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ТОПЫРАҚ ЖАМЫЛҒЫСЫ МЕН МҰНАЙ ҚОРЫНЫҢ ҚАЗІРГІ ЖАҒДАЙЫН БАҒАЛАУ, СОНЫМЕН ҚАТАР НЕГІЗГІ ЭКОЛОГИЯЛЫҚ МӘСЕЛЕЛЕРДІ АНЫҚТАУ

АҢДАТПА

Мақалада топырақтың физикалық-химиялық және биологиялық параметрлерін оңтайландыру мен жіктеудің сандық критерийлері негізінде әдіснамалық тәсілдерді жетілдіру үшін мұнай кен орындарындағы топырақ жамылғысының қазіргі жағдайын талдау нәтижелері келтірілген.

Түйінді сөз: топырақ жамылғысы, мұнай кен орындары, ластану, антропогендік, физикалық-химиялық талдау, сынау.

ОЦЕНКА СОВРЕМЕННОГО СОСТОЯНИЯ ПОЧВЕННОГО ПОКРОВА И ЗАПАСОВ НЕФТИ, А ТАКЖЕ ВЫЯВЛЕНИЕ ОСНОВНЫХ ЭКОЛОГИЧЕСКИХ ПРОБЛЕМ

АННОТАЦИЯ

В статье представлены результаты анализа современного состояния почвенного покрова на нефтяных месторождениях для совершенствования методологических подходов на основе количественных критериев оптимизации и классификации физико-химических и биологических параметров почв.

Ключевые слова: почвенный покров, нефтяные месторождения, загрязнение, антропогенный, физико-химический анализ, тестирование.

AN ASSESSMENT OF THE PRESENT STATE OF SOIL COVER AND OIL RESERVES, ALONG WITH AN IDENTIFICATION OF THE PRIMARY ECOLOGICAL ISSUES AT HAND

ANNOTATION

The article presents the results of an analysis of the current state of soil cover in oil fields to improve methodological approaches based on quantitative optimization criteria and classification of physico-chemical and biological parameters of soils..

Keyword: soil cover, oil fields, pollution, anthropogenic, physical and chemical analysis, testing.

INTRODUCTION

The term "soil" is defined by GOST 27593 as an independent natural-historical organo-mineral entity that has formed on the Earth's surface due to prolonged interactions with biotic, abiotic, and anthropogenic influences. It comprises solid mineral and organic components, along with water and air, and possesses distinct genetic and morphological characteristics. These properties contribute to the creation of suitable conditions for the growth and development of plants [1]. Soil composition exhibits significant chemical diversity, primarily comprising organic and mineral components. The organic fraction plays a crucial role in influencing soil fertility, while the mineral aspect is derived from the parent rock and is essential in determining the soil's classification [2].

In the modern world, anthropogenic influence has a significant influence on soil and soil, regrettably, this often leads to soil pollution with heavy metals, oil products, pesticides and other sources of pollution. In order to prevent, detect and eliminate negative effects leading to the deterioration of the quality of soils and soils, sanitary-epidemiological rules and norms have been developed, maximum permissible concentrations of pollutants have been established, after comparison with which a conclusion is made about the suitability or unsuitability of soils for further use or development revegetation measures for its restoration [3].

Kazakhstan ranks among the world's foremost nations in the production and sale of oil, with deposits located throughout nearly its entire territory. Any technical measures associated with the exploration and development of oil fields will inevitably result in environmental alterations. The primary challenge lies in assessing the extent to which natural processes can be disrupted while minimizing harm to the environment and public health. Consequently, sustainable resource management must consider both the natural and economic characteristics of the region, which are marked by several distinct features: concentrated development, underdeveloped infrastructure, a limited transportation network, and challenging climatic conditions amidst a rich diversity of flora and fauna. Oil spills and the contamination of soil with petroleum products lead to significant alterations in soil composition, which is crucial for maintaining biodiversity. Research into the effects of oil contamination revealed a spectrum of soil degradation, ranging from minor property impairments to the total loss of its ecological role, ultimately culminating in complete soil devastation. [4].

In this context, the systematic physical and chemical analysis of soil enables the state to oversee the production activities of oil extraction companies, thereby preventing, identifying, and mitigating adverse effects that can lead to the degradation of soil quality in the affected areas. This oversight is conducted in accordance with sanitary-epidemiological regulations and standards, which specify the maximum allowable concentrations of pollutants. Based on this comparison, a determination is made regarding the soil's suitability for future use or the necessity for implementing restoration measures.

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Physicochemical and biological tests of soil, encompassing oil field areas, are performed based on specific properties. These tests reveal soil composition details, aiding in recultivation and the recovery of the initial soil makeup.

Soil tests to determine the presence of various substances are conducted using a range of physical and chemical methods, encompassing nearly all available analytical techniques that utilize specialized instruments to measure the physical parameters of the examined systems. Nonetheless, research focused on the quantitative assessment of soil quality constitutes only 20% of the total number of studies performed, primarily due to the considerable financial and temporal resources required to analyze each specific indicator.

Optimizing soil parameters is crucial for a reliable, scientific evaluation of soil quality in oil fields. This is an important step for operational soil monitoring. The outcomes of this monitoring enable preventive and corrective actions, thus speeding up recovery. Our work was defined by a series of studies which we conducted.

EXPERIMENTAL METHODS

A key innovation in our work lies in crafting new techniques for choosing soil indicators based on how crucial they are to refining measurement strategies when assessing the soil's physical, chemical, and biological properties.

This research aims to formulate suggestions for refining the rules governing how we evaluate and categorize soil characteristics – encompassing both physical, chemical, and living components – using measurable standards and a system for ranking them. Ultimately, it seeks to establish a method for assessing the overall health and condition of soil ecosystems. To achieve the set goal in the dissertation research, it is necessary to solve the following tasks:

1. Examine the present condition of soil in oil fields, pinpointing key environmental issues, drawing on both local and international practices.
2. To investigate the primary physicochemical, biochemical, and biological characteristics of the soil cover that influence soil properties
3. To examine current soil testing methods, aiming to identify the best option and most suitable for accuracy, reliable results, and precision in measurements.
4. Analyze the legal and compliance standards concerning soil quality and health within oil field environments.
5. Conduct research and establish criteria for assessing the quality and effectiveness of instrumental methods used for analyzing the composition and properties of soil.
6. To conduct a selection of contemporary measurement tools and testing equipment employed in the qualitative and quantitative analysis of soil coverage
7. Formulate guidelines for acquiring experimental data regarding the agro-ecological stability of soil in oilfield environments, while also establishing standards for evaluating the optimization of physicochemical parameters
8. Create a documented process, "In-Lab Quality Control for Physical and Chemical Analyses," to guarantee accurate and dependable measurement results.

Oil is pumped from working oil wells arranged in KSh (kushty wells) – these are circular platforms housing the wellheads. Output from all the wells flows into pumping stations (DNS). These stations perform the initial separation of oil and gas, deliver gas for flaring, and move the liquid via pipeline to the oil collection facilities at the UPPN (primary oil treatment plant).

The objective of UPPN is to produce commodity-quality oil through the processing of oil emulsions, which involves dehydrogenation and desalination, followed by the transfer of the refined commodity oil into the main pipeline system for distribution to consumers.

The basic process of oil production technology can be broken down into three steps:

1. CS - oil production;
2. DNS - the first stage of separation of oil and gas;
3. UPPN - preparation of oil to commodity quality.

Each successive stage represents a more intricate technological process than its predecessor. Given the escalating man-made impact of oil production facilities on the adjacent natural environment, as indicated in the series KSDNS-UPPN [5], in order to assess the condition of the soil cover in the zone of potential influence of oil production facilities, an inspection was carried out in the zone of potential influence of UPPN, within the sanitary protection zone (1000 m). Technogenic impact of UPPN is usually accompanied by organic input, acidification, salinization of the environment. The environmental effects of UPPN often involve organic matter, increased acidity, and risings altlevels. Consequently, soil investigations near the potential reach of UPPN assess the presence of humus, the degree of acidity, as well as levels of oil byproducts, 3,4-benzopyrene, and chloride in soil specimens.

RESULTS AND ANALYSIS

The assessment and analysis of the soil cover condition are conducted in accordance with methodological guidelines for recognizing degraded and contaminated lands [6]. The extent of pollution and/or salinity was evaluated based on the classifications outlined in Tables 1 and 2.

Table 1 – Extent of soil contamination

Pollution level	Content of petroleum products, g/kg	Content of 3.4-BP, ng/kg
Inadmissible	< 1	< 20
Low	1-2	20-100
Average	2-3	100-250
High	3-5	250-500
Very high	> 5	> 500

Table 2 – Soil classification based on salt content.

Degree of salinity	Amount of soil in soil, %
What salty	< 0.3
Lightly salted	0,3-0,5
Srednesolanaya	0,5-1,0
Strongly salted	1,0-2,0
Very salty	> 2.0

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A comprehensive survey was conducted across the geographical regions encompassing the Tengiz, Karachaganak, and Kashagan deposits, spanning the Mangistau and Atyrau provinces. Soil samples were systematically collected using the envelope method from the topmost soil layers across a randomly distributed grid at designated locations. A total of 181 samples were obtained during a thorough examination of the areas surrounding the deposits.

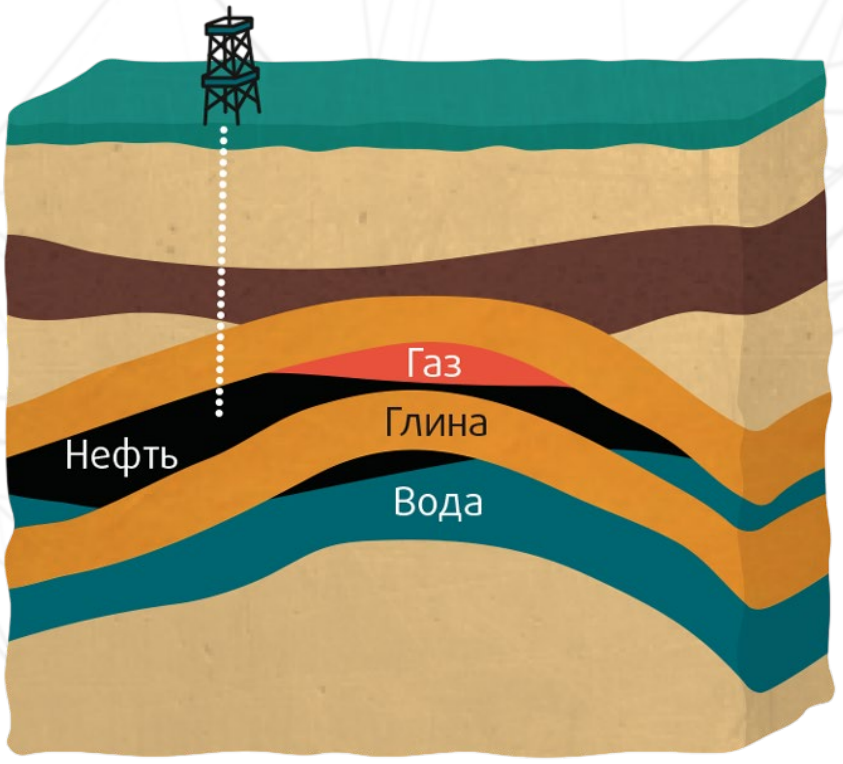
Collection depths: pasture, hay storage - 0-20 cm; forest (surface of the woods) - 0-10 cm; areas of oil industry sites, residential area - 0-10 cm. Soil bulk density was measured in the field. Physical-chemical and agrochemical analyses were performed using standard techniques. [7.8.9]. The main anticipated environmental impacts from oil field operations include acidification, contamination from oil derivatives, 3,4-benzopyrene pollution, and soil salinization. [10].

Within the area near the UPPN "Tengizskoe Mestrozhdenie," soil conditions (pH, humus) are within normal background levels. Emissions from UPPN, which could acidify the environment, have a negligible effect on the soil. Humus content fluctuates significantly, from 0.66-5.50 %, with the lowest and highest values found in meadows. In agricultural areas, humus content is less varied, rangingfrom 3.07-1.31 %. These humus levels are typical for this soil type. The industrial activity of UPPN has a minimal impact on the humus levels. One meadow sample indicates the fifth level of contamination, which would require soil conservation (19.40 g/kg). High petroleum product content was observed in a sample from the north and from meadows, at 2.18 g/kg. Elsewhere, the levels of oil do not affect the production or quality of agricultural goods. The sporadic higher pollution is likely tied to incidents with oil industry equipment.

The content of 3,4-benzpyrene generally exceeds ecological standards. Only one soil sample exhibits a higher level of pollution compared to the PDC standard for soil. This contamination appears to be a consequence of the degradation of man-made organic materials.

The most prevalent soil type within the "Karachaganak" UPPN area is modern medium podzolic, with a heavy loamy texture. Humus levels show considerable variation, ranging from 0.69% to 13.54 %. The soil cover doesn't exhibit acidification. Within the floodplain soils, salinity and hints of salinity (up to 0.8 % chlorides) are present, linked to industrial water leaks. An elevated concentration of petroleum products was found in the Ural River floodplain (up to 2.11 g/kg), leading to the accumulation of anthropogenic organic matter. The rest of the area shows no signs of contamination. No pollution is observed in the rest of the territory. While soil biogeochemical processes can mitigate the impact of petroleum products as atmospheric pollutants, the potential for their harmful buildup in the environment has not been definitively proven. The content of 3,4-benzpyrene varies from 0.9 d to 4.6 ng/g. The sanitary and hygiene standards deem this material harmless regarding the specified contaminant.

The most prevalent soil types in the UPPN "Kashagan" area are turf-weak, medium podzolic, and turf-gley heavy loamy soils. These soils have relatively low levels of phosphorus, both in total and particularly in its mobile form. However, the concentration of mobile phosphorus increases significantly with depth..



Typically, mobile nitrogen is insufficient. Mobile potassium content is quite high. pH KS1 values range from 4.3 to 6.6, and pH H2O values range from 5.0 to 7.2. There's no considerable increase in acidity stemming from human activities. Traces of chloride contamination exist in floodplain soils. Humus content in these soils varies significantly, from 0.12 to 9.63 %. Low humus levels are characteristic of hayfields, and high levels are typical for forest soils. These conditions correlate to the baseline anthropogenic load. Oil product pollution near UPPN is concentrated in low-lying areas. This results from accidental leaks and oil product migration. The content of oil products in the plain area doesn't go beyond environmental limits. Air pollution from technology doesn't produce negative effects. The concentration of 3,4-benzopyrene usually varies from 0.9 to 4.5 ng/g. Nevertheless, alluvial soils polluted by oil products in the southern ravine of UPPN contain up to 1109 ng/g of the pollutant (over50 times higher than the maximum permissible concentration).

CONCLUSION

The analysis of the soil cover in the sanitary-protective zone of the studied soil deposits at UPPN leads to the following conclusion: atmospheric emissions of harmful substances do not significantly impact soil acidity. The levels of petroleum products in the soils across all UPPN territories are primarily influenced by the discharge of water-oil emulsions from technological sites, along with atmospheric emissions of hydrocarbons. Salinity is nearly always found in floodplain soils. The levels of petroleum products and benz(a)pyrene in areas potentially affected by UPPN vary. Generally, the operation of oil fields results in the creation of both natural and artificial biotopes, where elevated concentrations of oil products and benz(a)pyrene are observed. Natural and man-made ecosystems of the accumulative type are formed in the places of installation of UPPN, intended for the regulation of migration and transformation of visually determined pollutants.

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