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Analysis of the potential for the use of artificial peat soil based on oil sludge

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Abstract. Oil sludge is one of the dangerous sources of environmental pollution, which causes significant damage to ecosystems. The technologies used for their disposal do not show efficiency, these data are confirmed by the authors' SWOT analysis of the existing method of waste data management – sludge accumulation. The paper considers a new technological solution for processing oil sludge into artificial peat soil. The study describes the process of obtaining artificial peat from oil sludge, the main characteristics and properties of the resulting material. The authors present the results of laboratory studies: assessment of the physico-chemical characteristics of artificial peat soil, such as its density, humidity, organic matter content, concentration of heavy metals and other harmful substances, as well as an experiment on the study of fertile properties. An analysis of the potential and possibility of introducing this material into practice was also carried out. The findings can be useful for further research and development in the field of oil sludge utilization and processing and improving the environmental sustainability of peat soils.

Keywords: secondary raw materials, artificial peat soil, oil sludge, neutralization of oil sludge, sludge accumulators, physical and chemical properties of soil, sustainable development, waste disposal

Authors' contribution. *Semyantseva P.K.* – development of a research idea, collection and analysis of source materials, laboratory research, writing a text; *Ilchenko A.A.* – selection of scientific literature, guidance on conducting an experiment in the laboratory, structuring the article and editing the text.

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Анализ потенциала применения искусственного торфяного грунта на основе нефтешламов

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Аннотация. Нефтешламы являются одним из опасных источников загрязнения окружающей среды, наносящих значительный вред экосистемам. В настоящее время отсутствуют эффективные технологии по их утилизации, эти данные подтверждаются результатами проведенного авторами SWOT-анализа существующего способа обращения с данными отходов – шламонакопления. Рассмотрено новое технологическое решение переработки нефтешламов в искусственный торфяной грунт. Описан процесс получения искусственного торфа из нефтешламов, приведены основные характеристики и свойства полученного материала. Представлены авторские результаты лабораторных исследований: оценка физико-химических характеристик искусственного торфяного грунта, таких как его плотность, влажность, содержание органических веществ, концентрация тяжелых металлов и других вредных веществ, а также выполнен эксперимент по исследованию плодородных свойств. Был проведен анализ потенциала и возможности внедрения данного материала в практику. Полученные выводы могут быть полезны для дальнейших исследований и разработок в области утилизации и переработки нефтешламов и улучшения экологической устойчивости торфяных грунтов.

Ключевые слова: вторичное сырье, искусственный торфяной грунт, нефтешламы, обезвреживание нефетешламов, шламонакопители, физико-химические свойства грунта, устойчивое развитие, утилизация отходов

Вклад авторов. *Семянцева П.К.* – разработка идеи исследования, сбор и анализ исходных материалов, проведение лабораторных исследований; *Ильченко А.А.* – подбор научной литературы, руководство над проведением эксперимента в лаборатории, структурирование статьи и редактирование текста.

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Introduction

The fuel industry is one of the key sectors of the world economy and largely determines the economy, social policies, and environmental conditions. Oil and gas enterprises provide the fuel needed for transport, energy production and heating, as well as other activities. They create jobs and generate significant revenues for the state. However, there are negative consequences. Mining has a significant impact on the natural environment. The most important influence on the state of the hydrosphere, atmosphere and soil is not the extraction, processing, or transport of hydrocarbons itself, but their waste is oil sludges [1].

Oil sludge is waste generated from the extraction, processing and use of oil and petroleum products. They contain harmful substances such as heavy metals, petroleum hydrocarbons, salts, and other chemical compounds. The impact of oil sludge on the natural environment can be severe. When entering water systems, oil sludge contaminates surface and ground water, which has a negative impact on the health of fish and other aquatic organisms. This could lead to the extinction of some species and the disruption of the ecosystem. In addition, the contaminated water becomes unusable for agriculture and drinking water supply. Oil slags can cause significant atmospheric damage, especially if a thermal method of their decontamination is used. The combustion of oil slags produces toxic gases such as nitrogen oxides and sulphur oxides, and hydrocarbons that contribute to greenhouse gas emissions and air pollution. As a result, there are problems with air pollution and climate change. The entry of waste oil into the soil can lead to degradation and deterioration of soil fertility. Some substances can be absorbed by plants and enter the food chain, which may pose a danger to living organisms including humans.

Thus, oil sludge waste becomes a serious problem for the environment. In order to minimise the negative impact, it is necessary to develop and apply effective methods of utilisation and treatment of such wastes, as well as to strictly control their storage and transportation. Such measures will help to reduce negative consequences and preserve the natural environment for future generations [1].

Despite the availability of recycling technologies and facilities, the amount of waste generated is still significant. Work in this area includes the development of efficient and environmentally friendly recycling methods, strict control of emissions and spills, and incentivising the use of secondary raw materials. Over 500 thousand tonnes of waste are generated in the Russian Federation every year, and the total amount of waste in sludge pits in 2022 is 4.5 million tonnes. Their formation occurs during the exploitation of oil fields due to:

1) discharges during oil treatment;
2) discharges during cleaning of oil reservoirs;
3) oily flushing fluids used in drilling operations;
4) discharges during testing and workover of wells;
5) emergency spills during oil production and transport [3; 4].

However, oil sludge can also be used as a secondary raw material. Their processing and utilisation allows to recover valuable components such as petroleum coke, bitumen, carbon materials and other products. In addition, oil sludge recycling helps to reduce environmental impact. Untreated oil sludge can lead to soil, water and air pollution, as well as adversely affect human and animal health. The recycling process helps to reduce the concentration of harmful substances and dispose of them in a safe way.

Unfortunately, at present it is not possible to determine with absolute certainty an environmentally friendly, economically feasible and resource-saving method of oily waste processing. In each specific case it depends on the chemical composition of oil sludge, duration of its storage, amount of mechanical impurities and other factors. The relevance of this problem is determined not only by the need to improve the ecological situation, but also by economic aspects, since oil sludge can serve as a secondary source of valuable petroleum products if properly treated [6].

The aim of the study is to analyse the potential of using artificial peat soil in the construction of roads and industrial sites, landfill reclamation and backfilling, in agriculture and horticulture.

Objectives of the research:

1) to identify the disadvantages of using sludge pits;
2) to study physical and chemical characteristics of artificial peat soil;
3) to assess the applicability of artificial soil in different spheres of economy.

Materials and methods

A 3 kg sample of artificial peat soil created from oil sludge was taken as the object of the study. Sampling was carried out according to the standard developed for soil GOST 12071–2014[1]. A point sample was taken using a soil drill, then the

[1] GOST 12071-2014. Interstate standard. Soils. Selection, packing, transportation and storage of samples. Date of introduction 01.07.2015. Interstate Council for Standardisation, Metrology and Certification.

soil was placed in a special box with a sealed lid (for moisture assessment). The next step was to issue an accompanying ticket for the packaged sample. The sample did not experience any sudden dynamic and temperature effects during transport. The collected soil sample was transferred to the laboratory with a storage period not exceeding 1.5 months. For the study of physical properties of the soil sample preparation for analysis was carried out in accordance with GOST 5180-2015 depending on the type of test.[2]

The paper applies theoretical and practical methods of research, namely:

1. Analysis:

– Study of scientific articles, publications and reports related to the utilisation of oil sludge and artificial peat soil.

– Study of existing research in the field of oil sludge utilisation and application of artificial peat soil in various sectors (e.g. agriculture, urban landscaping, remediation of contaminated sites).

2. Collection and processing of oil sludge samples:

– Taking a sample of artificial peat soil and transporting it to the laboratory;

– Studying the physico-chemical properties of the artificial peat soil (e.g. moisture, density, organic matter content).

3. Assessing the potential application potential of artificial peat soil:

– Conducting laboratory tests on artificial peat soil to determine its fertilising properties;

– Determining the extent to which artificial peat affects plant growth and development (e.g. in crop production);

– Assessing the efficiency of using artificial peat in different sectors of the economy.

Results and discussion

In the modern world there are several methods of oil sludge elimination, utilisation or neutralisation. One of these methods is the accumulation of oil sludge in special containers called sludge tanks, followed by treatment or incineration. Treatment of oil sludge is carried out using different technologies, e.g. mechanical, physico-chemical or biological treatment. Mechanical treatment includes filtration, separation and sedimentation to remove large particles and water. Physico-chemical cleaning is based on the use of chemicals and physical processes such as flotation, adsorption and demulsification to remove organic and inorganic contaminants. Biological treatment is based on the use of microorganisms to biodegrade oil sludge. Incineration of oil sludge is considered to be the most efficient method of oil

[2] GOST 5180-2015. Soils. Methods of laboratory determination of physical characteristics. Date of introduction 01.04.2016. Interstate Council for Standardisation, Metrology and Certification.

sludge utilisation, however, this process can have a negative impact on the quality and condition of the environment, as it leads to the release of harmful and polluting substances into the atmosphere. Therefore, special gas treatment and purification systems are usually used in oil sludge incineration to minimise negative impacts.

One of the disadvantages of storing drilling waste in sludge pits is that this technique does not address the very existence of the waste. While sludge ponds can temporarily hold drilling waste, they do not provide an effective solution for its complete disposal or recycling. This can lead to the accumulation of waste for long periods of time, which has a negative impact on the environment. Moreover, cuttings storage tanks may be prone to various damages, collapses or leaks which may lead to soil, water and environmental contamination. In addition, the storage of drilling waste in sludge pits requires constant monitoring and careful maintenance to prevent such potential problems. It is important to note that storing waste in sludge ponds is a temporary solution. In addition, it is very common in practice to observe a number of irregularities in the storage of wastes, environmental standards are not met, for example, there is no protective layer of soil, which prevents the penetration of contaminants into the soil or groundwater. This layer should have the minimum thickness required by regulations and the appropriate characteristics necessary to minimise the risk of contamination. In addition, sludge ponds should be inspected on a regular basis to identify possible irregularities and take remedial action. This will help prevent the spread of contamination and reduce the environmental impact of waste storage. In the long term, there is a need to find more sustainable and effective methods for managing drilling waste, such as recycling, disposal or reinjection back into the well. These methods may be more environmentally friendly and sustainable in terms of waste management.

The authors have made a SWOT-analysis of the method of sludge storage facilities utilisation. It revealed that the existing methods of oil sludge storage require more rational methods (Figure 1). The SWOT analysis is a useful tool for evaluating oil sludge disposal methods and helps to make informed decisions based on their characteristics and potential.

Another promising method of oil sludge elimination, according to the authors, is its injection into specially designed wells. This method is usually used in combination with other methods, e.g. cleaning or stabilisation of oil sludge before injection. The injection process consists of pressurising the oil sludge through a special pipeline system and injecting it into wells at a certain depth. The wells for this purpose are prepared taking into account geological and engineering-technical peculiarities of the field and oil sludge composition.

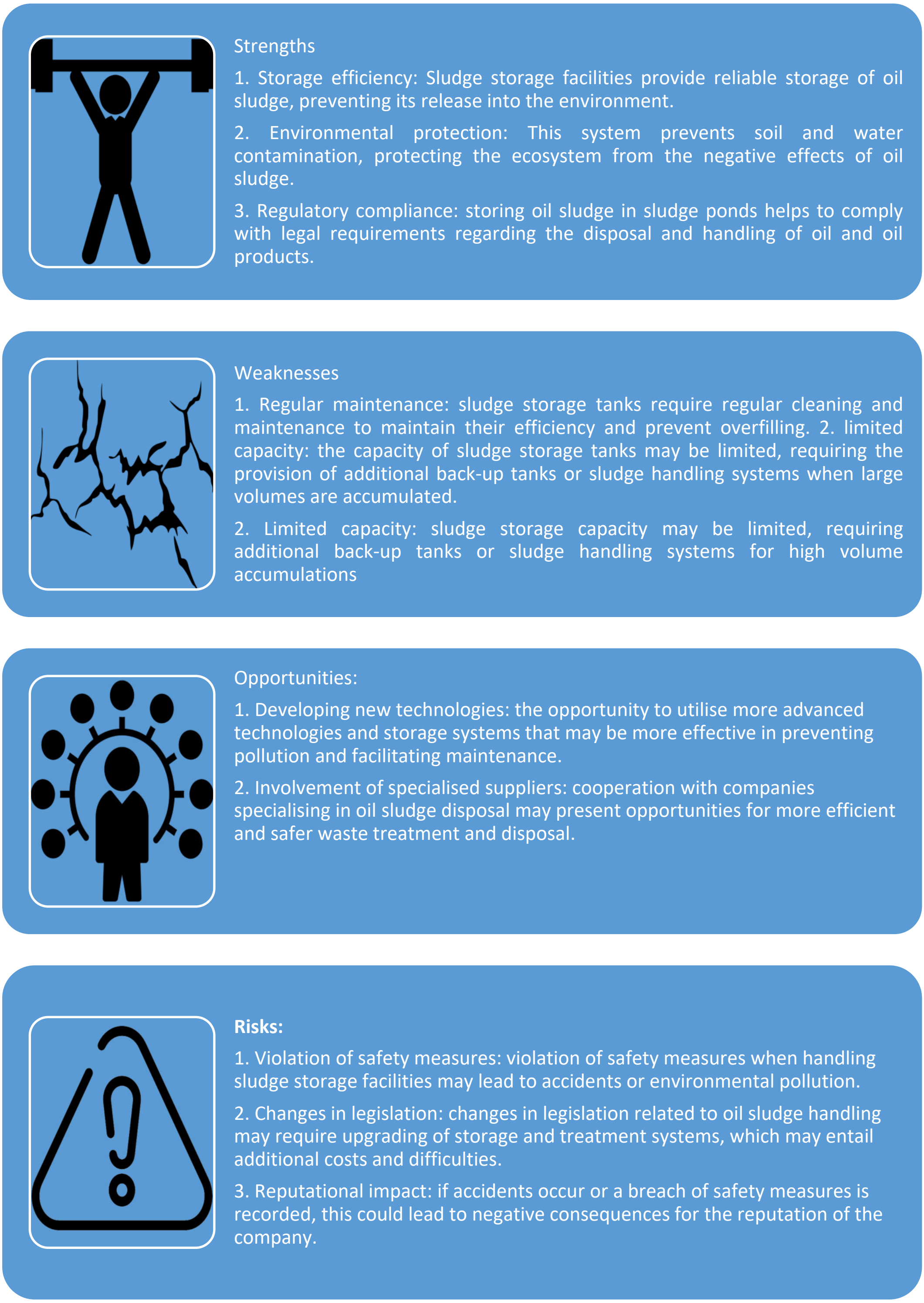

Figure 1. SWOT-analysis of sludge storage facilities utilization
Source: compiled by P.K. Semyantsev, A.A. Ilchenko.

The use of specially designed wells ensures reliable and safe retention of oil sludge inside the earth's crust. This method has a number of advantages.

Firstly, it allows oil sludge to be isolated from surface water resources and soil, preventing further contamination.

Secondly, it is an effective way to dispose of large volumes of oil sludge, which reduces its environmental impact.

Thirdly, the method is quite reliable and safe, preventing the possibility of oil sludge leakage and spillage.

However, it should be noted that the application of this method requires a detailed study of the geological, hydrodynamic and chemical characteristics of the field and oil sludge. Local environmental requirements and legislation must also be considered to ensure safety and minimise potential risks to the environment and human health.

This article deals specifically with the recycling method – creation of various materials from oil sludge. One of the main products of production is technical carbon fibre. This material has high strength and stiffness, at the same time it is light and heat resistant. However, this is not the only material recycled from this type of waste. Interesting and unique is the experience of creating artificial peat soil from oil sludge, which belongs to the 4–5th category of hazard. Due to the processing of drilling waste and addition of milling peat (sphagnum) of low decomposition degree (due to which organic inclusions such as pieces of wood, roots and plant fibres appear in the soil), a soil of the 4–5th category is formed with the possibility of its further use for construction and road reinforcement of industrial sites, reclamation of landfills and their backfilling. A sample of the above peat was taken from artificially created dumps (Figure 2) by the authors and delivered to the laboratory for research. The composition of the soil is diverse and includes petroleum products, chlorides, spent drilling muds, drilling wastewater, heavy metals and many other substances that do not exceed the maximum permissible concentrations MPC (APC) for soils.

The study of physical and chemical characteristics of the above-mentioned soil was carried out. Initially, the following soil properties were considered: structure, moisture, stability, organic matter content, presence of neoplasms and inclusions.

Soil structure is of great importance in construction. Proper understanding and consideration of soil structure allows for the construction of stronger and more stable structures. The following factors can influence the influence of soil on construction:

1) bearing capacity: different types of soil have different bearing capacity characteristics. For example, sandy soil usually has a high bearing capacity, while clay soil may be less stable. Understanding this allows engineers to determine

the necessary measures to reinforce the soil or decide to avoid building on an unsuitable site;

2) water drain and drainage: the structure of the ground can affect the ability of the ground to allow water to pass through or to accumulate moisture. This is an important aspect in the construction of foundations, pipelines and other structures. Improper drainage or the presence of water-bearing soils can lead to moisture problems or flooding of structures;

3) stability: some soils can be unstable, especially on slopes or when exposed to disturbing factors such as earthquakes or temperature variations. A preliminary study of the soil structure can prevent possible hazards and allow for additional reinforcement measures;

4) impact on construction: different soil types require different construction methods and materials. For example, construction on clay soil may require the use of piles to provide the necessary support. Otherwise, ground subsidence may occur, which in turn may lead to structural damage to the building.

Figure 2. Dumps of artificial peat soil
Source: photo by P.K. Semyantseva.

In general, the soil structure is an essential aspect in design and construction, so it is necessary to pay attention to it and carry out all necessary investigations before starting works. When determining the soil structure according to S.A. Zakharov's classification applied to natural soils: the object has an irregular rounded shape, irregular rounded and rough breaks are observed on its surface, and its faces are not pronounced, the particle size is 10^{-3} mm, therefore, the soil structure is coarse lumpy. The data obtained do not allow a general assessment of the capabilities of the investigated soil. The coarse lumpy structure may have positive and negative sides:

1) a lumpy structure may indicate high soil density. This can be a positive factor in construction, as dense soil usually has good bearing capacity. However, this may require the use of specialised equipment or methods for soil retention and handling;

2) a lumpy soil structure may also indicate the presence of organic materials or impurities such as plant roots or debris, which indicate heterogeneity, and hence such soil is capable of disintegration with minimal mechanical action.

Further, the moisture content and stability of the sample were studied. Soil moisture plays an important role in construction. Soil moisture can affect soil properties such as density, stability and soil tension. If the soil is too dry, it can easily collapse or fail to give the necessary support to building structures. At the same time, soil that is too wet can cause instability and shrinkage of constructed structures. The investigated soil has high humidity (quantitative value could not be recorded), in the course of the experiment this object was dried for about 5 days if the rules of drying soil samples were observed. The selected soil sample after 5 months in the laboratory still has a high moisture content. The investigated soil was created specifically for use as a construction material. The categories of land on which the soil under study can be used include the lands of industry, energy, transport, communications, radio broadcasting, television, informatics, lands for space activities, defence, security and other special purpose lands[3].

However, during the experiments in the field it was found out that this material does not freeze at minus temperatures, and at positive temperatures even weeds do not grow on it, in addition, it can contain up to 85% of water, which raises questions about its reliability as a building material. In addition, the content of organic components in the soil has been analysed. Organic matter in soil acts as a complex source of nutrients for plants. The identified amount of organic matter (about 60%) is quite high and indicates a relatively fertile soil. However, the quality of the organic matter must be considered, as it can be of different types and contain different nutrients. As the object was created artificially, no new formations involved in soil-forming processes were found in it. However, a great number of inclusions of biological origin were found – remnants of roots, stems, and trunks of plants. The process of work in the laboratory is presented in Figure 3.

[3] Resolution of the Government of the Russian Federation of 10.07.2018 N 800 ‘On carrying out land reclamation and conservation’

Figure 3. Study of physical properties of artificial peat soil in the laboratory
Source: photo by P.K. Semyantsev, A.A. Ilchenko.

Further studies of soil chemical properties were carried out by preparing the sample for analysis and determining the composition of soil extracts. The pH-meter data showed rather high pH = 7.8, this value exceeds the generally accepted standard. For example, lowland peat is slightly acidic or neutral (pH = 6–7), while upland peat, on the contrary, is characterised by high acidity (pH = 2–4). Usually peat has an acidic environment with a pH value below 7. In this case, however, the peat may have been treated or may have been influenced by other factors that have increased its pH. This may be caused, for example, by exposure to mineral additives or other materials during peat production or processing. This may be important when peat is used for certain agricultural or horticultural purposes, as many plants prefer an acidic environment.

No reactions in the soil extract for nickel and copper are observed, which indicates their relatively low content in the soil or their complete absence. A small content of lead was detected, but within MPC. The salt content was also measured, measured in mg/l, which reflects the total amount of dissolved impurities in the water. The conductometer showed a value of 2000 mg/l, but this is not the limit for the water extract under study, as this value is simply the maximum value for the instrument used for the measurement. It is necessary to emphasise the relationship between increased pH and increased salt content in the context of chemical equilibrium. Water interacts with salt compounds, decomposing them into ions. If the salt content of the solution is highly elevated, the amount of ions released will also be high. This leads to an increase in the concentration of liberated hydroxide ions (OH^-)

in the solution. Hydroxide ions are bases and can raise the pH of the solution. Therefore, a strongly elevated salt content in solution can, in turn, lead to an increase in pH. However, it is important to note that other factors such as buffer systems or the presence of acids can also affect the pH of a solution. Therefore, while elevated salt content may contribute to an increase in pH, it may not be the sole cause.

One of the main characteristics of soil/soil is its electrical conductivity (EC). The method of measuring electrical conductivity is based on the ability of salts to conduct electric current. Therefore, EC determines the concentration of dissolved salts in the soil solution. The higher the EC value, the easier it is for current to flow through the soil due to the higher concentration of salts. The EC value also depends on soil moisture, water phase state, temperature, density, particle size distribution and other factors. The conductometer recorded electrical conductivity values of 3999 µSm/cm. The specified value is also the maximum for this instrument. High electrical conductivity of soils indicates the presence of large amounts of dissolved salts or minerals in the soil. High conductivity can also indicate contamination of the soil with chemical compounds or the presence of metals. It is important to note that high electrical conductivity can be undesirable for plant growth as it can leach nutrients from the soil and create unfavourable conditions for plant development. Electrical conductivity affects the rate of nutrient supply to plants – as EC increases, the concentration of salts in the soil increases, making it more difficult for plants to absorb water. At very high salt concentrations, water leaves the plant and enters the nutrient solution, which can lead to plant death. Thus, EC is a critical indicator needed to make informed decisions in agronomy. This soil parameter influences the selection of crops and determination of the required variety with respect to the salinity level present in the soil. Knowing the salinity level of the soil, decisions can be made on cultivation, field size and irrigation measures. The process of measuring the chemical characteristics and the sample under study is shown in Figure 4.

The results of the conducted laboratory study are shown in Table.

During the study of artificial soil, an experiment was also conducted on growing flax in order to confirm the most important indicator – fertility. The plant was not chosen by chance, as it has a number of advantages:

1) is a phytoremediating plant, i.e. it can clean the soil of pollutants. It can absorb and accumulate harmful substances such as heavy metals, pesticides and other impurities in its roots and stems and improve soil quality;

2) it grows rapidly and has a short development cycle, which allows it to establish quickly in contaminated soil. It can be grown in the shortest possible time and used to evaluate the effectiveness of soil remediation in contaminated sites;

3) it has a high tolerance to pollutants in the soil, such as heavy metals. This makes it suitable for growing in areas that may contain high concentrations of harmful substances;

4) can be used in different conditions and climatic zones, making it an attractive choice for remediation experiments on contaminated soils.

Figure 4. Study of chemical properties of artificial peat soil
Source: photo by P.K. Semyantsev, A.A. Ilchenko.

Laboratory results

Substance	Analysis	MPC
Lead, mg/kg	100	130.0
Copper, mg/kg	0	132.0
Nickel, mg/kg	0	80.0
Ph	7.8	< 5.5
Mineralization, g/l	2000	< 500
Electrical conductivity, mkSC/cm	3999	< 1000

Source: compiled by P.K. Semyantsev, A.A. Ilchenko.

To begin with, 3 containers were taken filled with 1/1 black soil, black soil and peat soil and peat soil respectively. Next, each of these containers was moistened with tempered water. Thirty-five flax seeds were planted in each container. After three days, the first sprouts appeared (only in the container with black soil). After another 3 days, 28 seeds sprouted in the same container, while flax did not sprout in the other two containers. The experiment was repeated three times, and the result was identical to the first one each time (Figure 5).

Figure 5. Soil investigation for fertile properties
Source: photo by P.K. Semyantsev, A.A. Ilchenko.

Due to the high salt content/mineralisation values obtained during the experiment, it is quite obvious that plants cannot survive in this type of soil. Increased soil salinity can negatively affect the nitrogen cycle in nature. Normally, nitrogen in organic forms is converted to ammonia (ammonification) and then to nitrite and nitrate (nitrification). However, these processes can be interrupted or slowed down in the case of heavy salinity. All this can lead to disequilibrium in soil nitrogen concentration. Therefore, in order to maintain soil fertility and the nitrogen cycle, it is important to control mineralisation and ensure adequate amounts of organic material in the soil. This equilibrium can be achieved by using fertilisers, increasing the organic matter content in the soil, reducing pollution and other agronomic measures [2]. The authors do not exclude the possibility of using this soil in plant cultivation with a smaller proportion of the studied sample, but the obtained high indicators of electrical conductivity and mineralisation require a deeper specialised laboratory study for the possibility of safe use of artificial peat both for the environment and for humans in general.

The use of peat soil for landfill reclamation can be an important step in restoring soil fertility. However, the formation of a natural fertile layer will take a significant amount of time. The rate of formation of the fertile layer depends on many factors, including the composition and quality of the peat soil used, climatic conditions, and the activity of microorganisms as well as other factors in the decomposition of organic material. Estimates suggest that it may take at least 100 years for 1 cm of natural fertile layer to form. This time may vary depending on conditions and decomposition processes. However, due to the high moisture content of the test sample, microbiological soil formation is questionable, as it is unlikely that even after a long period of time, such as 50–100 years, soil-forming microorganisms will appear in this soil. In addition, according to the Resolution of the Government of the Russian Federation dated 10.07.2018 No. 800 'On the reclamation and conservation of lands', the landfill is considered reclaimed only if at the stage of biological reclamation on its territory was carried out landscaping and natural processes of soil formation were started, which is impossible to do with the use of this artificial peat soil. Thus, the present study confirmed that the soil created from neutralised oil sludge is not suitable for the stated purposes, such as reclamation, as no vegetation takes root on it.

According to GOST 25100-95[4], technogenic soils are classified separately from natural soils and their properties and characteristics may differ. Technogenic soil, as a man-made and modified soil, has its own characteristics compared to natural soils. It may contain highly altered structure and composition, which affects its physical properties. Dispersed bound soil is a soil in which the particles have low overall adhesion and form weak bonds with each other. Because of this, it does not have high strength and is unable to withstand high loads and tensile strength. The capillary water in the soil forms weak molecular bonds which can also reduce its strength. According to the source documentation, the investigated soil belongs to the dispersed bound soil, and therefore, it is not able to withstand high loads and tensile strength, because capillary water in its composition forms weak molecular bonds[5].

Technogenic soil is often used for road surfacing and construction, reclamation and landfill refilling, but there is one important property of the material – it should not swell and not swell, which is absolutely not characteristic of the studied artificial peat soil. Since artificial peat, like natural peat, has a high degree of water resistance and moisture retention capacity, and therefore constantly swells, it is not suitable for use for the stated purpose (GOST 25100-95). This property can be dangerous and undesirable when used for road surfacing and construction, as well as for reclamation and landfill backfilling. Swelling and swelling can lead to significant problems with the stability and durability of such structures, as well as affect the quality of landfill operations [2].

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[4] GOST 25100-95. Interstate standard. Soils. Classification. Date of introduction 01.07.1996. Interstate Scientific and Technical Commission on standardisation and technical norming in construction.

[5] GOST 13672-76. Milling peat for briquette production. Technical requirements. Date of introduction 30.06.1977. State Standards Committee of the USSR Council of Ministers.

The applicability of this soil could not be established during the experiments. The chemical properties of the artificial soil do not ensure its suitability for agricultural use. The physical properties of the soil, due to its high moisture content, do not allow its use in construction due to doubts arising about its stability.

Conclusion

The treatment and disposal of oil sludge is an important measure that allows to use of recycled raw materials and reduces the negative impact on the environment. Proper management of oil-bearing waste contributes to the sustainable development of the oil and gas industry and ensures a cleaner future.

Proper management of oily waste is essential for the sustainable development of the oil and gas industry and ensures a cleaner future. It reduces the risk of contamination of soil, water resources and the atmosphere, as well as reducing negative impacts on biodiversity and human health.

Various technologies and methods are used in the process of oil sludge processing and utilisation. For example, mechanical and chemical cleaning can remove contaminants and separate valuable components for further utilisation. Thermal treatment, such as pyrolysis, allows to turn oil sludge into useful products such as fuel and coal.

However, it should be noted that oil sludge treatment and utilisation are complex processes that require careful monitoring and adherence to strict environmental standards. These include proper storage, transport, treatment and disposal of waste, as well as compliance monitoring throughout the process.

Increasingly stringent requirements and regulations aimed at environmental protection stimulate the development of new technologies and innovations in oil sludge treatment and utilisation. Promoting more efficient and environmentally friendly waste management practices helps minimise the negative environmental impact of waste and contributes to the sustainable development of the oil and gas industry.

The most important property of any peat is to improve soil quality and fertility. Due to the high content of organic matter, peat soil is able to improve the physical and chemical properties of the soil, increasing its fertility and the efficiency of water and nutrient utilisation by plants. However, more research is needed to determine the optimal conditions for the use of artificial peat soil, its environmental impact and possible contraindications. In general, the use of artificial peat soil based on oil sludge seems to be a promising and important step in solving environmental problems and improving the sustainability of agriculture.

The idea of creating artificial peat soil from oil sludge does have the potential to be environmentally and economically efficient. Instead of traditional peat extraction, which is a long-lasting process and can have negative consequences for the ecosystem, the use of oil sludge can provide a more sustainable alternative.

Peat soil is an important component in agriculture and horticulture, as it has a good ability to retain moisture and contains essential nutrients for plants. Creating artificial peat soil from oil sludge can help reduce the need for traditional peat, which can have a positive effect on the environment. However, before using artificial peat soil from oil sludge, the authors re-emphasise the need for research and testing to ensure that it is safe and effective. The potential negative effects of using oil sludge in agriculture, such as soil contamination or dissolution of toxic substances into plant crops, should also be considered.

Thus, the creation of artificial peat soil from oil sludge can be one of the steps towards sustainable development, providing waste utilisation and improving environmental efficiency not only in industry, but also in agriculture and forestry.

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