ENVIRONMENT AND HEALTH STATUS OF THE NORTH POPULATION

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BIOREMEDIATION OF OIL-CONTAMINATED TERRITORIES AS THE BASIS OF A SYSTEM TO IMPROVE THE ENVIRONMENT OF HUMAN HABITATION IN NORTHERN SIBERIA

ABSTRACT

We assessed the effectiveness of bioremediation of oil-contaminated territories as the basis of a system of measures to improve the environment of human habitation in the Northern Siberia. We collected soil and water samples on the territory of the activities of oil companies in the South of the Yamalo-Nenets Autonomous area before and after cleaning with the association of microorganisms capable of decomposing oil and oil products. It is shown that treatment of oil-contaminated and petroleum sites with preparations on the basis of oil destructor microorganisms leads to decrease of oil products on average 56.64±18.82.

Keywords: bioremediation, petroleum products, microorganisms, the North of Siberia.

The North of Siberia (the Northern part of Khanty-Mansi Autonomous Okrug and Yamalo-Nenets Autonomous district) is an area with strong anthropogenic pressure to a certain mass extraction of natural resources, primarily gas, oil and oilgascondensate. Environmental pollution caused by gas and oil production, both due to the imperfection of the technology of production, and the result of emergency situations [7].

The overall toxicity of oil is low, however, its separate components (polyaromatic and polycyclic compounds) are highly toxic, and have severe carcinogenic and teratogenic properties. The most toxic for living organisms are aromatic compounds which can constitute up to 10% of the crude oil. The inhabitants of the areas where is oil production, have more often decreased immunity, allergies, cancer neoplasms and congenital deformities, etc [15, 18]. The presence of oil reservoirs has an adverse impact on the health of birds, fish and mammals [5]. When drops of crude oil to soil of low molecular weight fractions usually evaporate into the atmosphere. N-alkanes with chain lengths of C10-C16 and monocyclic aromatic hydrocarbons migrated into the soil and are biodegradable microbial biota. However, high molecular components, especially alkanes with a carbon chain length of more than 20 and polycyclic aromatic compounds such as naphthalene, anthracene, phenanthrene, chrysene, benzopyrene, etc., and their alkylated derivatives, are retained in the soil [19].

The problem of oil pollution today is one of the most acute environmental problems. It is known according to Greenpeace and the Ministry of environment that only Russian oil companies are losing about 20 million tons of oil annually (5% of total production). According to the Antistikhia center of EMERCOM of Russia [13] the total area of contamination of soil by oil and oil products as at the end of 2015 on the territory of the Russian Federation is approximately 1025 hectares. The main causes of soil contamination with oil products was deterioration of the equipment, transport accidents and unauthorized connections.

A serious problem is the contamination of soils by spills of oil and more frequent with the development of shipping oil spills by marine transportation. Soil pollution is usually accompanied by groundwater contamination [5, 10] that, in turn, has negative consequences for human health, animals and plants. Cleanliness of drinking water and its availability is one of the most important factors determining quality of life. According to experts, bad for the environment due 20% of all diseases.

The spread of contaminants most often takes the course of distribution of water:

First, there is a constant leaching of contaminants to surface waters and groundwater that can be used by man for drinking and other needs.

Secondly, the pollution of soil moisture, groundwater and open water bodies into the organisms of plants and animals who consume this water, and then food chains again into the human body.

Once in the water, the organic contaminant is a member of its cycle in nature and quickly spreads to components of the biosphere. Thus, by the water all living organisms on Earth, without exception, are involved in interaction with petroleum products. The most toxic for living organisms are aromatic compounds which can constitute up to 10% of the crude oil. They include volatile compounds (benzene, toluene, xylene; naphthalenes and polycyclic aromatic hydrocarbons), carcinogenic and mutagenic properties.

If water is one of the most important elements of distribution of oil pollution, soils largely determine the stability of the biosphere and its purification from pollutants [1, 8, 9, 10, 11, 17]. Self-purification of soil is the sum total of natural processes aimed at reducing the concentration of pollutants substances [6]. It is primarily due to the ability of soil microorganisms to decompose a wide range of natural and unnatural compounds [14]. Different soil microorganisms for which the oil products are often the source of carbon have a great influence on the persistence of chemical compounds in the soil. Even very persistent in relation to chemical compounds are decomposed by the microorganisms of the soil. In many cases such decomposition does not begin immediately, but after some time, necessary for the adaptation of microorganisms to the destruction of the chemical compound. The most easily decomposed by the microorganisms of the soil compounds of the aliphatic series, as well as hydroxycobalamin connection.

Modern technology of purification

of soils polluted with hydrocarbons, include excavation and containment of contaminated soils in secure landfills, stabilization and solidification, soil flushing, extraction, composting, chemical oxidation, thermal desorption and incineration, and bioremediation (bioaugmentation, biostimulation and phytoremediation).

Compared with physical and chemical remediation methods, bioremediation is widely regarded as the most cost-effective method and provides remediation of in situ soil without disturbing the natural ecosystems. The technology is environmentally friendly because there is a stimulation of the natural processes. In situ bioremediation also provides the ability to restore contaminated soil and groundwater without excavation, which is a big advantage.

The bacteria are available in almost all known hydrocarbons, but primarily degrades saturated hydrocarbon group. During their oxidation a number of intermediate products: biological surfactant (biopal), biopolymers, alcohols, hydroxy acid esters, carboxylic acids, aldehydes, ketones, small amounts of organic peroxides, peracids, and other compounds forms. It should be noted that the processes of oxidation of hydrocarbons occur, as a rule, during active growth and reproduction of microorganisms.

Currently there are various methods of remediation based on the oxidizing activity of microorganisms. Despite the apparent diversity, they are based on or stimulation of the indigenous soil microflora or introduction into the soil of hydrocarbon-oxidizing microflora with the introduction of complex mineral fertilizers or sorbents. Typically, microbiological methods are complemented with agronomic [4, 12].

The **aim** of this work was to evaluate the bioremediation of anthropogenically disturbed landscape, contaminated with hydrocarbons, as the basis of a system of measures to improve the environment of human habitation in Northern Siberia.

MATERIALS AND METHODS

Soil and water samples were gathered at the site of activity of JSC "Gazpromneft-Noyabrskneftegaz" and JSC "Gazpromneft-Muravlenko" (South of Yamal-Nenets Autonomous district) in 2005 – 2010 we collected 87 samples of soil and water samples before cleaning up and 87 soil samples and water samples after the microbiological treatment.

It is known that soils from different regions contain microorganisms, the fittest (natural selection) to living in the region and the ecological niche. It has been established that each region requires its own specially selected composition of microorganisms, which can form the basis biotechnologisch preparations for cleaning soil and water from oil [3, 4, 16].

Considering the complex temperature conditions in the Northern regions of Russia, in which most of the summer temperature at a depth of 10 – 20 cm is 6-14 ^{0}C, the use of biologics for optimal performance of which requires the temperature in 18-25 ^{0}C, is inappropriate.

In this regard, as preparations for cleaning of contaminated areas and water bodies used for commercial preparation of the brand "Biooil-Yugra" (production of JSC "Biooil"), effective at low temperatures.

Analysis of the content of petroleum products in soil and water was performed by the fluorimetric method in accordance with the method of PND f 16.1.21-98.

RESULTS AND DISCUSSION

All plots were divided into conventional groups on the content of oil products to the work on biological recultivation. Groups were formed according to the content of oil products to increase by 10%, from 5% (table 1).

Thus, there were formed 6 groups according to the content of oil products:

Group № 1 – the oil content of from 5% to 15%, 10 sites;

Group № 2 – oil content from 15.1% to 25%, 45 sites;

Group № 3 – oil content from 25.1% to 35%, 14 sites;

Group №4 – oil content from 35.1% to 45%, 6 sites;

Group № 5 – oil content from 45.1% to 55%, 6 sites;

Group № 6 – oil content from 55.1% and more, 6 sites.

The amount of oil in the samples to conduct bioremediation ranged from 7.14% to 80.73%. Reducing the amount of petroleum products after the bioremediation occurred at 56.64+18.82% and ranged from 1.23% to form for 61.42%.

Residues ranged from 1.23% to form for 61.42% and depended mainly on the topography and soils of a particular contaminated site.

Upon further analysis of the results, after division of all sites into groups according to the content of oil products before the bioremediation were obtained similar results, presented on graphs. The percentage of reduction of petroleum products varied only slightly and did not differ significantly among divided groups (table 1).

CONCLUSION

We evaluated a decrease in the content of oil products when you use the Association of microorganisms isolated from the contaminated soils of the southern part of the Yamal-Nenets Autonomous district. Evaluation of bioremediation of oil-contaminated territories as the basis of a system of measures to improve the environment of human habitation in Northern Siberia. It is shown that reducing the amount of petroleum products after the bioremediation occurred at 56.64+18.82%.

Thus, bioremediation can reduce the oil content in the contaminated areas, and revegetation to increase the indicators of pollutants to background norms. Since the main pollutant in the North of Siberia are hydrocarbons (oil, oil-gas-condensate), reducing their number or their full utilization in the process of bioremediation is the primary indicator of improvement of the human environment.

Problem of cleaning areas, including aquatic environments from wastes seems to be relevant, requiring innovative approaches and solutions, as well as increased attention and control of the administration of the state at all levels. It should be remembered that the efficiency of purification of circulating water to the natural environment directly determines the level of health and life of humans, as well as the quality of the state and the stability of relationships in ecological communities.

Table

Reducing the amount of petroleum products in groups of contaminated sites after the bioremediation

The group	Limits of the oil amount at the group formation	Mean reduction in the amount of oil after bioremediation, %
№1	5-15%	56.97+16.13
№2	15.1-25%	53.57+17.19
№3	25.1-35%	67.39+12.34
№4	35.1-45%	68.64+20.73
№5	45.1-55%	53.92+28,22
№6	>55.1%	44.74+25.29

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