ENVIRONMENTAL AND ECONOMIC RISKS OF THE OIL AND GAS SECTOR

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Abstract

In order to manage environmental safety in order to fulfill the tasks formulated in the Law of the Russian Federation "On the Basic Principles (Strategy) and State Environmental Policy for the Period until 2020", the problem of assessing the technogenic impact is becoming increasingly relevant. The works of many authors have created methodological and theoretical prerequisites for the further development of the assessment and modeling of environmental risks, taking into account technogenic atmospheric pollution for managing environmental safety. At the same time, there is a need to further improve the mechanisms for managing the environmental and economic safety of technogenically loaded regions, industrial centers and cities. The purpose of the article is to analyze modern methods for assessing environmental risks associated with the exploitation of oil fields.

Keywords: economic risks, environmental safety, environmental problems, technological atmospheric pollution, natural resources, industrial centers

I. Introduction

Under the environmental risk is understood the probability of adverse consequences for the environment of any changes in natural objects and factors. The risk is considered as the probability of occurrence of extraordinary events in a certain period of time, expressed in quantitative parameters. The man-made aspect of environmental risk is more often considered - the probability of man-made accidents that can cause significant harm to the environment or human health. Some risks are specific, others cannot be specifically identified. There are occupational risks – the danger of occupational diseases [1]. Environmental risk is often considered in two aspects - potential risk and real risk. Potential environmental risk is a phenomenon of danger of violation of the relationship of living organisms with the environment as a result of the action of natural or anthropogenic factors. A real environmental risk is formed by a potential one, taking into account the likely frequency of its implementation. According to the nature of manifestation, environmental risk can be sudden (technogenic accident, earthquake, etc.) and slow (displacement, flooding, erosion, etc.). Risk assessment is an analysis of the causes of its occurrence and the extent of its manifestation in a particular situation [2]. The danger of man-made accidents, significant in their consequences, is more associated with chemical and petrochemical enterprises, nuclear and thermal power plants, mines, and sewerage facilities. The probability of occurrence of man-caused accidents is largely determined by the effectiveness of environmental protection activities. Environmental risks when drilling wells. The experience of large offshore oil and gas projects shows that this type of activity is accompanied by a large amount of emissions: into the atmosphere, the marine environment, etc. Even after the cessation of oil or gas production at the field, environmental risks still remain [3]. Well drilling begins already at the stage of geological and geophysical surveys in those areas where seismic surveys indicate the presence of oil and gas bearing structures. Almost all stages and operations of exploration and production of hydrocarbons are accompanied by the discharge of liquid and solid waste. The volumes of these discharges reach 5000 m 3 for each passed well in the form of waste drilling fluids and cuttings, which are rocks drilled in the well. Liquid waste includes a huge number of toxic impurities necessary for the smooth operation of drilling equipment, heavy metals that accumulate from rock workings, as well as clay suspensions that increase the turbidity of water at discharge sites. The use of oil-based drilling fluids is of great danger. Sludges impregnated with such a solution are the main source of oil pollution during drilling operations. Another significant source of pollution is the discharge of formation waters coming from [4] wells. Their composition is distinguished not only by a high content of petroleum hydrocarbons and heavy metals, but also by abnormal mineralization, which is usually higher than the salinity of sea water. This may be the reason for the violation of the hydrochemical regime in the area of formation water discharge. In addition, they contain natural radionuclides, which, upon contact with sea water, precipitate and form local microclusters. The longer the field is exploited, the more formation water is formed. Produced water can be returned to the sea with or without prior treatment, or pumped back into natural reservoirs (wells). According to Russian legislation, used drilling fluid and other wastes must be accumulated and transported for further processing or undergo special treatment before being discharged overboard. Often these precautions are bypassed. Currently, there are no effective technologies for processing petroleum products, and specialized storage facilities are overcrowded. The local impact of waste from one well is noted within a radius of 3–5 km, but if the number of wells is large enough, then their negative impact can "cover" the whole fishing bank. For example, according to the Norwegian Institute for Marine Research, the scarcity of the North Sea ecosystem is the result of oil and gas activities. Oil spills [5]. The development of oil and gas fields, as well as the transportation of hydrocarbons, is accompanied by accidental spills of oil or chemicals. The most common causes of accidents include equipment failure, human error and extreme environmental conditions. The environmental consequences of accidental releases become especially severe when they occur near the coast or in areas with slow water exchange [5-6].

Drilling accidents are unexpected surges of liquid and gaseous hydrocarbons from a well during drilling when opening zones with abnormally high reservoir pressure. In rare cases, with very large pressure drops, the accident will have a long-term catastrophic nature, and deviated wells will have to be drilled to stop the blowouts. Another group of accidents includes regular "normal" blowouts that can be stopped within a few hours without additional drilling. The danger of such releases lies precisely in their regularity, which ultimately leads to chronic impacts on the marine environment. One-time or systematic oil spills can lead to serious disturbances in the functioning of the marine ecosystem [7]:

- deterioration of the chemical composition of water and its physical parameters (transparency, temperature, etc.);
- death of living organisms as a result of the ingress of oil products on the surface layer of the skin and plumage;
- forced change in migration routes, molting, nesting and spawning, etc.

Air emissions.

Emissions of pollutants into the atmosphere always accompany any oil fields. The most common source of such emissions is the flaring of associated gas and excess hydrocarbons during well testing and operation [8]. According to some estimates, up to 30% of flared hydrocarbons are released into the atmosphere and then fall to the sea surface, forming relatively unstable thin films around drilling platforms. Emissions of "greenhouse" gases. The oil and gas industry is a significant contributor to climate change through the release of large amounts of greenhouse gases such as CO2 and CH4. The majority of these emissions result from the burning of oil or gas to generate the energy needed to operate the production platform installed at the field, as well as from the flaring of associated gas. NOx emissions are generated by the combustion of associated gas and gas in turbines needed to generate energy. The influence of this type of emissions is local, but it can cause serious environmental damage to coastal ecosystems, since a large content of this substance in the atmosphere can lead to acid rain. Emissions of nmVOCs (non-methane volatile organic carbons) are generated as a result of the evaporation of crude oil during its storage or transshipment to terminals. When nmVOCs react with NOx in the sun, ozone is formed. High concentrations of ozone in the ground layer can harm human health, vegetation, and buildings.

II. Methods

Developed industry and infrastructure, an increase in the number of vehicles, the placement of a large number of industrial facilities in a small area leads to an increased technogenic load on the environment, causing its change and transformation [3-4]. The formation of an economic mechanism for nature management involves taking into account the consequences of possible environmental and economic risks, the emergence of which is initiated by the processes of anthropogenic activity. To assess the technogenic load, we proposed the concept of the threshold impact of technogenic objects on the components of the natural environment. The assessment of the technogenic load in general terms includes the process of identifying, assessing and predicting the negative impact on the environment and / or human health as a result of the operation of industrial and other industries and facilities that may pose a danger to the population and the environment after reaching a certain value, which can be called threshold of technogenic load [4]. Risk assessment is an environmental safety management tool. Environmental risk assessment is defined as a process that assesses the likelihood of adverse environmental impacts that cause stress and eventually degradation of ecosystems or deterioration in public health in areas with increased anthropogenic pressure. The procedure for conducting an analysis of environmental risk, which is caused by environmental pollution, can be divided into two stages [5]: risk assessment and risk management. A generalized risk assessment includes the identification of hazard factors and the determination of the degree of this negative impact in terms of the level of effects on human health and the state of the environment. In risk management, the tasks of regulating the effects of impact on humans and the environment are solved, the economic block of which is based on an analysis of the effectiveness of measures to reduce the magnitude of effects to a certain level. Depending on the purpose and scope of work, data and means, individual steps (screening analysis) or a complete risk assessment can be performed [6]. For example, if it is necessary to determine the size of the danger posed by one or more harmful environmental factors, a risk assessment is applied due to the action of these factors. If the task is to select technical solutions of various costs that reduce the risk from emissions from any source, it is necessary to use economic approaches to risk management. Comparative risk analysis guides users on how, given limited funds, to choose a priority and easier problem to solve from all possible ones. Assessment and analysis of environmental risks due to constant technogenic load or emergencies that have negative environmental and economic consequences, allow us to evaluate quantitative risk indicators in the form of [7]: 1) damage to natural ecosystems; 2) economic losses in the form of accelerated wear of units, structures, installations; 3) socio-economic damage to the health of the population caused by increased environmental pollution; 4) additional expenses for the elimination of the consequences of accidents and catastrophes. The quantitative value of the economic criteria used depends on environmental risk factors. In general, the economic assessment of environmental risk is based on the calculation of damage and benefits from potential or real changes in the state of the environment due to technogenic load. This assessment is based on the analysis of two main aspects - the state of the recipients of the impact and the characteristics of the technogenic impact [8]. Economic damage from environmental disturbance should be understood as the value of actual and possible losses that are inflicted on economic entities as a result of environmentally destructive impact. Different countries, depending on national characteristics, available resources and other factors, assess environmental and economic risks using various mechanisms. For example, in the Netherlands, the USA and a number of other countries, the principle is used, the essence of which is that the region establishes a general allowable emission rate for a particular pollutant. Within the framework of such a norm, the distribution of the total allowable emission volume between enterprises, as well as the distribution of the emission volume of each enterprise between individual sources of pollution, should be regulated [9].

The concept of environmental risk links the increase in environmental protection costs with the expected value of loss reduction, which are determined not by the established emission standard, but by the level of risk caused by the constant presence of a pollutant in the environment and the corresponding economic damage. At the same time, human health is taken as the main indicator of losses, i.e. The criterion for the cleanliness of the environment is not the normative levels of pollution, but the absence of diseases caused by environmental factors. The advantage in calculating the economic assessment of environmental damage based on the theory of environmental risk in comparison with the normative approach is the desire to obtain the maximum effect due to a more complete (comprehensive) accounting of losses from environmental pollution, reduced to one recipient person or ecosystem, and the choice of a rational investment structure resources in activities for its protection and restoration.

III. Results

Known methods of economic assessment of environmental risk by calculating the specific indicators of technogenic load, which leads to environmental risks. In this case, the environmental load is used as a tool for the economic assessment of environmental safety, the use and setting of the level of which causes the cost of compensatory measures, depending on the specific environmental situation, specific measures and the possibility of implementation. In order to take preventive and prophylactic measures aimed at reducing environmental accidents at oil and gas complex facilities, it is proposed to the heads of the territorial bodies of Rostekhnadzor: to analyze the materials on the state of accidents and injuries at oil and gas complex facilities with the inspector staff and bring the information to the heads of controlled organizations. When conducting inspections [10]:

- strengthen control over the implementation by supervised organizations of measures to eliminate violations of industrial safety requirements, as well as to finance these measures and reduce the time for bringing hazardous production facilities in line with the requirements of federal norms and rules in the field of industrial safety;
- pay special attention to the availability and implementation by organizations of plans for diagnosing equipment in a timely manner; timely decommissioning of defective equipment and its replacement; ensuring production control over the quality of audits, equipment repairs, industrial safety reviews;
- to include in the scope of verification activities the issues of compliance by the production personnel of organizations with technological regulations, instructions for the safe conduct of repair, gas hazardous, hot work and other operational documentation. If there are cases of violation of the requirements of the instructions when performing high-risk work or performing repair work on equipment that is in operation or unprepared for such work, take strict administrative measures against officials responsible for carrying out these works, up to and including their disqualification;
- ensure the verification of the implementation of industrial safety management systems at facilities of hazard classes 1 and 2, as well as the analysis of the developed action plans for the localization and elimination of the consequences of accidents. At the same time, it is necessary to pay attention to the effectiveness of preventive measures, as well as to the readiness of professional emergency rescue teams to localize and eliminate accidents as soon as possible.

The impact on marine organisms and ecosystems begins with geological and geophysical surveys of the seabed, aimed at determining its oil and gas content. Most often, seismic exploration methods are used. Marine seismic exploration is based on the generation of seismic waves and the registration of vibrations reflected from the bottom surface, which makes it possible to judge the structure and oil and gas content of sedimentary rocks. Water hammer effect up to 150 atm. leads to the death or damage to organs and tissues of adult fish and fry. There are known cases of disruption of salmon migration routes in the area of seismic surveys. The noise generated by seismic surveys makes it difficult for marine organisms to identify other sounds, communicate with each other and search for food. This is especially true for whales. There are cases when animals, attracted by sounds unknown to them, received serious, and often fatal injuries from powerful water hammers. Many species of fish are leaving the exploration areas. Following them, predators also leave, leaving their favorite habitats. However, some organisms can exist only under strictly defined conditions, and many of them will die without having time to get used to the new environment [9].

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IV. Discussion

The conducted analysis showed that as a criterion for assessing the real environmental risk that is formed on a local and regional scale, a potential characteristic of economic losses quantitatively associated with technogenic factors of industrial production can be used. The mechanism of economic assessment of damage from environmental pollution based on risk theory, in comparison with the normative approach, makes it possible to more fully take into account the consequences of the impact of anthropogenic factors in monetary terms for pollutants and their sources. In this case, it becomes possible to predict environmental pollution factors potentially dangerous for the state of the ecosystem and human health. In the theory of safety in the technogenic sphere, there are dozens of potential hazards that turn into threats and create various risks. In general, the safety of the technogenic sphere can be divided into two aspects [5]: 1) technogenic safety determines the degree of protection of a person, objects and the environment from threats emanating from the created and functioning complex technical systems in the event of the occurrence and development of emergency and catastrophic situations; 2) technological safety determines the degree of protection of a person, society, objects and the environment from threats associated with the unreasonable creation or non-creation of technical systems, technological processes and materials that ensure the achievement of the main national interests of the country. The growth of potential and real threats in the technogenic sphere requires strengthening the role of the state in solving the problems of technogenic and technological security. In the future, risks in the technogenic sphere may change dramatically: technogenic risks will replace technological risks, and damages will arise due to the destruction of the national technological base.

In a number of cases, accidental releases of oil and gas on onshore main pipelines, when they occur at the intersection or near large rivers, are also dangerous for coastal marine ecosystems, since any pollution of river waters sooner or later affects the state of the estuarine zone [6]. One of the main sources of impact on the marine environment during the construction of an underwater pipeline is excavation during trenching and approach channels, deepening and backfilling of pipelines and soil dumping, accompanied by: deposits; a change in the hydrochemical regime of sea water during the release of pollutants from bottom sediments during earthworks. As a result of the transportation of hydrocarbons by an underwater pipeline, the bottom waters are heated and cooled in the pipeline zone. It is likely that there will be no significant temperature changes in a layer of water mass that is significant in thickness, and the effect of temperature changes on benthos will be limited to a very narrow strip along the pipes. At the same time, the possibility of the influence of these changes as a signal factor on migratory demersal fish cannot be completely ruled out. Thus, it is the negative temperature of the bottom waters that under natural conditions limits the migration of some commercial fish, such as cod, haddock, and sea flounder [8-9]. At present, according to experts from the Ministry of the Russian Federation for Civil Defense, Emergencies and Disaster Relief (MES), the accident rate at pipelines is increasing every year. The intensive load of the main oil pipelines, which moved annually in the 80s. more than 500 million tons of oil, has led to the fact that their main part is badly worn out and requires significant reconstruction. Without this, accidents with great environmental damage and large material losses are likely in the coming years.

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