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ASSESSMENT OF ECOLOGICAL DANGER OF SEEPAGE WATER SOLID WASTE LANDFILL OF KOKSHETAU

The impact of landfills on the environment is not limited to the dumping of garbage, since the possible penetration of leakage through the subsoil can lead to contamination of groundwater. The study (2021) presents the results of studying the elemental composition of filtration waters and soil of the solid waste landfill in Kokshetau, the period of operation of which at the time of the study was 50 years.

Analysis of filtrate samples obtained from landfills showed that the filtrate is a highly concentrated solution containing toxic components. The chemical composition of the filtrate, developed by a generally accepted method from surface aggregation, showed a high content of organic matter and a BOC5 / COC ratio of about 0.01-0.005, which indicates a high content of bioresistant components. It is a liquid from black to yellow-brown in color with a specific odor and a slightly alkaline reaction of the medium (pH = 7.5-8.25). The concentration of heavy metals does not exceed the maximum permissible concentration for water. The pH value, ammonia ions, high mineralization and concentration of chloride ions are the characteristics of the garbage filter at the operational stage. Normalization of soil quality by chemical indicators showed that at sampling points at a distance of 500 and 1000 m from the landfill corresponds to a dangerous level of pollution, and at a greater distance decreases, these soils belong to the second level of pollution. According to the composition of the filtrate, the landfill belongs to the old landfills.

Key words: municipal solid waste, filtration water, environmental impact, pollutants, toxic substances.

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Көкшетау қаласындағы қатты тұрмыстық қалдықтар полигонының фильтрациялық суларының экологиялық қауіптілігін бағалау

Полигондардың қоршаған ортаға әсері қоқысты шығарумен шектелмейді, өйткені жер қойнауы арқылы ағып кету жер асты суларының ластануына әкелуі мүмкін. Зерттеуде (2021 ж.) Көкшетау қаласындағы қатты тұрмыстық қалдықтар полигонының фильтраттары мен топырағының элементтік құрамын зерттеу нәтижелері ұсынылған, оларды пайдалану кезеңі зерттеу жүргізу кезінде 50 жылды құрады.

Полигондардан алынған фильтрат үлгілерін талдау құрамында улы компоненттері бар жоғары концентрацияланған ерітінді екенін көрсетті. Беттік агрегаттаудың жалпы қабылданған әдісімен жасалған фильтраттың химиялық құрамы органикалық заттардың жоғары мөлшерін және ОБТ5 / ОХТ қатынасын шамамен 0,01-0,005 көрсетті, бұл биорезистентті компоненттердің жоғары құрамын көрсетеді. Бұл белгілі бір иісі бар және сәл сілтілі орта реакциясы бар қарадан сары-қоңырға дейінгі сұйықтық (pH=7,5-8,25). Ауыр металдардың концентрациясы су үшін ШЖК аспайды. PH мәні, аммиак иондары, жоғары минералдану және хлорид иондарының концентрациясы жұмыс кезеңіндегі қоқыс сүзгісінің сипаттамалары болып табылады. Химиялық көрсеткіштер бойынша топырақ сапасын нормалау полигоннан 500 және 1000 м қашықтықта сынама алу нүктелерінде ластанудың қауіпті деңгейіне сәйкес келетінін, ал үлкен қашықтықта төмендейтінін көрсетті, бұл топырақтар ластанудың екінші деңгейіне жатады. Фильтрат құрамы бойынша ҚТҚ полигоны ескі полигондарға жатады.

Түйін сөздер: тұрмыстық қатты қалдықтар, қалдықтарды жою, фильтрациялы су, қоршаған ортаға әсер, ластаушы заттар.

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Оценка экологической опасности фильтрационных вод полигона твердых бытовых отходов г. Кокшетау

Воздействие полигонов на окружающую среду не ограничивается сбросом мусора, поскольку возможное проникновение утечки через недра может привести к загрязнению грунтовых вод. В исследовании (2021 г.) представлены результаты изучения элементного состава фильтрационных вод и почвы полигона твердых бытовых отходов в г. Кокшетау, период эксплуатации которых на момент проведения исследования составлял 50 лет.

Анализ образцов фильтратов, полученных со свалок, показал, что фильтрат представляет собой высококонцентрированный раствор, содержащий токсичные компоненты. Химический состав фильтрата, разработанный общепринятым способом из поверхностной агрегации, показал высокое содержание органического вещества и соотношение БПК5 / ХПК около 0,01-0,005, что указывает на высокое содержание биорезистентных компонентов. Он представляет собой жидкость от черного до желто-коричневого цвета со специфическим запахом и слабощелочной реакцией среды (pH = 7,5-8,25). Концентрация тяжелых металлов не превышает ПДК для воды. Значение pH, ионы аммиака, высокая минерализация и концентрация хлорид-ионов являются характеристиками мусорного фильтра на этапе эксплуатации. Нормирование качества почвы по химическим показателям показало, что в точках отбора проб на расстоянии 500 и 1000 м от полигона соответствует опасному уровню загрязнения, а на большем удалении снижается, данные почвы относятся ко второму уровню загрязнения. По составу фильтрата полигон ТБО относится к старым полигонам.

Ключевые слова: твердые бытовые отходы, фильтрационные воды, воздействие на окружающую среду, загрязнители, токсические вещества.

Intoduction

Solid waste management is a local issue with global implications. As the world's population continues to grow, so does the amount of waste generated. Waste generation projections indicate that these problems will become more acute over time. In 2015, the world generated 2 billion metric tons of solid waste. This figure is expected to reach 3.4 billion metric tons by 2050. In low-income countries, waste is expected to more than triple by 2050. As the generation of waste increases, the importance of having an effective municipal solid waste management system increases. However, cities and local governments face many challenges when it comes to the proper management of municipal solid waste. Ineffective solid waste management systems pose a serious risk to human health (for example, decomposing organic waste attracts rodents, insects and stray animals), and is a vector of diseases such as typhoid fever, cholera, plague, paratyphoid fever A and B, tularemia, acute gastroenteritis , leptospirosis, foot and mouth disease, hemorrhagic fever with renal syndrome, cholera, helminthiasis (trichinosis, ascariasis), rabies, dysentery, pseudotuberculosis, botulism, tuberculosis, brucellosis and many others [1].

Improper handling of municipal solid waste and landfills can lead to environmental pollution through surface and groundwater, which are common sources of drinking water. Uncontrolled burning of waste can lead to the release of air pollutants, including dioxins, furans, soot, heavy metals and particulate matter, many of which can be toxic to human health. These health effects can be especially serious in people who are in direct contact with this waste or who live near landfills [2].

In world practice, the burial of municipal solid waste (MSW) remains a priority method for their neutralization. However, landfills and MSW landfills are sources of long-term pollution of atmospheric air, groundwater and soil cover. Despite this, landfills and municipal waste landfills are a source of long-term pollution of atmospheric air, soil cover and groundwater. The study of the environmental impact of solid waste landfills is one of the topical topics studied by many scientists from different countries [3-4]. The main factor of the negative impact of solid waste disposal facilities on the environment is the ingress of filtered water from the landfill site (filter), which is the result of the influence of atmospheric precipitation and decomposable waste [2].

Solid waste delivered to a landfill controlled over time is exposed to a number of biological, chemical and physical phenomena that also occur simultaneously and lead to the formation of liquid and gaseous products and uneven sedimentation of the waste mass. The biological phenomena occurring in landfills are largely associated with the decomposition of the organic fraction contained in the waste, which leads to the formation of biogas and filtrate. This decomposition is essentially anaerobic. In fact, initially, when oxygen is still present in the deposited waste, the decomposition processes are aerobic in nature. But the oxygen present in the waste, available to aerobic microorganisms, is running low. quickly, except for the oxygen present inside the surface layer of the waste itself, due to the fact that this layer is in direct contact with atmospheric oxygen and, therefore, oxygen is exchanged directly with the atmosphere inside this layer. Then, when the availability of oxygen in the waste layers inside the landfill ends, the activity of aerobic microorganisms stops and the activity of anaerobic microorganisms begins [5-7].

Solid waste, once delivered to a landfill, is subject to a number of phenomena of different nature, biological, chemical and physical, which lead to the formation of liquid and gaseous products, as well as to uneven sedimentation of the mass of waste. The liquid products that form in the landfill are the so-called filtrate. Leachate is the liquid that is formed when waste decomposes by compressing it, but this is mainly due to the infiltration of rainwater inside the waste heap. Since the waste is wet, due to the pressure exerted by the overlying layers, they release some of the water they contain. Consequently, this liquid, the filtrate, is formed within the waste, which, flowing downward through the decomposing mass of waste, is enriched with pollutants, suspended and dissolved, both originally contained in the waste and resulting from transformation reactions, thus forming a mixture of organic and inorganic compounds in the aqueous phase, called the «filtrate». The filtrate is very harmful to the environment. Upon reaching the bottom, the filtrate must be collected and promptly removed for appropriate treatment and disposal. In addition, a number of gaseous products are generated in the landfill during the biodegradation processes, a mixture of which is commonly referred to as biogas [8].

Direct discharge of leachate poses a great risk to all components of the natural environment due to organic pollutants and heavy metal content exceeding discharge standards. Therefore, great care must be taken to avoid contamination of the environment [9-12].

Even if the filtrate contains low concentrations of chemical pollutants with a known carcinogenic potential, the combined presence of several substances can cause high toxicity and cause synergistic or additive effects in terms of cytotoxicity and genotoxicity [13]. In vitro studies have also shown that filtrate can cause DNA damage, hepatotoxicity, and oxidative stress, which poses a serious risk to human health and the environment [14-19].

Landfills are characterized by sodium chloride and technogenic waters from sodium biocarbonate, low levels of ammonia, predominance of nitrate in ammonia, heavy metals, organic pollutants, dioxins and furans [20-21].

In 2020, 130 MSW dumps (with a land act) functioned on the territory of the region, of which 26 MSW landfills had permits. Thus, the share of solid waste disposal facilities that meet environmental requirements and sanitary rules (of the total number of their disposal sites) amounted to 20%. There are 5 districts in the region, in which there is not a single legalized landfill (Akkol, Arshaly, Zerendy, Korgalzhyn, Burabay).

Also, there are no MSW in 10 regional centers of the region: Shchuchinsk, Burabay district; the village of Zerendy, Zerendy region; Makinsk, Bulandy district; Korgalzhyn village, Korgalzhyn district; the village of Akmol, Tselinograd district; Akkole, Akolsky district; Arshaly village of Arshaly region; the village of Yegindykol, Egindykol region; the village of Astrakhanka, Astrakhan region; Stepnyak town of Birzhan sal district [22].

The collected garbage in Kokshetau is exported to the territory of the landfill, which is on the balance of the municipal association of public utilities. The area occupied by the landfill is 42.5 hectares. The central landfill does not have clear boundaries, and work on sorting, burtovke and storage of solid waste is carried out insufficiently. A mechanical solid waste sorting line with a capacity of 60,000 tons per year operates at the landfill. There is a constant clogging of nearby lands with light materials, since due to the lack of protective forest belts, i.e. hedges, garbage is carried by the wind. The landfill is operated with violations of sanitary and hygienic requirements and is a technologically imperfect and environmentally unstable facility that does not meet environmental requirements.


Figure 1 – Solid waste landfill in Kokshetau

Object and methods of research

The object of the study was a municipal solid waste in Kokshetau, which, like other municipal solid waste landfills in the region, is a source of environmental pollution. Currently, the landfill does not meet modern requirements in terms of design and technological parameters, the validity period of the landfill has expired, the capacity has been exhausted. Previously the landfill was located on the site of the spontaneous formation of the landfill and is located 9 km from the village. The district has a slope to the northeast. Constant winds are strong in the northeast and northwest. The groundwater is located at a depth of 6 m and is filled with landfill technology. The maximum height of the pyramid of the polygon should not exceed 16 m, so a large amount of solid waste accumulates at the landfill.

In accordance with the schedule of garbage collection, special vehicles arrive at the stops to collect them. There is no lighting at the landfill, no capital entrance, no wells, no water, no garages and appropriate equipment, no utility area and utility rooms for personnel, the existing condition of the fences requires repair, planting of green spaces is required. Constant fires at the landfill, methane emissions, harm the health of residents of the Station Village, Kokshetau airport. In addition, the landfill, opened in 1960, does not have a waterproof base, leachate drainage and its neutralization, and the untreated leachate, getting into the soil, contributes to the further degradation of nearby farmland [23].

Sampling. Water sampling was carried out consistent with the requirements [24]. The dishes intended for sampling and storage of samples were washed with a 1:1 hydrochloric acid solution and then with distilled water. Water samples were taken using a bathometer from a depth of at least 1–2 m below the water level in wells and from a depth of 0.3–0.5 m in surface water bodies. The water extracted from the well poured into containers with ground-in plugs. The total volume of the water sample is 10 liters. A part of the sample, 2 liters in volume, intended for general chemical analysis, taken without preservatives. The rest of the sample poured into five vessels, each of which preliminarily placed with a preservative. For the preservation of iron, a buffer solution of sodium acetate and acetic acid was used, phenols – sodium hydroxide, petroleum products – a solution of carbon tetrachloride, hydrogen sulfide – a solution of cadmium acetate. The volume of the vessel with the preservative for hydrogen sulfide is 250 ml, and with the preservatives of the other specified components – 500 ml.

The morphological and fractional composition of the studied remains of settlements was analyzed on the basis of recommendations for the selection of a representative sample of solid waste weighing 30 kg from a landfill of solid household waste. The samples were averaged, quartered, and sieved through a sieve with cell sizes of 15×15 mm. Fractions of a large class are sorted on sieves with the size of cells 300, 250, 200, 150, 100, 50, 30 and 20 mm. The distribution by measurement classes was based on the results of the primary measurement of fractional samples. The data obtained during the study of the morphological composition of waste at the landfill are shown in Table 1.

The initial moisture of solid waste is on average 54-66% and depends on the time of year, the amount of organic substances in the waste and their density. The study of the environmental impact of the landfill for solid waste in Kokshetau includes the study of the landfill and its surroundings, topographical work on the landfill and laboratory studies of sediments. Physico-chemical analysis methods of natural and wastewater were used to determine the filter composition. Control points are located inside and outside the effective area of the landfill.

Table 1 – Morphological composition of waste at the MSW landfill

MSW components	Content), %
Food waste	32
Plastic	27
Paper, cardboard	27
Glass	6
Textile	3
Slag, stones, bricks	2
Metal	2
Wood	2,7
Other	2,7

Any penetration into the soil of the filtrate formed at the landfill can lead to groundwater contamination conditions, the characteristics of which are affected not only by the type of waste being disposed of, but also by the degree of their stabilization, as well as chemical and chemical substances. biochemical reactions that develop in landfills first in an aerobic and then in an anaerobic environment. The filtrate after penetration into the soil can undergo further transformations after the establishment of reactions that change its original composition. Substances that characterize the possible contamination of groundwater as a result of the presence of solid waste landfills are: nitrogen compounds; sulfates and chlorides; carbon compounds; heavy metals.

Results and discussion

On the territory adjacent to the landfill, there is a decrease in soil pollution, steppe vegetation and a decrease in the diversity of vertebrates on earth. Soil contamination with light waste fractions was observed in the territories near the landfill, which was characterized by a decrease in plant species diversity. Proper shrinkage of waste, isolated filling, collection and disposal systems led to the filling of the pit and the flow of filtrate to the bottom of the landfill. To study the chemical composition , a sample of the solution was taken from a solid waste landfill in Kokshetau with a volume of 10 liters of surface connections. The bed and sides of the landfill are not isolated by a filter screen, so the solution that is formed in the waste column enters the groundwater, rises to the surface of the landfill, accumulates in the depressions and pollutes the soil. Soil and land resources, water evaporation lead to air pollution, all these negative factors cause irreparable damage to the environment.

Burns and dust formation from the landfill were not observed. Environmental pollution of the landfill is associated with the filter water. The filtrate is highly toxic and the sediments accumulated on its surface are moderately toxic. To choose a way to protect the environment from burying household solid waste, it is first necessary to determine the size and composition of the resulting solution.

The approximate amount of the formed filtrate was calculated according to the formula developed by V.V. Raznoshchik, N.F. Abramov. They found that filtrate is not formed when storing solid household waste with a humidity of less than 52% in climatic zones where the annual amount of precipitation exceeds by no more than 100 mm the amount of moisture evaporated from the surface of the landfill. This dependence is mathematically described by the following expression:

$$Q_ф = 0{,}01 \times F \times (h - 100) + 0{,}01 \times V \times (W - 52)$$

$Q_ф$ – annual volume of filtration waters, thousand m^3 /year;

F – landfill area (42.5 hectare);

h – average precipitation (312 mm/year);

100 – reduction of the flow rate due to water evaporating from the landfill surface, mm/year;

V – average annual intake of solid waste (1905 thousand m^3 /year);

W – the average annual humidity of waste (55-60%).

For this landfill , the annual volume of filtrate will be about 290 thousand m^3.

Chemical analysis of the composition and its properties is necessary for the development of a method of cleaning and disinfecting the pits formed in the thickness of the landfill. When studying the chemical composition of solutions from landfill of solid household waste, only the usual components of water that are provided in regulatory documents are identified. The analysis of the filtrate samples from landfills showed that the filtrate is a highly concentrated solution with toxic components. It is a dark brown-yellow liquid (pH = 7.5-8.3) with a characteristic odor and a moderately refined reaction.

The chemical composition of the filtrate selected according to generally accepted methods from aboveground sediments is presented in the table 2. Chemical analysis of the filtrate showed a high content of organic substances, while the ratio of BPK5 / COD is about 0.01-0.005, which indicates a high content of bioresistant components. The concentration of BOD5 in the filtrate exceeds the MACpx from 137.5 to 188 times, in some samples up to 266 times; the concentration of COD exceeds 28 to 74 times. Also, contamination of the filtrate with chlorides (2MACpx), copper (50-150MACpx), ammonium nitrogen (36-126MACpx), zinc (3-5MACpx), iron (5MACpx), etc. chloride ions are characteristic features of the filtrate of landfills that are at the stage of this operation. Thus, the concentration of pollutants in the leachate is very high and poses an environmental hazard to surface water bodies (Table 2).

Table 2 – Results of the analysis of filtration waters of the municipal solid waste landfill

Index	Value	Index	Value
pH	7,5-8,3	Chlorides, mg/dm^3	615,0-302,0
Suspended substances, mg/dm^3	47,0-352,0	Total iron,, mg/dm^3	0,1-0,62
BOD_5(BOD 20), mgO_2/dm^3	275-376 (514-532)	Sulfates, mg/dm^3	0,22-23,4
COD, mgO_2/dm^3	415-1108	Sulfides, mg/dm^3	17,1-20,0
Petroleum products, mg/dm^3	2,8	Copper, mg/dm^3	0,05-0,15
Cadmium, mg/dm^3	0,0005	Manganese, mg/dm^3	0,15-0,59
Ammonium nitrogen, mg/dm^3	18,0-63,0	Lead, mg/dm^3	0,05-0,3
Nitrates, mg/dm^3	9,4-18,0	Nickel, mg/dm^3	0,21-0,54
Nitrite, mg/dm^3	0,07-2,10	Zinc, mg/dm^3	0,03-0,05
Phenol, mg/dm^3	0,4	Phosphates, mg/d^{m}3	24,3-31,32

The chemical composition of filtration waters depends on the phase of biodegradation of solid waste. The following phases of MSW biodegradation are distinguished: aerobic, anaerobic – hydrolysis, acetogenesis and active methanogenesis, stable phase of methanogenesis and complete assimilation. The stage of the landfill life cycle and the stage of waste biodegradation can be determined by the indicators of filtration water pollution: pH, the ratio of BOC5 / COC values, the content of iron and zinc ions. The acetogenic phase corresponds to pH values of 5-6.5; The BOC5/COC ratio is in the range of 0.8-0.6; the iron ion content is 50-100 mg/ dm^3; the content of zinc (II) ions is up to 70 mg / dm^3. The methanogenic phase is characterized by pH values of 7.5-8.5; the BOC5/COC ratio in the range of 0.6-0.06; iron ion content 5-10 mg / dm^3; zinc (II) ion content – 0.1-3 mg/ dm^3 [6]. Comparison of the results of chemical analysis with the indicator indicators of filtration water pollution allows us to conclude that the processes occurring in the thickness of the landfill correspond to the methanogenic phase of waste biodegradation. According to the composition of the filtrate, the landfill of solid household waste belongs to the old landfills.

Contamination of surface water filtrate by the gradient of removal from the landfill is reflected in Table 3 (elements whose concentrations exceed the established MPC for household waters are presented).

As we move away from the waste disposal plant, the concentrations of pollutants decrease, but at a distance of 5000 m in the waters of the MPC for chromium, manganese and ammonium ions are exceeded.

The most important role in the functioning of terrestrial ecosystems is played by soils, which are considered as a bio-supporting organism that ensures the existence of biogeocenoses and the biosphere as a whole, one of the main functions of which is to maintain biodiversity and preserve habitats for a community of different species of pedobionts and all inhabitants of terrestrial ecosystems. Table 4 shows the content of heavy metals in the upper horizons of soils at different distances from the landfill

Table 3 – Chemical contamination of surface waters along the gradient distance from the MSW landfill

Contaminants (mg /I)	Distance from the MSW landfill, m			MPC for household water.(mg /1)
	500	1000	5000	
Cadmium	0, 0005	<0,0001	<0,0001	0, 0001
Chromium common	0,205	0,190	0,011	0,05
Nickel	0,060	0,025	0,005	0,02
Manganese	0,350	0,280	0,250	0,1
Chlorides	1115	515	265	350
Ammonium ion	32	26	5,8	0,5
NS	7,1	7,2	7,3	-

Table 4 – Chemical characteristics of soils (layer 0-20 cm) along the gradient of distance from the WSW landfill

Chemi cals (mg / kg)	Soil sampling sites (distance from the MSW landfill, m)				MPC of soils, mg/kg
	500	1000	5000	Background Soil (2000)|	
Mercury	0,04	0,03	0,01	<0,01	2,1
Arsenic	3,2	3,1	2,5	4,9	5,0
Manganese	51	54	100	150	400
Copper	8.-9	10,2	6,3	2,8	3,0
Cadmium	0,04	<0,04	<0,04	<0,04	1,0
Chromium total	5,1	5,0	3	2,5	-
Nickel	5,0	5,1	2,9	4,3	4
Zinc	8,1	18	12	8,5	23
Strontium	5,2	4,9	<0,10	<0,10	-
pH aq.	6,2	6,5	5,5	4,6	-

The content of mobile forms of copper (up to 3 MPC per 1000 m) and nickel (up to 1.1 MPC) was isolated. At a point 500 m from the landfill, the temporal dynamics of the content of pollutants was studied in comparison with the background, which is fluctuating in nature. The increased content of strontium, mercury, copper and some other elements that are part of the landfill filtrate was noted in comparison with the background.

A brief overview of biotechnological methods that can be used for disinfection and treatment of organic waste is given in Table 5. The table does not list and does not take into account plant waste, waste rich in dissolved organic substances, waste containing solid proteins and fats, special organic waste such as sedimentary yeast, litter, bird droppings and manure.

As can be seen from the table, microbiological processes are widely used for processing various organic wastes. The ability of microorganisms and their enzymes to produce complex organic substances and modify natural and anthropogenic polymers is the basis for the production of many products used for microbiological synthesis and waste treatment. Eco-biotechnological methods are used for processing, including carbohydrates, proteins and fats, plant biomass, OF-MSW, SS and others. Important industrial microbiological processes in the processing of organic waste: production of fortified foods, microbial proteins or proteins of unicellular organisms; silage; composting; anaerobic fermentation (fermentation); Bioconversion to fuel (ethanol production, dissolution of biogas and methane in anaerobic reactors, conversion to direct heat) [25].

Table 5 – Methods for neutralization or processing of organic waste

Organic waste	Method of biological processing
Plant waste	Vennicomposting, composting, silage, biomodification, methane fennentation in anaerobic bioreactors, protein production of unicellular organisms, delignification, biofuel production, mushroom cultivation
Waste rich in dissolved organic matter (carbohydrates, fats, proteins)	Methane fennentation in anaerobic bioreactors, protein production from unicellular organisms, protein products, biofuels, microbiological and enzymatic processing products.
Solid protein and fat-containing waste, sedimentary yeast	Production of biological components, food and feed additives, various products of microbiological processing, biologically active substances, fennentation of methane in anaerobic bioreactors, organomineral fertilizers.
Manure and bird droppings, litter	Vennicomposting, composting, production of orga|nomineral fertilizers, fennentation in anaerobic bioreactors, processing into feed additives.
Precipitation and activated sludge of sewage treatment plants	Composting, methane fennentation in methane tanks and septic tanks, aerobic stabilization, vennicomposting, aging on silt sites, production of organomineral fertilizers.

In addition, the technology of anaerobic microbial fermentation (methane fermentation) producing biogas can be used to treat all types of organic waste (Table 3). Methane oxidation is controlled by a large number of environmental factors that significantly affect the process: temperature, humidity, nutrients, etc. Therefore, environmental conditions are of particular importance for a good methane conversion. Temperature has a strong influence on all biological processes, including the process of methane oxidation (Streese et al., 2009). Most methanotrophic bacteria are mesophilic in nature, so the optimum temperature for their development ranges between 25 ° C and 35 ° C with a constant increase in efficiency from 12 to 25 ° C (Boeckx et al. 1996). King et al. (2001) reports optimum temperatures up to 31 ° C. In addition, methane oxidation is almost completely suppressed at temperatures close to freezing. It was also found that at low temperatures (below 10 ° C) all bacteria found belonged to type I methanotrophs, and from 20 ° C and above, most bacteria belonged to type II (Börjesson et al., 2004). Humidity is an important factor for microorganisms as they can do their best. In fact, it affects both the transfer of nutrients and the removal of residues of biological activity. However, it should be noted that high humidity can adversely affect the transport associated with the gas phase, since molecular diffusion in water is about a hundred times slower than in air (Benderet al. 1995). When, for example, the saturation value is about 85%, the void has good interconnections precisely because of the presence of water, so the gas must first diffuse inside the liquid phase, which drastically reduces the availability of methane and oxygen and thus inhibits the oxidation process. On the other hand, a drastic reduction in moisture content can significantly reduce the methane conversion rate due to microbial stress in dry conditions.

In addition, the technology of anaerobic microbial fermentation (methane fermentation) in biogas-producing bioreactors can be used to treat all types of organic waste (Table 3). Currently, vermicomposting is used for the treatment of OF-MSW, land worms and composting, bioreactors at landfills and landfills, methane fermentation in anaerobic bioreactors. The goal and end product of the OF-MSW biotechnology is the production of useful products, mainly fertilizers, as well as biogas and energy products during anaerobic processing.

Conclusion

In conclusion, note that all of the above makes it possible to classify solid waste landfills as ecologically hazardous areas, even as «time-delayed chemical bombs». It is important to study the microbiological processes in the mass of waste, to understand the nature of the activities of such facilities and to develop methods to reduce their negative impact on the environment and restore their landfills for urban needs. The main problems of the method of disposal of organic waste at the solid waste landfill used in Kazakhstan are: long-term local negative impact on the environment and public health; global emissions of greenhouse gases into the atmosphere – carbon dioxide and highly dangerous greenhouse gases – methane, which can be used as a raw material for energy production; isolation of large areas for landfills, as well as the spread of pollution over large areas due to the lack of thermal insulation. loss of organic matter used to improve soil quality. Reducing the harmful impact of landfills on the environment can be achieved by reducing the amount of organic matter in household waste.

Waste prevention and reduction, as well as processes and techniques to waste reduction generated, are good practice for solid waste management systems. Reducing waste and reusing household waste is not only good for the environment, but it can also be beneficial to public health and help save money. Food waste, packaging materials and disposable products are some of the typical elements of waste streams that can be used to prevent and reduce waste. Food waste can be recycled to produce fertilizer as well as biogas. Packaging materials can be reduced by searching for products with low-degradation packaging and by imposing taxes on plastic and plastic bags. Disposable packaging materials can be reduced by encouraging the transition from disposable to reusable packaging materials, thereby preventing the accumulation of waste. Since waste prevention avoids waste generation, this is the preferred and most cost-effective way to handle solid waste.

Preventing or reducing waste can save resources (for example, by lowering collection and transport costs), improve the environment and prevent greenhouse gas emissions.

Adopt an overarching and integrated vision: move away from a circular economy of «mine, produce, consume and then release», unanimously recognized as harmful to the environment and conserve natural resources, and move to a green economy: which is mainly based on recycling in raw materials to be used as raw materials, in turn, they are reused to develop other products, thereby creating green jobs.

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