

## Review Article

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## Environmental Problems in the Petrochemical Industry and Gas Production

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### ABSTRACT

The article provides information on the brief history of the petrochemical industry in Azerbaijan, including offshore oil and gas extraction. Sources of danger in the petrochemical and gas extraction industry and aspects of life safety in general are determined. The article shows that the safety of life depends more on the human factor and oil the effect of the application of new technologies in gas extraction on the environment, including the field of labor protection and technical safety, was investigated. In this article, we have tried to find out about the specific risks of oil and gas production, especially the work carried out in the sea. Also, measures to reduce specific risks that may occur during production and processing and general risk assessment have been reviewed.

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The most important place in both the economic and cultural social life of the Republic of Azerbaijan is occupied by the petrochemical and gas industry. A significant area of this industry is concentrated on the Absheron Peninsula. In general, the perception of the oil industry as an area that initiated the rapid development of engineering, chemistry and petrochemical sciences in our country has deep historical roots. At the beginning of this process stood prominent figures of their time - Haji Zeynalabdin Tagiyev, Musa Nagiyev, Shamsi Asadullayev, Isabey Hajinsky, Murtuza Mukhtarov, the Nobel brothers, Dmitri Mendeleyev, Movsumbey Khanlarov and many others [1].

It should be noted that it was in Azerbaijan (in November 1837) in the village of Balakhani (on the Absheron peninsula) that the first oil refinery in the world, led by Colonel N.I. Voskoboynikov of the Corps of Mining Engineers, began operating (the first such plant in the USA would be built only in 1853-1855 by Samuel Kayer). At this plant, oil was heated with natural gas for the first time in the world and water vapor was expelled along with the oil. In addition, in 1846, the first well in the world with a depth of 21 m was drilled in Baku (in the village of Bibiheybat on Absheron peninsula) for oil exploration; that is, the drilling of an oil well for the first time in the world had a positive result. The work continued under the leadership of the director of the Baku oil fields, Major of the Corps of Mining Engineers N.M. Alekseyev [2].

On the eve of 1899-1901, the Baku oil industry was in 1st place in the world with 11.5 million tons of oil produced. During this period, the total oil production in the United States of America was 9.1 million tons [3]. It should be noted that until 1910, the Russian oil industry was mainly represented by the Azerbaijani oil industry (note: Until 1917, Azerbaijan was part of the Russian Empire).

The Caspian Sea played a very important role in the development of the petrochemical and gas industries in Azerbaijan. Back in history, in 1946, two large-block platforms were built for offshore drilling at the "Gorgan" field. This event could be considered the beginning of systematic and technologically advanced oil and gas exploration activities in the Caspian Sea. In 1949, a fountain that erupted in oil rocks, which were considered rare deposits at that time, marked the beginning of a new stage of offshore oil production, and for the first time in the world, oil began to be extracted offshore.

On August 24, 1949, the development of the unique offshore field "Oil Rocks" on the Absheron shelf and the construction of steel offshore platforms began; on November 7, the first well was drilled in this field, from which a daily oil flow of 100 tons was obtained from a depth of 1,000 meters. It should be noted that the "Oil Rocks" are sometimes called the "Seven Ship Island", because 7 ships were sunk to create a foundation for drilling the first wells, one of which was the famous ship "Zoroastrian", built in 1877 by order of Ludwig Nobel in Sweden (Motala city). The ship "Zoroastrian" was the first oil tanker of the company owned by the "Nobel brothers" in the world [4].

The most important moment in oil and gas production in the Caspian Sea was the "Contract of the Century" developed by the brilliant politician Heydar Aliyev, signed in Baku on September 20, 1994. This contract, with the participation of 11 of the world's largest well-known oil companies, breathed new life into the oil and gas industry of modern Azerbaijan. Of course, with the arrival of these foreign companies to Azerbaijan, it brought modern technology to the petrochemical and gas industry, as well as safety and environmental standards applied in these areas. Considering the great risks in the process of offshore oil and gas production, this moment was very important. Throughout history, oil and gas production in Azerbaijan has had a great impact on the environment. The issues

of labor protection and technical safety of workers working in this sphere have always been relevant. Modern technology and proven international standards have served to minimize risks in the petrochemical and gas industry, creating safer working conditions for workers. We should emphasize that today the main source of energy is hydrocarbon raw materials (oil and gas). The oil and gas industry is one of the leading economic sectors in Azerbaijan and the world economy.

In general, the technogenic activity of people in the process of extraction, processing, transportation, storage of hydrocarbons usually has a negative impact on the environment and people. Work related to the development and exploitation of oil and gas fields has a whole spectrum of such impacts. The scale of negative consequences depends on the stage of implementation and the scale of human activity; natural conditions in the area where it is carried out; the sensitivity of natural objects; as well as the effectiveness of measures to reduce environmental impacts and prevent pollution using control methods, taking into account the analysis of all existing risks [5]. Currently, oil and gas industry companies are exposed to the influence of the current economic situation in the world, and against the background of this pressure, additional risks have arisen. Almost all of the identified risks are of a certain nature. Their relative importance primarily depends on the current state of the economy and labor productivity.

For example, the accident in the Gulf of Mexico (in April 2010) further aggravated the situation in the industry. The consequences of the large-scale environmental disaster that occurred in the Gulf of Mexico have affected companies engaged in the exploration and production of hydrocarbons on the continental shelf not only in this region, but also far beyond its borders. Discussion of issues related to the elimination of the consequences of the oil spill, as well as liability issues, will undoubtedly answer many questions related to the accident on the British oil platform [6]. It is necessary to identify and carefully analyze the main root causes of the accident in the Gulf of Mexico. In order to minimize the likelihood of such a disaster occurring again, appropriate safety measures should be taken and a specific risk assessment should be carried out.

It should be noted that, when assessing the risks associated with the production of offshore oil and gas fields in a given period, all oil companies should conduct a comprehensive assessment of the technical condition of the production facilities used, including taking into account specific risk assessments and environmental aspects. During the assessment, which should cover all potentially hazardous equipment, special attention should be paid to parameters such as the type of devices used, their actual age, maintenance history and natural human factors.

All oil and gas companies in the Caspian region should realize the need to prepare and implement comprehensive measures aimed at minimizing risks and environmental impacts during the commercial operation of oil and gas facilities. Against the background of growing production volumes and large-scale oil and gas projects being implemented in the Caspian Sea, issues of industrial ecology and life safety should be a priority. The intensity of oil and gas production in the Caspian is steadily growing: for example, only in Azerbaijan, the leading oil company of Azerbaijan - State Oil Company of Azerbaijan Republic (SOCAR) and partners in the project to develop the Shah Deniz gas condensate field in the Azerbaijani sector of the Caspian Sea signed an agreement in December 2010 to extend the term of the contract for this field until 2036 (the previous contract was valid until 2031).

According to SOCAR, by 2024 the volume of gas production in Azerbaijan can reach 50 billion cubic meters per year; and proven gas reserves in the republic amount to 2.6 trillion cubic meters. This is confirmed by new discovered Azerbaijani gas fields - Shah Deniz, Umid and Absheron, as well as the development of promising structures - Zafar-Mashal, Babek, Shafag, Asiman and Nakhchivan.

For reference: the Babek field, with estimated gas reserves of 400 billion cubic meters and Umid with reserves of at least 200 billion cubic meters. Significant volumes of gas are planned to be obtained from the deep-water part of the Azeri-Chirag-Guneshli field. As well as the gas field "Absheron", where proven recoverable reserves amount to 350 billion cubic meters. Of this amount, a maximum of 50 billion will go to meet the needs of the domestic market, the rest will be sold on foreign markets. As per SOCAR data the Absheron gas field is one of the largest gas condensate fields. Also, the proven reserves of "Shah Deniz" gas field are estimated at 1.2 trillion cubic meters of gas and 240 million tons of condensate. According to SOCAR: The proven natural gas reserves in Azerbaijan are 2.6 trillion cubic meters, and according to forecasts, up to 6 trillion cubic meters.

### **The Interesting Facts (in 2025)**

On January 30, BP Co. published a draft Environmental and Socio-Economic Impact Assessment (ESIA) document for the Shah Deniz Compression (SDC) project. The SDC project is a continuation of the previous stages of development of the Shah Deniz contract area in the Azerbaijani sector of the Caspian Sea.

As of February 4, the total volume of gas transported via Trans Anatolian Pipeline -TANAP (TANAP is key link in the Southern Gas Corridor) since the start of deliveries amounted to 75 billion cubic meters. The estimated useful life of the TANAP system will last until 2062.

3. On February 13, SOCAR will begin implementing the Leucipa monitoring program in the Caspian region for the first time, which is part of the digital transformation of SOCAR's Upstream sector. In cooperation with Baker Hughes, the program will be deployed on 100 wells, monitoring Baker Hughes pumps.

The Front-End Engineering Design (FEED) stage for the 2nd phase of the Absheron field development (French company Total Energies office in Baku) began on February 24. Gas and condensate production from Absheron has been carried out since July 2023 by JOCAP based on an early production project from one Deepwater well.

Since February 28, Total Energies, SOCAR and XRG have defined the concept of the 2nd stage of development of the Absheron field, which is based on the scheme of subsea production with access to the shore. The wells will be drilled at a depth of 500 m, and their penetration will exceed 7,000 m, which makes them among the deepest in the Caspian.

As of March 17, Trans Adriatic Pipeline (TAP) has transported a total of 44.40 billion cubic meters of gas since the start of commercial operations on December 31, 2020. It should be emphasized that TAP supplies gas from Azerbaijan's Shah Deniz field in the Caspian Sea directly to Europe.

7. On April 24-25, the Caspian and Central Asian Oil Trade and Logistics Forum was held in Baku, which became an important platform for discussing issues of trade, logistics, oil refining and petrochemicals in the Caspian and Central Asian regions.

## Conclusions

Environmental control over environmental pollution caused by intensive oil and gas production in the Caspian Sea is necessary. Moreover, accelerated oil and gas production is expected in the near future (until 2050). An increase in production volumes will certainly lead to an increase in the production volumes of oil and gas processing and the chemical industry in general. In this regard, environmental problems and safety of life should be the main issue for all companies operating in the Absheron Peninsula, where the petrochemical and gas industry is most located, and in the Caspian basin, where most oil and gas production is carried out.

The operation of offshore oil and gas installations carries significant hazards, which must be minimized as much as possible due to their specific risks. This process can be carried out by introducing new techniques and technologies, as well as by creating a qualified personnel pool, in order to minimize risks.

Considering that the fire and explosion hazardous oil and gas processing and chemical industry enterprises, most of which are located on the Absheron Peninsula, are not far from residential areas, we believe that even more serious measures should be taken from an ecological and life safety perspective.

If we turn to history, the primary cause of any man-made accidents is the human factor. In addition to learning from the history of man-made accidents in the oil, gas and chemical industries, we must also minimize the risks that arise. However, experience has shown that even with the most modern production technology, the risk is never zero.

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