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APPLICATION OF POLYMER-MINERAL MATERIAL «PMM» FOR CREATION OF WATERPROOFING LAYER DURING CONSERVATION OF TAILINGS: DEVELOPMENT OF INSTALLATION TECHNOLOGIES AND LABORATORY RESEARCH

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Abstract

It is recommended to waterproof the surface of the mothballed tailings storage facility by directly applying the polymer-mineral material "PMM" or a composite created on its basis. During laboratory research, an effective composition of the waterproofing layer was determined and two technologies for its installation were developed.

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Laboratory studies show that when creating an anti-filtration composite using sandy-loamy soil, the required amount of «PMM» filler is significantly lower than when using ordinary soil.

Keywords: recreation, urban environment, tailings storage facilities, waterproofing.

Introduction

The service life of tailings storage facilities may be relatively short, but the waste will be stored for an extended period. Conservation of a tailings storage facility involves stopping the supply of processed ore waste for storage and maintaining the facility in a safe, pollution-preventing condition for an indefinite period. The area of the conserved tailings storage facility may be used for agricultural or other purposes. Conservation measures may include dismantling infrastructure, reclamation, landscaping, and using the storage facility and adjacent lands for national economic development. After completion of conservation measures and implementation of the necessary design solutions for conservation, the tailings storage facility is transferred to a long-term maintenance and monitoring mode. During the post-conservation period, responsibility for the tailings storage facility may be transferred from the owner to the local administration. Operation of the tailings storage facility should ensure the creation of a sustainable, safe, and low-maintenance facility that does not pose long-term safety risks or environmental impacts for future generations [1].

A large number of works are devoted to the impact of tailings storage facilities on the environment [2–4].

A mothballed tailings storage facility located at a distance of 2 km from populated areas, in accordance with the safety regulations for the operation of tailings, sludge and hydraulic waste disposal facilities of the Russian Federation, must be fenced along the perimeter with a prefabricated reinforced concrete fence, at least 2 m high. If a mothballed tailings storage facility is located more than 2 km from populated areas, it is permissible to construct a fence along its perimeter from two rows of barbed wire on reinforced concrete posts [5].

This approach is unacceptable for the conservation of tailings ponds in Armenia, since the flat areas of mountainous zones remain unused.

The primary objective of tailings storage facility conservation should be to ensure long-term stability of the physical and chemical state, as well as environmental and social conditions, and to maintain the storage facility in a trouble-free condition for a reasonable period. The key objectives are [1]:

- Reclamation and storage should not require any ongoing maintenance or costs beyond normal land-use requirements;
- The tailings storage facility, after conservation, should not pose an unacceptable risk to human health and safety;
- The tailings storage facility, after conservation, should not pose an unacceptable risk to the environment;

- Conservation of the storage facility area should allow for the use of the storage facility area for agriculture or other purposes.

Based on a combination of factors, the optimal approach to reclamation (preservation) is sanitary and hygienic, which includes the following measures [6]:

- Site planning with the installation of an anti-seepage element;
- Restoration of previously removed fertile soil layer;
- Removal of contaminated soil.

The use of polymer-mineral materials "PMM" will allow the construction of environmentally friendly modern tailings storage facilities, as well as the safe use of areas where waste has been buried [7, 8].

To utilize former tailings dumps for agricultural purposes, before covering them with a layer of soil suitable for sowing, some researchers propose preparing a sarcophagus 7-10 cm thick by mixing 30 g of polymer-mineral material (PMM) with 1 kg of soil and compacting it. This will prevent chemicals hazardous to human health from penetrating upward from the tailings dump, as well as prevent water from precipitation and irrigation from penetrating into the tailings dump layer and spreading into the surrounding environment. When applying the proposed technology, it is important to consider that polymer-mineral material (PMM) can decompose in the aggressive environment of the tailings dump, so the impact of the PMM on the latter must be studied [7].

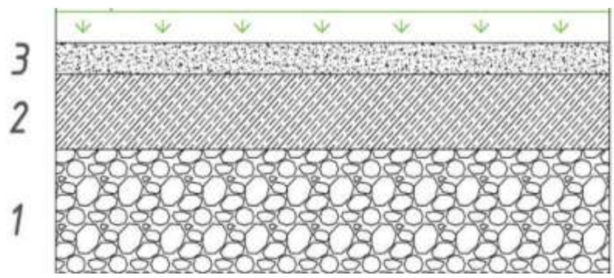

Fig. 1 Technology for reclamation of the tailings surface
1-tail, 2-loam (h=0.5m), 3-soil

The technology for reclaiming the surface of a tailings storage facility developed in [6] is shown in Fig. 1 and includes:

- Leveling the surface of the deposited tailings with soil from overburden waste dumps (rocks) to stabilize the surface, grading toward the drainage ditch; backfilling with loamy soil to create an anti-seepage element, grading it 0.5 m thick;
- Laying a fertile soil layer.

Landscape pollution with heavy metals is a serious problem because it negatively impacts soil characteristics and limits its productive and vital functions. Heavy metals are considered a key environmental pollutant due to their stability and bioaccumulative potential; their accumulation leads to negative consequences for ecological systems. Metal waste contributes to the leaching of metallic substances into water bodies, appears in dangerous quantities in food products, and impacts the biodiversity of ecosystems [7].

Until the restoration of natural vegetation on the reclaimed site, close to the natural ecosystem, it is proposed to carry out mountain-ecological monitoring [9].

However, it is obvious that without laying a waterproofing layer on the waste dumps, it is impossible to prevent dangerous filtration processes that could hinder the use of the protected waste dump area for agricultural, recreational and other purposes.

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Water use opportunities are declining not only due to global economic and population growth, but also due to the pollution of water resources and their subsequent withdrawal from economic circulation. As a result, the environmental challenge of preserving and efficiently using water resources is becoming increasingly pressing. Currently, not only the concept of economic capital is used, but the existence of closely interconnected and interdependent economic, socio-political, and environmental capitals for the well-being of human society is emphasized [7, 10, 11].

Conflict Setting

The conservation of tailings storage facilities is a serious issue for many countries. The aim of this study is to conduct research into the creation of a waterproofing layer on the surface of tailings storage facilities using polymer-mineral material (PMM) and the development of installation technologies.

Research Results

Below is a description of the technologies for creating and installing a waterproofing layer for tailings dams using the polymer-mineral suspension "PMM" (hereinafter also referred to as PMM) and an analysis of laboratory test results.

Two technologies for creating and installing a waterproofing layer have been developed, based on the results of laboratory tests conducted in Yerevan and Moscow.

Analysis of laboratory test results for the waterproofing layer, conducted at the Institute of Mechanics of Moscow State University and the I.V. Yegiazarov Institute of Water Problems and Hydraulic Engineering, suggests conducting field studies on a small section of the tailings dam. The development and installation of a waterproofing layer on the surface of the tailings dam as part of a pilot project (preliminary testing of the impervious lining of a tailings dam covering an area of approximately 1,500-3,000 square meters) will allow us to verify the reliability of the waterproofing layer, refine its installation technology, and evaluate the cost of each proposed option.

Samples of enrichment waste provided by the Department of Environmental Protection and Subsoil Inspection of the Republic of Armenia, soil used during the reclamation of the tailings storage facility, sandy loam soil, ordinary soil and polymer-mineral material "PMM" were used for the tests.

A modified version of the "PMM" material was used during testing. Its physical and technical characteristics are presented below:

- The density of the dry fraction of the PMM material with a particle size of up to 1 mm is 1 kg/l;
- Inert (according to preliminary tests) to aggressive environments and non-polar liquids;
- Frost-resistant during operation. Frost resistance is between that of sandy and sandy-loamy soils;
- Chemical resistance to aggressive environments (sulfate and acid resistance) – stable in the pH range of 4-12;

- Stable when laid on slopes with a ratio of 1:3;
- Resistance of the waterproofing layer to groundwater – resistant to erosion at speeds of up to 5 m/s.

Description of the first technology for conducting laboratory tests:

1. A composite mixture of polymer-mineral material "PMM" and soil is laid on the pre-leveled surface of the mothballed tailings dam and then compacted with a rammer. The soil must be as uniform as possible.
2. To ensure the integrity of the waterproofing layer, a layer of soil (without PMM) 7-10 cm thick (soil, sandy loam soil or other material) is placed on top, which is compacted with a rammer.
3. The resulting surface is slowly covered with water using sprinkling until the water reaches the top of the test tube (a layer of water 10-15 cm thick is formed).
4. Every day, depending on the degree of absorption, water is added to the test tube until it reaches the top of the test tube.

To obtain composite waterproofing layers, laboratory tests were conducted with various types and masses of soil, with different ratios of the use of the "PMM" material.

The aggressive tailings material was placed in a transparent plastic cylindrical tube with a diameter of d=0.225 m with holes in the bottom and compacted.

Experiment N1

1. Experiment start: November 2, 2025.
2. Soil type: inorganic material with a predominance of quartz sand, containing a limited amount of aluminosilicate and carbonate mixtures (hereinafter referred to as soil). Soil type: inorganic material with a predominance of quartz sand, containing a limited amount of aluminosilicate and carbonate mixtures (hereinafter referred to as soil).[1]
3. The mass of the soil is 4 kg.
4. The amount of "PMM" material is 280 g (based on 7 kg/m^2).
5. The total mass of the test tube at maximum saturation with water is 14.85 kg - 12/04/2025.
6. Water absorption level at maximum saturation - 100%: 12/04/2025 Water absorption level at maximum saturation - 100%: 12/04/2025.
7. A weak filtration flow is observed through the holes in the bottom of the test tube (slight wetting of the bottom. No measurable yield is observed). A weak filtration flow is observed through the holes in the bottom of the test tube (slight wetting of the bottom. No measurable yield is observed).
8. The onset of the filtration phenomenon through the holes in the bottom of the test tube: 12/04/2025.
9. Termination of the filtration phenomenon through the holes in the bottom of the test tube: 12/13/2025.

[1] Soil characteristics are given after the description of the experiments.

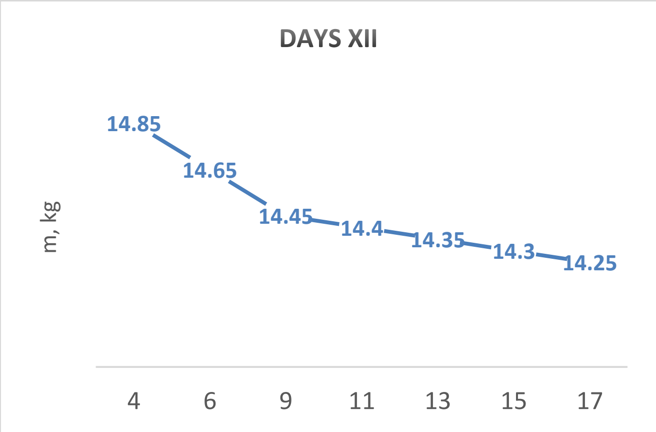

Fig.2 Evaporation losses after opening the lid for the baseline data of experiment N1

10. The decrease in the total mass of the test tube with an open lid by days from the start of filtration through the holes in the bottom of the test tube (12/04/2025) is shown in Fig. 2.

Experiment N2

1. Experiment start: November 2, 2025.

2. Soil type: sandy loam soil used for reclamation of tailings ponds. Soil type: sandy loam soil used for reclamation of tailings ponds.
3. The mass of the soil is 4 kg.
4. The amount of "PMM" material is 280 g (based on 7 kg/m^2).
5. The total mass of the test tube at maximum saturation with water is 14.7 kg - 12/04/2025.
6. Water absorption level at maximum saturation- 60%: 12/04/2025.
7. There is no filtration through the holes in the bottom of the test tube (the tail material is completely dry).
8. On December 14, 2025, the lid of the test tube was opened to study the evaporation process.

Fig. 3 Experiment N2, Point 6

Experiment N3

1. Experiment start: November 11, 2025.
2. Soil type: sandy loam (Fig. 4, right).[2]
3. The mass of the soil is 4 kg.
4. The amount of "PMM" material is 320 g (based on 8 kg/m^2).
5. The total mass of the test tube at maximum saturation with water is 14.85 kg - 12/04/2025.
6. Water absorption level at maximum saturation - 60%: 12/04/2025.

[2] Soil characteristics are given after the description of the experiments.

7. There is no filtration through the holes in the bottom of the test tube (the tail material is completely dry).

Experiment N4

1. Experiment start: November 11, 2025.
2. Soil type: Sandy loam soil used for reclamation of tailings ponds (Fig. 4, right).
3. The mass of the soil is 4 kg.
4. The amount of "PMM" material is 320 g (based on 8 kg/m^2).
5. The total mass of the test tube at maximum saturation with water is 15 kg -12/04/2025.
6. Water absorption level at maximum saturation – 50-55 %: 12/04/2025.
7. There is no filtration through the holes in the bottom of the test tube (the tail material is completely dry).

Fig. 4. Experiment 3, point 6: left & Experiment 4, point 6: right

Experiment N5

1. Experiment start: November 17, 2025.
2. Soil type: Sandy loam soil used for reclamation of tailings ponds.
3. The mass of the soil is 3 kg.
4. The amount of "PMM" material is 320 g (based on 8 kg/m^2).
5. The total mass of the test tube at maximum saturation with water is 14.05 kg -12/04/2025.
6. Water absorption level at maximum saturation – 50 %, Fig.5: 12/04/2025.
7. There is no filtration through the holes in the bottom of the test tube (the tail material is completely dry).

Fig. 5 Experiment N5, Point 6

Experiment N6

1. Experiment start: November 17, 2025.
2. Soil type: inorganic material with a predominance of quartz sand, containing a limited amount of aluminosilicate and carbonate mixtures (hereinafter referred to as soil). Soil type: inorganic material with a predominance of quartz sand, containing a limited amount of aluminosilicate and carbonate mixtures (hereinafter referred to as soil).[3]

3. The mass of the soil is 3 kg.
4. The amount of "PMM" material is 320 g (based on 8 kg/m^2).
5. The total mass of the test tube at maximum saturation with water is 14.75 kg -12/14/2025.
6. Water absorption level at maximum saturation – 100 %, Fig.6: 12/14/2025.
7. The onset of the filtration phenomenon through the holes in the bottom of the test tube: 12/14/2025.
8. The increase in the total mass of the test tube when additional water is absorbed with the lid closed over in Fig. 7.

Fig. 6 Experiment N6, Point 6

Experiment N7

1. Experiment start: November 22, 2025.
2. Soil type: inorganic material with a predominance of quartz sand, containing a limited amount of aluminosilicate and carbonate mixtures (hereinafter referred to as soil). Soil type: inorganic material with a predominance of quartz sand, containing a limited amount of aluminosilicate and carbonate mixtures (hereinafter referred to as soil).[4]
3. The mass of the soil is 3 kg.
4. The amount of "PMM" material is 360 g (based on 9 kg/m^2).
5. The total mass of the test tube at maximum saturation with water is 13.8 kg - 12/14/2025.
6. Water absorption level at maximum saturation – 100 %: 12/14/2025.
7. Slight filtration flow from the holes in the bottom of the test tube (slight wetting of the bottom. No measurable flow is observed).

Experiment N8

1. Experiment start: November 22, 2025.
2. Soil type: inorganic material with a predominance of quartz sand, containing a limited amount of aluminosilicate and carbonate mixtures (hereinafter referred to as soil). Soil

[3] Soil characteristics are given after the description of the experiments.
[4] Soil characteristics are given after the description of the experiments.

type: inorganic material with a predominance of quartz sand, containing a limited amount of aluminosilicate and carbonate mixtures (hereinafter referred to as soil).[5]

3. The mass of the soil is 3 kg.
4. The amount of "PMM" material is 400 g (based on 10 kg/m^2).
5. The total mass of the test tube at maximum saturation with water is 13.4 kg - 11/22/2025.
6. The total mass of the test tube at maximum saturation with water is 14.45 kg - 12/14/2025 (Fig.8).
7. Water absorption level at maximum saturation – 100 %: 12/14/2025.
8. Slight filtration flow from the holes in the bottom of the test tube (slight wetting of the bottom. No measurable flow is observed).
9. Filtration through the holes in the bottom of the test tube stops.

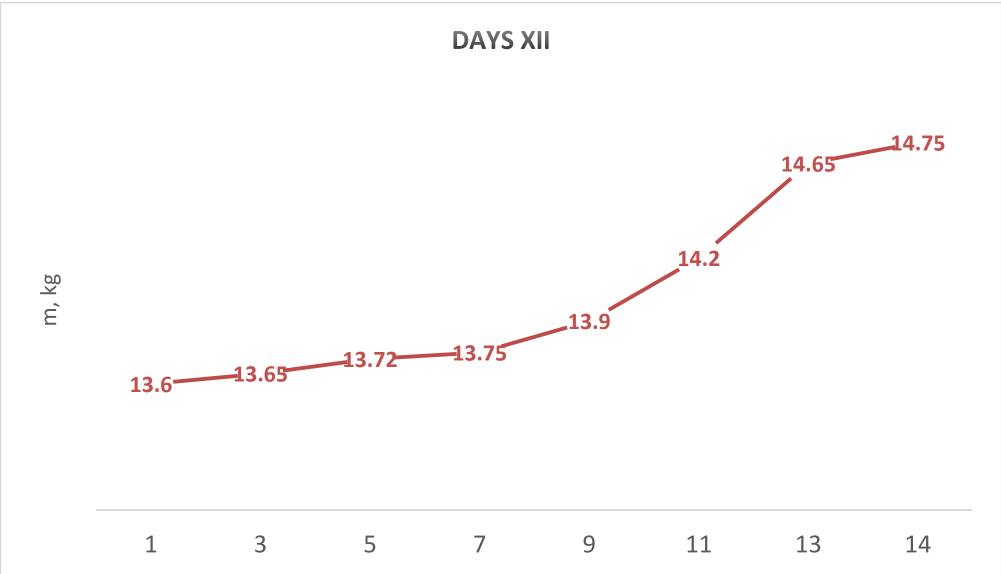

Fig. 7 Increase in total test tube mass due to absorption of additional water for baseline data of experiment N6

Description of the second technology for the purpose of conducting laboratory research:

1. A leveling layer of sandy loam soil at least 3 cm thick is laid and compacted with a rammer.

2. A layer of "PMM" material several millimeters thick (5 to 7 mm) is laid on top of the compacted sandy loam soil and compacted with a rammer.

3. To protect it from mechanical damage during operation, it is covered with a protective layer of sandy loam soil (up to 10 cm) and compacted with a rammer.

[5] Soil characteristics are given after the description of the experiments.

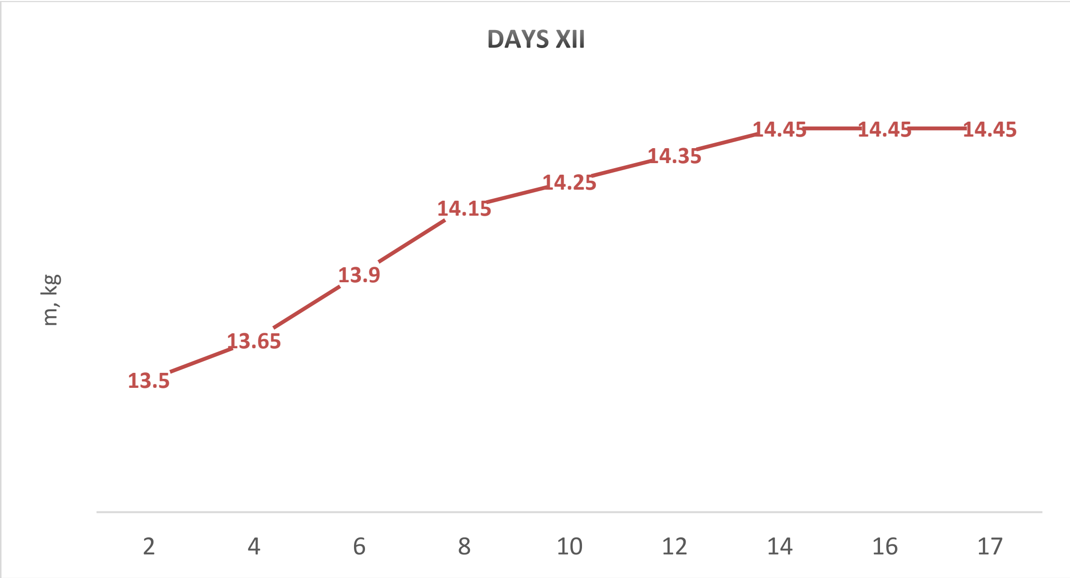

Fig. 8 Increase in total test tube mass due to absorption of additional water for baseline data of experiment N8

Experiment N9 (Technology 2: PMM with a separate layer)

1. Experiment start: December 14, 2025.
2. Soil type: sandy loam.
3. The mass of soil below and above the «PMM» layer is 4 kg.
4. The amount of PMM material (without mixing with soil) was 360 g (estimated value: 9 kg/m2) (Fig. 9).
5. The total mass of the test tube, 13.25 kg, remained constant from the beginning of the experiment (12/14/2025).

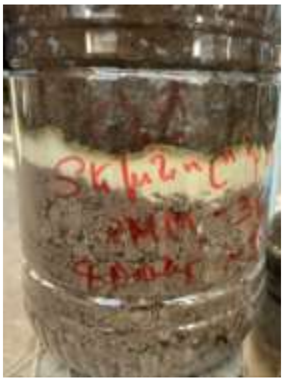

Fig. 9 Experiment N9, Point 4

Experiment N10 (Technology 2: PMM with a separate layer)

1. Experiment start: December 17, 2025.
2. Soil type: sandy loam.
3. The mass of soil below and above the «PMM» layer is 4 kg.
4. The amount of PMM material (without mixing with soil) was 280 g (estimated value: 7 kg/m2)
5. The total mass of the test tube, 13.65 kg, remained constant from the beginning of the experiment (12/17/2025) (Fig. 10).

Fig. 10 Experiment N10, Point 5

Experiment N11 (Water from under the tail)

1. Experiment start: December 14, 2025.
2. Soil type: sandy loam.
3. The mass of the soil is 3 kg.
4. The amount of "PMM" material is 360 g (based on 9 kg/m^2).
5. Additional added soil mass without PMM - 2.5 kg.
6. Water is added to the top of the test tube and it is turned upside down.
7. The added soil settles to the bottom of the test tube after 3-4 hours.
8. The composite does not allow the water to rise (Fig. 11).

Fig. 11 Experiment N11, Point 8

Soil characteristics

A) Natural sandy soil.

FTIR spectroscopic analysis results show that the sample under study is characterized by a predominantly sandy (quartz) composition. The most intense absorption band in the spectrum is observed in the 1100–1000 cm⁻¹ range, which corresponds to asymmetric stretching vibrations of Si–O–Si bonds and is the main parameter characteristic of quartz sand.

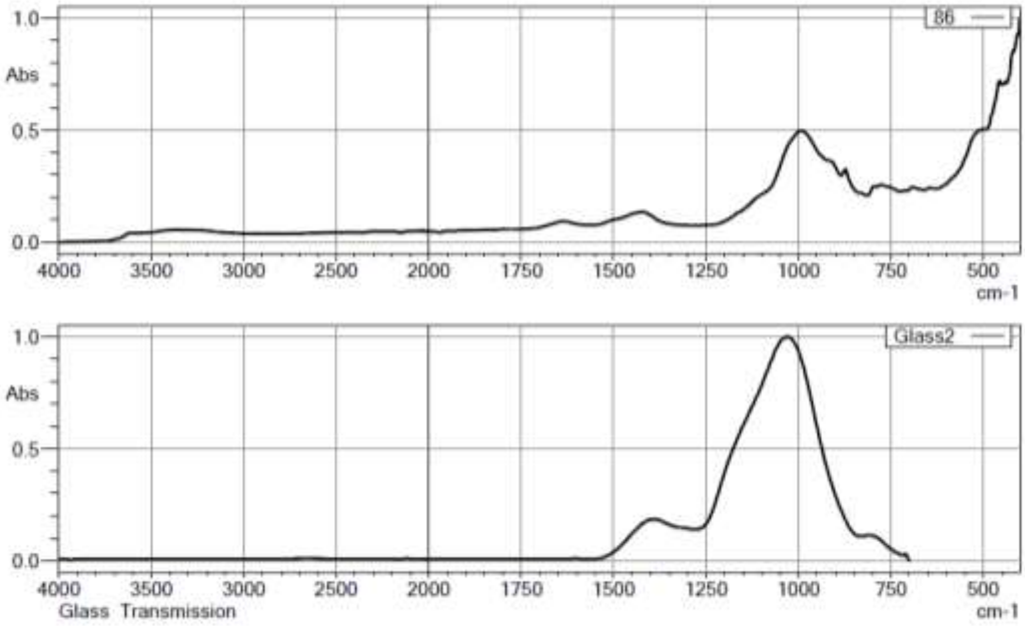

Fig. 12 IR-Fourier analysis of soil

The absorptions recorded in the ranges of 800–780 cm^{-1} and 470–450 cm^{-1} are associated with the symmetric Si–O–Si stretching vibrations and Si–O bending vibrations, respectively, further confirming the presence of a SiO_2-rich well-formed silicate structure.

Weak absorption bands observed in the 3600–3200 cm^{-1} and around 1630 cm^{-1} ranges are due to the presence of surface hydroxyl groups and physically adsorbed water, which is typical of sand and quartz materials. A weak band detected in the 1450–1400 cm^{-1} range may indicate the presence of small amounts of carbonate impurities. Very weak C–H vibrations observed in the 2950–2850 cm^{-1} range indicate a negligible content of organic components in the sample.

The study results show that the sample is an inorganic material dominated by quartz sand (Fig. 12), containing limited amounts of aluminosilicate and carbonate impurities. This composition is typical of natural sandy soils and ensures the chemical stability of the material.

B) Sandy loam soil.

Analysis shows that the soil is clayey in nature, rich in kaolinite or similar aluminous clays, and dominated by the silicate/quartz fraction. According to data obtained from the soil extract, the environment is close to neutral, and the electrical conductivity is also low, indicating a relatively low content of dissolved salts (Table 1, Fig. 13). For initial field studies, it is recommended to use sandy loam taken from reserves near the tailings dump as the soil.

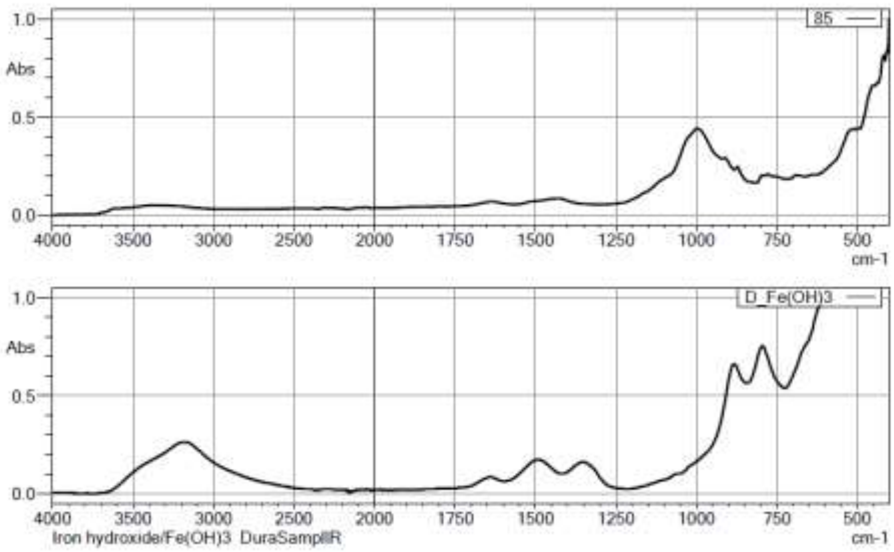

Fig. 13 IR-Fourier analysis of sandy loam soil

Table 1

Sample	Electrical conductivity, μm/cm Water analyzer HACH LANGE HQ 14d	pH Water analyzer HACH LANGE HQ 14d
1	595	8.18

Laboratory tests at the Institute of Mechanics of Lomonosov Moscow State University.

For laboratory testing, PMM material was added to the waterproofing layer at various doses (from 7 to 10 kilograms of PMM per square meter in 1-kilogram increments).

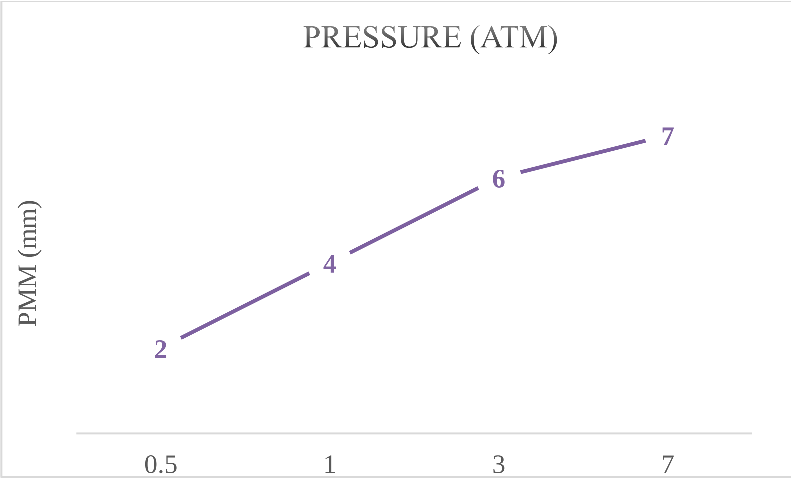

Fig. 14 Dependence of the thickness of the PMM material on the applied pressure at which the liquid begins to flow out of the bottom of the testing device.

The composite manufactured using PMM was placed on an experimental device, which was subjected to a water column pressure ranging from 0.25 to 30 meters (Figs. 14 and 15).

Composites prepared in various combinations were tested, with a PMM suspension weight of 7-10 kg per square meter of surface area.

Depending on the installation method and the amount of PMM used in the waterproofing layer, the amount of water leaking from the holes in the bottom of the container was determined over time. As a result of laboratory testing, a waterproofing layer using PMM material was created that was capable of withstanding high water column pressure over a long period.

During the tests, the mass of the PMM material was changed in steps of 1 kg from 5 kg/m^2 (0.5 cm of compacted material PMM) to 10 kg/m^2 (1 cm of compacted material PMM).

Experiment N12 (Technology 2)

A 3-cm-thick layer of sandy loam is laid on compacted soil 7 cm thick, followed by a 0.6-cm-thick layer of PMM material, followed by a 5-7-cm-thick layer of sandy loam material. With this layering sequence, the system can withstand a water column of 30 meters.

However, if the sandy clay layer is not laid on compacted soil 7 cm thick, and then a 0.6-cm-thick layer of PMM material is immediately laid on top of it, followed by a 5-7-cm-thick layer of sandy loam material, water will begin to leak within a week under a water column of 15 meters at a rate of no more than one drop per day. However, over time, the leakage rate may increase, and the waterproofing layer will become highly permeable.

Therefore, to ensure the effectiveness of the waterproofing layer, it is recommended to level the compacted soil base with a layer of sandy-loamy material at least 3 cm thick before laying the compacted layer of PMM material.

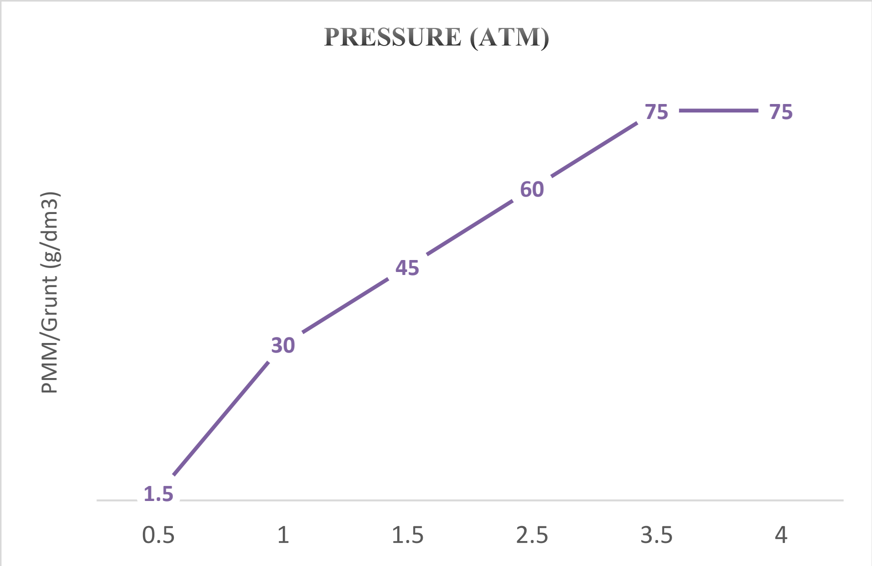

Fig. 15. Dependence of the magnitude of the applied pressure and the characteristics of the composite with different ratios of soil and PMM material, at which the liquid begins to flow out of the bottom of the test device

Experiment N13 (Technology 1)

A 7 cm thick layer of compacted soil is placed at the bottom of the test tube, followed by a 3 cm thick layer of sandy clay. A 7 cm thick compacted waterproofing layer consisting of a mixture of 65 g of PMM per 1 kg of soil is then placed on top, which, after compaction with a rammer, turns into a 5 cm thick layer. Using a mixture of 65 g of PMM aggregate per kg of soil, the protective layer will withstand a water column of 30 m.

PMM materials should be stored in covered warehouses protected from moisture. They do not release toxic compounds into the air or water, do not pollute the environment, and are environmentally safe.

The development and installation of a waterproofing layer on the surface of the tailings dam as part of a pilot project (full-scale testing on a tailings dam covering approximately 3,000 square meters) will allow us to verify the reliability of the waterproofing layer and improve its installation technologies, as well as estimate the labor costs for each of the recommended options.

Conclusion

1. It is recommended to cover the surface of recycled waste dumps by directly applying a layer of "PMM" or using a composite created with its application.
2. Laboratory tests show that when creating an anti-filtration composite, in the case of using sand-loamy soil, the amount of the required mass of the "PMM" material is much smaller and more effective.

3. The first stage of natural tests is recommended to be carried out on the area of landfills of recycled waste of 1500-3000 m^2, of which 80% - according to technology № 1 and 20% - according to technology № 2.
4. At the first stage of tests, it is recommended to use reclaimed sand-loam soil.
5. In the case of using technology No. 1, it is recommended to use 8 kg/m^2 of composite in a ratio of 1:10 with soil.
6. In case of technology No. 2 effectively use 8-9 kg/m^2 material "PMM".

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ՊՈԼԻՄԵՐԱՀԱՆՔԱՅԻՆ «PMM» ՍՈՐՈՒՆԻ ԿԻՐԱՌՄԱՄԲ ՀԻԴՐՈՄԵԿՈՒՍԻՉ ՇԵՐՏ ԿՈՆՍԵՐՎԱՑՎԱԾ ՊՈՉԱՄԲԱՐՆԵՐԻ ՀԱՄԱՐ. ՏԵԽՆՈԼՈԳԻԱՆԵՐԻ ՄՇԱԿՈՒՄ ԵՎ ԼԱԲՈՐԱՏՈՐ ՀԵՏԱԶՈՏՈՒԹՅՈՒՆՆԵՐ

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Կոնսերվացված պոչամբարների մակերևույթն առաջարկվում է ջրամեկուսացնել «PMM» սորունի անմիջական տեղադրման կամ դրա կիրառմաբ ստեղված կոմպոզիտի միջոցով: Լաբորատոր հետազոտությունների ընթացքում որոշվել է ջրամեկուսիչ շերտի արդյունավետ բաղադրակազմը և մշակվել է դրա տեղադրման երկու տեխնոլոգիա: Լաբորատոր փորձարկումները ցույց են տալիս, որ հակաֆիլտրացիոն կոմպոզիտ ստեղծելիս, ավազակավային գրունտի օգտագործման դեպքում, «PMM» սորունի անհրաժեշտ չափաքաքանակը զգալիորեն ցածր է, քան սովորական հողերի օգտագործման դեպքում:

Բանալի բառեր. ռեկրեացիա, քաղաքային միջավայր, պոչամբար, ջրամեկուսացում:

ПРИМЕНЕНИЕ ПОЛИМЕРНО-МИНЕРАЛЬНОГО МАТЕРИАЛА «ПММ» ДЛЯ СОЗДАНИЯ ГИДРОИЗОЛЯЦИОННОГО СЛОЯ ПРИ КОНСЕРВАЦИИ ХВОСТОХРАНИЛИЩ: РАЗРАБОТКА ТЕХНОЛОГИЙ УКЛАДКИ И ЛАБОРАТОРНЫЕ ИССЛЕДОВАНИЯ

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Рекомендуется гидроизолировать поверхность законсервированного хвостохранилища путем непосредственного нанесения полимерно-минерального материала «PMM» или композита, созданного на его основе. В ходе лабораторных

E.V.Avanesyan, V.R.Grigoryan, D.H.Grigoryan, H.V.Tokmajyan
APPLICATION OF POLYMER-MINERAL MATERIAL «PMM» FOR CREATION OF WATERPROOFING LAYER DURING CONSERVATION OF TAILINGS: DEVELOPMENT OF INSTALLATION TECHNOLOGIES AND LABORATORY RESEARCH

исследований был определен эффективный состав гидроизоляционного слоя и разработаны две технологии его укладки.

Лабораторные исследования показывают, что при создании антифильтрационного композита с использованием песчано-суглинистого грунта, необходимое количество наполнителя «ПММ» значительно меньше, чем при использовании обычной почвы.

Ключевые слова: рекреация, городская среда, хвостохранилище, гидроизоляция.

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