The Arctic's environment is a fragile ecosystem, with all the components being closely interconnected. Currently, there is continuous degradation of submarine permafrost in the East Siberian Arctic Shelf, and large amounts of methane released cause negative environmental impact [4]. Though gas hydrate resources are enormous, the efficiency of the production depends on the technological advances implemented to mitigate the negative environmental impact and improve the safety of field exploitation. Hydrates are particularly responsive to any changes, and inadequate solutions taken with regard to economic reasons can result in irrecoverable damage.

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PROBLEMS OF BARENTS OFFSHORE OIL PRODUCTION BY MEANS OF GAS HYDRATES

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Next few years there will be the development of unique deposits of hydrocarbons on the Russian Arctic shelf covering an area of more than 6 million km^3. At the same time the largest resources of oil (more than 3 billion tons) are concentrated in the Barents Sea [1]. There are the most severe climatic conditions in the world, so there is a number of problems associated with permafrost bottom of the sea - "Submarine Cryolithic Zone". Possible formation of crystalline compounds of water and gas called "gas hydrates" is associated with this area. Outwardly, they look like ice or snow. Figure 1 shows a map of the Arctic Ocean in relation to the forecasts of gas hydrate accumulations [2].

Unfortunately, the studies of gas hydrates in the Barents Sea are not classified and virtually have not been carried out yet. The formation of gas hydrates occurs due to the negative impact of freezing temperatures and freezing of the bottom layer of water.

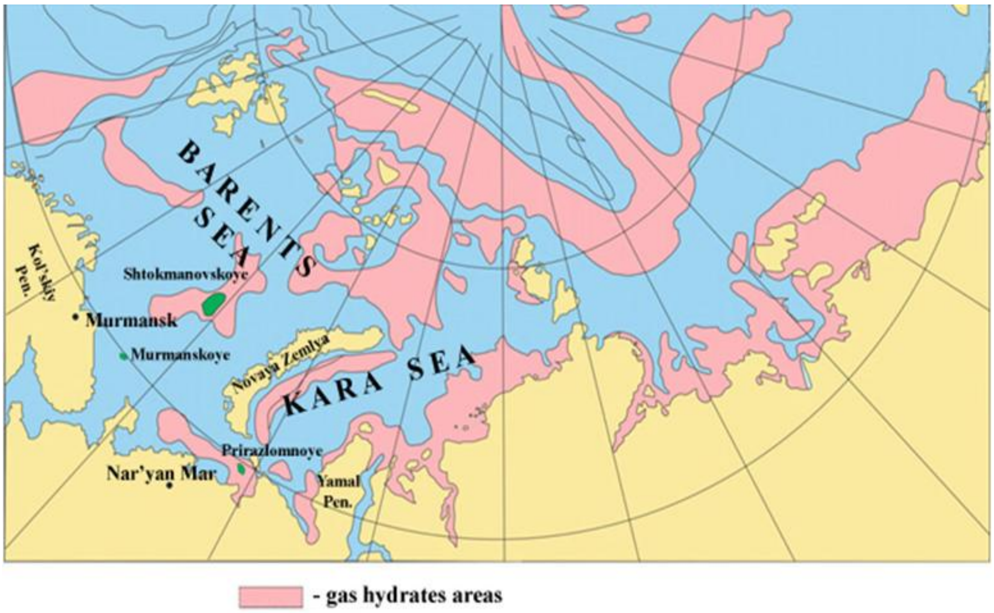

Fig.1. Map of gas hydrate accumulations

There are anthropogenic and natural gas hydrates. Anthropogenic gas hydrates can be formed in oil production systems. They are deposited in the wellbore, thereby greatly reducing its bandwidth. This reduces the well production and can cause an emergency stop of its operation. Natural gas hydrates can form clusters of gas hydrate deposits around the production casing. With the rise of warm oil from the lower horizons the temperature of the surrounding rocks increases. This leads to a change in the phase state of water and gas in hydrate intervals around the wells. This process is similar to "thawing" of frozen ground in the development of hydrocarbon deposits in permafrost regions [1] and leads to severe accidents: casing collapse, gas breakthrough of the conductor during the gas showings, gryphon formation and wellhead failure [3].

As this problem has a significant impact on oil production it needs to be solved. There are several basic methods of fighting with gas hydrates.

Heat insulation method of the wellbore is intended for fighting with "thawing" of natural gas hydrates. Another method is aimed at increasing the temperature in the wellbore, thus preventing the formation of anthropogenic gas hydrates. The temperature increases with heating different "bottom-hole heaters". Currently, these methods are still in the industrial testing and do not guarantee complete elimination of gas hydrates formation. The most common and effective method is the use of different inhibitors. This method is applicable both to prevent gas hydrates formation and remove already formed ones. The essence of this method consists in introduction of substances that prevent hydrate formation at the bottom hole [4]. Ethanol, methanol, diethylene glycol (DEG), triethylene glycol (TEG) and calcium chloride are used as inhibitors [5].

In recent years, interest in the issue of gas hydrates throughout the world has increased significantly. The growth of research activity is explained by the active development of hydrocarbon deposits on the Arctic shelf, in particular in the Barents Sea [6]. Research of the environmentally-friendly and cost-effective production of hydrocarbons on the shelf in this area is extremely important for the companies all over the world.

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TOWARDS THE REGIONAL PARTICULARITIES OF OFFSHORE OIL PRODUCTION AND SUBSEA TRANSPORTATION IN THE ARCTIC

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Access to global market is a key issue to ensure effective oil production, therefore, transportation is a remarkable component of the petroleum industry. Depending on field location and size, different modes of transportation may be used, with some being more suitable than the others. However, it seems that all forms of petroleum transportation will potentially play a role in the energy future of the Arctic.

Various options imply different operating environments and should be designed to secure reliable transportation under the Arctic conditions, as well as to ensure proper maintenance and monitoring of the equipment. When selecting a transportation option, safety, reliability, and cost should be taken into account to find an adequate solution.

In shallow water, conventional pipeline equipment can be used in the winter season to trench through the ice and bury the line. The case in point is the BP Exploration’s Northstar pipeline, which is an example of shallow water construction technique. In deeper waters, where ice gouging is not an issue to be considered, the lines can be designed and installed on the seafloor as is done for deeper water non-Arctic offshore pipelines. Installation would take place in summer open water season. It can take several seasons to install longer pipelines, and the mobilization/demobilization or overwintering of equipment would significantly increase the cost of offshore Arctic pipelines compared to non-Arctic applications.

Additionally, the existing global fleet of vessels and barges for offshore pipeline construction are not designed for Arctic conditions. Therefore, for offshore Arctic pipelines, ice-strengthened and upgraded equipment and vessels would be required to operate in the Chukchi and Beaufort Seas.

The life cycle of an offshore Arctic pipeline is similar to onshore, but the design and installation methods also must consider strudel scour, ice gouging, thaw settlement of permafrost, and upheaval buckling. These are the issues to be considered when offshore