Экобиотехнология – избранные вопросы. Учебный курс, 2024.

Разработанный курс может служить в качестве самостоятельного лекционного курса, а также может использоваться в качестве части более широкого курса по тем или иным вопросам экологии, наук об окружающей среде или вопросам природопользования. Данный курс был использован в практике преподавания. А именно, автор этого курса был приглашен в качестве приглашенного лектора для преподавания материала об экобиотехнологии в рамках курса "Экобиотехнологии и управление прибрежными зонами" (тип дисциплины: обязательная, вариативной части; направление: Экология и природопользование), для студентов 2 курса магистратуры географического факультета МГУ в ноябре 2024.

Данный курс рассматривает ряд избранных вопросов экобиотехнологии, в том числе вопросы и проблемы, связанные с прибрежными территориями.

Структура учебного материала. Четыре части.

1.Терминология. Переводы into Eng.

2.Нефть. Разливы. Борьба с разливами.

3.Дисперсанты и новые экотоксикологические проблемы.

4.Экобиотехнологии. Биоремедиация. Фиторемедиация. Примеры.Constructed wetlands.

5. Источники информации.

Часть 1.

Перевод "прибрежная зона" на английский

Синонимы:

coastal zone,

littoral zone,

shoreside,

shorefront,

shoreland,

riverside,

waterland,

streamside,

coastal area,

the nearshore,

riparian zone,

coastal module,

The foreshore

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Часть 2. Экобиотехнология и разливы нефти.

Ecobiotechnology – bacteria - oil cleanup technology, oil spill cleanup

The future of oil cleanup technology is likely the use of microorganisms such as Fusobacteriota (formerly Fusobacteria), species demonstrate potential for future oil spill cleanup because of their ability to colonize and degrade oil slicks on the sea surface.[43][44]

There are three kinds of oil-consuming bacteria. Sulfate-reducing bacteria (SRB) and acid-producing bacteria are anaerobic, while general aerobic bacteria (GAB) are aerobic. These bacteria occur naturally and will act to remove oil from an ecosystem, and their biomass will tend to replace other populations in the food chain. The chemicals from the oil which dissolve in water, and hence are available to bacteria, are those in the water associated fraction of the oil.

Bioremediation: use of microorganisms[46] or biological agents[47] to break down or remove oil; such as Alcanivorax bacteria[48] or Methylocella silvestris

Bioremediation Accelerator: a binder molecule that moves hydrocarbons out of water and into gels, when combined with nutrients, encourages natural bioremediation. Oleophilic, hydrophobic chemical, containing no bacteria, which chemically and physically bonds to both soluble and insoluble hydrocarbons. The accelerator acts as a herding agent in water and on the surface, floating molecules such as phenol and BTEX to the surface of the water, forming gel-like agglomerations. Undetectable levels of hydrocarbons can be obtained in produced water and manageable water columns. By overspraying sheen with bioremediation accelerator, sheen is eliminated within minutes. Whether applied on land or on water, the nutrient-rich emulsion creates a bloom of local, indigenous, pre-existing, hydrocarbon-consuming bacteria. Those specific bacteria break down the hydrocarbons into water and carbon dioxide, with EPA tests showing 98% of alkanes biodegraded in 28 days; and aromatics being biodegraded 200 times faster than in nature they also sometimes use the hydrofireboom to clean the oil up by taking it away from most of the oil and burning it.

Часть 3.

Дисперсанты и новые проблемы экотоксикологии. Dispersants

 A U.S. Air Force Reserve plane sprays Corexit dispersant over the Deepwater Horizon oil spill in the Gulf of Mexico.

• Dispersants can be used to dissipate oil slicks.[54] A dispersant is either a non-surface active polymer or a surface-active substance added to a suspension, usually a colloid, to improve the separation of particles and to prevent settling or clumping. They may rapidly disperse large amounts of certain oil types from the sea surface by transferring it into the water column. They will cause the oil slick to break up and form water-soluble micelles that are rapidly diluted. The oil is then effectively spread throughout a larger volume of water than the surface from where the oil was dispersed. They can also delay the formation of persistent oil-in-water emulsions. However, laboratory experiments showed that dispersants increased toxic hydrocarbon levels in fish by a factor of up to 100 and may kill fish eggs.[55] Dispersed oil droplets infiltrate into deeper water and can lethally contaminate coral. Research indicates that some dispersants are toxic to corals.[56]

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• A 2012 study found that Corexit dispersant had increased the toxicity of oil by up to 52 times.[57] In 2019, the U.S. National Academies released a report analyzing the advantages and disadvantages of several response methods and tools.[58]

• Watch and wait: in some cases, natural attenuation of oil may be most appropriate, due to the invasive nature of facilitated methods of remediation, particularly in ecologically sensitive areas such as wetlands.[59]

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Estimating the volume of a spill

By observing the thickness of the film of oil and its appearance on the surface of the water, it is possible to estimate the quantity of oil spilled. If the surface area of the spill is also known, the total volume of the oil can be calculated

Table.

 Film thickness Quantity spread

Appearance inches mm nm gal/sq mi L/ha

Barely visible 0.0000015 0.0000380 38 25 0.370

Silvery sheen 0.0000030 0.0000760 76 50 0.730

First trace of color 0.0000060 0.0001500 150 100 1.500

Bright bands of color 0.0000120 0.0003000 300 200 2.900

Table. Examples of oil spills.

Spill / Tanker Location Date Tonnes of crude oil

(thousands)[a]

Kuwaiti Oil Fires[b]

Kuwait

January 16, 1991 – November 6, 1991 136,000

Kuwaiti Oil Lakes [c]

Kuwait

January 1991 – November 1991 3,409–6,818

Lakeview Gusher

Kern County, California, USA March 14, 1910 – September 1911 1,200

Gulf War oil spill [d]

Kuwait, Iraq, and the Persian Gulf

January 19, 1991 – January 28, 1991 818–1,091

Deepwater Horizon

United States, Gulf of Mexico

April 20, 2010 – July 15, 2010 560–585

Ixtoc I

Mexico, Gulf of Mexico

June 3, 1979 – March 23, 1980 454–480

Atlantic Empress / Aegean Captain Trinidad and Tobago

July 19, 1979 287

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Losses.

following the world's largest oil spill, the Deepwater Horizon Oil Spill in 2010,[122] the U.S. Travel Association estimated 23 billion dollars’ worth of associated costs for affected tourist infrastructure.[123]

Reduction in fishing

After the Deepwater Horizon crisis,[122] the Gulf of Mexico suffered an estimated 1.9-billion-dollar loss in revenue from fishing. This is because fishing closures were imposed due to fears of the safety of seafood,[124] there was also a decline in demand, as seafood restaurants and markets suffered such severe losses that many were forced to shut

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Clean-up operations can also interrupt usual fishing routes, and sometimes fishing bans are imposed.[119] This further illustrates the damaging economic effects of oil spills on commercial fishing, which is particularly detrimental for regions whose economy relies heavily on fishing.

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Часть 4. Innovative ecobiotechnology.

Bioremediation, Phytoremediation.

Constructed wetlands. Terminology

Many terms are used to denote constructed wetlands, such as reed beds, soil infiltration beds, treatment wetlands, engineered wetlands, man-made or artificial wetlands.[4] A biofilter has some similarities with a constructed wetland, but is usually without plants.

 Effluent from a constructed wetland for greywater treatment at an ecological housing estate in Hamburg-Allermöhe, Germany Constructed wetland for domestic wastewater treatment in Bayawan City, the Philippines

A constructed wetland is an engineered sequence of water bodies designed to treat wastewater or storm water runoff

\_\_ Vegetation in a wetland provides a substrate (roots, stems, and leaves) upon which microorganisms can grow as they break down organic materials. This community of microorganisms is known as the periphyton. The periphyton and natural chemical processes are responsible for approximately 90 percent of pollutant removal and waste breakdown.[5] The plants remove about seven to ten percent of pollutants, and act as a carbon source for the microbes when they decay. Different species of aquatic plants have different rates of heavy metal uptake, a consideration for plant selection in a constructed wetland used for water treatment. Constructed wetlands are of two basic types: subsurface flow and surface flow wetlands.

Constructed wetlands are one example of nature-based solutions and of phytoremediation.

Constructed wetland systems are highly controlled environments that intend to mimic the occurrences of soil, flora, and microorganisms in natural wetlands to aid in treating wastewater. They are constructed with flow regimes, micro-biotic composition, and suitable plants in order to produce the most efficient treatment process.

Plants used.

Plants such as water hyacinth (Eichhornia crassipes) and Pontederia spp. are used worldwide (although Typha and Phragmites are highly invasive).

Typhas and Phragmites are the main species used in constructed wetland due to their effectiveness, even though they can be invasive outside their native range.

In North America, cattails (Typha latifolia) are common in constructed wetlands because of their widespread abundance, ability to grow at different water depths, ease of transport and transplantation, and broad tolerance of water composition (including pH, salinity, dissolved oxygen and contaminant concentrations). Elsewhere, Common Reed (Phragmites australis) are common (both in blackwater treatment but also in greywater treatment systems to purify wastewater).

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The large roots of this uprooted plant growing in a constructed wetlands indicate a healthy plant (Lima, Peru)

Removal of contaminants.

Physical, chemical, and biological processes combine in wetlands to remove contaminants from wastewater. An understanding of these processes is fundamental not only to designing wetland systems but to understanding the fate of chemicals once they enter the wetland. Theoretically, wastewater treatment within a constructed wetland occurs as it passes through the wetland medium and the plant rhizosphere. A thin film around each root hair is aerobic due to the leakage of oxygen from the rhizomes, roots, and rootlets.[8] Aerobic and anaerobic micro-organisms facilitate decomposition of organic matter. Microbial nitrification and subsequent denitrification releases nitrogen as gas to the atmosphere. Phosphorus is coprecipitated with iron, aluminium, and calcium compounds located in the root-bed medium.[8][9] Suspended solids filter out as they settle in the water column in surface flow wetlands or are physically filtered out by the medium within subsurface flow wetlands. Harmful bacteria, fungi, and viruses are reduced by filtration and adsorption by biofilms on the gravel or sand media in subsurface flow and vertical flow systems.

Ammonia removal occurs in constructed wetlands – if they are designed to achieve biological nutrient removal – in a similar ways as in sewage treatment plants, except that no external, energy-intensive addition of air (oxygen) is needed.[6] It is a two-step process, consisting of nitrification followed by denitrification. The nitrogen cycle is completed as follows: ammonia in the wastewater is converted to ammonium ions; the aerobic bacterium Nitrosomonas sp. oxidizes ammonium to nitrite; the bacterium Nitrobacter sp. then converts nitrite to nitrate. Under anaerobic conditions, nitrate is reduced to relatively harmless nitrogen gas that enters the atmosphere.

The total number of constructed wetlands in Austria is 5,450 (in 2015).[32] Due to legal requirements (nitrification), only vertical flow constructed wetlands are implemented in Austria as they achieve better nitrification performance than horizontal flow constructed wetlands.

Часть 5. Источники информации.

Публикации.

Используются многие публикации на бумажном носителе и в Интернете, в том числе публикации автора, где затрагиваются вопросы экотоксикологии дисперсантов (книги по теме surfactants) и по водным макрофитам в связи с изучением толерантности к поллютантам (в том числе совместные работы с аспирантом Е.Соломоновой). Используются также публикации автора по изучению биосорбции контаминантов (тяжелых металлов и других токсичных элементов биогенными матрицами.

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