

OIL-GAS ECOLOGY OF THE CASPIAN SEA

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Abstract. The article provides a brief overview of the oil and gas ecology of the Caspian Sea. It is shown that with the increasing intensity of oil and gas production in the Caspian Sea, it is very important that all environmental protection measures be thoroughly observed by oil-gas companies operating in the five countries of the Caspian region.

Keywords: offshore oil and gas pollutions, Trans-Anatolian pipeline, Trans-Adriatic pipeline, environmental protection measures, five countries of the Caspian region, Caspian convention.

Rezumat. Articolul oferă o scurtă privire de ansamblu asupra ecologiei petrolului și gazelor din Marea Caspică. Se arată că, odată cu creșterea intensității producției de petrol și gaze în Marea Caspică, este foarte important ca toate măsurile de protecție a mediului să fie respectate în mod minuțios de către companiile petroliere care operează în cele cinci țări din regiunea caspică.

Cuvinte-cheie: poluarea în larg a petrolului și gazelor, conducta Trans-Anatoliană, conducta Trans-Adriatică, măsuri de protecție a mediului, cinci țări din regiunea caspică, convenția Mării Caspice.

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1. Introduction

One of the main environmental problems of the Caspian Sea is the general pollution from oil processes (from exploration / production to the use of oil products), since all of them ultimately lead to severe environmental pollution and, as a result, to negative effects on human health. According to the UN, more than 21 million barrels of oil spill annually into the seas and oceans.

2. Main part

In the last decades of the 20th and in the beginning of the 21st century there have been significant changes in public consciousness. These changes are related to scientific views on the future of humanity in connection with the worsening global environmental conditions, a number of adverse events and their serious consequences for the environment: man-caused disasters, natural disasters, etc.

The main causes of oil pollution due to human fault are conventionally divided in the following ratio: regular transportation – 30.%; accidents during transportation by ships – 4.9.%; waste in the purification of raw materials – 3.3.%; emissions of equipment into the atmosphere – 9.8.%; production operations – 0.3.%; industrial and municipal waste – 9.8.%; accidents at the oil refinery – 2.%. Total – 60.1.%.

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Oil is a multicomponent system of substances. The environmental consequences of oil pollution depend on the size of the fractions, their nature, as well as the degree of vulnerability of organisms to the influence of toxins. Under the influence of water, ultraviolet rays, wind, temperature, time, the composition changes. The polluting layer spreads through the water, spreads by the wind and the current.

The main stages of the use of oil are: exploration of oil fields; oil production; oil transportation; oil refining and petrochemicals; the use of petroleum products and waste management [1]. In the following we consider these stages associated with environmental pollution, separately.

Exploration of oil fields. The drilling required for this stage is accompanied by severe contamination of the soil and water with drill cuttings containing polymers, hydrocarbons, heavy metals, etc.

Oil production. At this stage, the greatest danger among all types of pollution is the release of petroleum hydrocarbons, air pollutions into the atmosphere, as well as oil spills on the soil surface, which contribute to its destruction, while reducing the land fund and reducing the number of animals.

When transporting oil, the danger of environmental pollution is associated mainly with its transportation by sea and with the rupture of pipelines. Moreover, the later type of accidents is typical for countries with huge pipelines. For example, in Russia, the length of the main pipelines is more than 200 thousand km, and the field pipelines - 350 thousand km [2]. According to statistics, about 60 thousand pipeline ruptures occurred here, leading to large-scale oil losses and "contamination" of the territories [3].

Oil refining and petrochemicals. According to the intensity of the negative impact on nature, oil refining and petrochemicals are similar to oil production. In Azerbaijan, the primary source of atmospheric pollution from industrial emissions is the oil refining and petrochemical industries, concentrated in Baku and Sumgait. Naturally, the total concentration of harmful substances in the air near oil refineries is hundreds of times higher than the maximum permissible concentration, which leads to deterioration of not only air quality. Some contaminants such as metal salts and stable organic compounds are stable and accumulate in soil and food, and this is already more dangerous. During some petrochemical processes, very toxic compounds (dioxins, dibenzofurins and benzopyrenes) are formed and released into the atmosphere as a result of reactions [4, 5].

When using petroleum products, the maximum environmental pollution occurs from automobile exhaust gases, the composition of which is mainly a mixture of toxic (carbon and nitrogen oxides, paraffins and olefins) and carcinogenic (aromatic hydrocarbons, soot and benzopyrene) substances.

Recycling of oil refining and petrochemical industry is an important problem for Azerbaijan. As waste-free production, as a rule, does not exist (even in the case of the complete exclusion of harmful substances into the atmosphere and discharges into water), the bulk of toxic compounds accumulate in the form of solid and /or semi-liquid waste. According to American environmentalists, large oil refineries annually accumulate up to 40 thousand tons of solid or semi-liquid oil waste [2].

Recently, in the Republic of Azerbaijan, in connection with the rapid development of offshore oil and gas production (work at great depths), the problem of water pollution from oil waste from drilling and production has become extremely acute, leading to a violation of the ecological balance. The main sources of pollution of the Caspian Sea (in particular, the Absheron coast) are drill cuttings, drilling mud, oil-containing formation sand and produced water.

We emphasize that drilling fluids are especially toxic when oil and a set of special chemicals are used as a prophylactic additive. It was found that the specific volume of formation of drilling

wastewater, treated drilling fluid and drill cuttings during well drilling, respectively, is 0.24; 0.20 and 0.18 cubic meters per 1 liter of penetration, and 1 cubic meter of waste accounts for up to 68·kg of contaminated organic substances, not including oil and mineral pollutants [4].

For example, on average, 1 cubic meter of produced water from oil wells contains more than 65·g of salt, 150·mg of bromine, 250·mg of soda, 25·mg of iodine and many other chemicals, that is, there is also “destruction” of a huge amount of valuable chemical reagents and petroleum hydrocarbons. Already in 1998, it was found that the lethal concentration of drill cuttings for aquatic organisms in the Caspian is $1.5 \div 2.0$, and the limit is $2.0 \div 2.3$ g/l, while the harmless concentration of drill cuttings for representatives of the Caspian fauna is $0.3 \div 0.4$ g/l.

It should be noted that in the Caspian Sea, as oil production and transportation increase (especially recently due to the development of new large oil and gas projects), the risk of environmental catastrophes associated with accidental oil spills increases. For example, on January 9, 2014, the West Chirag drilling platform was commissioned as part of the large-scale development of a block of ACG oil and gas fields in the Caspian Sea. More than 8 million tons of oil and up to 3 billion cubic meters of gas are produced annually from this platform. An increased technogenic load can lead to a gradual decrease in the compensatory ability of the environment, as a result of which the environmental situation can develop into a global problem with the maximum deterioration in the safety of society.

Here we must mark that from the beginning of putting into operation the Azeri-Chirag Guneshli (ACG) block from 1997, 500 million tons of oil have been produced on it (on date: 09-January-2020).

For note: ACG is a group of offshore oil and gas condensate fields in Azerbaijan in the southern waters of the Caspian Sea to 90·km in the East of Baku. The sea depth in the area of the ACG field varies from 110·m to 450·m (Guneshli was discovered in 1981, Chirag in 1985, and Azeri in 1987).

According to the management of State Oil Company of Azerbaijan Republic (SOCAR), on 18 September of 2019 the confirmed gas reserves in Azerbaijan are 2.6 trillion cubic meters, but it is estimated that about 6 trillion cubic meters. This indicates an intensive oil and gas production in the nearest future.

We emphasize that by September 18, 2019, Azerbaijan transported 2 billion cubic meters of gas through the Trans-Anatolian pipeline (TANAP).

More recently (January 13, 2020), the leadership of SOCAR and BP companies announced that drilling of the first exploratory well (SAX01) had begun in the Azerbaijani sector of the Caspian Sea on the Shafag-Asiman offshore block. The total depth of this well will reach 7,000 meters, and drilling operations will continue for nine months. It should be noted that drilling operations at the well SAX01 are carried out using the Heydar Aliyev drilling rig, managed by SOCAR Caspian Drilling Co.

It should be noted here that TANAP is the most important link in the Southern Gas Corridor, which will strengthen the energy security of Turkey and Europe, and will also contribute to the development of stability in the region. Thanks to TANAP, the EU will have a great advantage for many years in meeting the growing consistency in energy and energy security [6]. The pipeline, with a length of up to 2000 km and a diameter of 56 inches, is the largest international natural gas pipeline in Turkey, the Middle East and Europe. The volume of gas transportation to Turkey through TANAP from the beginning of commercial gas supplies from June 30, 2018 to the end of October 2019 amounted to 3.08 billion cubic meters.

Returning to the events in the Gulf of Mexico that we wrote earlier [6], we can note that a number of environmental scientists associate this accident not with the "human factor", but with natural phenomena that have recently become more frequent around the world. Thus, Yuri

Pikovsky, a researcher at the Geography Department of Moscow State University, believes that the cause of the accident on the British drilling platform Deep Water Horizon in the Gulf of Mexico *"could be a sudden release of oil under high pressure due to the movement of the earth's crust."*

Not so long ago (August 12, 2018, Aktau, Kazakhstan), the Convention on the Status of the Caspian Sea was signed by the presidents of the five Caspian countries. The Caspian Sea comprises five countries with a total population of some 280 million. It is almost as many as in the region of Middle East and North African (MENA), about 300 million which is comparable with the market of the USA. Geostrategic importance of the Caspian Sea lies in its being a central link between the rapidly growing economies of India and China, the region of MENA and the EU, the largest market in the world [7].

In spite of the fact that the convention does not fully settle issues of cross-border fields, the Presidents of the five Caspian states positively assessed the signed document, as a good base for further development of economic and ecological cooperation in the Caspian region².

We must note that the settlement of the Caspian Status will likely stimulate the creation of new mechanisms of establishment and development of economic relations, which depends on the level of development of the private sector in the Caspian countries, level of protection of economies from the situation in the world markets, creation of the favorable investment background for attracting new strategic investors and innovative technologies. In this case, the convention will certainly promote a more dynamic turnover of goods both between all five countries and the three global segments of the world market – European Union, MENA States, and also East and Central Asian markets.

It is characteristic that today hundreds of kilometers of oil and gas pipelines from operating offshore fields have already been laid along the bottom of the Caspian Sea: since 1949, oil and gas activities have been carried out in Azerbaijan, since 2006 in the Turkmenistan, since 2010 in the Russian sectors of the Caspian Sea; and in November 2016, hydrocarbon production began from the Kashagan field in Kazakhstan. To the place, we note that preparatory work for drilling the first exploratory well on the Azerbaijan oilfield Oil Rocks ("Neftyanje Kamni")³ started in June 1949 [8]. For the entire history of operation on the Oil Rocks, 175 million tons of oil have been produced and to date (October 16, 2019) there are 570 active wells on the field.

And also, it is necessary to emphasize that despite historical knowledge about the volumes and levels of hydrocarbon occurrence in the Caspian basin, the importance of the region at the world level does not cease to grow and close cooperation of the Caspian states is the only key to improving production efficiency and environmental safety of this unique lake.

In support of the foregoing, let us cite interesting facts on the accelerated development of offshore oil and gas production rates by Azerbaijan in 2018:

² The signed convention is designed to resolve the whole range of issues related to the rights and obligations of coastal countries, as well as become a guarantor of security, stability and environmental cooperation in the Caspian region. The top officials of the states proposed to launch a mechanism of five-way regular consultations under the auspices of the foreign ministers. It was especially noted about the continuation of negotiations on the establishment of dividing baselines at sea and the early ratification of legal procedures in the Caspian countries. It is gratifying that already on September 17, 2019, in Baku, there were bilateral consultations between Azerbaijan and Kazakhstan, at which they discussed the establishment of the Secretariat of the framework convention on protecting the ecology of the Caspian Sea from the effects of marine pollution during oil and gas operations was discussed, and the importance of acceleration procedures for coordinating the work of the Secretariat between all the Caspian countries was emphasized.

³ Oil Rocks is the extreme eastern land point of Azerbaijan, an urban-type settlement in the Caspian Sea, 42 km east of the Absheron Peninsula. Oil Rocks are located on metal racks built in 1949 in connection with the start of oil production from the bottom of the sea around a stone ridge barely protruding on the surface of the sea. This is the first stilt city in the world, built in the Caspian Sea more than 70 years ago. See <http://www.visions.az/en/news/47/3fe59957/>.

1) On February 6, at the European Gas Conference in Vienna, the management of SOCAR noted that the company was already studying the possibility of the third phase of the development of the Shahdeniz gas condensate project. However, a final investment decision on Shahdeniz-3 is not expected until 2025.

2) On February 23, the Heydar Aliyev semi-submersible rig was launched at sea to carry out drilling operations at the Absheron gas field. This installation is the first and only in the world installation of the sixth generation, withstanding a pressure of 1400 atmospheres. It was built by SOCAR Caspian Drilling Co. in May 2017 and belongs to the Azerbaijani state.

3) On November 13, a law was approved on granting permission for the adoption and implementation of a production sharing agreement for joint exploration and development at the promising D230 block in Northern Absheron in the Azerbaijani sector of the Caspian Sea. According to the agreement, designed for 25 years, 50·% of the stake belongs to BP, which will be the operator for the exploration period and 50·% to SOCAR.

3. Conclusion

Thus, in order to reduce the pollution of the Caspian Sea during exploration and drilling it is necessary, in our opinion, to use the least toxic chemicals; reduce toxicity of waste from exploration, drilling and production, by storage with subsequent disposal in various ways (chemical, technical and mechanical); create non-waste technology by completely neutralizing waste and reusing it in various industries.

The methods for overcoming the consequences in water are the same during accidents, normal operation and as a result of migration processes: mechanical - involve scooping up the contaminant layer by any means from shovels to cars. Azerbaijan uses a non-pressure hydro cyclone, which separates hydrocarbons and pumps raw with a pipe. In France, the product is collected on a special vessel. In Russia, an emergency vortex funnel with a capacity of 30 m³/h has been developed for emergencies. The essence of the methods is the separation of oil from other fractions and its collection.

Finally, we note that a brief overview of the environmental situation around the Caspian Sea highlighted many issues requiring concrete solutions by the combined efforts of not only environmentalists, but also specialists from various fields of knowledge.

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