POLLUTION

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THE RESULTS OF RESEARCH OF THE BIOLOGICAL PRODUCT "REMEDOIL" FOR THE PURIFICATION OF OIL-CONTAMINATED SOILS

Research article

Abstract

The article presents data on the analysis of the oil-destructive ability of the drug "Remedoil". The problems of the modern oil industry affect the state of the soils of the oil production territories and the cleaning of these territories is an urgent problem. Soil treatment with biological products is a promising direction of oil treatment. The proposed biodestructor "Remedoil" does not contain pathogenic and conditionally pathogenic microorganisms in its composition and is a very effective preparation for the bio-purification of oil-contaminated soils. For 30 days, there is a significant decrease (from 42.8% to 63.8 %) in the amount of petroleum products from the initial one in the studied samples. During 8 months of remediation, the amount of petroleum products is reduced by almost 70-96 % of the initial concentration.

Keywords: Oil pollution, bioremidiation, biodestructor, bio-treatment, oil treatment, microorganisms, *Candida sp*.

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РЕЗУЛЬТАТЫ ИССЛЕДОВАНИЯ БИОПРЕПАРАТА «РЕМЕДОЙЛ» ДЛЯ ОЧИСТКИ НЕФТЕЗАГРЯЗНЕННЫХ ПОЧВ

Научная статья

Аннотация

В статье приводятся данные по анализу нефтедеструктивной способности препарата «Ремедойл». Проблемы современной нефтедобывающей промышленности отражаются на состоянии почв территорий нефтедобычи и очистка этих территорий является актуальной проблемой. Очистка почвы биопрепаратами является перспективным направление нефтеочистки. Предлагаемый нами биодеструктор «Ремедойл» не содержит в своем составе патогенных и условно патогенных микроорганизмов и является весьма эффективным препаратом для биоочистки нефтезагрязненных почв. За 30 суток наблюдается значительное снижение (от 42,8% до 63,8 %) количества нефтепродуктов от исходного в исследуемых образцах. За 8 месяцев ремидиации количество нефтепродуктов снижается практически на 70 - 96 % от исходной концентрации.

Ключевые слова: Нефтяное загрязнение, биоремидиация, биодеструктор, биоочистка, нефтеочистка, микроорганизмы, *Candida sp*.

1. Introduction

Modern civilization is characterized by environmental disasters associated with land spills of oil and petroleum products. Such pollution negatively affects the soil layer, surface and underground waters, the geological environment, ecosystems and their inhabitants [8].

Imperfect technologies of oil production, transportation, processing and storage lead to significant losses, which reach 50 million tons/year – 2% of the total production. An example of this is the release of oil (from 5 to 60 thousand barrels per day) in 2010 on the drilling platform of British Petroleum in the Gulf of Mexico, the accident on the tanker "Exxon Valdez" (about 260 thousand barrels of oil) etc. [8].

On the territory of Russia, more than 20 thousand accidents related to oil production occur annually. 5 million tons (1% according to official statistics) of hydrocarbons are lost, causing difficult consequences for flora, fauna and human health.

According to Greenpeace Russia, if 1 cubic meter of oil enters the soil, the potential area of contamination of the surface layer of ground water can be more than 5 thousand square meters [3].

The natural decomposition of oil and petroleum products under normal conditions is slow, because increased concentrations of hydrocarbons suppress the self-cleaning activity of soil and water. As a result, the ecosystem accumulates difficult-to-oxidize chemical products that prevent self-purification and self-healing. The process of natural self-healing of the polluted environment is long. At the level of contamination of 5 g / kg of soil, it lasts from 2 to 30 years [8].

Thus, the soil degradation observed in the territories contaminated with oil and petroleum products allows scientists to classify them as areas of ecological disaster. The problem of remediation of oil-contaminated soils is of exceptional importance. Oil pollution by hydrocarbons causes irreversible changes in the morphology, physical and chemical properties of the soil [2]. The erasure of the features of the natural profile is accompanied by the appearance of an intense black or brown color, the formation of a bituminous crust on the surface, and the compaction of the addition. This inevitably causes a decrease or loss of soil fertility, leads to changes in the ecological functions of soils, accompanied by a decrease in biodiversity [4]. In the process of transformation, petroleum hydrocarbons form toxic compounds with carcinogenic, teratogenic and mutagenic properties, resistance to microbiological degradation, and the ability to pass into plants, which reduces the quality of cultivated crops and poses a threat to human and animal health [6], [7].

Currently, bioremediation (bio - life, remedio – treatment) – the purification of the natural environment using biological methods-is promising for the purification of oil pollution. For example, the stimulation of native microflora by applying fertilizers to a polluted ecosystem or the introduction of specialized microorganisms preparations designed to clean up polluted ecosystems [5], [7].

Previously, it was assumed that microorganisms, capable of decomposing and using hydrocarbons of oil and petroleum products, are found only where oil fields, oil storage facilities or oil pipelines are located, however, MO-oil destructors are quite widespread in nature and can be isolated from soil, sedimentary rocks, sea and river water. These heterotrophic microorganisms can absorb a variety of organic compounds – carbohydrates, proteins, fats, etc.

Microorganisms-oil destructors are able to effectively oxidize oil hydrocarbons with a chain length of C9-C30 and aromatic hydrocarbons in a wide range of medium acidity (pH 4.5-9.5) and temperatures (5-45°C). The efficiency of hydrocarbon oxidation reaches 99%. As a result of biological treatment of oil pollution with biological products, easily decomposing bacterial protein remains in the environment, which does not require subsequent disposal, and non-toxic products of oil decomposition. The products of the vital activity of bacteria and the dying bacteria themselves are easily absorbed by the native microflora, giving the basis for the formation of humus (when using a preparation for cleaning the soil) or forming bottom silt (if used on water). The degree of purification depends on the initial amount of contamination, the chemical nature of petroleum products, and the mechanical composition of the soil.

The purpose of the study was to study the oil-destructive properties of the biological product "Remedoil "(TU 9291-001-86142353-2012), created at the Department of Technical Chemistry and Materials Science of the Engineering Faculty of Bashkir State University at the suggestion of the management of LLC" BashNIPIneft " in Ishimbay for bioremediation of oil-contaminated soils in local conditions. The composition of the drug includes vegetative cells of strains of Candida sp cultures. The biodestructor does not contain pathogenic and conditionally pathogenic microorganisms in its composition.

The components of the biological product were grown in sterile conditions on special selective media in Petri dishes.

A liquid growth medium was prepared. At room temperature, the production of the seed material was carried out with constant stirring and growth control on a Den-1 densitometer for 7-10 days. The minimum concentration of cells in the resulting mother liquor should be 4-6 •106/ml.

In order to adapt the cells to the utilization of petroleum hydrocarbons, cultivation was carried out under intensive aeration with microcompressors (air consumption of at least 2 l/min).

To study the activity of the drug Remedoil, oil sludge was used, which is a multicomponent mixture of substances of various nature (mechanical impurities, asphaltenes, resins, hydrocarbons, paraffin, naphthenic hydrocarbons, alcohols, esters-dioctyl phthalates, heavy metal ions (Pb, Cr, Fe, Al, Cu, Hg, etc.). The studies were conducted in 2018-2020.

2. Methods

The research was carried out in the laboratory of environmental monitoring of physical and chemical pollution of the environment of the Birsk branch of the Bashkir State University.

The method for determining petroleum products in soils is based on the extraction of petroleum products with tetrachloroethylene (C_2Cl_2) or carbon tetrachloride (C_2Cl_4) in special desiccators, filtration of the resulting extract, separation of polar compounds on a chromatographic column filled with aluminum oxide, and measurement of the content of petroleum products by IR-spectometry on an AN-2 analyzer.

To study the oil-destructive activity of the drug, a 50 g soil sample was placed in a Petri dish and 5 ml of Remedoil biodestructor was added. Then oil sludge was added in concentrations from 10 to 30 g / kg of soil. The biodestructor was added to all variants of the experiment, after sampling for analysis by 1% for every fifth day of testing with careful mixing of the soil. Samples for the analysis of the content of petroleum products in the soil were taken at 5,10,15,20,25,30 days and after 8 months. After 30 days of research, the soil was left in Petri dishes in the air. During the summer period, the soil naturally dried to a completely dry state, and then was moistened with tap drinking water.

3. Results

Soil contamination with petroleum products in concentrations from 10 to 30 g/kg of soil is the most common in all oil-contaminated soils. Therefore, we determined exactly such concentrations for the study. The data is given in Table 1. completely dry, and then moistened with tap drinking water.

Table 1 – Change in the concentration (g / kg of soil) of petroleum products under the influence of the biodestructor "Remedoil"

Experience option	Initial concentration of oil sludge, g / kg	Concentration of petroleum products, g / kg						
		5 days	10 days	15 days	20 days	25 days	30 days	8 months
1	10	9,54	9,06	8,49	7,84	7,14	5,75	0,42
2	20	18,48	15,27	11,80	11,57	10,33	8,98	1,17
3	30	29,76	25,79	21,37	16,09	12,28	11,71	3,94

When the soil is contaminated with oil sludge 10 g / kg of soil during the first fifteen days, there is a decrease in pollution by an average of 1 % per day, in the next fifteen days there is a more intense decrease – up to 3% per day. On the thirtieth day, the concentration of petroleum products is 57.5% of the original. After 8 months of remediation, the amount of petroleum products is reduced by 95.8% of the initial concentration.

With 20% contamination of the soil with oil sludge, there is a decrease in pollution by an average of 2-3 % per day for the entire observation period. On the thirtieth day, the concentration of petroleum products is 44.9% of the original. After 8 months of remediation, the amount of petroleum products is reduced by 94.83% of the initial concentration.

When 30% of the soil is contaminated with oil sludge during the first five days, there is practically no reduction in pollution (less than 1% for 5 days of observations), in the subsequent period of observations, the concentration of petroleum products significantly decreases - by 10 -14% for every 5 days. On the thirtieth day, the concentration of petroleum products is 39.0% of the original. After 8 months of remediation, the concentration of petroleum products is 13.13% of the initial concentration.

For 30 days, there is a significant decrease (from 42.8% to 63.8 %) in the amount of petroleum products from the initial one in the studied samples. For 8 months of remediation, the amount of petroleum products is reduced by almost 70-96 % of the initial concentration..

Conflict of Interest

None declared.

Конфликт интересов

Не указан.

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