natural circuit.

A large amount of leachate pollutants often requires combining several treatment methods to achieve a result within the limits imposed by the legislation.

The introduction of the aeration lagoon into the leachate treatment circuit has many positive effects among which I mention:

➢ in aerated lagoons, organic matter is stabilized by both aerobic and anaerobic metabolism processes. The oxygen required for aerobic bacteria is introduced into the lagoon through the

deaeration plant. In the lower part of the lagoon, where the processes are anaerobic, the odorous compounds are oxidized in the aerobic zone.

➢ the performance of lagoons can be characterized primarily by reducing the concentration of pollutants during lagging leaching. Thus, the efficiency index (Ie) can be defined as the ratio between the concentration difference at the entrance (Ci) and the lagoon outlet (Ce) and the concentration at the entrance (Ci) of the leachate in the aeration lagoon

$$Ie = (Ci - Ce) / Ci$$

➢ the effluent from the aeration lagoon is introduced into the purification station by reverse osmosis with a much-reduced pollution load which will facilitate its operation at its higher parameters.

➢ by introducing the aeration lagoon, reductions in the content of organic leachate pollutants have been achieved, especially the nitrates, nitrites, and ammonia content

➢ under these conditions it is possible that the permeate resulting from the deepening station meets the conditions of the discharge directly into the Dâmbovița river, thus reducing the costs of the purification.

The amount of leachate and its degree of contamination are dependent on: the composition of the waste deposited, the age of the leachate, the weather conditions of the location, the constructive characteristics of the drainage system.

The pollutants do not show significant variations in the first 2 years of the storage cell for which the experimental determinations have been made (2014 and 2015). The pH value shows a slightly alkaline medium during the first 2 years of the warehouse operation after which a slight decrease to neutral values can be found.

The optimal leachate treatment method must ensure that the negative environmental effects are eliminated altogether.

The biochemical activity of the microorganisms present in the aeration lagoon - highlighted by samples taken before and after the lagoon - has as a first effect observed in the experimental determinations, low pH variation that has remained close to the neutral value and which has led to a high intensity of processes of microbiological degradation of pollutants (nitrates, nitrites, ammonium, phosphates, CCO, CBO)

In order to have a high efficiency of purification it is necessary to take into account the following results obtained in the research:

 The optimal contact time of leachate with microorganisms in the lagoon is 14-20 days in aerated stationary regime;

- The temperature of the biological treatment processes is from 6^0C to 30^0C, the optimal one being between 15-25^0C;
- In cold weather, it is recommended to cover the lagoon with thermal insulating sheets;
- pH should be kept as close to neutral as recommended 7 - 7.4.

The increased contact time of anaerobic organisms allowed the microorganism in the leachate samples to adapt to the conditions of the aeration lagoon, to harness the existing microorganisms in the lagoon sludge and to intensify its biodegradation activity.

Higher content in biodegradable waste material (obtained by separation of plastics, paper, metals, and glass) had a positive inflection on biological purification materialized by subtracting nitrates, nitrites, ammoniacal nitrogen, chemical and biochemical oxygen content with values between 12 and 28%.

The microbiological treatment of leachate is a technically and economically efficient method due to the advantages of leachate treatment with high concentrations of organic substances with high nitrogen content and a high COD / BOD ratio.

The presence of certain substances in waste, especially in leachate, can negatively influence the activity of microorganisms that cause the degradation of organic pollutants.

Selection of the best treatment solution is conditional on knowing the characteristics of the leachate and mastering the purification technologies. The choice of the neutralization method must also take into account to a large extent both the costs of the process and its efficiency.

Due to the complexity of the leachate, choosing a treatment solution becomes very difficult. The variation over time of leachate properties and volumes makes treatment processes difficult to choose and cannot be adapted and universally recommended.

The approach to combining the biological process with reverse osmosis, as used in Glina, is recommended as a feasible method for removing organic substances, nitrogen and other pollutants from leachate generated by municipal landfills.

PERSONAL CONTRIBUTIONS

In the present paper we can highlight a number of contributions of the author to the problem of techniques and methods of leachate treatment, which I mention:

➢ an exhaustive analysis of the aspects related to the operation of the Glina waste repository, the natural environment in which the experiment was carried out, the leachate collection and treatment system, including the operation of the deposit;

➢ the establishment of the limitations of the treatment process at the Popeşti Leordeni - Glina depot and elaboration of the intervention proposals for the optimization of the leaching process at the respective deposit;

➢ the analysis of how the leachate is formed, the sources of its composition, its composition and the factors that influence the characteristics of the leachate;

➢ the study of the most modern and efficient methods and techniques of leaching treatment, finally choosing a new, economical and efficient method for the leachate resulting from the Glina ecological deposit;

➢ the introduction of the biological treatment step into an aerated lagoon before reverse osmosis and elaboration of the principle of the leachate treatment process;

➢ dimensioning the lagoon, under the conditions of a flexible treatment system taking into account the amount of leachate correlated with precipitation, the main source of leachate formation;

➢ the proposal of preliminary technical measures for smoothing the leachate flow by introducing the suspended basin between the collector and the lagoon;

➢ in the thesis, a lot of determinations were made on the composition and characteristics of the leachate on samples taken from the characteristic points of the Glina deposit between 2015 and 2017 in order to determine the efficiency of the proposed system in the thesis;

➢ establishing correlations between the environmental factors (temperature, precipitation) and the processes taking place in the aeration lagoon and in the context setting the optimal temperature for the physical, chemical and biological processes taking place in the leachate;

➢ determination of residence time of the leachate in the aeration lagoon for efficient treatment and the optimal period of operation of the aeration lagoon;

➢ to monitor the functioning of the lagoon with its negative aspects and disposal solutions to determine the factors that influence the efficiency of the treatment process;

➢ The choice of a method that preserves and protects the environment and sewerage has led to an increase in the efficiency of the sewage treatment plant from 82-84%, in view of the introduction of the lagoon at 96-98% yield after the lagoon construction.

RECOMMENDATIONS AND PERSPECTIVES

In Romania, environmental issues are particularly acute as a result of the intense local environmental pollution caused by household waste produced by populated centers that have led

to the deregulation of ecosystems and worsening of people's living conditions in adjacent areas controlled warehouses, but especially in the area of wild deposits.

In this context, I believe that a series of recommendations would be required:

1. Reducing the amount of leachate by reducing the amount of waste deposited and consequently the storage surface by introducing waste sorting together with their capitalization.

2. The measure has several positive effects such as reducing costs of storage and leachate treatment, material recovery, environmental impact reduction, etc.

3. Establish a long-term monitoring plan of the leakage treatment system correlated with climate change that can directly influence the efficiency of the leachate treatment system (by modifying the rainwater regime).

4. The monitoring of the amount and composition of the leachate produced in household landfills constitutes the basis of assessment of the technologies applied in its current purification and constitutes the element of re-evaluation of these technologies and performance improvement.

5. Implement an automatic leachate management system to avoid potential accidents in the operation of the leachate treatment system and accidental pollution of the environment.

6. Extending and developing the microbiological treatment method of the leachate and, if necessary, by setting up laboratories for the selection and multiplication of the bacterial species required in the microbiological treatment process.

7. Finding solutions for the recovery of heavy metals left in lagoon sludge, sludge from leachate basins and reverse osmosis filters.

Theoretical studies and comparative analyses in this paper can be useful and indispensable in addressing similar issues in the field to identify different aspects of the processes taking place in landfills at different periods of the life cycle.