Improvement of Emergency Oil Spill Management Technology

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Abstract. As a result of the study, the main causes of emergencies at oil fields were analyzed. Most often, emergency spills occur due to violations of the tightness of field pipelines. Basically, accidents occur from pipe wear due to internal corrosion under the influence of oil and oil products. In the paper, existing methods of oil spills elimination are considered. In order to reduce the negative impact of oil spills on the environment, it is necessary to pay special attention to the study of methods for containment of spilled oil and eliminating the consequences of emergencies and to developing a set of necessary measures. Today, there is a large selection of sorbents offered by various companies. For rapid oil gathering in case of emergency spills, it is proposed to use a biological sorbent “Peat-sorb” based on peat sphagnum moss which has the ability to self-biodegrade the absorbed hydrocarbons.

1. Introduction

Today, the development of industrial facilities in the oil and gas industry as well as the development of new oil and gas fields, are potentially dangerous in terms of the risk of technogenic accidents and disasters.

The oil industry is an object of increased danger from the point of view of industrial and environmental safety. The processes of oil production, preparation and transportation have a negative impact on the natural environment.

According to scientists, up to 5% of oil produced is lost during the development of oil fields. The biggest loss of oil occurs during its transportation. Emergency oil spills are the result of cutdown in repair capacities and slow pace of work on replacing old pipelines.

In order to reduce the negative impact of oil spills on the environment, it is necessary to pay special attention to the study of ways to eliminate the consequences of accidents and to developing a set of necessary measures.

2. Relevance of the issue with a brief review of literature

Currently, the development of oil and gas production, the processing of primary raw materials and the development of wells at the fields carry a potential risk that can cause technogenic accidents and disasters [1-3].

The oil industry is a dangerous type of raw material extraction, which includes such aspects as extraction, primary oil processing, preparation and transportation. In case of emergency situations, the environment can be exposed to danger [4-7].
Extracted from clusters of oil wells, the complex mixture consists of oil, associated petroleum gas, water, mechanical impurities (rock particles, cement) and mineral salts in the form of crystals in oil. The water cut of oil can reach 95%, which increases the cost of transportation as well as corrodes the metal of pipelines and equipment and makes oil refining process more difficult. The presence of mechanical impurities causes abrasive wear of pipes and oil pumping equipment. Therefore, a centralized oil gathering and treatment scheme is used in all newly constructed oil fields.

Primary oil treatment is a continuous technological process that includes the processes of desalting, dehydration, degassing and removal of solid particles. For preliminary separation of raw materials extracted from oil wells, an oil treatment unit is used. This unit serves to separate the extracted raw materials into gas, oil and local water with further purification, measurement, pumping of the products through the pipeline and final treatment of marketable oil.

Oil spills are possible at all stages in the field development processes. Sources can be oil fields and boreholes for various purposes. Oilfield and interfield pipeline systems are especially dangerous. Most often, emergency spills occur due to leaks in oilfield pipelines. Most emergencies occur from pipe wear due to internal corrosion. In order to respond promptly to emergency situations, it is necessary to have a set of technical means and materials in readiness.

3. Theoretical part

Getting into the environment, oil disrupts all vital processes of soils and water bodies because it is an environmentally hazardous substance. The degree of damage to the environment directly depends on its quantity and quality.

Local accidents, due to the deeper penetration of oil into the soil through stratal waters, pose an increased danger to soils. Finding such sites in the process of environmental monitoring is very difficult. The most severe contamination of soils with hydrocarbons of the liquid fraction occurs when discharges of crude or commercial oil.

The solid phase of soil is the main sorbent of pollutants, including oil and oil products. Once in the soil, they are exposed to intense influence of external agents that contribute to their weathering, transformation and etc. Contamination with crude oil and petroleum products pose the greatest threat to the normal functioning of soils. Physicochemical properties change, biological processes are inhibited, the solubility of most trace elements decreases, the ratio between carbon and nitrogen sharply increases [8-15].

Work to eliminate large spill on the ground is divided into the following stages:
- containment of spilled oil;
- oil gathering;
- land reclamation.

The following are used to gather spilled oil:
- pits, earthen barns, channels, trenches;
- unloading mobile pumping units for pumping oil mixture.

For small volumes of emergency oil spill, sorption-retaining barriers are used. If necessary, the operation to clean up the soil is carried out by mechanical removal of the contaminated soil layer (manual and mechanized oil spill management methods). There is also a thermal method, which is based on burning off a layer of oil; a biological method, which is used after applying the mechanical method with the oil film thickness of at least 0.1 mm. The biological method is based on the concept of bioremediation (the ability of microbial molecules to change the species composition under the influence of external conditions, primarily nutritional substrates based on stimulation of local soil biocenosis).

Currently, the most relevant and effective method of rapid oil gathering in case of emergency spills is sorption, that is, the use of various sorbents. Sorbents are the most effective means in the final stages of shoreline cleaning as well as for removing oil puddles that cannot be removed by other purification methods [16-18].
They can act on the principle of adsorption (surface absorption) or less commonly on the principle of absorption. During adsorption, oil is selectively attracted to the surface of the substance, while absorbents absorb oil or other liquid to be removed.

Sorbents come in various forms depending on the composition and purpose. They are divided into four types, such as loose unbound sorbent (often in the form of individual particles); sorbents in the form of mats, sheets, rolls; sorbent in the form of loosened fibers combined in the form of a loop or trawl.

4. Practical relevance, suggestions
To respond to emergency oil spill in the Site 17 km - Site 41 km of Samotlor group fields, we propose the following oil spill response measures below.

The process of primary gathering of spilled oil from the surface of the earth is carried out in a combined way using self-priming pumps and mobile vacuum pumping units. In this case, the method of flooding the diked area with water can be used, and the most intensive pumping of oil is organized from special storage pits.

The required volume of containers for storing the gathered oil is determined by the formula:

\[ V_{\text{cont}} = \frac{V_1}{T} \cdot 0.8 \]

where:
- \( V_{\text{cont}} \) - volume of container
- \( V_1 \) - maximum estimated oil spill volume, m³
- \( T \) - transportation period, h
- 0.8 - coefficient taking into account that the filling of container should not exceed 80% of its volume.

\[ V_{\text{cont}} = \frac{5444.15}{4} \cdot 0.8 = 1088.83 \text{ m}^3 \]

After the spilled oil is gathered, the area is cleaned with special sorption materials. We propose to use the "Peat-sorb" sorbent. It is a sorbent for gathering oil, the main ingredient of which is peat sphagnum moss. Therefore it is an absolutely natural industrial sorbent. This sorbent is completely organic and non-toxic; it has been tested in laboratory conditions and in the Arctic. Sorbent "Peat-sorb" suppresses vapors and absorbs hydrocarbons from soil and water in wet and dry conditions. The inherent capillarity of the absorbent provides a very strong absorbency, which makes it suitable for gathering oil.

In the course of calculations, the volume of the sorbent required for eliminating the oil spill in the Site 17 km – Site 41 km of Samotlor group fields was determined.

The required volume of sorbents is calculated by the formula:

\[ V_{\text{sorb}} = 0.2 \cdot \frac{V_1}{J} \]

where:
- \( V_{\text{sorb}} \) - volume of sorbent
- \( V_1 \) - maximum estimated oil spill volume, m³
- \( J \) - absorbing capacity of sorbent, 5 m³/m²;
- 0.2 - coefficient taking into account that 20% of oil is gathered;

\[ V_{\text{sorb}} = 0.2 \cdot \frac{5444.15}{5} = 217.77 \text{ m}^3 \]

5. Conclusion
It is proposed to improve the existing technology for elimination of emergency oil spills by using the biological sorbent "Peat-sorb" based on peat sphagnum moss.

The calculation of predicted emergency situation showed at the critical section of the pipeline in the Site 17 km – Site 41 km of Samotlor group fields that the maximum oil spill is 5444.15 m³. The required volume of the “Peat-sorb” sorbent for oil spill elimination is 217.77 m³.
6. References

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