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RESEARCHES REGARDING THE IMPACT OF WASTE LANDFILL IN SIBIU COUNTY, ROMANIA ON THE ENVIRONMENT AND MEASURES TO REDUCE IT

Alina AGAFITEI, Vasile Lucian PAVEL

"Gheorghe Asachi" Technical University of Iasi, Faculty of Hydrotechnical Engineering, Geodesy and Environmental Engineering, 65 Dimitrie Mangeron Blvd, Iasi, Romania

Corresponding author email: alinaagafitei@yahoo.com

Abstract

Environmental impact assessment has emerged as a basic tool in identification and reduction of negative environmental consequences due to anthropogenic activities, reflecting a preventive approach to environmental management, with a view to sustainable development. Our research is made in Sibiu County, from Romania, and concerns the impact of the local waste landfill on the main environmental factors (water, air, soil). The proposed methods of prevention and reduction of pollution are characteristic of the technological process, and are given by the following conformations: waterproofing of the warehouse, realization of leachate drainage / discharge / treatment system, procedures for: acceptance of waste at storage, technological self-monitoring, self-monitoring of emissions and quality factors environment, procedures for cell closure with the implementation of the biogas combustion system resulting from anaerobic decomposition of waste, fencing (with fence and forest curtain).

Key words*: biogas, collection, landfill, recycling, waste.*

INTRODUCTION

Waste management represents the most important component of sanitation services and refers to activities of collection, transport, treatment, recovery and their disposal. Waste recycling and the circular economy are among the most important issues in the European Union strategies.

Because Romania has yet to meet many requirements of the European Commission's policies, there have been opened several infringement proceedings against our country for pollution, wood management, and waste management.

This paper presents our researches regarding the implementation of an integrated waste management system in one of the most important touristic sites of Romania - Sibiu County.

As a result of rapid increase in production and consumption, urban society generates solid material, which regularly leads to considerable increase in the volume of waste generated from several sources.

A proper management system of solid waste is a central pillar of the policies for a sustainable environment.

The management system of the solid waste is associated with the control of the processes regarding generation, storage, collection, transfer and transport, processing and disposal of solid wastes in a manner in accord with known principles of public health, economics, conservation, environmental engineering, and other considerations.

MATERIALS AND METHODS

The landfill analysed in this study is located in Sibiu County (Figure 1).

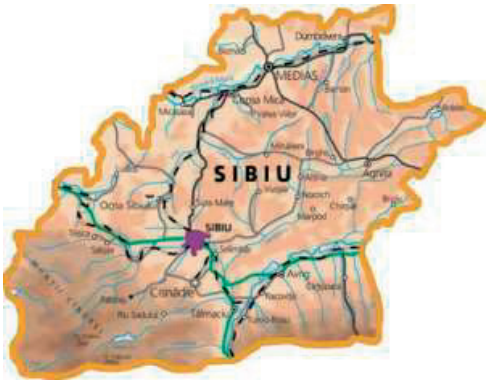

Figure 1. Map of Sibiu County, Romania

The water supply is made from the underground source, through drilling located near the administrative pavilion. Water captured from underground is used for hygienic-sanitary, technological, and partial for purposes to ensure the reserve intangible fire.
The categories of wastewater discharged are the following: domestic wastewater from the administrative pavilion, rainwater, and leachate generated by waste storage.
Rainwater is discharged through the perimeter gutters of the deposit, located at the base the outer slopes of the cell contour dam, in the authorized receiver, the Salcii Valley brook (right tributary of the Ruscior brook), located 100 m away from the warehouse location.
The leachate taken over by the drainage and collection system is directed to the leachate basin (three-compartmented with V = 500 m^3), from where it is pumped to the leachate treatment plant.
Within the ecological landfill located on a land from Cristian commune, Sibiu County, it is stored and neutralized household and industrial waste assimilated to household waste and at the same time insured monitoring the cell whose operation has been completed.
The main activities carried out in the warehouse are as follows:
- a visual control of waste;
- weighing of waste;
- waste unloading on the concrete platform and visual inspection;
- levelling and compaction with the help of the bulldozer and the compactor;
- periodic coating with inert material;
- permanent anaerobic decomposition of waste;
- permanent collection of storage gas;
- permanent collection of domestic, technological wastewater and leachate;
- leachate treatment and evacuation into the natural emissary from the area, an operation that is performs periodically;
- permanent disinfection of the wheels of motor vehicles leaving the warehouse.

The control system on pollutant generating processes corresponds to the concept design as well as the operation which in turn, comply with the regulations of national legislation transposing European Union waste disposal one.

The wastes are brought to the landfill with the means of transport of the sanitation operators and are unloaded from the car access platform to the unloading ramp.
The waste is placed in successive layers, using blade bulldozers, then is compacted with heavy earthmoving equipment. Thanks to the front blade of the bulldozer also performs waste levelling. In addition, the high weight of the equipment can ensure a mixture and an efficient compaction as well as a crushing of the waste that increases their specific surface area and, in this way, an acceleration of biodegradation process.
The leachate resulting from the fermentation of waste and rainwater falling on the landfill is drained through collector wells and the drainage pipe system over the layer waterproofing in the lowest level fireplace, from where it is pumped into the leachate storage basins, and from here by pumping it reaches the treatment plant; the treated effluent is discharged into the natural emissary.
The leachate is pumped from the leachate collection tank into the storage leachate tank station; then, concentrated sulphuric acid is added to adjust the pH to 6.5, thus reducing the number of hydrocarbons in the leachate, where it is pre-filtered through a filter multilayer sand; microfiltration follows through cartridge filters and then it is sent to the treatment phase of leachate (reverse osmosis - stage I - nano-filtration).
Water will have values below the usual standards for drinking water, in terms of salt content and can thus be well used as industrial water or for other purposes; ex. irrigation of parks public buildings, gardens, orchards, etc.
The maximum storage capacity is 1125000 m^3 for the third cell of landfill (Figure 2).

Figure 2. Waste treatment plant from Sibiu County

The storage of household waste is ensured and industrial assimilated to them and the non-hazardous ones, in ecological conditions for Sibiu municipality, Sibiu County and the surrounding areas. Total surface is of 18 ha.
The average height of the deposited waste will be 20 m measured from the average level of soil. The minimum degree of compaction will be 0.9 tons/m^3.
Waste disposal will be carried out in such a way that the impact on the environment and the population to be minimal.
The deposition and distribution of waste in the cells is done in layers as much as possible thin up to 1 m, which then compacts.
The compaction density must be cat longer, increasing the life of the cell. Non-hazardous waste that does not come from households are deposited only mixed with household waste.
Discharged and compacted waste is periodically covered with a layer of inert material of 10-15 cm, to avoid odours, light scattering of light waste and the appearance insects and birds.
The inert material may be of solid mineral waste or of constructions and demolitions.
A household waste cover is not required if the next day is storage continues. After complete filling and levelling of a storage cell, the layer surface waterproofing is applied immediately.
The temporary coating is made on the surface on which the storage was stopped with soil with a thickness of 30-50 cm; lawn is planted on it.
Temporary coverage with earth is made during the period when the highest settlements take place (3-5 years).
From a topographical point of view, the location of the ecological deposit is a valley, dug in the formations of the upper terrace of the Cibin River, at the contact with the hilly area neighbouring to the west, so that by successive cell filling, covering and grassing enclosed areas will be framed in the pasture area with which the warehouse is borders in the Southeast and West.
Laying the last layer of waterproofing on the surface is done only when the settlements of the body of the deposit can no longer cause its deterioration.
The leachate collection system ensures that it is kept to a minimum the body of the warehouse and the capacity of the storage tank takes into account the average value of the volume of leachate generated and the dimensions of the deposit.
Periodically, in addition to the qualitative monitoring of the leachate emission purified (permeate) and its quantity and volume are measured (Hester et al., 2002). The passive degassing solution was used to evacuate the storage gas; through creation of areas of depression in the mass of waste (gases formed passing through the gaps in walls of prefabricated homes) leading to free discharge into the atmosphere.
Following the mathematical modelling performed, we noticed that the amounts of methane and carbon dioxide did not exceed the threshold value.
In the case of facilities for combating and controlling pollution, such as landfills, are not provided emission limit values for emissions from the main activity, ex.: for biogas emissions.
The biogas installation is related in Figure 3.

Figure 3. The biogas installation from Sibiu County

There is also a quarterly monitoring, with analysis bulletins performed by an accredited laboratory - of CH_4 and CO_2 emissions.
Following the anaerobic decomposition of the waste, the landfill gas is formed (fermentation gas) with a calorific value of 5000-6000 kcal/m^3 and a composition in which predominates, when gas generation reaches steady state, CH_4 (54%) and CO_2 (45%) at which add small amounts of hydrogen sulphide, carbon monoxide, mercaptans, aldehydes, esters, traces of non-methane organic compounds.

Installations for the collection and evacuation of storage gas have the role of ensuring controlled collection of fermentation gas that is formed for a long time of time, in all landfills containing biodegradable waste and periodically (monthly), it is eliminated by combustion, through the wells provided with installations intended for this process.
If the formed gas is not discharged controlled from the deposit, migration and its accumulation can present a series of risks, among which: fire danger through self-ignition, release of unpleasant odor and toxic compounds (hydrogen sulphide, organic-phosphorus compounds, other unsaturated organic substances), damage to the component biological properties of the soil, by reducing the concentration of oxygen, danger of explosion by possible occurrence of gas accumulations in the vicinity of residential areas, increasing accumulations of gases that contribute to the greenhouse effect.

RESULTS AND DISCUSSIONS

The general concept of the ecological landfill of household and industrial waste that serve the population of the entire county corresponds to the most modern system of organization of non-hazardous waste disposal.
The leachate collection and storage gas collection systems correspond to the best worldwide practices.
The way of covering the warehouse corresponds to the most demanding norms at the level being provided with a waterproofing and drainage system above it, as well as with a layer of soil and soil fertile enough for a efficient ecological restoration of the surface released by technological loads.
The leachate treatment plant corresponds to a modern technology - reverse osmosis.
The main types of waste that will be generated as a result of the activities:
- technological waste: fertile soil and excavated soil, construction waste (waste from polyethylene), used oils, batteries and used tires, materials impregnated with products oil tankers (ex.: cloths, car oil filters);
- waste assimilated to household waste resulting from the activities of staff on location.

The main types of waste that will be generated as a result of the operating activities are:
- technological waste;
- waste resulting from maintenance activities of vehicles and equipment: oils, used batteries and tires, materials impregnated with petroleum products (ex.: cloths, car oil filters);
- scrap metal (resulting scrap metal and unusable spare parts);
- assimilable waste, following the activities of the employed staff.
The packaging of chemical reagents used both to regulate the pH of wastewater entering the treatment plant, as well as when cleaning the membranes of the treatment plant are collected separately and periodically returned to suppliers of hazardous chemicals.
The resulting concentrate is returned to the depot and subsequently taken over as leachate.
Green waste is collected and transported to a compost station.
The sludge is collected and transported for disposal to the nearest landfill of non-hazardous waste (Figure 4).

Figure 4. The ecological landfill from Sibiu County

Regarding the environmental factor - water, the categories of wastewater discharged are the following:
- domestic wastewater from the administrative pavilion;
- rainwater;
- the leachate generated by the storage of waste in the landfill.
Wastewater is discharged through sewerage networks.
The quality indicators of the wastewater discharged into the natural emissary are observed (Salcii Valley brook), established in accordance with the norms in force.

The decomposition process of landfill waste is complex and variable; the main products of waste decomposition - leachate and biogas - can become a problem for neighbouring areas in non-compliant management conditions.
The network of drainage pipes is built above the sealing system of the base of the deposit, having the role of collecting the leachate resulting from the fermentation of the organic materials stored in cells.
The leachate collection system ensures that it is kept to a minimum the body of the warehouse and the capacity of the storage tank takes into account the average value of the volume of leachate generated and the dimensions of the deposit.
Periodically, in addition to the qualitative monitoring of the leachate emission purified (permeate) and its quantity and volume are measured (Pelt, 1993).

CONCLUSIONS

The values of the quality indicators for wastewater falls within the permitted limits. Given that the limits are respected, the current impact is insignificant.
Regarding the operation of the machines, the way of working, the age of the machine and the condition of its technique are elements that can constitute sources of surface water pollution and even depth. This can cause diesel leaks and engine oils that can damage it the quality of water resources.
Leaching is the major source of environmental pollution in case of management non-compliance or the occurrence of incidents/ accidents. Because of its content (high organic load, heavy metals, pathogens, other polluting chemical compounds - e.g. vinyl chloride), a possible untreated discharge caused by system failures sealing or collection and treatment leads to a significant impact on water resources. Due to the configuration of the land, the leachate will flow to the valley lines with a high speed.
The potential contamination of groundwater resources can have the effect of alteration the health of the inhabitants of the adjacent areas. Contamination of surface waters with untreated leachate leads to changes in water quality and changes in the existing aquatic ecosystems.
Excess water (incorrectly catalogued by some sources as leachate) which can result in leakage from the waste mass placed in the pile subjected to the intensive treatment process (the first phase of the biological process) has leachate-like properties. The pollutants contained are usually on an order of magnitude smaller, instead the effects induced of a potential direct discharge (without purification) into the surface water bodies or underground are similar in intensity to those generated by leachate.
Pollutant content of wastewater resulting from car washing and the machinery on site is similar to leaching (however the concentrations are lower). The impact of their uncontrolled discharge is similar to that of the discharge unpurified leachate (Agafitei et al., 2018).
Other activities that can have a negative impact on water are management non-compliance of the waste produced on site and the operation of the equipment and equipment. The impact produced is similar to that produced in the construction phase of the warehouse.
In order to reduce the impact, it is necessary to permanently monitor the wastewater discharged from the treatment plant, as well as the permanent monitoring of the groundwater from the three monitoring wells.
To monitor the influence of waste storage activity on underground water quality, all the analyses will be compared with the control samples initially performed at the drilling execution.
Regarding the air pollution sources, we mention that there are agricultural lands in the vicinity of the landfill, and they are:
- those specific to zoo-technical activities: ammonia NH_3, methane CH_4, nitrogen oxides, specific odor, also those specific to agriculture: ammonia (NH_3 - 20000-40000 g/ton fertilizer) in the case of the use of fertilizers, nitrous oxide (N_2O - 2500 g/ha) for surfaces without fertilizers.
As mobile air pollution sources, we mention road traffic on DN 1 and in the area. In addition to particulate emissions, there will be emissions of pollutants specific to greenhouse gases exhaust from the equipment with which the operations will be carried out and from the vehicles for transport of materials.

Pollutant's characteristic of Diesel internal combustion engines with which are equipped the equipment's and vehicles for transport are: nitrogen oxides, carbon oxides, sulphur oxides, heavy metal particles (Cd, Cu, Cr, Ni, Se, Zn), organic compounds (including polycyclic aromatic hydrocarbons - PAHs, substances with carcinogenic potential).

In conclusion, the air pollutants are: mineral particles in suspension, but which settle rapidly even in an atmosphere real estate; exhaust gases: SO_x, NO_x, CO, particulates, organic compounds (including hydrocarbons polycyclic aromatics - PAHs, substances with carcinogenic potential).

Landfill gas generated by the decomposition of municipal waste must collected and treated in a way that reduces the negative effects that it can have them on the environment and to reduce the potential danger of the main components are methane (danger of explosion) and carbon dioxide (danger of suffocation) (Robu et al., 2010).

The gas treatment is done depending on the capture technique used - active or passive. The treatment and recovery techniques of the gas are chosen depending on the concentration of methane.

The passive degassing solution was used to evacuate the storage gas; by creating some areas of depression in the mass of waste (gases formed passing through the gaps in the walls prefabricated homes) leading to free discharge into the atmosphere.

Pollutant dispersion study was performed to determine the distribution method in the atmosphere relative to local climatic and location conditions.

The dispersion study of air pollutants was done with the SIMGP program v.4.1. This program simulates the transport of gases and dusts and calculates concentrations for them averages for different periods of time.

Emissions on the ventilation tubes were considered as point sources, taking an equivalent diameter, the calculation being coverage (Figure 5).

The graph shows that the concentration areas are much smaller than these values, therefore the impact is insignificant for the outside of the site, more importantly on the site where the limits of pollutants in the workplace apply.

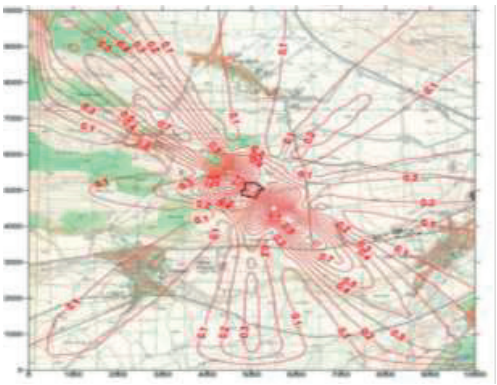

Figure 5. Dispersion graphic for Sibiu ecological ramp

As measures to reduce particulate emissions from material handling (especially earth), we propose:

- watering of work platforms and access roads during periods without precipitation;
- washing the wheels of motor vehicles when leaving the site;
- avoidance of loading/unloading activities of vehicles with materials dust generators in windy periods with speeds over 3 m/s;
- limiting the disturbed areas around the platforms;
- rehabilitation of disturbed lands around the sites, after the completion of the works construction/closure.

The degassing system must be constructed in such a way as to guarantee the safety of the construction and the health of the operating personnel, to be perfectly watertight to the external environment and to be located in isolation from the leachate drainage and drainage systems, respectively precipitation.

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