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**NEFT MAHSULOTLARI BILAN IFLOSLANGAN TUPROQLAR VA OQAVA SUVLARNI
EYXORNIYA YUKSAK SUV O'SIMLIGI YORDAMIDA TOZALASH**

**ОЧИСТКА ПОЧВ И СТОЧНЫХ ВОД, ЗАГРЯЗНЕННЫХ НЕФТЕПРОДУКТАМИ, С
ПОМОЩЬЮ ВЫШЕГО ВОДНОГО РАСТЕНИЯ ЭЙХОРНИИ**

**CLEANING OF SOILS AND WASTEWATER CONTAMINATED WITH PETROLEUM
PRODUCTS USING THE EICHHORNIA AQUATIC PLANT**

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Annotatsiya: *Ushbu maqolada neft va neft maxsulotlari bilan ifloslangan tuproqlar va oqava suvlarni yuksak suv o'simligi Eyxorniya (Eichhornia crassipes Solms.) yordamida tozalash xususiyatlari, imkoniyatlari, samaradorligi, biomassa hosil bo'lishi hamda hosil bo'lgan biomassadan turli sohalarda qo'llanilishi to'g'risida ma'lumot berilgan.*

Tayanch so'zlar: *Eyxorniya (Eichhornia crassipes Solms.), neft, neft mahsuloti, tuproqlar, mikrolandshaft, neft konsentratsiyasi, pH-muhiti, namlik, aeratsiya, tuproqning morfologik, fizik-kimyoviy xususiyatlari, tuproq tiplari, tuproq mikroflorasi, rivojlanish, o'sish, oqava suv.*

Аннотация: *В данной статье представлена информация об особенностях, возможностях и эффективности очистки почв и сточных вод, загрязненных нефтью и нефтепродуктами, с помощью высшего водного растения эйхорнии (Eichhornia crassipes Solms.). Также рассматриваются процессы образования биомассы и применения полученной биомассы в различных областях.*

Ключевые слова: *нефть, нефтепродукт, почвы, микроландшафт, концентрация нефти, pH, влажность, аэрация, морфологические, физико-химические свойства почвы, типы почв, почвенная микрофлора, развитие, рост, сточные воды.*

Annotation: *This article provides information on the characteristics, potential, efficiency, and biomass formation of using the higher aquatic plant Eichhornia (Eichhornia*

crassipes Solms.) for cleaning soils and wastewater contaminated with oil and oil products. It also discusses the applications of the resulting biomass in various fields.

Key words: *oil, oil product, soils, microlandscape, oil concentration, pH environment, humidity, aeration, morphological, physicochemical properties of the soil, soil types, soil microflora, development, growth, wastewater.*

INTRODUCTION

The effective and targeted use of wastewater generated by reducing fresh water consumption through highly cost-effective methods, the determination of the degree of purification of such water using the process of wastewater formation and macrophyte plants rich in biologically active substances, and the study of its properties, its effective reuse in the sectors of the national economy and industrial enterprises, the propagation of nutritious higher plant species and obtaining biomass from them, the use of the obtained biomass as additional feed in various sectors, especially in fisheries and agriculture, and increasing fish productivity are of significant scientific and practical importance.

Our republic has achieved certain achievements in the efficient use of water resources, their protection and keeping water sources clean and hygienic, and biological treatment of wastewater, and more promising scientific research is being conducted. In addition, preventing soil pollution in our region and cleaning up contaminated soils directly related to the pollution of water sources remains a pressing issue.

In particular, the individual factors of biological remediation of soils contaminated with oil and oil products prevent the study of the properties of soils contaminated with oil and oil products using general methods and the development of effective general remediation technologies for them, due to the diversity of the chemical composition of oil, soil and climatic conditions and properties.

When developing and implementing a plan for the remediation of natural soils contaminated with oil and oil products, a number of scientists have identified key approach factors, including the natural conditions of the area, climate, soil type, composition, systematic plant cover, land use status, natural self-cleaning properties of soils, ecological and hydrological conditions of the site, characteristics of microlandscapes in the area, oil concentration, pH environment, humidity, natural aeration processes, morphological, physicochemical properties of the soil, soil types, inter-source characteristics of the area (water source basins), duration of different degrees of contamination (newly contaminated lands up to 4 years, moderately contaminated lands up to 4-10 years, old contaminated lands over 10 years, etc.), the amount and activity of soil microflora, etc.

The description of pollution depends on the climatic factor, the chemical composition of the soil, the properties of the soil, the main microbiological indicators of the soil, and the biological indicators of the soil.

These factors of reclamation based on the biological treatment method are divided into sub-factors and are closely related to each other.

Accordingly, the elemental composition of the total oil is an average of 79-88% carbon element, an average of 11-14% hydrogen element, an average of 0.1-5% sulfur element (in some cases 8%), an average of 0.2-1.6% oxygen and nitrogen elements, an average of 0.2-1.6% heavy metals - V (10-5-10-2%), Ni (10-4-10-3%). The overall composition is hydrocarbons, on average - 90% (paraffins - 32%, naphthenic hydrocarbons - 57%, aromatic hydrocarbons - 11%), water - 10%, and mineral salts are also present in varying amounts, mainly chloride and sulfate salts (up to 400 mg/l).

The most important properties of oil include its density, sulfur content, fractional composition, viscosity, water content, chloride salts, mechanical impurities. Density of oil. Usually, the density of oil is of four types: light - 0.800-0.839 g/cm³, medium - 0.840-0.879 g/cm³, heavy - 0.880-0.920 g/cm³, very heavy - 0.920 g/cm³. The oils produced in our republic are characterized by the composition of heavy oils and are paraffin-based. The greater the density of oil, the stronger its binding to the soil, which creates major difficulties in carrying out reclamation measures and takes a long time.

The sulfur content in oil is classified as follows: low-sulfur oils with an average of up to 0.5%, sulfur oils with an average of 0.51-2%, and high-sulfur oils with an average of more than 2%. Sulfur in oil is in the form of mercaptan (thioalcohol) and disulfide (polysulfide). As a result, soil microorganisms are reduced by several tens of times compared to the background. Oil refineries have hydrodesulfurization units for gas oil, which remove sulfur from oil products. (Gasoil hydrodesulfurization GDS).

Oil-containing waters are found in wells that are produced under high pressure and are characterized by the presence of chloride and, in some cases, sulfate salts in dissolved form, as a result of which the soils are subjected to a certain degree of technogenic salinization, that is, the soil is simultaneously subjected to chemical pollution and salinization, which negatively affects the process of applying reclamation technology in general. Bacterial strains with high decomposition properties of oil and oil products act very passively in saline soils.

This situation is explained by the death of microorganisms affected by high concentrations of oil in heavily and very heavily contaminated soils, the weakening of the activity of primary enzymes in the soil, and the general disruption of the soil's air, water, and nutrient regimes.

In order to activate the bioremediation process of soil and water contaminated with oil and oil products, the seeds of adapted seedlings of alfalfa, corn and rice plants with phytoremediation properties are isolated separately. In the climatic conditions of Uzbekistan, months other than winter are considered favorable for biological treatment and the level of efficiency is high.

The climatic conditions of each soil and water are sharply different from each other, and the microflora and plant world are also formed in a unique way. In the northern

regions, microorganisms adapted to the cold climate are active at an average temperature of -40 °C, even -70 °C, while in the southern regions there are microorganisms that can decompose oil at an average temperature of +70 °C and +85 °C. These indicators relate to the minimum and maximum temperature limits.

In various soil types of our republic, microorganisms are moderately active at an average temperature of 18-38 °C. Oil-degrading bacterial strains are variably active or inactive in the bioremediation process, depending on air temperature and humidity.

Soil contamination by oil and oil products is expressed in the area of contaminated soil, and when these products reach groundwater, the entire area is contaminated. As a result, water contaminated with oil and oil products is formed. Several methods of biological purification of such contaminated water using macrophytes have been put into practice.

One such macrophyte is *Eichhornia* (*Eichhornia crassipes* Solms.), a free-floating plant on the surface of the water, with a swelling of spongy tissue on the underside of the leaf blades. These air-filled chambers allow the plant to grow and float in the water, and to change the nutrient environment due to its floating nature. *Eichhornia* is effective in cleaning water contaminated with oil and oil products, but it does not break down oil, but cleans it by accumulating it.

The roots, leaves and accumulation cells of *Eichhornia* have the ability to absorb oil and oil products. These plants help remove toxic substances and organic matter from water by accumulating them. The roots of *Eichhornia* are designed to adapt to oil and oil products. These properties are effective in absorbing oil products from water contaminated with oil products and reducing their concentration. *Eichhornia* roots contain voluntary microorganisms and provide them with a source of food. These microorganisms can also be active in the process of breaking down oil, but the main function of *Eichhornia* is to accumulate and purify them.

Eichhornia helps to work together with local microflora (mainly bacteria) to increase its effectiveness. These microorganisms play an important role in the process of breaking down oil substances.

Eichhornia has a mechanism based on accumulation rather than decomposition in the purification of water contaminated with oil and oil products. It plays an important role in the process of absorbing toxic substances from water, cooperating with microorganisms, and then purifying them.

Eichhornia stores oil and oil products mainly in its roots and leaves, as well as in aerenchyma tissue. These mechanisms ensure the efficiency of the plant in the process of accumulating oil substances and purifying water. Within these mechanisms, *eichhornia* plays an important role in the absorption and purification of oil substances. Several bacteria and microorganisms are involved in the process of decomposing oil and oil products in *eichhornia*.

Pseudomonas species are bacteria that have the ability to break down oil and oil products. These bacteria play an important role in the destruction of oil substances and the cleaning of the ecosystem. They participate in the effective metabolism of hydrocarbons.

Bacillus species are also capable of breaking down oil substances. Many of them are widespread in the ecosystem. These bacteria are important in metabolizing oil, acting as auxiliary microorganisms.

Alcanivorax species are bacteria adapted to oil and hydrocarbons. They participate in the effective breakdown of oil products.

Some species of *Mycobacterium* bacteria have the ability to metabolize hydrocarbons. They participate in the breakdown of oil substances.

Sphingomonas species of bacteria are active in the breakdown of oil, many of them have the ability to metabolize organic substances.

Rhodococcus species of bacteria are active in the breakdown of oil, many of them have the ability to metabolize organic substances.

Bacteria and microorganisms such as *Pseudomonas*, *Bacillus*, *Alcanivorax*, *Mycobacterium*, *Sphingomonas*, and *Rhodococcus* participate in the process of oil degradation by *Eichhornia*. These microorganisms, together with *Eichhornia*, play an important role in the efficient decomposition of oil and the purification of the ecosystem.

The treatment of water contaminated with oil and oil products using the *Eichhornia* plant is considered very convenient and inexpensive, and the cultivation of this plant does not require additional nutrient media, which saves money, labor, electricity, treatment facilities, disinfectants and additional reagents, which are actually spent on wastewater treatment in factories.

The plant biomass produced by the cultivation of the *Eichhornia* plant can be used to produce biogas and bioethanol, an unconventional energy source.

The effectiveness of the *Eichhornia* plant in purification is not only its water purification properties, but also the water purified with the help of higher aquatic plants in the purification plant can be used to dilute wastewater, for technological purposes at the enterprise or for irrigation of the surrounding trees around the purification plant. Therefore, drinking water treatment plants and enterprises that produce wastewater containing harmful substances in their production will be able to use wastewater treatment technology using higher algae, including the *eichhornia* plant.

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