ISSN 2518-1467 (Online),
ISSN 1991-3494 (Print)

ҚАЗАҚСТАН РЕСПУБЛИКАСЫ
ҰЛТТЫҚ ҒЫЛЫМ АКАДЕМИЯСЫНЫҢ

Х А Б А Р Ш Ы С Ы

ВЕСТНИК

НАЦИОНАЛЬНОЙ АКАДЕМИИ НАУК
РЕСПУБЛИКИ КАЗАХСТАН

THE BULLETIN

OF THE NATIONAL ACADEMY OF SCIENCES
OF THE REPUBLIC OF KAZAKHSTAN

1944 ЖЫЛДАН ШЫҒА БАСТАҒАН
ИЗДАЕТСЯ С 1944 ГОДА
PUBLISHED SINCE 1944

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АЛМАТЫ
АЛМАТЫ
ALMATY

2016

ҚЫРКҮЙЕК
СЕНТЯБРЬ
SEPTEMBER

«Қазақстан Республикасы Ұлттық ғылым академиясының Хабаршысы».
ISSN 2518-1467 (Online),
ISSN 1991-3494 (Print)
Меншіктенуші: «Қазақстан Республикасының Ұлттық ғылым академиясы»РҚБ (Алматы қ.)
Қазақстан республикасының Мәдениет пен ақпарат министрлігінің Ақпарат және мұрағат комитетінде 01.06.2006 ж. берілген **№5551-Ж** мерзімдік басылым тіркеуіне қойылу туралы куәлік

Мерзімділігі: жылына 6 рет.
Тиражы: 2000 дана.

Редакцияның мекенжайы: 050010, Алматы қ., Шевченко көш., 28, 219 бөл., 220, тел.: 272-13-19, 272-13-18,
www: nauka-nanrk.kz, bulletin-science.kz

Типографияның мекенжайы: «Аруна» ЖК, Алматы қ., Муратбаева көш., 75.

«Вестник Национальной академии наук Республики Казахстан».
ISSN 2518-1467 (Online),
ISSN 1991-3494 (Print)
Собственник: РОО «Национальная академия наук Республики Казахстан» (г. Алматы)
Свидетельство о постановке на учет периодического печатного издания в Комитете информации и архивов Министерства культуры и информации Республики Казахстан **№5551-Ж**, выданное 01.06.2006 г.

Периодичность: 6 раз в год
Тираж: 2000 экземпляров

Адрес редакции: 050010, г. Алматы, ул. Шевченко, 28, ком. 219, 220, тел. 272-13-19, 272-13-18.
www: nauka-nanrk.kz, bulletin-science.kz

Адрес типографии: ИП «Аруна», г. Алматы, ул. Муратбаева, 75

Bulletin of the National Academy of Sciences of the Republic of Kazakhstan.
ISSN 2518-1467 (Online),
ISSN 1991-3494 (Print)
Owner: RPA "National Academy of Sciences of the Republic of Kazakhstan" (Almaty)
The certificate of registration of a periodic printed publication in the Committee of Information and Archives of the Ministry of Culture and Information of the Republic of Kazakhstan N 5551-Ж, issued 01.06.2006

Periodicity: 6 times a year
Circulation: 2000 copies

Editorial address: 28, Shevchenko str., of. 219, 220, Almaty, 050010, tel. 272-13-19, 272-13-18,
http://nauka-nanrk.kz /, http://bulletin-science.kz

Address of printing house: ST "Aruna", 75, Muratbayev str, Almaty

BULLETIN OF NATIONAL ACADEMY OF SCIENCES
OF THE REPUBLIC OF KAZAKHSTAN
ISSN 1991-3494
Volume 5, Number 363 (2016), 42 – 45

UDC 504.062.4

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A METHOD OF PURIFICATION OF OIL CONTAMINATED SOIL WITH THE HELP OF CALIFORNIAN WORMS

Abstract. In this paper, the possibility of recovery of oil contaminated soil through the application of vermi-compost and Californian red worms is presented.

Keywords: oil products, soil, oil pollution, earthworms, biotechnology, vermi-compost.

Introduction. Soil landscape is a component of biosphere which assumes major "ecological press". Contaminants are emitted into the atmosphere, water sources eventually will deposit into soil system. In this regard, soil degradation has become major environmental problem. Soil degradation is a result of various natural and man made causes, taking the form of chemical pollution, desertification, bogginess, etc. Anthropogenic degradation is either result of immediate human impact (mechanical, chemical), or reasons connected with natural supergene or soil-forming process. As a result, separate combinations of adverse soil properties are developed and reduction of biological productivity of landscape occurred.

We can identify oil and gas industry activities among the anthropogenic factors leading to soil degradation. Especially biggest damage to nature caused by accidents on the oil and gas pipeline. Thus in one oil pipeline leak there is in average 2 tons of discharging oil which pollute 1000 m^3 of land and as a result of accident at gas condensate pipeline there will be discharged at an average 2 millions of tons of oil product to the ground per year [1].

Currently, solution of environmental problems regarding soil cover of Kazakhstan requires urgent actions. Even today about 60% of soil cover of the republic apply in varying degrees to degraded, depending on the characteristics of natural environment and their national economic use. Kazakhstan is occupying the 9^{th} position in the world by area and is already at risk to become a zone of ecological disaster in near future. In many respects the cause of created dismal environmental situation is a human factor. Progressive increase of anthropogenic load of soil will hardly complicate the environmental situation of oil producing regions.

There is high soil pollution with oil and oil products on the area of 1.5 millions of hectares. The most of the soil and environmental pollution is occurring in the following areas: Atyrau – 59%, Aktobe – 19%, Western Kazakhstan region – 13% and Mangystau – 9% [3].

Oil spill on land causes significant, at times irreversible changes to its features such as forming of bituminous salt marsh, tarring, cementation, etc. These changes result in vegetation damage and biological productivity of land.

As far as it known for dissolution of oil in soil, decisively influence functional activity of complex of soil microorganisms which provide full mineralization of oil and oil product into carbon dioxide and water [4].

In the first stage, changes of soil biota is characterized by mass mortality of meso and micro faunas; in the second stage – "boom" of microbiological activity of specialized microorganisms and subsequent gradual evolution of the ecological community correlating with the constantly changing geochemical situation of soil.

Oil pollution significantly changes the structure of soil actinomycentes, reducing their number and impoverishing the species composition. In addition to oil contaminated soil, the number of phytotoxic

species of microfungus increases. The development of phytotoxic form of microfungus can enhance the negative impact of oil pollution [5]. Initially, in the interval of concentration corresponding to zone of homeostasis (1 ml/kg), the oil does not have a significant influence on soil microbiota, it acts as biological stimulant. A higher dose of oil (zone of stress 1-30 ml/kg) leads to irreversible changes in the microbiological properties of the soil and to the disturbance of its water-air regime in the future.

Oil pollution differs from other human impacts with its "immediate" load to environment, causing a rapid response. In assessing the effects of such pollution, we cannot always surely state if the ecosystem will return to a steady state or continue irreversible degradation. Self healing and land restoration are inseparable biogeochemical processes. The natural self-purification of natural objects from oil pollution is a lengthy process. Existing mechanical, thermal, physical and chemical methods of purification of oil pollution of soil are expensive and only effective at a certain level of pollution (usually not less than 1 % of the oil in the ground) and often associated with adding more contamination and do not provide completeness of purification. In this regard the development of methods for cleaning soil from pollution of petroleum hydrocarbons is an urgent task.

The aim of this paper is to find out the possibilities of using biotechnological approach for land restoration of oil polluted soil.

Research methods. We studied the effect of earthworms and biohumus to change the content of petroleum products in contaminated soils at laboratory conditions. For the study we used a hybrid red Californian earthworm Eisenia foetida.

Experiments were carried out in box of 500 mm x 300 mm x 250 mm. We used cerozem, artificially contaminated with oil additives from Kumkoil oilfield in Kyzylorda region (the rate of 1 g of oil per 1 kg of soil). For the experiment we used same age worms about 60-70 mm in length by 150 individuals. As a control there was oil contaminated soil without additives of biohumus.

Research results and discussion. Providing worms in soil significantly stepped up the process of dissolution of oil in the samples. On the basis of experimental data it was found that to reduce oil content in contaminated soil, impacts various factors (duration of experiment, the concentration of biohumus, etc.). Namely, there was a gradual reduction of oil in soil in substrates with Californian red worms and biohumus with increasing duration of experiment. Experiment results are given in Figure 1.

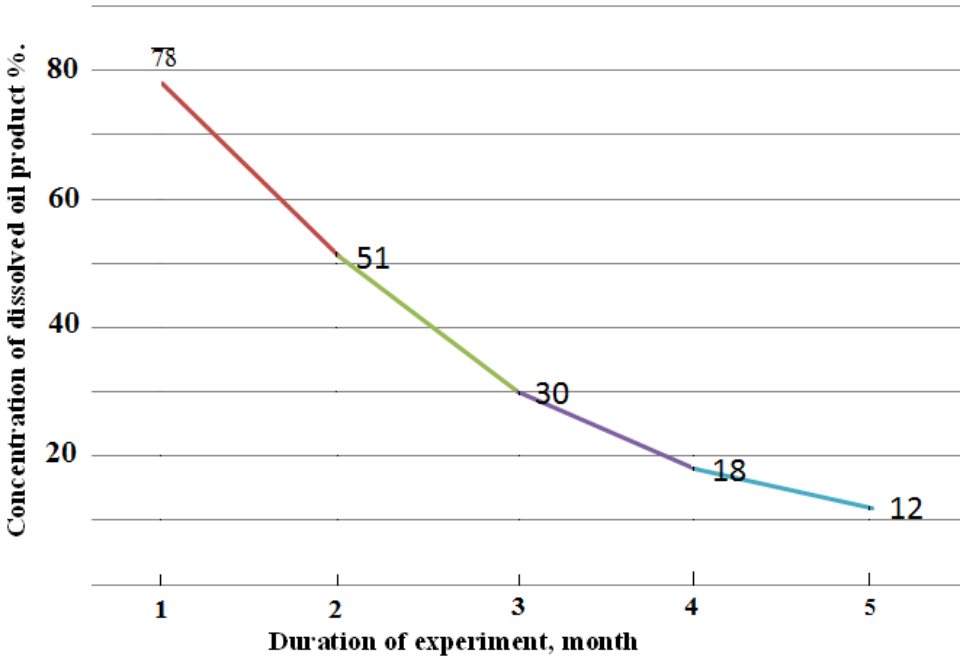

Figure 1 – Dependence of oil content from the duration of experiment.

Substrate: gray soil (5 kg): biohumus (0,25 г/кг), oil (1 g/kg). Initial numbers of worms in soil – 150 individuals

By visual observation it was found increase of soil structure and its porosity due to biohumus and worms provided in soil. This should increase aeration and improve soil water regime, thereby contributing to physical, chemical and microbiological process of destruction of oil.

The process of disintegration of oil products was observed in substrates while adding biohumus without presence of worms. With increase of added mass of biohumus into soil up to 0.30 g/kg, there was a gradual reduction of oil in contaminated soil (Figure 2). These results show that except worms, additional contribute in destructing of oil product in some extend make microorganisms living in biohumus.

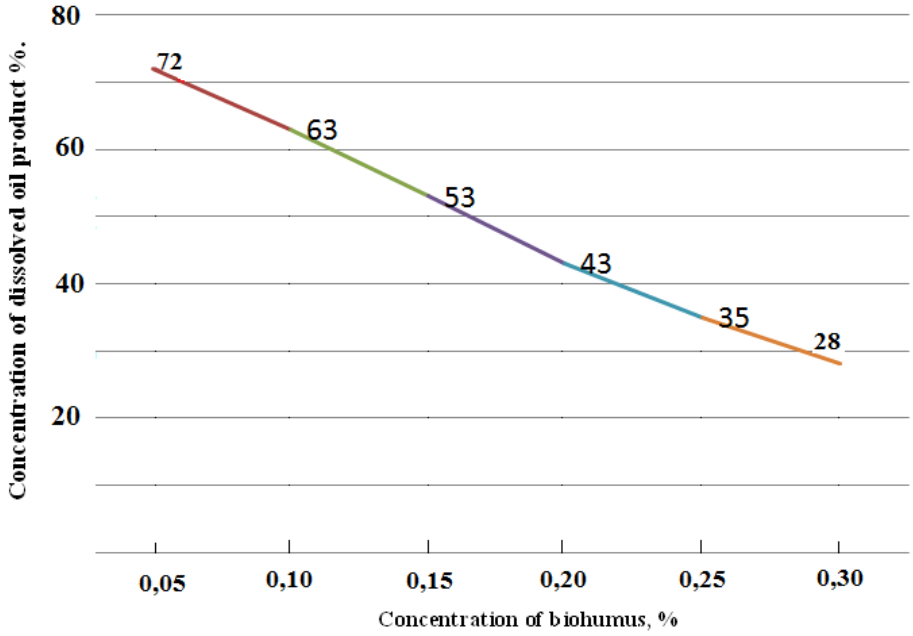

Figure 2 – Dependence of the residual concentration of oil in the soil to the amount of biohumus (duration of the experiment) = 4 months; m (soil) = 1 kg; C (oil) = 1g/kg

By the end of study it became clear that adding worms to soil and biohumus greatly intensifies the process of dissolution of oil in samples. According to comparative data it was presented a significant reduction of oil content under the influence of Californian red worms and biohumus. If at the beginning of experiment 1 kg of soil was contaminated with 1 g of oil (0,1%), at the end of experiment 1 kg of soil of contaminated soil with oil turned to 0,68 g (32%), in the treated soil with biohumus without worms 0,51 g (49%) oil, and in soil treated with worms and biohumus oil content was reduced to 0,32 g (68%).

Contaminated oil was cleaned from oil product by 68% in the result of elimination process activation (Table).

The degree of soil purification from oil product

№	The content of test sample	Oil residue in soil, g/kg	The degree of soil purification from oil product, %
1	Control	0,68	32,0 ±0,5
2	Soil + biohumus	0,51	49,1 ± 0,5
3	Soil + biohumus + worms	0,32	68,1 ± 0,5

Conclusion. The results of these experiments suggest the possibility of using earthworms and biohumus for detoxification of soil from oil products. It was shown good rate of studied Californian worms and preservation of their producing activities in the oil contaminated soil substrates and they can be used for contaminated soil remediation.

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МҰНАЙМЕН ЛАСТАНҒАН ТОПЫРАҚТЫ КАЛИФОРНИЯЛЫҚ ҚҰРТТАР КӨМЕГІМЕН ТАЗАЛАУ ӘДІСІ

Аннотация. Мақалада мұнай өнімдерімен ластанған топырақ жүйесін вермикомпост және Калифорниялық құрттар көмегімен қалпына келтіру мүкіншілігі көрсетілген.

Түйін сөздер: мұнай өнімдері, топырақ, мұнаймен ластану, жауын құрттар, биотехнология, вермикомпост.

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МЕТОД ОЧИСТКИ ЗАГРЯЗНЕННЫХ НЕФТЬЮ ПОЧВ КАЛИФОРНИЙСКИМИ ЧЕРВЯМИ

Аннотация. В статье показана возможность восстановления загрязненных нефтепродуктами почв вермикомпостом и Калифорнийскими красными червями.

Ключевые слова: нефтепродукты, почва, загрязнение нефтью, земляные черви, биотехнология, вермикомпост.

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ISSN 2518-1467 (Online), ISSN 1991-3494 (Print)

http://www.bulletin-science.kz/index.php/ru/

Редакторы *М. С. Ахметова, Д. С. Аленов, Т. М. Апендиев*
Верстка на компьютере *Д. Н. Калкабековой*

Подписано в печать 11.10.2016.
Формат 60x881/8. Бумага офсетная. Печать – ризограф.
17,9 п.л. Тираж 2000. Заказ 5.