Environmental problems in the transportation of petroleum products in Kazakhstan

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Abstract. The presented article tells about the placement of countries in terms of reserves and processing volumes. About the state of oil production and oil refining in Kazakhstan and the presence of environmental risks in the transportation of petroleum products. Without the transportation of oil and oil products, economic development is impossible. For Kazakhstan, the possibility of organizing the correct transit of oil and oil products is an urgent task. The profits from transportation should be commensurate with the environmental risks in the event of an accident. To reduce environmental risks, the authors of the article recommend using only modern specialized vehicles, tight control when unloading oil products at small gas stations and huge fines if spills and leaks are allowed. For multimodal transportation, it is recommended to use flexitanks and conduct constant environmental monitoring in the process of transporting oil and oil products. All this can easily be done if there is mandatory certification according to ISO 14000 standards.

1 Introduction

Oil reserves in Kazakhstan are very large (Fig. 1). And the prospects for further development are also huge. It is possible to distinguish: the Aral Sea region, the Kostanay depression, the Turgai trough and the Zaikan depression. Significant are the prospects for the coast of the Caspian Sea.

In 2022, oil production was to be 85.7 million tons. Exports will amount to just over 67 million tons. It is planned to increase production by at least 2 million tons, it will be achieved at the expense of the Tengiz and Karachaganak fields - these are the words of the Minister of Industry of the Republic of Kazakhstan at the International Forum [1]. The implementation of important projects in the oil and gas industry - Kalamkas - Sea and Khazar, which will cost $4.5 billion, will allow to produce 4 million tons of oil starting from 2028.

The Kashagan field is considered one of the largest oil fields discovered in recent decades. Its recoverable reserves are estimated to be between 9 and 13 billion barrels of oil. Commercial production at Kashagan began in autumn 2016.
The shareholders of the NCOC consortium, the operator of Kashagan, are KMG Kashagan B.V. (16.877%), Shell Kazakhstan Development B.V. (16.807%), Total EP Kazakhstan (16.807%), Agip Caspian Sea B.V. (16.807%), ExxonMobil Kazakhstan Inc. (16.807%), CNPC Kazakhstan B.V. (8.333%) and Inpex North Caspian Sea Ltd. (7.563%) [2].

“While the drop in oil availability is positive news for the environment, it may threaten to further destabilize an already precarious energy landscape. Energy security is a matter of redundancy; we need more of everything to meet the growing demand for transport and any action to curb supply will quickly backfire on pump prices worldwide, including large producers such as the US. Politicians and investors can find success by targeting energy consumption, encouraging electrification of the transport sector and drastically improving fuel efficiency,” says Per Magnus Nysveen, Rystad Energy’s head of analysis [3].

Despite the relatively high position in terms of oil reserves, Kazakhstan has low oil refining capacity (Fig. 2).

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Fig. 1. Oil reserves for 2022 in billion tons (according to BP)

Fig. 2. Oil refining volumes in 2021 in million barrels per day (according to OPEC)
The main transport losses are accidental spills of oil and oil products during tanker transportation (about 85% of all losses). In fairness, it should be said that recently the contribution of this source to the total volume of pollution has greatly decreased. Most leaks occur in small volumes and can be repaired quickly. For example, in 2020, there were a total of 12,000 spills reported worldwide, 85% of which were leaks of less than 7 tons. However, it is these persistent small spills that create persistent contaminating iridescent films in areas of the greatest traffic flow and in oil production areas [4].

37 percent of such pollution enters the aquatic environment without accidents. This is due to the environmental imperfection of existing oil refining technologies, as a result of which polluting products enter the environment with domestic and industrial effluents. Approximately 5 percent of all oil pollution enters the Earth’s largest water bodies (rivers, seas and oceans) with atmospheric transport, since the atmosphere (compared to soils, sediments and water) contains relatively few pollutants. However, the high speed of air mass movement makes atmospheric transport an important channel through which harmful products enter the sea surface. Any chemically stable substance or material can be transferred in this way [5].

With the advent of the automotive industry, and then the aircraft industry in the 20th century, gasoline and other petroleum products began to not only dominate the market, but also dictate policy. The use of petroleum products for heating, power generation and industry further increased the importance of the oil industry.

Despite the development of alternative energy sources, oil remains a very important factor influencing the formation of the domestic economy of states and, as a result, the development of the world economy. Proceeding from this, political relations (treaties and agreements) are formed between different states and individual groups of countries. Their development strategies are determined, among other things, taking into account oil production and the production of petroleum products [6].

Environmental risks inevitably arise in the process of sale and consumption of petroleum products. Leaks to the ground can occur around any storage of oil and oil products. There are known cases of the formation of large (up to several thousand tons) fuel lenses around fuel storage facilities, and this is practically a disaster. It can be assumed that the situation around gas stations is not much better. Of particular danger are old gas stations, although leaks there do not reach huge sizes, but the damage to the environment is not small [7].

The purpose of the study was to determine the state of the oil refining industry in Kazakhstan and to identify environmental risks in the organization of transportation of petroleum products.

The object of study in the work was the issue of transportation of dangerous goods. The subject of the study was the analysis of the state of the transportation process and the degree of environmental safety in the transportation of oil and oil products.

The degree of knowledge of the issue is quite high. The fundamentals of environmental problems in the transportation of dangerous goods are qualitatively described in the works of Yu.S. Drugova and A.A. Rodina, V.I. Bulatov, A.P. Khaustov, D.Z. Izmagambetova and many other Kazakh and Russian authors.

Indicative values of individual sources in the total emission of pollution are given below:
- Spills when refueling vehicles - 30%
- Spills during the discharge of oil and oil products from tankers - 25%
- Spills and leaks of oil and oil products during maintenance and repair of process equipment - 20%
- Leakage of oil and oil products due to equipment malfunction - 15%,
- Other sources - 10%.
2 Materials and methods

The methodological and theoretical basis of the work was statistical, analytical methods and simulation experiments, as well as a large amount of search work on the Internet.

Now the oil industry of Kazakhstan is at the peak of its development. It is planned that by 2025 about 110 million tons of oil will be produced. However, after that, the level of production will begin to decline - experts say so. This is due to the gradual full development of the first discovered deposits. By 2050, there will be significantly less oil produced in Kazakhstan. In the worst case scenario, they will amount to 40-50 million tons per year.

Currently, there are three large oil refineries and more than thirty mini-refineries in Kazakhstan. The total capacity of the three main oil refineries in Kazakhstan for oil refining as of 2020 amounted to 16.6 million tons. In 2019, Kazakhstan produced 90.4 million tons of oil, including gas condensate. At the same time, 12.6 million tons of oil products were produced against the internal market demand of 12 million tons. Surpluses were sent for export abroad.

According to the National Energy Report for 2020, the three main refineries in Kazakhstan - Atyrau, Pavlodar and Shymkent accounted for 93.6% of the total oil refining in the country. The rest was processed at 34 mini-refineries. Individually, they produce small volumes of low-quality products or semi-finished products, but play an important role in supplying the market with low-octane AI-80 gasoline, which large refineries stopped producing after modernization. This type of fuel is mainly used in agriculture, and its price is still regulated by the state. According to the Kazakh Institute of Oil and Gas, in total, mini-refineries in Kazakhstan have the technical ability to process up to 6.5 million tons of oil per year, but the actual volume of processing does not even reach 10%. The Ministry of Energy notes that the production of popular types of oil products at mini-refineries is insignificant, since technological installations at mini-refineries do not allow producing more light types of oil products. They mainly produce dark oil products, heating oil, diesel fuel, kerosene. At the same time, the fuel oil they received was often purchased and processed additionally outside of Kazakhstan. Among the stably functioning mini-refineries are Aktobe oil refining LLP, Vernal Oil Kazakhstan LLP (Aktobe region), Kyzylorda Small-tonnage Oil Refinery LLP (Kyzylorda region), Amangeldy Gas Processing Plant LLP and Zharas LLP (Zhambyl region).

3 Results

Worldwide oil reserves are distributed unevenly and are not available to all states. As a result of this state of affairs, some economies are forced to budget for the cost of acquiring it from other states, which in turn receive profit from this, spent on other purposes. This situation is caused by the need to use petroleum products in various industries. During the collapse of the USSR, Kazakhstan was in the third ten countries that produce oil. Independence brought significant changes to the industrial sector of the country. Within the first ten years, Kazakhstan entered the top ten oil-producing countries in the world. Production increased almost five times. The opening of the Kashagan field increased the production of raw materials by another three times over the period of 2017-2018.

An analysis of statistics around the world has shown that up to 35% of dangerous situations occur when loading tankers at an oil depot, i.e. at the consignor, up to 25% of emergency situations can occur directly during the transportation of petroleum products, up to 25% of dangerous situations can occur when oil products are discharged at gas stations or oil depots, up to 10% of dangerous situations are recorded when empty tankers are moving, there are emergencies when servicing tankers (up to 5%).
Data for Russia and Kazakhstan are similar.

Oil products of a commercial nature are transported in factory packaging, placed in standard packages (boxes, boxes) or on pallets covered with thermal film.

Some types of solid petroleum products (paraffin, cold bitumen, some others) can be transported in non-specialized containers - cardboard or paper drums, boxes, boxes, etc.

For the transportation of liquid petroleum products in large quantities, flexitanks are widely used - elastic loose containers for standard containers. Their volume is from 10 to 24 thousand liters.

Flexitank (Flexitank, Flexitank, Flexi tank or flexibletank) on the Kazakh market is represented by imported disposable products. The company from Russia "Neftetank" offers reusable flexitanks. The price of a flexitank in this case will be higher, but the cost of operating flexitanks will ultimately be lower due to reusable use (fig. 3).

Fig. 3. Transportation of petroleum products in flexitanks (\[\text{Image}\])

Table 1. Comparison table

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Flexitank</th>
<th>Barrel</th>
<th>IBC container</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of units per standard ISO container, pcs.</td>
<td>1</td>
<td>85</td>
<td>20</td>
</tr>
<tr>
<td>Container volume, l.</td>
<td>23,000</td>
<td>207</td>
<td>1,000</td>
</tr>
<tr>
<td>Usable volume in ISO container, l.</td>
<td>23,000</td>
<td>17,589</td>
<td>20,000</td>
</tr>
<tr>
<td>Average filling time, minutes</td>
<td>40</td>
<td>120</td>
<td>120</td>
</tr>
<tr>
<td>Average preparation time, hour</td>
<td>0,5</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Number of operators, people</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Working space</td>
<td>low</td>
<td>high</td>
<td>moderate</td>
</tr>
</tbody>
</table>

The price of a flexitank is determined by its type, depending on the purpose of the transported products, the number of strength and protective layers, size, and does not exceed the cost of traditional packaging for the corresponding volume.

Companies in Kazakhstan are increasingly faced with a situation where the presence of a manufacturer of management systems is a prerequisite for the development of its business. Most often, these systems are developed in accordance with international standards adopted by most countries of the world, including our country. With their help, various areas of interest are taken into account, both for the enterprise itself and for its partners, customers, the state and society [10].

JSC "KazTransOil", a subsidiary of NC "KazMunayGas", has been successfully operating for several years certified and well-established management systems for quality, ecology, health and safety that meet the requirements of international standards ISO 9001:2000, ISO 14001:2004 and OHSAS 18001: 2007.

Environmental protection and environmental safety are important components of the sustainable development of KazTransOil JSC. The company in its practice seeks to maintain...
a balance between solving production problems and the level of its negative impact on the atmospheric air, water and land resources and other natural components (fig. 4).

Fig. 4. Integrated environmental monitoring

Environmental monitoring is a complex system for observing the state of the environment, assessing and forecasting changes in the environment under the influence of hazardous anthropogenic factors.

Environmental management is part of the overall corporate governance system, which has a clear organizational structure and aims to achieve the provisions specified in the environmental policy of Kazakhstan through the implementation of environmental protection programs.

One of the key priorities of post-crisis development in recent years has been the transition to an innovation-based "green" economy.

Until recently, the development of the economy was considered a priority, and the financing of measures for the protection and restoration of nature and the environment was carried out according to the "residual" principle. In recent decades, the relationship between ecology and the economy has increased significantly, as evidenced by the process of implementing the most important requirement of our time - the greening of the economy.

This means a versatile and systematic approach to the "man-nature" system. Ecology and economics in their unity constitute an ecological-economic system. The studies carried out in the work can be recommended for familiarization and implementation at all enterprises of the transport system for the transportation of oil and oil products.

The results of the study allow us to make recommendations:

1. The ideal means of transportation for the transportation of petroleum products is a fuel truck, its mobility and speed compared to alternative modes of transport, such as rail and sea, make it the most used method of transporting not only gasoline, but also other petroleum products.

2. Strict control is required when unloading oil products at small gas stations. Reducing environmental risks can only be achieved through harsh punishment. This means constant monitoring of the state of the environment around gas stations and a huge fine if there are spills or leaks.

3. It is necessary to take into account the general trend in the development of the transport system of Kazakhstan, which is focused on multimodal transportation. In this case, the ideal option is the transportation of liquid cargoes in flexitanks using flexi tanks. The main advantages of liquid cargo transportation in flexitanks and container liners over the already well-known methods of transportation in barrels and tanks:

- Excludes the cost of hauling empty containers
4 Discussion

In connection with the state policy aimed at taking preventive (warning) measures in the field of environmental protection, environmental monitoring plays an important role in environmental activities. In this regard, KazTransOil JSC has begun work on the development of a geo-information monitoring system, as well as an analysis of the priority of environmental measures [15].

For several years, KazTransOil JSC has been disposing of oil sludge and oil-contaminated soil, attracting specialized contractors for this type of work. First of all, cleaning concerns...
Acting on the principle of “it is easier to prevent than to fix,” the company is doing a lot of work to prevent fires and train personnel in fire safety measures. For these purposes, complex large-scale exercises are organized annually with the involvement of all forces and means. Basically, all the exercises take place from May to September, during the warm season, when the risk of fires increases. During the exercises, the main mechanisms of actions for localization and elimination of possible, largest fires are being worked out. The main thing here, of course, is speed, coherence and clarity of action.

JSC “KazTransOil” is not going to stop at the achieved results, knowing full well that certification is not the end, but only the beginning of a long, but, of course, a successful path to the heights of its business. Thanks to the ongoing work, KazTransOil JSC has a reputation as a company that strives for advanced standards in the field of quality, ecology, health and safety.

A high level of responsibility for the activities of the enterprise and concern for its employees are the key principles of the work of the main oil transportation operator in Kazakhstan.

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