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SOIL MONITORING IN PRODUCTION FIELDS

Monitoring can be considered one of the main methods of solving the problem of pedosphere pollution, because the necessary information to overcome the problems can be obtained only through the large-scale specific study. At present, there are some monitoring programs aimed at solving the problems, but they are not effective enough and, therefore, cannot completely fulfill their tasks.

The current problems of land monitoring in Ukraine are primarily related to its organization, which could provide the comprehensive and systematic accounting and assessment of the status of land in order to protect and improve the quality of agricultural soils. There is a need to create a permanent system of accounting, observation, comparison, measurement, inventory and forecasting of the ecological status of lands with the detection and registration of changes against the background of natural and anthropogenic processes, in the continuous functioning of the ecological monitoring service of land. Analyzing the studies in the field of monitoring the oil-contaminated soil on the territory of oil and gas fields, it becomes necessary to develop the new methods of ecological monitoring of the soil of depleted oil and gas fields in order to study the problem of pedosphere contamination.

The development results of a new method of environmental soil monitoring in depleted oil and gas fields are described. The method allows obtaining adequate information on the studied area. An important role in the new monitoring scheme is played by the method of locating soil sampling points, the benefits of which are the system's flexibility in relation to the studied territory and complexity of research that does not necessarily depend on the size of the studied area. The proposed schemes introduce a new view of monitoring the soil, which is subjected to the heavy anthropogenic impact of the mining industry. The analyzed schemes help to develop new reclamation methods of the soil located in the depleted oil and gas fields, which is contaminated with hydrocarbons and drilling waste.

Key words: monitoring methods, petroleum products, soil, expert, pollution, degradation, ecological safety, field, hydrocarbons.

Problem statement. To improve the environmental safety of the soil, the existing monitoring scheme should be improved. The process of mineral extraction affects the quality of the geological environment, and in the main, the pedosphere. Current monitoring methods do not provide complete and qualitative information on the ecological safety of land, in particular, in the area of contamination risk.

The purpose of the work is to develop a soil monitoring scheme in the areas that are at risk of contamination with heavy and light hydrocarbon fractions, which cause the irreversible degradation of land. It is also important to develop a flexible method to control the impact of drilling and production processes on the soil.

Literature review. Reliable information about the real spatial and temporal changes of society's impact on land resources is one of the most important factors of human optimization, a multifaceted human-environment system. The study of the current state and prognosis of the development of these processes, their interaction with other factors are a priority in most social and natural sciences. Monitoring land resources and optimizing their structure and functional connections are of great importance for solving the outlined problems [5].

The current problems of land monitoring in Ukraine are primarily related to its organization, which could provide the comprehensive and systematic accounting and assessment of land status in order to protect and improve the quality of agricultural soils. There is a need to create a permanent system of accounting, observation, comparison, measurement, inventory and forecasting of the ecological status of lands which detects and registers changes against the background of natural and anthropogenic processes, i.e. the continuous functioning of the environmental monitoring service of land.

The dynamic nature of the environmental state, especially land resources, requires reliable data on their quantitative and qualitative indicators in order to substantiate management decisions. The monitoring system of land resources is regulated first of all by the Land Code of Ukraine and the applicable normative legal acts. Based on the current multifaceted nature of land monitoring tasks, it is necessary to establish at the legislative level the procedures for land monitoring in Ukraine. It should be clearly defined which prerogative of the administrative and territorial government agencies involves

taking the appropriate measures of land monitoring, which public offices are responsible for implementing the land monitoring instructions and possess and transmit the official information. In addition, the regulatory framework for land monitoring and the responsibilities of the relevant public offices should be provided.

It is necessary to develop the mechanisms for the harmonization and systematization of information at all levels of the executive branch. Developing a unified approach to the implementation of land monitoring is an important task. Defining the functions of organizations and institutions in providing reliable data is a serious problem of the regulatory control of land monitoring. This raises the problem of the legal regulation of examining the objectivity of land monitoring results.

The issues of developing and improving the theoretical basis for land monitoring are equally important. The significant aspects of land monitoring have not been developed yet, in particular: the system of organization and its management, detailed structure of land monitoring and its technological stages, complex methods of land resources analysis, basic criteria and norms for assessing the state of land resources and crisis detection.

An important issue of land monitoring is the development of clear approaches to interpolating the results of discrete surveys of land resources over a large area. This requires determining the interpolation radii of different land monitoring indicators that can be territorially generalized. The problems of land monitoring theory that directly affect the quality of consequence evaluation of negative processes and the implementation of adequate measures for their prevention and elimination [4-8] have not been solved yet.

Land resources monitoring is an integral part of geosystem monitoring. Monitoring changes in the natural territorial complexes requires a simultaneous consideration of man-made factors, since human activity is manifested without exception in all regions of the globe. Thus, a complex geosystem monitoring requires the use of a multi-sector probing system to identify changes in all qualitative and quantitative parameters of the natural environment and the anthropogenic impacts on them.

As monitoring the geosystems is a complex and holistic mechanism for environmental probing, it is advisable to introduce a systematic classification of its objects, methods and means. The areas of monitoring natural systems are divided into three groups: geosphere, biosphere and sociosphere (O. M. Adamenko). The first direction covers inanimate nature, the second – wildlife and the third – human activity. Geosphere monitoring includes probing the lithosphere, geomorphosphere, geophysical spheres, hydro- and atmosphere. Biosphere monitoring combines probing the phytosphere (vegetation) and zoosphere (wildlife). Sociosphere monitoring involves probing the demosphere (human society) and technosphere (human performance). Of course, the given geosphere monitoring scheme has a logical construction and a holistic structure [10].

In addition, it is important to systematically divide the studied objects into structures of different physical nature. In the context of establishing natural relationships, this gradation helps to begin a systematic study of all the processes under study. The fundamental gradation of geographical envelopes is made according to the principles of dividing them into the components of inanimate and living nature and complex components, for example, soils, natural waters, etc.

The monitoring of land resources is impossible without taking into account their interrelations with the components of wildlife, especially when predicting changes in the structure of land resources. The impact of human society on the structure, condition and changes of land resources is equally important. This is especially true in the fields of ecology, environmental protection, sustainable use of nature and optimization of the maximum efficiency of natural resources. Land resources are monitored in all subsystems of the geosphere, using all applicable methods and technologies of natural and applied sciences.

Land resources are monitored at three levels – national, regional and local.

National monitoring is conducted on the basis of systematization of regional monitoring data. At this level, the problems of a purely technical nature usually arise in connection with the timely provision of regional reporting materials. The problem of reconciling the remote sensing data with space research findings from regional studies is equally important.

Results and discussion. Soil monitoring in depleted oil and gas fields is one of the important issues of land ecological safety. At present, monitoring methods do not provide complete information on the state of the environment and level of the ecological safety in the areas at risk of contamination with hydrocarbons and drilling waste. To solve this problem, we have developed a new monitoring scheme, which is distinct in that it takes into account the geographical features and the hazard level of the pollutant, its specific and peculiar features.

Soil monitoring in depleted oil and gas fields can be divided into 3 categories: lowland, highland, mountainous. Each category is important and requires a specific approach, since the soil in different territories has specific properties that will affect the distribution of hydrocarbons and the level of soil contamination.

A lowland monitoring method is used if the contamination source is located directly in the lowland. This method is a systematic observation – a scientifically based observation type, the systematic character of which is planned and accurate. It consists in data acquisition in the research area over a period of time and at regular intervals. The quarterly data collection is an example of this. This method also involves the annual or one-time observation, which consists in the non-recurring data collection and is carried out to obtain information on the state of the sampling area under study, in particular soil contamination with petroleum products, heavy and light fractions of hydrocarbons used during drilling. The location of possible contamination source (drilling mud pit, well, oil refinery, oil base) is important for this method. The lowland monitoring method involves the study in the area with height variations not exceeding 10–15 meters and can be divided into 3 subtypes [1-3].

Highland monitoring is intended to investigate the likely soil contamination sources in the highlands. The sources of soil contamination with petroleum products, heavy and light fractions of hydrocarbons, can be drilling mud pits, wells, storage facilities, and pressure maintenance stations. Sampling is carried out in four directions, each corresponding to the four cardinal directions. Samples are taken at 50 m intervals to determine the overall soil contamination situation. After analyzing the situation, the next group of samples is taken in 4 directions (north-west, north-east, south-west, south-east), but the sampling is non-linear. At first, one sample is taken, the midpoint is set between the east and the south, that will be the south-east.

Then there will be a couple of points that are in the same direction. They will not lie on the same line, but will be equally spaced both from each other and from the starting point in the direction shown in the example. This sampling method will provide information on the contamination level, migration direction of the pollutant and cyclic measurement of the migration speed of the pollutant. This information helps to predict the level and direction of contamination and create reclamation facilities that will slow down or prevent the further distribution of substances, such as oil [1].

The monitoring of mountainous areas is defining the location of likely contamination sources in a mountainous area.

Soil samples are taken along the slope in six lines that evenly spread from the center of the possible contamination source. The distance between sampling points may be 25–30 m, 50 m, 100 m, and 200 m, depending on the details of the study. In most cases, the contamination sources in the mountainous area are at an altitude that is not maximum for the surface, that is, they are below the mountain top or the mountainous area. In this case, it is necessary to locate sampling points above the possible contamination source.

A reference line is a group of soil sampling points above the altitude above the possible contamination source, such as a drilling mud pit. Therefore, soil samples can be used as a reference and for comparison. These activities are carried out to determine the increase in the concentration of the heavy and light fractions of hydrocarbons compared with the initial pollution effect of the possible contamination source. It is also necessary to select a reference point for the reference line at the mountain top where the contamination source is located [1-5].

We have proposed three soil sampling schemes for the areas that are at risk of hydrocarbon contamination. Each of the proposed schemes is aimed at obtaining complete and qualitative information about the condition of the studied soil at different scales [2,3].

SPIop4 – Sanitary protection installation of oil pollution in four directions

SPIop8 – Sanitary protection installation of oil pollution in eight directions

SPIop16 – Sanitary protection installation of oil pollution in sixteen directions

SPIop4 is a monitoring method of soil that is at risk of pollution with oil and petroleum products. Using the proposed scheme, soil samples should be taken in four directions or lines oriented in the four cardinal points of the world (west, north, east, south). All directions come from a single center that is considered a possible source of soil contamination. Soil samples should be taken at 25 m intervals. However, this method, depending on the details of the study, involves a sampling interval from 25 to 100 meters. Each sampling point can be selected radially in relation to the contamination source (at the same distance from the contamination source, in a circle, at each line) and by alternating the lines (sampling is alternately carried out from the contamination source in each direction, another line is

chosen when the complete sampling is achieved along the entire profile). Regardless of the direction type (primary or secondary), each soil sample can be taken with a deviation of up to 5 meters and radially in relation to the sampling line [2, 3].

SPIop8 is a monitoring method of soil that is at risk of pollution with oil and petroleum products. Using the proposed scheme, soil samples should be taken in eight directions or lines, four directions are primary and correspond to the cardinal directions of the world (west, north, east, south), and four directions are secondary and are located between the primary ones so that the distance between all directions is the same, they correspond to such directions as north-west, north-east, south-west, and south-east. All directions come from a single center that is considered a possible source of soil contamination. Soil samples should be taken as follows: in primary directions, soil samples should be taken at 25 m intervals; in secondary directions, soil samples should be taken at 20 m intervals from the source for the first samples, and at 30 m intervals for the following samples. Each sampling point can be selected radially in relation to the contamination source (at the same distance from the contamination source, in a circle) or by alternating the lines (sampling is carried out from the contamination source in clusters in the required amount and upon completion it is followed by the complete sampling in the next line). Regardless of the direction type (primary or secondary), each soil sample can be taken with a deviation of up to 5 meters and radially in relation to the sampling line [2, 3].

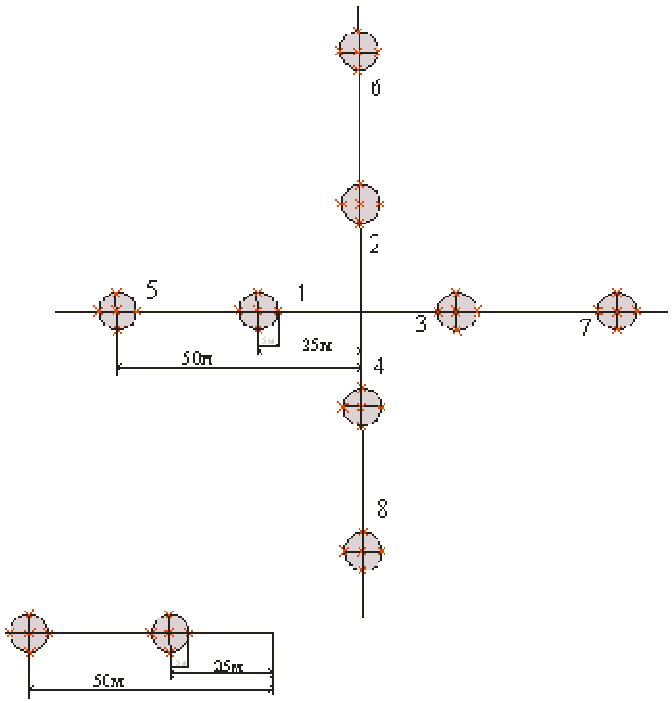

Fig.1. Scheme of locating soil sampling points to determine the concentration of petroleum products in 4 directions (SPIop4)

SPIop16 is a monitoring method of soil that is at risk of pollution with oil and petroleum products. Using the proposed scheme, soil samples should be taken in 16 directions or lines, eight directions are primary and correspond to the directions of the world (north, north-east, east, south-east, south, south-west, west, north-west), other eight are secondary and are placed between the primary ones so that the distance between all directions is the same. All directions come from a single center that is considered a possible source of soil contamination. Soil samples should be taken at the following intervals: in primary directions, soil samples should be taken at 25 m intervals; in secondary directions – at 30 m intervals. Each sampling point can be selected radially in relation to the contamination source (at the same distance from the contamination source, in a circle), and by alternating the lines (sampling is carried out from the contamination source in the line in the required amount and upon completion it is followed by the complete sampling in the next line).

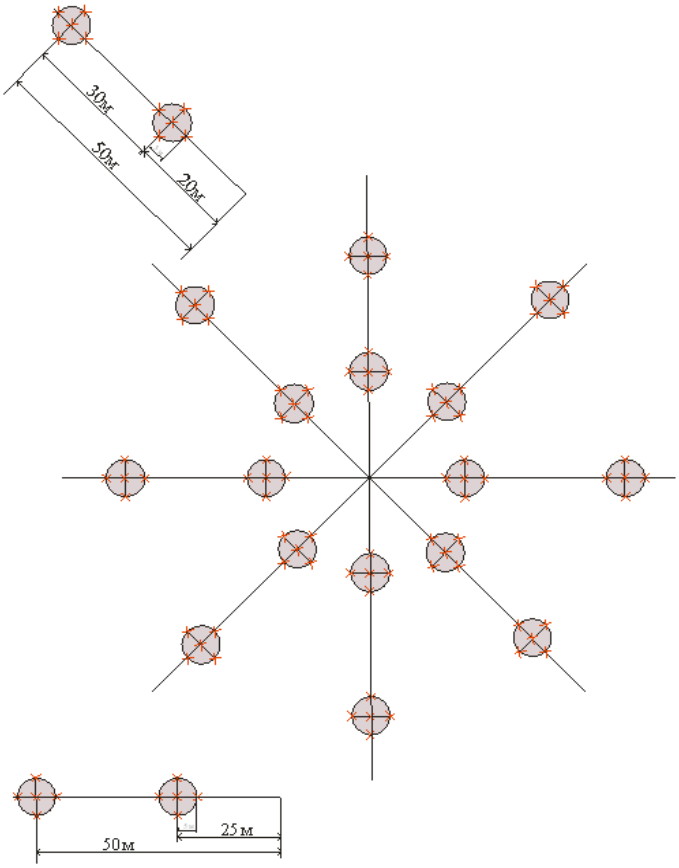

Fig.2. Scheme of locating soil sampling points to determine the concentration of petroleum products in 8 directions (SPIop8)

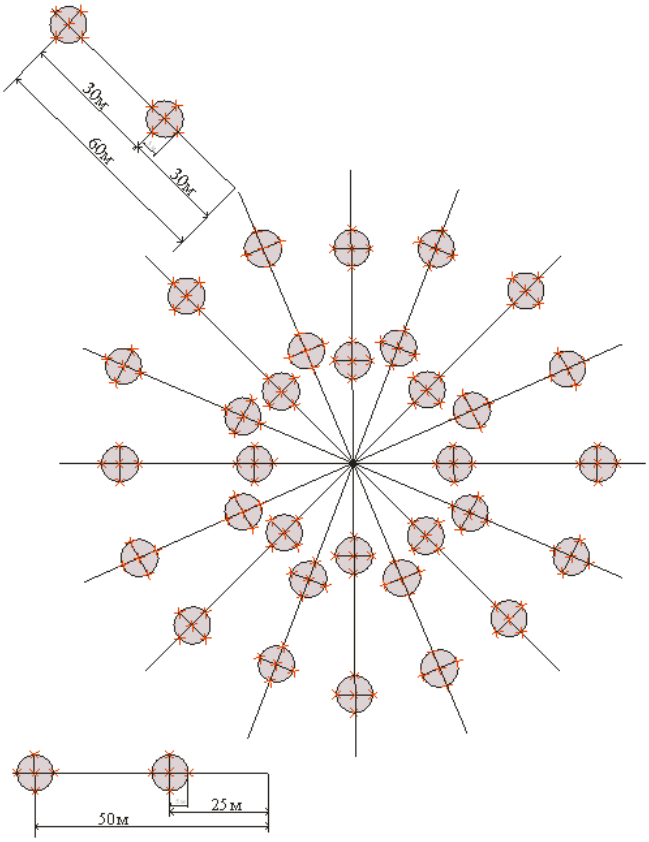

Fig.3. Scheme of locating soil sampling points to determine the concentration of petroleum products in 16 directions (SPIop16)

Regardless of the direction type (primary or secondary), each soil sample can be taken with a deviation of up to 5 meters and radially in relation to the sampling line [1-3]:

To control the soil contamination level, we have proposed sampling at different depths and in terms of the concentration of petroleum products. Determining the contamination load at different depths will help to obtain information on the status of soil profile and make forecasts for further degradation of the territory or to identify the areas that are at risk. The proposed monitoring schemes will enable a more effective use of the methods of soil cleaning from pollutants and will allow developing new methods of soil reclamation due to the information on the spread dynamics of pollutants (oil or petroleum products) in the soil profile [3].

Conclusions. This work draws attention to the issue of studying the areas exposed to hydrocarbons production. This article deals with landfills in drilling mud pits, heavy and light oil fractions, and drilling waste. Such drilling waste management affects the soil and causes a systematic land degradation and impossibility of further land use. That's why, monitoring these territories deserves attention and requires new approaches to studying them and obtaining adequate and dynamic data.

The proposed monitoring schemes will help to predict risk areas in different geographical locations. These schemes draw attention to the need of developing a special scientific approach, which takes into account geographical features and the unique distribution of the studied pollutant in the environment.

For the first time, this article deals with dependencies, which help to develop a better understanding of the spreading processes of pollutants in the pedosphere and to find new ways of eliminating the consequences of pollution.

The paper also proposes a soil sampling scheme that differs from the existing ones. By applying this scheme, the obtained information can become more flexible and complex. Dividing the sampling into three types will provide grounds for its use in the large-scale territory development.

The proposed soil monitoring method in depleted oil and gas fields and the location of sampling points create a system that has already demonstrated its effectiveness in obtaining adequate information on the exploration of areas at risk of being polluted with hydrocarbons.

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МОНІТОРИНГ ҐРУНТОВОГО ПОКРИВУ НА ТЕРИТОРІЇ РОДОВИЩ

Одним з основних методів вирішення проблеми забруднення педосфери можна назвати моніторинг, оскільки тільки за допомогою масштабного цільового дослідження можна одержати необхідну інформацію для подолання проблем. Сьогодні вже існують деякі програми моніторингу, які намагаються розв’язати проблеми, але вони є недостатньо ефективними, а отже, не можуть повністю вирішувати поставлені перед ними завдання.

Сучасні проблеми здійснення моніторингу земель в Україні пов'язані насамперед з його організацією, що могла б забезпечити проведення всебічного і систематичного обліку й оцінки стану земель з метою захисту і поліпшення якості ґрунтів сільськогосподарського призначення. Виникає необхідність у створенні постійної системи обліку, спостереження, порівняння, вимірювання, інвентаризації і прогнозування екологічного стану земель із виявленням і реєстрацією змін на тлі природних і антропогенних процесів, тобто в постійному функціонуванні служби екологічного моніторингу земель. Аналізуючи дослідження у сфері моніторингу ґрунтового покриву, забрудненого нафтопродуктами на території нафтогазових родовищ, постає необхідність у розробленні нових методів екологічного моніторингу ґрунтового покриву виснажених нафтогазових родовищ з метою дослідження проблеми забруднення педосфери нафтопродуктами.

Розглянуто результати розробки нового методу екологічного моніторингу ґрунтового покриву виснажених нафтогазових родовищ. Розроблений метод дозволяє отримати адекватну інформацію про досліджувану територію. Важливу роль у новій схемі моніторингу закладено у методі розміщення точок для відбору проб ґрунтового покриву, переваги якого полягають у гнучкості системи відносно території, яка розглядається та різномасштабністю власне дослідження, яке не обов’язково залежить від розмірів ділянки. Запропоновані схеми вносять новий погляд на розвиток моніторингу ґрунтового покриву, який потрапив під важкий антропогенний вплив гірничо-видобувної діяльності. Розглянуті схеми дозволяють розробити нові методи рекультивації ґрунтового покриву, який знаходиться на територіях виснажених нафтогазових родовищ та забруднюється вуглеводнями та відходами буріння.

Ключові слова: методи моніторингу, нафтопродукти, ґрунт, експерт, забруднення, деградація, екологічна безпека, родовище, вуглеводні.

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