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MONITORING THE QUALITY OF ENVIRONMENTAL FACTORS WITHIN THE SITE OF A COMPLIANT LANDFILL

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Abstract: In terms of waste management all economic changes must be reflected in the integrated waste management practices. The real issues concern the growth of the quantity and variety of wastes in contrast with the inadequate facilities and locations. This continuous neglect will lead to the deterioration of the water, soil and air resources.

The design of a waste deposit is made according to a series of factors, the most important of which are: the amount and nature of the waste to be stored - it is evaluated according to the development forecasts of the localities, the characteristics of the location correlated to the economic efficiency (dimensions, duration of malfunction, waste transport distance) and ecological efficiency (requirements related to the protection of environmental factors and human health) necessary to be achieved, the possibilities of rehabilitation and subsequent use of the land, transformation during the storage period, long-term development plans, etc.

For the exploitation phase, the project must include information on: the waste acceptance procedure for storage; operation mode – including the storage method used, leveling and compaction, daily coverage, delimitation of work areas, collection, treatment and disposal of leachate, collection and evacuation of storage gas, the need for mobile equipment and the spaces intended for their maintenance, instructions regarding the storage of certain specific types of waste (powdery materials, bulky objects, very light waste), technological self-monitoring, self-monitoring of emissions and quality control of environmental factors in the influenced area, safety measures to prevent fires and explosions, including an intervention plan in case of accidents or breakdowns, work protection measures and to ensure hygienic-sanitary conditions, security and surveillance system.

Keywords: integrated waste management, collected waste, municipal wastes, industrial wastes, environment protection.

1. INTRODUCTION

Technological processes and storage technology in a compliant landfill have been conducted following the normative acts:

- Ordinance no. 2 of August 11, 2021 [1] regarding waste storage on waste storage;

- Technical regulations regarding waste storage - construction, operation, monitoring and closing of compliant, approved by MAPM Order no. 757/2004 [2];

- MAPM Order 95/2005 on defining the criteria that must be met by waste in order to be found on the specific list of a deposit and on the national list of waste accepted in each landfill class [3];

- EU Decision 955/2014 amending Decision 2000/532/EC establishing a list of waste pursuant to Directive 2008/98/EC of the European Parliament and of the Council [4].

The waste reception operator must be trained so that he has the necessary competence for the verification of waste shipments and the accompanying documents and to notify the non-conformities.

Non-compliance can occur for a number of reasons, including:

• accompanying documents are incorrect, insufficient or inappropriate;

• the transported waste does not correspond to that described in the accompanying documents or does not fall within the conditions imposed by the environmental authorization or by the legislative norms in force.

In case of non-compliance, the operator must apply the established procedures, the transport vehicle being directed to a specially arranged area, where he will remain until the authority the authority makes a decision regarding the waste it transports.

If the waste has already been unloaded, it will be isolated as much as possible, and the vehicle of transport will remain in storage until a decision is made.

All registered non-conformities will be recorded in the Landfill Register, along with dates regarding the actions taken, who made the decisions and whether damages were recorded.

Waste transport data is recorded automatically (weighing platform is connected to a computerized system) and will be completed in two copies (one for the waste carrier another for the landfill operator).

The warehouse operator will record the data related to: quantity and characteristics of waste received, source, date of delivery, other information considered relevant.

2. WASTE DEPOSITING TECHNOLOGY

For municipal waste storage, the technological process is as follows:

- weighing on the electronic weighing platform, located at the entrance;

- visual inspection of the waste composition;

- unloading at the storage place

- spreading and compacting, to reduce the volume

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- layering of covering layers, periodically
- weighing at the exit of the garbage truck without the load.

For urban waste, the technological process is as follows:

- unloading at the storage place
- spreading and compacting, to reduce the volume
- layering of covering layers, periodically

The waste is deposited and distributed in layers as thin as possible (class b - max. 1 m), then compacted. The compaction density for household waste must be at least 0.8 tons/m^3. The municipal waste storage method of surface storage consists of unloading and compacting the waste, a relatively horizontal platform is formed maximum height, usually does not exceed 2.5 m.

The landfill body will have slopes with an inclination of 1:3, with min. 3 m wide, at 10 m height of the waste layer.

When the degree of filling reaches 70-80% of the capacity designed for the sector active storage, the procedures for building the next storage sector must be started, which must be functional before the storage space in the active sector is exhausted.

The actual waste unloading activity is subject to strict rules that must be followed all landfill workers, as well as transport vehicle drivers, know them. Download of a waste transport is supervised and controlled by a person trained for this purpose. If there are doubts about the characteristics of the waste and its acceptability at storage, the warehouse management will be informed immediately, so that measures can be taken.

In the case of storing waste with high biodegradable potential, an optimal degree of compaction must be calculated, so that the density of the waste layer does not hinder the processes of formation and evacuation of leachate and deposit gas. The optimal degree of compaction will reach approx. 0.8-0.9 t/m^3.

The operations of leveling-modelling and compacting in layers the waste inside of the storage compartment will be done with the warehouse's own equipment: bulldozer and steel roller compactor. Storage will be done in well-established and delimited daily perimeters in a detailed exploitation plan.

Storage will be done in areas 25 m long and 15 m wide, in compacted layers of 1.5 m, on the entire width of the compartment. The length of 25 m was chosen to ensure operation the efficiency of the spreading and compacting machines, and the width of 15 m is imposed by the bulldozer blade width.

The layout of the cells will be interwoven, like bricks in a masonry (Figure 1), to ensure the best possible stability of the body of the backfill, on the one hand and to allow infiltration of water from precipitation to the drainage system, on the other hand. They will be avoided at the same time the formation of bags with fermentation gases, which constitute an explosion hazard if they are not present accumulated gases are captured and evacuated in a directed manner.

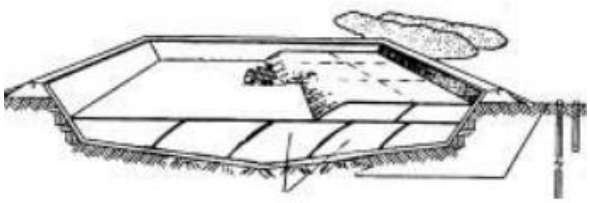

Figure 1 The layout of the daily cells

3. THE FERMENTATION PROCESS

When the chosen technical solution is the successive exploitation of the landfill sectors, although it is possible to differentiate stages, distinct in time, of the execution, respectively of the exploitation of the works, they are not characterized by similar pollutant generation processes (leachate and landfill gases).

We can consider (in accordance with the principle of worst-case analysis) that during a calendar year we can have the following situation:

- closure operations will be carried out on the previously exploited sector;
- the immediately adjacent cell will be in operation (waste disposal).

The primary constituents of the gas emitted by waste deposits are methane (CH_4) and carbon dioxide (CO_2), gases produced by microorganisms in anaerobic conditions. CH_4 and CO_2 transformations are mediated by microbial populations adapted to material cycles in anaerobic environments [5].

Landfill gas generation, including generation rate and composition (Figure 2), goes through four phases:

• Phase I- is aerobic (with available oxygen) and the primary gas produced, CO_2.

• Phase II- is characterized by the destruction (disappearance) of O_2, which leads to an anaerobic environment, in which large amounts of CO_2 and hydrogen (H_2) are produced.

• Phase III- the production of CH_4 begins, accompanied by the reduction of the amount of CO_2 produced. The nitrogen content (N_2) in the emitted gas is initially high in the first phase and drops sharply as the deposit moves into the second and third phases.

• Phase IV- the gaseous production of CH_4, CO_2 and N_2 becomes relatively stable.

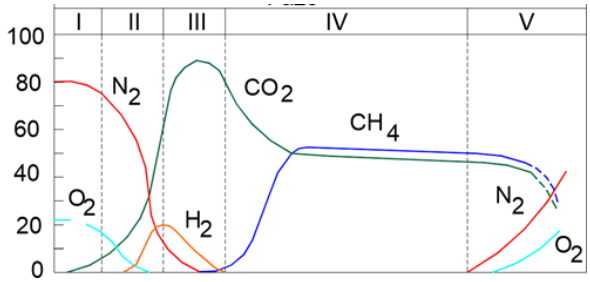

Figure 2 Generation phases for fermentation gases [5]

The gas emitted from landfills is constant, when the gas generation reaches the state stationary, in approximately 50% (by volume) CO2, 50% CH_4 and traces of non-methane organic compounds (CONM).

The CONM emissions result from the CONM contained in the stored waste and from their creation

through biological processes and chemical reactions. For this example, studied in the present case the concentration of CONM in the exhaust gases is 595 ppmv (parts per million by volume) expressed as hexane.

The types of waste that are stored in the landfill are represented by: household waste and similar to municipal waste (waste produced by the population and waste assimilable products produced by economic agents) and non-hazardous waste (non-hazardous industrial similar to municipal ones).

Also, in the evolution of waste disposal, an important factor is the reduction of quantities stored by removing from the waste stream important amounts of waste packaging and biodegradable waste.

According to theoretical quotes, no fermentation gas is produced in the first year of operation. As the landfill expanded and waste is stored, the amount of gas of fermentation increased, expected to reach a maximum in the first year after closure storage (storage cells). After the total closure of the landfill, the production of biogas will decrease.

In the table and graphs below [5], we have presented the evolution of the quantities of biogas produced in the period of exploitation of landfill sectors (developed in the first stage) as well as the whole landfill body.

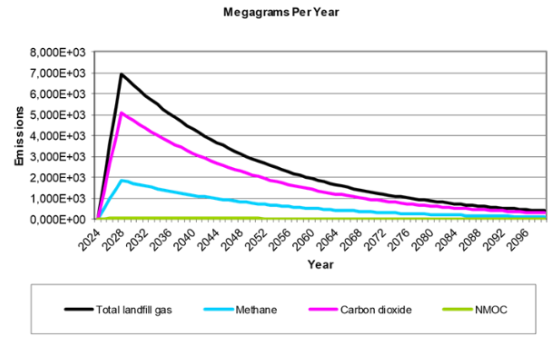

Figure 3

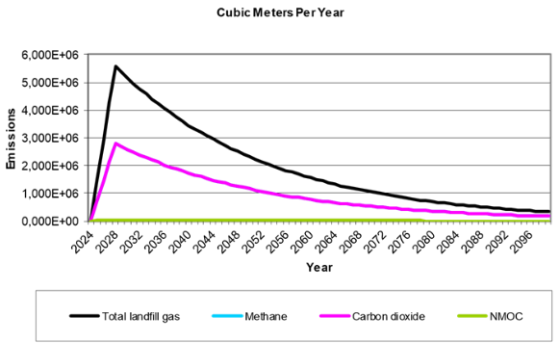

Figure 4

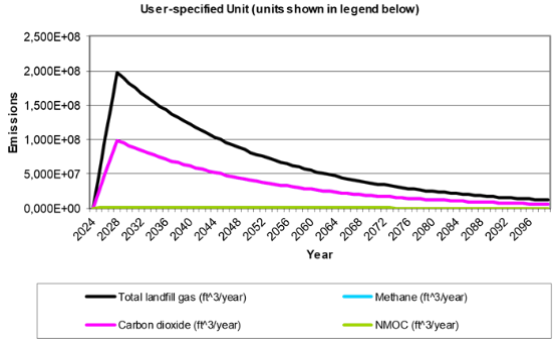

Figure 5

The decomposition period for rapidly degradable waste is 5 years, and for slowly degradable waste it is 15 years.

The quantities of gas produced were calculated using the LandGEM model (Landfill Gas Emissions Model), developed by the EPA – USA, a program intended for the study of landfills [5].

The gas emitted from landfills consists, when gas generation reaches a steady state, of approximately 50% (by volume) CO_2, 50% CH_4 and traces of non-methane organic compounds (CONM).

The negative impact on the waters manifests itself only in accidental situations or in the case of malfunctions arising in the proper functioning of the wastewater drainage and purification system. The impact is reversible when immediate mitigation measures are taken.

The measures taken to protect the main environmental factor that could be affected by the operation of the landfill, water, will be addressed according to the pollutant emission source.

The actual waste:

• periodic covering (recommended weekly) of the waste stored in the active storage cell with inert materials;

• prohibition of disorganized or unauthorized storage of waste around the landfill;

• the use of mobile fences in the active storage area, so that light waste carried by air currents or wind does not affect the neighbouring surface waters;

• checking the waste arriving at the warehouse and rejecting the inappropriate ones (hospital, toxic and/or potentially dangerous).

These measures are taken in order to avoid:

- the formation of leachate in areas without protection;

- scattering light waste on the water surface - illegal storage of waste in undeveloped areas.

Regarding the leachate production process, a series of limitation are necessary in order to minimize the waterbody quality impact:

• designing the landfill so that the formed leachate cannot leave the base area; for this purpose, drainage slopes were provided and the premises were closed with perimeter dykes;

• the entire base of the deposit will be sealed;

• a sensor system should be installed at the base of the warehouse to detect any cracks in the sealing system (geomembrane);

• in the backfill, the deposit will rise with a slope of 1:3, which, in addition to stability, also ensures a drainage of rainwater without causing erosion;

• collection and directed evacuation of the leachate formed in the landfill; for this, the entire base is covered with a drainage system consisting of absorbent drains with slots, made of HDPE Dn 225 mm, placed in a layer of gravel sort 16-32 with a thickness of 0,50 m;

• the absorbent drains are discharged into the PEHD Dn 315 mm collector drain and further into the leachate tank from where it finally reaches the reverse osmosis purification station;

• the leachate tank, as well as the concentrate tank,

are lined with geomembrane;

• after reaching the projected elevation, the entire surface of the landfill (external slopes and cap) will be closed in accordance with the provisions of the Regulations on waste storage.

• ensuring the leachate treatment capacity;

• exploitation of the landfill body will be done in stages, so that a minimum amount of leachate results.

• apply all prevention and/or intervention measures in case of accidental water pollution, as follows:

Pollution with water-soluble products:

- depending on the minimum propagation time of the dilution wave, clean rainwater can be discharged into the emissary in order to achieve an appropriate degree of dilution so that the aquatic ecosystem is as little affected as possible.

- in the polluted water body, neutralizing substances (antidote) will be administered, provided that they do not worsen the ecological impact; the administration of the neutralizer will be carried out from the downstream limit of the polluted area towards the upstream, the operation being continued until the physico-chemical parameters prior to the pollution are recorded.

Pollution with suspended products:

- it is neutralized by administering specific substances - if there is a possibility of neutralization.

- specific substances are administered for decanting the pollutant through coagulation – flocculation; the decanted residue is removed to prevent their entrainment downstream.

- depending on the settling speed of the pollutant, obstacles are set up in the bed to reduce the speed of the water and respectively the settling time;

- filter dams are placed to retain suspensions;

- the surface layer of soil located in the impact zone with the polluting product will be removed;

- the harvested material is stored in a controlled manner and neutralized (if necessary).

Pollution with floating products (oil products, waste, etc.):

- a sufficient number of floating dams are placed in the intervention section so that the polluting wave does not exceed the last downstream dam;

- absorbent material is spread, from downstream to upstream, specific to the type of pollutant over the entire surface of the affected water body;

- the absorbent material is collected after the expiration of the specific absorption time and stored under control for neutralization.

4. CONCLUSIONS

Through the constructive measures adopted, through the execution and exploitation technology, which will be applied in accordance with the current legislation, the probability of the occurrence of the impact is reduced to a minimum.

The impact on the health of the population can be manifested throughout the operation of the landfill, with reversible effects and with a frequency related to the landfill activity.

Measures to avoid, reduce or ameliorate the significant impact on the population and human health:

- periodic coverings of stored waste with inert material will be carried out

- insecticides and rodenticides will be used only in extreme cases;

- the entry of foreign persons and animals will be restricted by creating a complete enclosure of the warehouse;

- the rules of hygiene and security for the transport of waste and for the machines used for this purpose will be respected, with the purpose to not affect the traffic on the sectors of access roads to the landfill.

The constructive measures proposed are aimed to reduce to a minimum the inconveniences related to the operation of the landfill.

Compliance with the landfill operating regulations.

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