CHEMICAL ENGINEERING

OIL POLLUTION PROBLEMS

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ПРОБЛЕМЫ ЗАГРЯЗНЕНИЯ НЕФТИ

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ABSTRACT

The ability of the World Ocean to absorb oil that has fallen for various reasons and recommendations for eliminating their consequences are given. Shown are the processes of weathering of oil that got to the sea and its duration depending on various factors, the responsibility of various international organizations to prevent oil from entering the World Ocean.

АННОТАЦИЯ

Описана способность Мирового океана поглощать нефть, выпавшую по разным причинам, и даны рекомендации по устранению их последствий. Показаны процессы выветривания попавшей в море нефти и их продолжительность в зависимости от различных факторов и ответственность различных международных организаций по предотвращению попадания нефти в Мировой океан.

Keywords: oil pollution, weathering, oil gathering devices, tanker transport, oil slick, environmental program.

Ключевые слова: нефтяное загрязнение, выветривание, нефтесборные устройства, танкерный транспорт, нефтяное пятно, экологическая программа.

According to the National Academy of Sciences of the United States, about 5.1 million tons of hydrocarbons of petroleum origin fall into the oceans and seas every year (according to 2018 data). More than half of the total volume of pollution comes from sources that are to a small extent associated with the oil industry.

The ability of the oceans to absorb polluting oil is great, but not infinite. In deep waters, adverse consequences are rare, but the consequences of oil spills near the shores, estuaries of rivers or low coastal areas flooded at high tide can be catastrophic. The volume of annual oil transportation by sea exceeds 3 billion tons, which is more than the total volume of transportation of all other goods. Since as a result of international trade in oil, some of it ends up in the sea, in order to solve the problem, it is necessary to take measures on an international scale at the level of governments of various countries.

Some of the oil ends up in the sea independently of human activity and independent of human activity and cannot be controlled, for example, due to oil seepage in some areas of the seabed or erosion processes. Such uncontrolled pollution accounts for 400 thousand tons of oil per year. About 1.95 million tons, or 45%, goes to the sea with municipal industrial and storm water flows from urban areas. Another 420 thousand tons of oil at sea during the transportation of various goods and as a result of accidents not related to the oil industry.

In 2018, 950 million tons of oil were produced in offshore areas, and of this amount, about 60 thousand

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tons fell into the sea. According to an estimate by the National Academy of Sciences, this represents only 1.5% of the total oil that entered the sea, although the degree of pollution from such a source is different (it is higher in areas characterized by high exploration and development of oil fields, such as the Gulf of Mexico or North Sea). Oil discharges into the sea are increased as a result of open flowing events. Drilling of one and 750 wells ends with open flowing and every third of these flowing wells is a source of oil pollution in the seas. However, it should be noted that cases of open flowing, in which large amounts of oil enter the sea, are very rare.

Tanker transport of oil into the sea receives about 30% of the total volume of oil pollution, with 20% during normal tanker operations. On return voyages, tankers take water as ballast and in the past it was common practice to discharge ballast water before loading oil into tanks. The remaining oil from the previous voyage of the tanker was also dumped with the water. The use of modern technology for cleaning tanks from oil residues in recent years has made it possible to reduce its discharge into the sea with ballast waters.

As a result of tanker accidents, 12% of the total volume of oil pollution fell into the sea. During this period, there were several accidents with very large discharges of oil into the sea. However, in subsequent years, the number of accidents with crude oil of 900 m^3 and more sharply decreased.

After a spill on the surface of the water, oil that could not be collected by oil-gathering devices undergoes many physical and chemical transformations. Typically, oil spreads over the surface of the water in the form of a film several millimeters thick, depending on its viscosity and water temperature. The film thickness of heavy oils in cold sea water can reach 6 ... 7 mm. Winds and sea currents allow the oil slick to travel long distances and even reach the coast.

Subsequently, under the influence of air, sun and sea water, chemical reactions occur with oil in combination with processes of dissolution, evaporation, photochemical reactions and microbiological degradation. All these processes are united by one term weathering. The weathering time largely depends on the viscosity of the oil, the temperature of the seawater and its turbulence. Typically, according to the US Environmental Protection Agency, the degradation of the oil slick proceeds in the following sequence: the spread of low molecular weight oil, which occurs during the first few days; dissolution of low molecular weight oil components and polar components in the surrounding water (this process is characterized by duration and occurs during the entire weathering process); emulsification, when one liquid is dispersed in another liquid that does not shift with it (the emulsion can be water-oil or oil-water); autooxidation - light hydrocarbons react with atmospheric oxygen to form polar components, which are then dissolved in water: microbiological degradation - aerobic or anaerobic microorganisms use hydrocarbons as food; immersion - occurs as the light components weather and the density of the remaining oil increases, followed by the latter sinking to the bottom, where it degrades as a result of the action of anaerobic microorganisms; the spread of oil on the seabed - occurs as a result of the impact on the submerged oil of anaerobic microorganisms (its density decreases and oil spreads along the seabed).

These processes can be repeated until the oil slick disappears completely or reaches the coast.

The immediate threat from an oil spill is a fire hazard. They can spread through water very quickly and pose a great danger to piers, ships and marine berthing facilities. Heavy oil products are less fire hazardous, but they can lead to severe pollution of shores, estuaries and tidal zones. In some cases, the pollution persists for 10 years.

The main focus is on preventing the oil slick from reaching the shore, but this is often not possible as the weathered forms of the oil become asphalt-like and highly resilient; sooner or later they reach the shore. Sometimes chemical dispersants are used to decompose oil at a considerable distance from the coast, but these reagents can be more dangerous to marine life than oil itself, therefore their use is sharply limited in coastal waters of the United States in accordance with the adopted emergency response plan. The deliberate burning of spilled oil is also dangerous and prohibited.

Oil spill prevention and response is an international issue. After the accident with the tanker "Torrey Canyon", when more than 110 thousand m3 of oil got into the sea off the south-west coast of Great Britain, it became obvious that the world was not prepared to deal with large spills of oil or other dangerous products.

About 80% of accidents involving oil spills are due to human error, so one of the real ways to prevent them is to improve the quality of personnel training and tighten standards. Several international organizations, the most famous of which is the International Maritime Organization, worked on the creation of new rules and regulations that increase the reliability of the development of oil fields and oil transportation. As an integral part of the UN, it unites 178 states closely cooperating with each other. As a result of this cooperation, rules, norms and recommendations are developed aimed at improving the existing Standards. These standards come into force after their adoption as laws by the member states of the International Maritime Organization. The global oil industry is represented in this organization by the International Offshore Oil Companies Forum and the Offshore Oil Companies Forum.

The UN Environment Program encourages and supports the creation of regional plans and agreements aimed at reducing the risk of marine oil pollution, cooperation with the International Maritime Organization, the development of training programs for personnel and the exchange of information. The oil industry is also represented in this program through the International Environmental Association of Petroleum Companies.

The aforementioned Forums and the International Chamber of Cargo Transportation are actively involved in identifying the causes of accidents, developing standards for the operation of ships and facilities for the development of offshore fields, aimed at reducing the risk of oil pollution of the seas and creating conditions for personnel training. Oil companies engaged in offshore development are taking measures to improve the reliability of

the equipment used and to train personnel. A number of specialized maritime colleges offer courses for offshore oil company personnel. In some countries, boatmasters are required to complete such courses. The significant decrease in the number of accidents in recent years is a consequence of the increased emphasis on personnel training.

Improvements in technology have helped to reduce the incidence of marine pollution from drilling ships and platforms, production facilities and oil transfer depots. Oilfield wastewater can be discharged into the sea only after it has been cleaned from oil to permissible limits; Contaminated water is treated using efficient separators that provide a high degree of separation of hydrocarbon fluids from drilling fluids discharged into the sea, especially oil-based fluids, in which the hydrocarbon content can reach 15%. In addition, there is a trend towards increasing use in oil-based fluids low-emission oils instead of diesel fuel. Since the introduction of top loading on tankers, oil emissions from tankers have sharply decreased. This method is used by companies in accordance with the Convention on the Prevention of Marine Pollution, which prohibits the dumping of oil or its mixtures into the sea. It is allowed to discharge oily liquids into the sea at a very low concentration of oil and at a distance of at least 80 km from the coast. New tankers should be equipped with separate tanks for oil and ballast water, and existing tankers should use a special technique for flushing tanks from oil residues. In theory, the culprit of the pollution is legally responsible in each case and is obliged to eliminate its consequences. However, in practice, in many cases, the culprit cannot be identified. The government of the country where the pollution has occurred should itself take measures to limit the spread of oil pollution and carry out clean-up work. In accordance with the UN Sea Pollution Prevention Program, signatory countries must have contingency plans to deal with the consequences of pollution. The plans should define a clear sequence of emergency clean-up operations with the establishment of the priority of each operation. In almost all countries, offshore emergency plans must be approved by local authorities. The adverse effects of pollution can be significantly reduced as a result of the cooperation of all companies operating this field.

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