Management of the Large-Scale Arctic Transport System – the Basis for the Exploitation of the Hydrocarbon Resources of the Northern Seas Shelf

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Abstract. The problems of managing the Arctic transport system are considered. Particular attention is paid to the development of Arctic shelf deposits, as well as to the challenges and risks associated with the extreme conditions of transportation of hydrocarbon raw materials. Certain volumes of cargo transportation via the NSR have positive dynamics, which determines the encouraging results and allows us to develop strategic plans for the extraction of hydrocarbons and the delivery of finished products. The main promising directions for the development of sea transportation of hydrocarbons in the waters of the Northern Sea Route are outlined. Certain prospects for the development of Arctic oil and gas resources are identified. It is shown that an increase in the number of freight vehicles in the water areas of marine transport corridors in the near future will be associated with an increase in the turnover of ports and terminals. The main directions of improving the Arctic fleet and technological updates of the port infrastructure to ensure the development of hydrocarbon deposits in the Arctic seas are substantiated. The introduction in this area of the most important innovative methods for the development of the oil and gas sector is a full-scale implementation of transport and transit traffic, primarily in order to improve the system of internal corridors passing through the NSR under the jurisdiction of the Russian Federation. The directions of improving and increasing the efficiency of operation of the Arctic transport system are proposed.

1. Introduction

The work goal is to analyze the modern condition of the Arctic transport system in the connection with development of the hydrocarbon fields as well as development of recommendations for improving and increasing efficiency of ATS functioning.

The Arctic transport system (ATS) is a sea highway, including the Northern Sea Route (NSR), railway, river and airport communications that make up the network of international transport corridors: the North-Western and Transpolar (Central) passages. Transit tracks of ATS are routes along the coast of the Arctic from May to October, excluding the Bering Strait, the Long Strait and the Kara Gates. With the through movement in the western direction of the NSR the most favorable period is from June to July, passing through the straits of the Ugra Ball and the Kara Gate. In September and October it is necessary to bypass the Desire Cape on Novaya Zemlya.

The importance of ATS will be increasing, first of all, for the economic, technological, and social development of the country [1].
Under the modern conditions ATS management is subject to higher standards. The most important requirements to efficiency and quality of transport services are reliability and continuity of work, high speed of delivery of goods within strictly stipulated terms, excluding losses and damage of goods, and minimum costs.

Management of ATS taking into account the application of logistics is considered in connection with the development of Arctic hydrocarbon fields and must meet the requirements of users. Logistics allows ensuring the increase of efficiency of transport flows, decrease in costs and expenses of producers of hydrocarbon raw materials and consumers of the production and may serve as the catalyst of achieving multiplier effect [2]. This characterizes the relevance of the work for the world ATS.

2. The arctic transport system of the Russian Federation

ATS is not only a world transport artery, but also an internal maritime communication of Russia connecting the northern regions with the Far East, forming a single complex of river and sea communications. The transport system allows carrying out delivery of goods, including heavy equipment for large-scale facilities and annually provides the Northern delivery.

The Government of the Russian Federation has taken a number of measures for ensuring the operation of the ATS infrastructure, including navigation services, taking into account satellite communication systems and geopositioning, and navigation maps. Particular attention is paid to the renewal of the Arctic icebreaking group, new modernized icebreakers are being designed [3].

The increased pace of development of the natural resources of the North and the Arctic has led to the revival of the NSR and the development of the ATS as a transit international route. The volume of cargo transportation has a positive dynamics (Figure 1).

![Figure 1. Dynamics of cargo transportation along the Northern Sea Route.](image)

*2019 year - forecast

Such trend determines promising results and allows developing strategic plans to increase extraction of hydrocarbon raw materials and transportation of finished products.

The most realistic directions for the further development of shipping in the coming years are transportation of hydrocarbons from land deposits adjacent to the Russian Arctic coast. Schemes for liquefied natural gas (LNG) transportation from the village of Indiga (project “Pechora LNG”) have been developed.

In connection with the development of world economic relations the ATS acquires a new significance. As a result, in the short term, the role and importance of transport systems will increase. Globalization of the world economy stimulates forming a transport intercontinental route Europe-Asia, which will contribute to the economic and national security of Russia.

In the foreseeable future, the ATS should become a competitive alternative to the Suez Canal, whose length of the route is more than 37 days. The NSR allows shortening the way by 6 days. According to expert estimations, taking into account innovative transport development, by the year of 2030 the NSR will be able to operate nine months a year, which will allow reducing the time of cargo...
transshipment on the Europe-East Asia route by 60% in comparison with the routes through the Panama or Suez Canals [4].

Most of the future shipping routes will take place in high-latitude water areas and in places where hydrocarbon fields are being exploited at great depths, for example, the Shtokman gas condensate field. The probability of meeting icebergs in these areas increases from 1-2%, typical for southern routes, to 40-60% near the polar archipelagoes with glacial domes. Creation of an “iceberg patrol” in the Arctic should be among the priority tasks of ensuring industrial and environmental safety [5].

The management of the ATS is envisaged taking into account the development of Russian shipbuilding capacities and the increase of the icebreaking fleet for transportation of hydrocarbon raw materials. According to the forecast, in the coming years, more than 45 large ice-class vessels and more than 150 vessels of the servicing fleet will appear on the NSR.

The modernization of the Russian Arctic fleet is necessary, first of all, to expand the role of dual-purpose and universal vehicles, which are most efficient in the modern Arctic. In addition, it is necessary to create modern small- and medium-tonnage “river-sea” vessels, dry bulk carriers, as well as vessels for transit of containerized cargo.

For the rational use of tankers of reinforced ice class Arc7 of Yamalmax size in 2022-2023 PJSC “NOVATEK” plans to build a LNG transshipment terminal in Kamchatka (in Mokhovaya Bay, Petropavlovsk-Kamchatsky district) with a capacity of 20 million tons / year, taking into account a possible increase in capacity up to 40 million tons / year. For the same purpose, in October 2018, the Government of the Murmansk region and PJSC “NOVATEK” signed an agreement on the construction of an LNG transshipment complex with a capacity of 20 million tons per year in Ura-Guba (50 km from Murmansk). In the future, it is planned to bring the volume of LNG production in the Arctic to the level of 58 million tons / year [6].

ATS management is one of the priority activities in the Arctic not only for the Arctic states but also in the non-Arctic countries such as China, Japan and South Korea, etc. [7]. According to authoritative scientists Ivanty V.V. Leksin V.N. and Porfiryev B.N. «with the national significance of the NSR development as a unified national arctic transport system, oriented including for transcontinental shipping, it is forecasted (and already manifested) a difference of interests to this problem from shipbuilders, consignors and competing transport systems etc.» [8].

The development of the ATS provides for the modernization of existing and construction of new seaports for supply of materials, equipment and foodstuffs to the Arctic regions of the country. 60 km north of Arkhangelsk it is planned to build a new deep-sea area “Severny” of the Arkhangelsk Sea Port, which will occupy an area of about 180 hectares on the western coast of Mudugsy Island and in the northeastern part of the Sukhoye More bay. The new port will service oil-loading cargo as well as general and container cargo of export-import directions.

The Arctic support port is developing in the region of the deep-water and the ice-free for most of the year Indiga bay on the coast of the Barents Sea for ocean vessels.

For transportation of natural gas from the coast of the Yamal-Nenets Autonomous District, a deep-sea port “Sabetta” was built. The work is carried out within the Yamal LNG project at the Yuzhno-Tambeyskoye field. LNG production on the first production line of the plant was started in 2017, and the first commercial consignment was shipped on December 5, 2017 [9].

Navigation through the ATS determines the complexity of container transportation. This is due to compliance with the schedules of loading, transportation, unloading and delivery of a goods, which does not allow for efficient use of logistics and reducing costs. Changes in weather conditions can either break the ship's arrival time at the port of destination, which often leads to paying penalties, or in case of force majeure require icebreaker support, which increases the freight cost.

Prospects of the ATS in the near future associated with the transportation of liquid and bulk cargo. For such vessels external conditions have less influence. In addition the vessels can save fuel at the expense of rational speed and reduce pollutant emissions.

Thus the increase in the volume of cargo transportation in the water area of sea transport corridors in the near future will be associated with the growth of cargo turnover of ports and terminals. In this
regard transportation hydrocarbons becomes of special significance. The structure of the global gas market is changing due to the growth of world trade and transportation of LNG. The largest LNG importer in the Asia-Pacific market is Japan.

The development of shelf deposits in extreme natural and climatic conditions will require using special legal mechanisms and organizational measures. Particular attention should be paid to the challenges associated with the extreme conditions of operating shelf fields and the population life including: technological, financial, personnel and environmental ones.

The extraction of hydrocarbons on the shelf of the Arctic seas is a knowledge-intensive activity. To develop innovative technologies and related equipment first of all it is necessary to create and develop the “science-education-innovation” complex and the need for long-term investments [10, 11].

One of the most important innovative directions in the development of the oil and gas sector is the full-scale implementation of the transport and transit potential, primarily in the direction of improving the system of international corridors passing through the NSR under the jurisdiction of the Russian Federation. The prospects for the development of Arctic oil and gas resources are primarily associated with the exploitation of the Shtkom man gas condensate field in the Barents Sea, additional exploration and identification of hydrocarbon resources adjacent to the Prirazlomnoye and Dolginsky oil fields, the creation of the Bovanenkovo, Tambey and South industrial zones in the Yamal-Nenets Autonomous District [12].

To fulfil the plans for the development of the Russian Arctic shelf and the delivery of hydrocarbons to Europe and the United States, as well as the use of the NSR for transit traffic between the countries of North-Western Europe and the Asia-Pacific region (Japan, China, the USA, Canada), it is necessary to accelerate the development of the navigation safety infrastructure by the Northern Sea Route, primarily the construction of specialized ice-class vessels and reinforced ice-class vessels and double-hulled tankers with additional emergency supplies [12, 13].

PJSC “NOVATEK” is developing a major infrastructure project in the field of LNG production and transportation - Arctic LNG-2. As part of the project in the Kola Bay, the company began implementing a new large-scale infrastructure project - the creation of a Center for the construction of large-capacity offshore structures. Total investments in this project amount to about 25 billion rubles. Within the framework of this project, 10 thousand jobs are created, two production lines are envisaged - the first will be launched at the end of 2019, the second in 2020 [14].

To implement effective control of ATS it is necessary first of all to take measures to solve the following tasks:
- improvement of the regulatory framework;
- development of a competitive market of transport services;
- integration in the global transport system and use of the transport potential;
- improving the supply of goods under any ice conditions;
- renewal of the icebreaking fleet;
- development of coastal infrastructure and modernization of ports;
- improvement of navigation and cartographic support;
- formation of emergency and rescue infrastructure;
- increasing labor productivity and energy efficiency;
- providing reliability and safety of functioning the transport system.

3. Conclusion
Issues of the transport system management under the extreme conditions of the Arctic are studied. A special attention is paid to the development of the Arctic shelf deposits as well as to challenges and risks associated with hydrocarbon cargo transportation. Directions for improving and increasing the efficiency of ATS functioning are proposed.

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