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Қ. И. Сәтпаев атындағы Қазақ ұлттық техникалық зерттеу университеті

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ИЗВЕСТИЯ

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ENVIRONMENTAL MONITORING ON THE LANDFILL OF SOLID DOMESTIC WASTES OF THE TOWN KENTAU

Abstract. The article presents the results of an analysis of environmental problems arising from the disposal and operation of solid domestic waste landfills. The most important of them can be a negative impact of landfill on the state of environmental medium in the area of its location. The result of this impact is the degradation of the existing ecosystem, namely soils, groundwater, atmospheric air, vegetation. Pollution of environment can hurt the life of biological resources, including human resources.

The results of experimental studies have been presented on the qualitative and quantitative composition of greenhouse gases (methane, carbon dioxide) and other toxic gaseous substances (nitrogen dioxide, nitric oxide, soot, sulfurous anhydride, carbon monoxide, formaldehyde, hydrogen sulfide, ammonia, xylene, toluene, ethylbenzene) released to the atmosphere from the landfill surface of the town Kentau . Based on the experimental measurement of the landfill territory, it was determined that there is no radiation pollution above the maximum permissible level. An average morphological composition of solid domestic waste is identified. A significant part of the fractional components of SDW is represented by a wide variety of organic and synthetic materials. Ashes (46%), manure (20%), bones of domestic animals (11%), paper and textiles (6%) are considered as basic fractional groups.

A conclusion is made on the expediency of regular environmental monitoring for taking measures to protect the environment and the rational use of valuable components of waste as secondary raw materials.

Key words: landfill, sanitary protection zone, solid domestic waste, monitoring, greenhouse gases, biogas.

The actuality of the problem. Waste is a source of pollution of atmospheric air, ground and surface waters, soils and vegetation [1-3]. Initially, the solution of waste problem was mainly in their destruction-burial in the upper layers of the geosphere or burning, but with increase of environmental pollution more environmentally acceptable measures for disposal of waste – their sorting and reuse came to the fore, in other words recycling as well as using low-waste technologies [4]. When harmful impact on the environment does not exceed the level permitted by sanitary and hygienic norms is considered as low-waste production, while a part of raw materials and materials are passed to waste which are sent for processing or disposal. waste minimization in various industries can be achieved with the following ways: improvement of technological processes towards reducing the amount of waste generated; waste recycling, preferably in the process of their generation, processing of waste into useful by-products; decrease in volumes and toxicity of waste to facilitate subsequent disposal and processing [5, 6].

In accordance with the Environmental Code of the Republic of Kazakhstan, individuals and legal entities that generate waste in the course of their economic activities are obliged to provide for safe handling measures, to comply with environmental and sanitary and epidemiological requirements and to carry out measures for their disposal, decontamination and safe disposal [7]. Removal of solid domestic waste ensures sanitation of cities and provides necessary sanitary and ecological conditions for the existence of the settlement.

At the present time the most common facilities for decontamination of removed SDW from the town are their storage at specially equipped landfills [8].

Landfills are a complex of nature conservation facilities designated for SDW storing, isolating and decontamination, providing protection from pollution of the atmosphere, soil, surface and groundwater, preventing the spread of rodents, insects and causative organisms of disease.

The objective of this work is conduction of environmental monitoring over environmental components in the area of influence of the landfill of Kentau town.

Objects and methods of research. The object of our research is a state of the Kentau town landfill (area 33.0 ha) and determination of action spectrum on the natural environment. It is designed for receiving and burial of solid domestic waste generated from residential, industrial, commercial, public, etc. buildings in Kentau. The storage area is the main structure of the landfill. It occupies about 85-95% of the landfill area.

The nearest settlements are Khanatagi and Kentau located at 6 km and 3 km, respectively to the western direction of the landfill. In geological consideration, the location area is composed by Upper Quaternary sediments of the left bank floodplain terrace of the Hanatagi River. The soil is represented by brownish-brown loams with plant roots and light yellow loam with a high content of crushed stone.

The capacity of SDW landfill is 1251152 m^3, expected useful life is 20 years. SDW landfill has been operating since 2010. The service life of landfill is 15 years. The standard of waste disposal for the years of 2018-2020 is fixed in the volume of 20643,412 tons in 2018; 20643,412 tons in 2019, 20134.3966 tons in 2020. At the same time, the capacity of landfill is 1111490m^3 (646,000 tons). All wastes belong to the green hazard level with code GO060. According to the sanitary and epidemiological rules and norms approved by Government decree of the Republic of Kazakhstan on January 17, 2012 No. 93, the sanitary protection zone (SPZ) of landfill is 1000 m, and I hazard class.

The following main types of work are performed at the site: reception, storage and isolation of SDW.

Reception of solid domestic waste is done:

- in a packless state (i.e. in the same physical state, in which the waste comes from the population and organizations), the average density is 190-200kg / m^3;
- in a packed state: when compacted by garbage truck equipped with compaction mechanisms, the average density is 500 kg/m^3, and sometimes it reaches upto780 kg/m^3.

The intermediate and final isolation of the compacted layer of SDW is carried out by the soil. When storing SDW on open, non-deep plots, an intermediate isolation in the warm season is carried out on a daily basis, in the cold season - with an interval of no more than three days. The layer of intermediate insulation is 0.25 m. In winter, a construction waste, waste products (lime, chalk, soda, gypsum, etc.) are used as an insulating material.

The following parameters and pollutants have been determined for air pollution sources:

- environment and gas temperature;
- barometric pressure and pressure of gas-dust flows;
- geometric characteristics;
- nitrogen dioxide, nitrogen oxide, carbon black, sulfurous anhydride, carbon monoxide, formaldehyde, hydrogen sulphide, kerosene, ammonia, methane, xylene, methylbenzene (toluene), ethylbenzene.

To assess the amount of greenhouse gases emitted into the atmosphere by a SDW dump, trap caps have been installed on its surface near the wells to collect methane and carbon dioxide (metal cubes with screwed nipples).

When determining the concentration of pollutants, the well-known normative documents [9-13] and the following measuring instruments were used: combined instrument "TKA-PKM", aspirator "PU-3E", manometer "DMC-01", pressure tubes RIGAA and PITO, gas analyzer " HANK-4", equal arm laboratory weight "VLR-200 g-M", photometric photometer "KFK-3-01-" ZOMZ ", radiometer-dosimeter RKS-01-Solo.

Results and discussion. Various wastes in composition are stored in the landfill. When they come into contact with the geological environment, complex chemical and biochemical reactions begin to occur. A number of toxic substances are released into the environment in solid, liquid and gaseous form from the waste. As a result of exothermic processes, thermal energy is released, which leads to a fire hazardous state due to the ignition of the landfill gas of methane and other flammable substances [14].

This year, due to a sharp increase in air temperature up to 40^0C and above, there has been multiple spontaneous combustion of waste in many landfills, including the considered landfill. Taking into account

this condition, a regular moistening of SDW was carried out at the Kentau landfill in summer during fire-hazardous periods. Average water consumption for irrigation in this landfill is 10 liters per 1 m^3 of SDW.

A biothermal anaerobic process of decomposition of the waste organic component takes place under the influence of microflora in the thickness of solid domestic and industrial waste buried in landfills. During the initial period (about a year), the process of waste decomposition is characterized by their oxidation occurring in the upper layers of waste, due to the oxygen of the air contained in the voids and penetrating from the atmosphere. Then, as natural and mechanical compaction of wastes and their isolation by the soil are intensified, anaerobic processes are intensified with formation of biogas, which is a final product of the biochemical anaerobic decomposition of the waste organic component under the influence of microflora [15-21].

A simplified stoichiometric equation on the reaction of anaerobic decomposition process of organic matter is as follows: n $C_6H_{10}O_5$ + n H_2O > 3n CH_4 + 3n CO_2. The final product of this process is biogas, the bulk of which is methane, carbon dioxide. Methane and carbon dioxide are greenhouse gases; they greatly enhance the effect of global climate change. In order to avoid the negative impact of greenhouse gases to the state of environment, in the work [22] shown possibility of their use in the mix with natural gas as a fuel . Co-combustion of natural gas and greenhouse gases leads to a dramatic phenomenon of harmful emissions into the atmosphere. Along with these components, biogas contains water vapor, carbon monoxide, nitrogen oxides, ammonia, hydrocarbons, hydrogen sulphide, phenol and in minor amounts other impurities.

The process intensity and specific volume of gas emissions depend on the environmental conditions, the age of landfill and the fractional composition of waste. The main factors influencing the intensity of biological conversion are temperature, humidity, value of hydrogen index, content of organic matter.

Tables 1, 2 present the characteristics of main greenhouse gases and other gases formed in the landfill area and their volumes.

Table 1 – Characteristics of greenhouse gases (tons/year)

#	Name of greenhouse gas	Chemical formula	Number of emissions by types of greenhouse gases	Number of greenhouse gas emissions in the equivalent to CO_2
1	Carbon dioxide	CO_2	301.715	301.715
2	Nitrous oxide	N_2O	0.00253	0.7873
3	Methane	CH_4	0.0544	1.1421
	Total			**303,6444**

Table 2 – Content of gas emissions (mg/m^3)
in the territory of sanitary protection zone of the Kentau landfill

Component name	MPC	South	East	West	North
Nitrogen dioxide	0,2	0,086	0,087	0,085	0,08
Ammonia	0,2	N / A	N / A	N / A	N / A
Sulphurous anhydride	–	N / A	N / A	N / A	N / A
Carbon monoxide	5,0	3,0	3,0	3,5	3,0
Methane	1,0	N / A	N / A	N / A	N / A
Xylene	0,2	N / A	N / A	N / A	N / A
Methylbenzene (toluene)	0,6	N / A	N / A	N / A	N / A
Ethylbenzene	0,04	N / A	N / A	N / A	N / A
Formaldehyde	0,035	N / A	N / A	N / A	N / A

In order to prevent unauthorized storage of waste containing radionuclides, when entering the landfill, the waste passes radiation dosimetric control. For these purposes, the geological prospecting devices СРП-68-01 or СРП-88Н are used. Table 3 shows the averaged indicators of radiation measurements carried out at different sites of the landfill's upper layer.

Table 3 – Results of radiation measurements

Name of indicators	Units	Normative values	Actual results
Gamma radiation	Mk3v/hr	0,2	0,05-0,12
Radon exhalation	mBq/(m^2·s)	80	36-43

Solid domestic waste is a complex heterogeneous mixture. A morphological composition of solid domestic wastes stored in the landfills, according to the average data of our studies as percentages by mass, is presented in table 4.

Table 4 – Morphological composition of solid domestic wastes of the Kentau landfill

#	Waste	Content of components, %
1	Ash	46
2	Manure and litter	20
3	Waste in the form of wood	3,7
4	Plastic masses (bottles, packaging materials, etc.)	5
5	Bones of pets	11
6	Broken glass	5,4
7	Metal	0,5
8	Leather, rubber	1,5
9	Paper and textiles	6,0
10	Stones	0,9

As can be seen from the data in table 4, a significant part of SDW fractional components is represented by a wide variety of organic and synthetic materials. Ash, manure, animal bones, paper, and textiles are considered to be the main faction groups. Their ratio depends on a number of factors, which primarily include the level of economic development of the region, its geographical location and the formed mentality. Morphological composition may vary depending on the season, weather conditions. So in autumn, an increase in the amount of food waste, this is associated with a large consumption of vegetables and fruits in the food intake. And in winter and spring, the content of small residues (street sweepings) is reduced.

When analyzing the results of waste management works for the last year, the trend on increase of SDW generation can be clearly traced. The volume of generation of solid domestic waste is directly related to the life activity of population and production processes of the enterprises located in the serviced territory. The quantitative and qualitative content of waste depends on the production factors of enterprises, the development of infrastructure in the living territory of the population and the number of people served.

Based on the development prospects of the town Kentau for 2018-2020, it can be assumed that this volume of SDW generation will increase by at least 10% each year. Currently, measures are taken to organize selective collection and disposal of SDW for environmental improvement, as well as lowering of harmful effects on the environment, For example, there is a separate collection of waste paper, polymeric waste, plastic bottles, scrap metal, organic waste (manure, bird droppings, sawdust), glassware. These types of waste are further sent to the relevant enterprises for further utilization with receipt of either marketable products or secondary raw materials based on a contract. This measure significantly reduces the technogenic load of the landfill on the environment. Under this approach, pollution of biosphere objects is prevented to a certain extent, as well as resource-saving is provided.

In such a way, conduction of regular environmental monitoring over the environmental objects in the area of influence of the landfill will enable to solve the following problems:

a) to receive reliable information on the level of its negative effect;

b) to assess the dynamics of pollution;

c) to take appropriate actions to protect the environment from pollution and complex rational use of valuable components contained in waste as secondary raw materials.

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КЕНТАУ ҚАЛАСЫНЫҢ ҚАТТЫ ТҰРМЫСТЫҚ ҚАЛДЫҚТАР ПОЛИГОНЫНА ЭКОЛОГИЯЛЫҚ МОНИТОРИНГ

Аннотация. Бұл мақалада қатты тұрмыстық қалдықтарды орналастырғанда және полигондарды пайдаланғанда туындайтын экологиялық мәселелердің талдау нәтижесі көрсетілген. Ең маңыздысы, полигон орналасқан аймақтардың қоршаған орта нысандарына кері әсерін тигізуі. Осының нәтижесінде қазіргі экожүйенің бөліктері, яғни топырақ, жерасты сулары, атмосфералық ауа, өсімдіктер деградацияға ұшырайды. Қоршаған ортаның ластануы тіршілік ететін биологиялық, сонын ішінде адами ресурстарға зиян келтіруі мүмкін. Кентау қаласындағы полигоннан атмосфераға бөлінетін жылы жай газдардың (метан, көмірқышқыл газы) және басқа да улы газ тәрізді заттардың (азот диоксиді, азот оксиді, күл, күкіртті ангидрид, көміртегі тотығы, формальдегид, күкіртті сутек, аммиак, ксилол, толуол, этилбензол) сапалық және сандық құрамына жүргізілген тәжірибелік зерттеу нәтижелері көрсетілген. Полигон аумағына жүргізілген тәжірибелік өлшеулер нәтижесінде аймақтың радиациялық ластану деңгейі шекті рауалды мөлшерден аспайтыны анықталды. Қатты тұрмыстық қалдықтардың орташа морфологиялық құрамы зерттелді. Қатты қалдықтардың фракциялық құрамдас бөліктерінің көбісі органикалық және синтетикалық материалдардан тұратындығы айқындалды. Олардың негізгі фракциялық түрлері ретінде күл (46%), көң (20%), үй жануарларының сүйектері (11%), қағаз және тоқыма бұйымдары (6%) болып саналады.

Қорытындылай келе, қатты тұрмыстық қалдықтардағы құнды құрамдас бөліктерді екінші реттік шикізат ретінде қолдану үшін және қоршаған ортаны қорғау іс-шараларын жүргізуге мақсатты түрде тұрақты экологиялық мониторинг жүргізу керектігі қорытындыланды.

Түйін сөздер: полигон, санитарлық қорғау аймағы, қатты тұрмыстық қалдықтар, мониторинг, жылы жай газдары, биогаз.

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ЭКОЛОГИЧЕСКИЙ МОНИТОРИНГ НА ПОЛИГОНЕ ТВЕРДЫХ БЫТОВЫХ ОТХОДОВ ГОРОДА КЕНТАУ

Аннотация. В статье приведены результаты анализа экологических проблем, возникающих при размещении и эксплуатации полигонов твердых бытовых отходов. К важнейшим из них можно отнести негативное воздействие полигона на состояние объектов окружающей среды, находящихся в зоне его расположения. Результатом такого воздействия является деградация существующей экосистемы, а именно почв, подземных вод, атмосферного воздуха, растительности. Загрязнение окружающей среды может причинить вред жизнедеятельности биологических ресурсов, включая человеческий ресурс.

Представлены результаты экспериментальных исследований качественного и количественного состава парниковых (метан, углекислый газ) и других токсичных газообразных веществ (диоксид азота, оксид азота, сажа, ангидрид сернистый, оксид углерода, формальдегид, сероводород, аммиак, ксилол, толуол, этилбензол), выделяющихся в атмосферу от поверхности полигона города Кентау. На основе экспериментального замера территории полигона установлено отсутствие радиационного загрязнения выше предельно допустимого уровня. Определен средний морфологический состав твердых бытовых отходов. значительная часть фракционных компонентов ТБО представлена большим разнообразием органических и синтетических материалов. Зола (46%), навоз (20%), кости домашних животных (11%), бумага и текстиль (6%) рассматриваются как основные фракционные группы.

Сделан вывод о целесообразности регулярного проведения экологического мониторинга для принятия мер по защите окружающей природной среды и рационального использования ценных компонентов отходов в качестве вторичных сырьевых ресурсов.

Ключевые слова: полигон, санитарная защитная зона, твердые бытовые отходы, мониторинг, парниковые газы, биогаз.

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