

# ECOLOGICAL ISSUES OF OIL AND GAS PRODUCTION AT THE CASPIAN SEA

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## **ABSTRACT:**

The article shows that due to the increasing capacities of production and large-scale oil-gas projects in the Caspian Region, the problems of ecological safety must be of top priority.

**KEYWORDS:** oil and gas production, offshore oil pollution, oil and gas reserves, ecological safety.

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## **INTRODUCTION**

A brief overview of environmental issues arising from oil and gas production in the Caspian Sea is presented. It is known that at present there is an intensive offshore oil and gas production, therefore environmental problems and their solutions for all oil and gas companies operating at sea should be in the first place. The article identifies the main problems for environmentalists, oil and gas specialists of the five Caspian countries, which should be considered and solved in the first place.

## **MAIN PART**

In recent years, the problem of preserving a unique natural asset, that is the Caspian Sea, has become extremely acute. It is known that the Caspian Sea is a unique water area, its hydrocarbon resources and biological resources have no analogues in the world. At the same time, the Caspian is the world's oldest oil-producing basin; oil production here (in Azerbaijan, in the village of Bibi-Heybat) began more than 170 years ago.

And the industrial development of oil on the shelf began as early as 1924. We note that the Caspian received its modern name by the name of the ancient tribes – the Caspians, who inhabited the right bank of the Kura, near the sea in the 2nd millennium BC. The Arabs called this the Khazar Sea – from the name of the Khazars, the Turkic people who lived on the northwestern coast of the sea (this name is still used in the Azerbaijani, Turkish and Persian languages).

Ecological control over the oil pollution of the Caspian Sea, and in particular, the Absheron coast, is essential for the implementation of offshore projects, the operation of transportation and storage infrastructure, as well as the introduction of new technologies aimed at accelerating oil and gas production processes [1-5].

As is known, the contract for the development of a large offshore field in the Azerbaijani sector of the Caspian Sea, Azeri-Chirag-Guneshli (ACG), was concluded in 1994. In March 2013, it was established that the volume of reserves to be recovered should be increased at this ACG field

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oil by 76%; and the total oil reserves of the block are estimated at 1.2 billion tons. These facts also mean an increase in environmental problems in the Caspian region.

The role of petroleum products and petroleum wastes entering the sea has not yet been fully studied: oil is a mixture of various substances, of which from 50% to 90% (depending on the field) accounts for hydrocarbons, and the rest – for heteroatomic compounds containing carbon as well as hydrogen, and sulfur, nitrogen, oxygen and trace elements. Depending on the presence and predominance of one of the hydrocarbon groups in the oil, they are divided into methane, methane-naphthenic, aromatic, etc. At present, the chemical composition of oil has not been fully studied, although it already has more than 400 different hydrocarbons. Low molecular weight oil products (in crude oil, this fraction is up to 50%-60%) evaporate relatively quickly from the surface of the water; part of the petroleum products dissolves in seawater — during chemical transformations, new substances are formed, being more soluble than the initial ones. They react with water to form persistent emulsions, which then turn into oil clots: the further decomposition of petroleum products leads to an increase in their specific gravity, and ultimately, they settle to the bottom, poisoning the marine ecosystem.

Here we will especially emphasize the impact on the flora and fauna of the Caspian Sea of polyaromatic hydrocarbons (PAHs), which accumulate in marine ecosystems. PAHs are cyclic hydrocarbons consisting mainly of benzene rings with substituted and unsubstituted hydrogen atoms; moreover, almost all PAHs are carcinogenic substances with mutagenic activity (benzopyrene is the most studied carcinogenic compound). They are formed in the processes of combustion, processing and use of petroleum products and organic substances. The main sources of PAHs in the sea are river runoff, precipitation and urban runoff, and shipping. In urban areas, exhaust and industrial gases make up the bulk of PAHs, which are washed away with precipitation either into rivers or directly into the reservoir (Caspian Sea). Therefore, industrialized cities with large populations on the shores of the Caspian Sea serve as stationary sources of PAHs (on the shores of the Caspian there are many oil refineries, and many oil and gas fields are exploited).

No less dangerous role is played by the process of formation of drilling waste (drilling cuttings, spent drilling fluids and drilling waste water), which are formed during the construction and drilling of wells. We note the environmental hazard of drill cuttings, which is determined by toxic effects; increased turbidity of water, which disrupts the vital activity of young fish and physical impact on bottom organisms. Drilling sludge is potentially dangerous for the ecology of the sea also because it contains mobile forms of heavy metals, which under long-term exposure to sea water can leach out, creating dangerous concentrations of toxicants.

Drilling waste also contains such toxic reagents as acrylic polymers, caustic soda, soda ash, polyacrylamide, bromide, clay, barite, which enter the Caspian Sea over the years: they are accumulated during the construction of countless wells during large-scale drilling in all sectors of the Caspian countries. So, when drilling in the Caspian Sea, mainly clay suspension is used, and in this case fine clay particles and polymers are discharged from the well into the sea. The discharge of technological drilling waste continues at the stage of fixing the well direction. To ensure the descent and subsequent cementing of the direction, the wellbore is filled with a clay flushing fluid, weighted with barite to a density of 1160 kg / cubic meter. When cementing the direction, the flushing fluid is replaced with cement slurry. Thus, the flow of flushing fluid into the sea is equal to the volume of the injected solution (more than 40 cubic meters). And this is only the case of drilling one well.

All these critical environmental issues were debated during the dedicated International Conference “A World View on Environmental Issues in the Oil Industry” held in Baku (November 4-5, 2013), that was attended by representatives of government organizations from various countries, world oil and gas companies, scientists and leading experts in the field of industrial ecology. The

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main purpose of the conference was not only to analyze existing issues in the field of environmental protection, but also to develop relevant proposals for their solution in the framework of international cooperation.

Currently such topics – as the development of the oil and gas industry; air emissions; the impact on the reservoir of marine and gas operations; restoration and management of soil contaminated with oil and oil products; innovative approach to oil industry waste management; alternative energy and energy efficiency in oil and gas operations – are relevant and require speedy resolution.

In our opinion, oil and gas companies should be aware of the need to prepare and implement comprehensive measures aimed at minimizing risks and environmental impact during the commercial operation of oil and gas facilities. Against the background of growing production volumes and large-scale oil and gas projects implemented in the Caspian Sea, issues of industrial ecology and life safety should be prioritized. For example: the leading oil company of Azerbaijan, the State Oil Company of Azerbaijan Republic (SOCAR) and the partners of the Shah Deniz gas condensate field development project in the Azerbaijani sector of the Caspian Sea, signed in December 2010 an agreement to extend the contract for this field to 2036 (the previous contract assumed validity until 2031).

According to the management of SOCAR and of the British Petroleum subsidiary BP-Azerbaijan (BP), the reserves of the Shah Deniz field are estimated at 1.2 trillion cubic meters of gas. It is not uninteresting fact: according to the results of 2012, three production wells at this field were among the five most productive wells of the British company BP. To the place we would like to note that if by the beginning of the twentieth century Azerbaijan was the world leader in oil production, at the beginning of the twenty-first century the republic was turning into a powerful gas exporter in the Caspian region. Recall that in 1899-1901, in terms of the absolute amount of oil produced, the Russian (Baku) oil industry ranked first in the world, producing 11.5 million tons of oil per year, and the United States – 9.1 million tons [6].

According to the management of SOCAR, by 2024 the volume of gas production in Azerbaijan can reach 50 billion cubic meters per year; and the proven gas reserves in the republic amount to 2.6 trillion cubic meters. This is confirmed by new open fields - Shah Deniz, Umid and Absheron, as well as the development of promising structures - Zafar-Mashal, Babek, Shafag, Asiman and Nakhchivan. That is, intensive oil and gas production being expected in the near future, the environmental issues and their solutions for all oil and gas companies operating in the Caspian Sea should represent a hot priority.

It is gratifying that already on August 12, 2011, five Caspian littoral countries (Azerbaijan, Russia, Kazakhstan, Turkmenistan and Iran) signed an agreement on joint control of pollution of the Caspian Sea in Aktau, and that representatives of these countries continue an intensive dialogue on resolving disputed issues, reacting to various accidents and timely inform each other. And accidents, as it is well known, make a significant contribution to oil pollution of the seas [7].

The incident in the Gulf of Mexico (April 20, 2010) showed the danger of environmental pollution, becoming the impetus for the development of innovative technologies to clean water from oil spills. Thus, as of May 26, 2010, about 5 million gallons of oil fell into the waters of the Gulf of Mexico (1 gallon equals 4.456 liters). This accident was the largest environmental disaster in US history: on the BP Deep Water Horizon platform, an explosion occurred in the Macondo well that killed 11 people. The oil spill caused enormous damage to the territory of 10 national parks in the states of Louisiana, Florida, Alabama and Mississippi. That is, the oil that actually spilled into the Gulf of Mexico has caused irreparable harm to the ecology not only of the entire region adjacent to the bay, but also of the entire ecosystem of North America.

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American researchers (Francesco Stelacci and others) from the Massachusetts Institute of Technology in September 2012 developed a unique method of separating water and oil, based on the use of magnets. The material (“nanofollow”) removing oil film consists of special nanofibers which can remove 20 times their own weight. However, this collection method is suitable only for thin layers of oil. The uniqueness of the method lies in the fact that the extracted oil can be reused and the fact that the whole separation process can occur on board of the oil-collecting ship.

The necessity and importance of protecting the natural environment of the Caspian Sea is also highlighted in the perspective of the sale of the South Gas Corridor (SGC), along which, from 2020, 10 billion cubic meters of Azerbaijani gas from the Shah Deniz field should begin to be supplied to Southern Europe. Note that SGC is an energy project that enhances the diversification of sources of transportation of energy resources and ensures the energy security of Europe.

The statement of the head of the “International Energy Security” program at the Center for European Security Strategies, Frank Umbach in Berlin on February 24, 2017 is most relevant: *“The South Gas Corridor is the most important project for the European Union to diversify gas supply routes”* [8].

In September 2017, the oil strategy for the oil and gas industry of Azerbaijan until 2050 was defined and approved. In the same month, a consortium to develop the Azerbaijani gas condensate field Shah Deniz headed by BP put into operation the Khankendi vessel to carry out underwater construction works within the second stage of development of the project.

It should be noted that the ship was designed and built using the latest technical achievements for the construction of the largest underwater mining system in the Caspian Sea within the framework of the Shah Deniz-2 project. The uniqueness of the Khankendi is that it can carry out the most complex work without the need for anchors. This vessel is planned to be used in the development of the Absheron field (depth of the sea up to 650 m; estimated reserves – 350 billion cubic meters of gas and 45 million tons of condensate) and the Karabakh field (depth of the sea up to 450 m; projected oil reserves – 100 million tons). Work on the development of these fields is scheduled to begin in 2021.

Comparatively recently (May 29, 2018), the launch of the first stage of SGC took place in Baku: the first gas from the Azerbaijani Shah Deniz field has already gone through the first segment of the SGC from the Sangachal terminal expanded for Shah Deniz-2 via the expanded South Caucasus gas pipeline. The next stage was the commissioning of the TANAP (Trans Anatolian Pipeline) gas pipeline, through which the gas will enter the territory of Turkey and further to Europe.

Recall that the TANAP pipeline, with a length of up to 2,000 km, is laid from the Georgian-Turkish border to the western border of Turkey, and it is shared with another gas pipeline – the Trans Adriatic Pipeline (TAP) – and is part of the SGC project, which provides for the transportation of gas from the Azerbaijani Shah Deniz field to Europe. The initial capacity of the TANAP pipeline will be 16 billion cubic meters of gas per year. About 6 billion cubic meters will be supplied to Turkey, and the rest to Europe. After the completion of the construction of the TAP, with a length of up to 882 km, gas will flow to Europe around the beginning of 2020.

Based on the above, the importance of environmental control over the oil pollution of the Caspian Sea (creation of a system for monitoring pollution by oil hydrocarbons of the Caspian Sea), necessary when implementing new offshore infrastructure projects, as well as introducing new technologies to accelerate oil and gas production processes, is obvious.

We emphasize that the intensity of development of oil and gas production is typical for all the Caspian countries. For example, we note that in 2016 only SOCAR produced on the onshore and offshore fields in the Azerbaijani sector of the Caspian Sea – 7.52 million tons of oil, and in total in Azerbaijan in 2016 oil production amounted to more than 41 million tons.

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The energy significance of the Caspian Sea, in the first place, is determined by its powerful hydrocarbon reserves. According to the US Department of Energy (2012), the total resources of the Caspian Sea amount to about 100-200 billion barrels of oil (this exceeds the oil reserves of the entire North American continent as a whole) and about 8 trillion cubic meters of natural gas.

According to the Organization for Economic Cooperation and Development, the proven oil reserves of the Caspian region account for about 3% of the world's hydrocarbon reserves, and natural gas reserves are about 5% of the global gas volumes. We underline that Kazakhstan is the leader in terms of oil production and proven reserves among the Caspian countries, followed by Azerbaijan and Turkmenistan. In terms of natural gas reserves, according to the BP Statistical Review report (September 5, 2015), Turkmenistan ranks fourth in the world after Iran, Russia and Qatar.

It is gratifying that relatively recently, in the Kazakh city of Aktau, on August 12, 2018, a meeting of the leaders of Russia, Azerbaijan, Kazakhstan, Turkmenistan and Iran (Vth Caspian Summit) took place, after which a historic document for the region was signed – a convention on the status of the Caspian Sea; work on it was carried out for 22 years. The convention is invaluable in resolving a wide range of problems of the Caspian littoral states.

## CONCLUSION

Based on the above, we note that the presented brief overview of environmental and energy issues arising from intensive oil and gas production characterizes the importance of environmental measures necessary to prevent the oil pollution of the Caspian Sea by the Caspian countries. Moreover, intensive oil and gas production is expected in the nearest future (up to 2050); in this perspective, environmental issues and their solution for all oil companies operating on the Caspian Sea should be paramount.

Further, since more than 15 million people live in the Caspian region, which mainly depend on the natural resources of the sea, environmental protection of the region is not only a matter of protecting the environment, but also a prerequisite for reducing the risks for the health of the coastal population. That is, it is obvious that most environmental issues are transboundary in nature and definitely require the closest cooperation between the Caspian littoral countries.

Finally, the creation of an inter-ethnic flexible and decentralized system of the Caspian countries, combining the functions of monitoring and informing the public, would be a significant contribution to the ecological protection of the Caspian Sea.

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