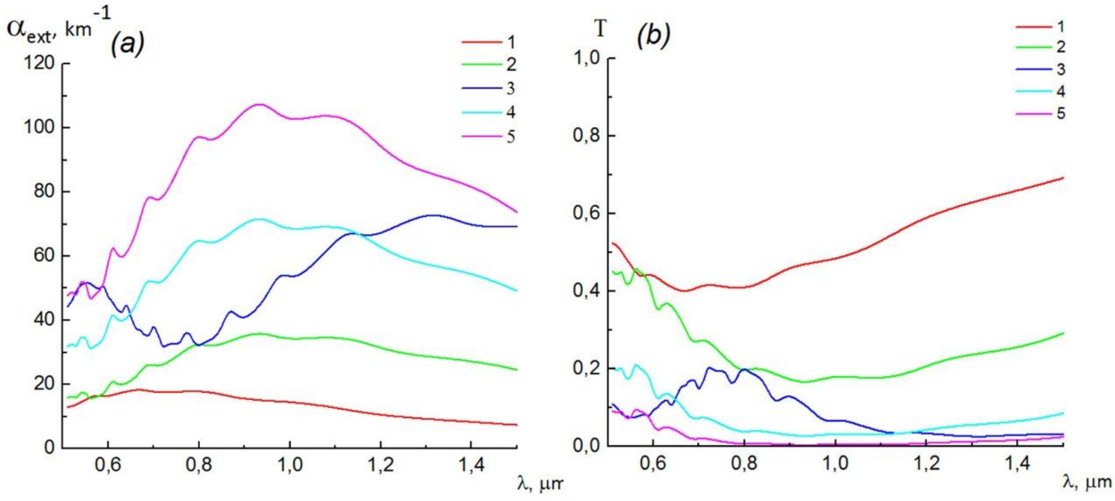

Fig. The wavelength dependence of the extinction coefficient (a) and transmission function (b), h = 100 m; 1 – a=0.5 μm, C=5·10^3 l^{-1}; 2 – a=0.7 μm, C=5·10^3 l^{-1}; 3 – a=1 μm, C=5·10^3 l^{-1}; 4 – a=0.7 μm, C=10^4 l^{-1}; 5 – a=0.7 μm, C=1.5·10^4 l^{-1}.

The wavelength dependence features of the studied optical properties can be used to locate the soot particles and estimate their microphysical parameters.

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ARCTIC DRILLING CHALLENGES

A.A. Marina

Scientific advisors associate professor I.A. Matveenko

National Research Tomsk Polytechnic University, Tomsk, Russia

Over the last decades, the world demand for hydrocarbon resources and their depletion in easy-accessible field has intensified exploration and development in the areas covered by seas and oceans leading to growth of oil production.

According to an assessment by the U.S Geological Survey, the Arctic holds an estimated 13% (90 billion barrels) of the world's undiscovered conventional oil resources and 30% of its undiscovered conventional natural gas resources [1]. However, oil-drilling operations in the region are extremely challenging as both high-cost and high-risk.

Although this is a fragile region, many major oil companies are approaching the Arctic to explore its untouched resources as there are some promising aspects for facilitating oil-drilling operations such as increasing technology developments and melting of sea ice due to global warming.

The Arctic conditions pose special physical challenges: remoteness, ice, extreme temperatures, and long periods of darkness. Technology is the key to meeting these challenges.

Let us enumerate the main challenges:

-Remote locations and harsh weather conditions (extreme cold, long seasons of darkness, high wind, hurricanes, storms, fog)

-Complex surface conditions (areas covered by ice most of the year)

-Lack of equipment and infrastructure

-Complex operational conditions and high costs

-Short-term drilling activity (seasonality)

-Tough and inadequate infrastructures to respond to major accidents

-Unproven technology in such harsh climate conditions

-Low knowledge of industrial activity in the Arctic region

-Country-specific environmental laws to preserve animals and unique plants species

-Long process to get a permit for exploration and production

Running a drilling rig in arctic environments is a challenge in many points. Operating a drilling rig in arctic environments is one of the hardest challenges for a rig builder and a drilling contractor worldwide.

When a rig is operated in these environments, there are many risks and challenges: It begins with the absolutely isolated location of the rig itself - for example, the accessibility only at wintertime by winter roads. This fact requires a complete other logistic and project planning. The engineering process of an arctic rig differs completely from a normal rig. It starts with the choice of materials and ends with the complete winterization concept of the rig itself.

However, oil companies have different views on drilling for oil in the Arctic. On the one side, firms, such as Total, believe that energy companies should not drill in Arctic waters as it may be too dangerous, but, on the other side, others companies, such as Shell and Statoil, are still planning to go ahead with operations in the near future.

Offshore operations in the Arctic encounter the same subsurface difficulties as those onshore, but have more severe surface challenges. The open-water season is very short and the conditions are harsh. Strong currents, fierce storms, multiyear ice, intense floating ice motion and, in some areas, icebergs all combine to increase the danger associated with drilling in open water. To withstand such challenges, offshore drilling and production facilities - vessels, platforms and submerged structures - must be particularly rugged. In shallow waters, artificial islands, typically made from gravel or ice, are the most technically and economically efficient solution. Offshore drilling and well operations in ice covered waters in the Arctic require ice management systems, which are able to detect, track and forecast the sea ice and icebergs. It is also recognized that Ice Management systems include threat evaluation and alerting as well as ice breaking and towing of icebergs [2].

Exploratory drilling:

Offshore drilling in the Arctic region poses extra challenges because of very low temperatures, ice conditions and darkness. Exploratory drilling usually takes place during the short open water season from ice strengthened mobile drilling rigs. Where conditions allow, winter and year-round drilling can take place from artificial gravel islands and specialized rigs that rest on the seabed.

Mobile drilling rigs are used so that operations can move easily to a new location once drilling is complete. However, these rigs are limited to open water conditions because at other times the movement of ice makes drilling impossible. Regardless, normal drilling procedures and the use of equipment must be adjusted to Arctic conditions to withstand and work safely in ice. These include the use of barriers and procedures to prevent spills (see box on barriers, next page). Additionally, we continuously seek ways to reduce any impacts of our operations such as the effect that the sound of drilling can have on marine life.

Drilling rigs Shell engineers have helped develop a new drillship that is easier to maneuver and more energy-efficient than traditional drillships. This “bully rig” is 25% smaller and 60% lighter than normal drillships, and has a reinforced ice-class hull that increases protection between its cargo and the sea. The bully rig can drill to a depth of four kilometres and can also navigate in shallow water. Shell owns and operates the Kulluk, one of the few Arctic rigs capable of year-round operation in severe ice environments. We also redesigned and refurbished the Frontier Discoverer drilling rig for Arctic service.

When thinking about future Arctic drilling, it should be clearly emphasised that for precise planning of any future Arctic Ocean drilling campaigns, including site selection, evaluation of proposed drill sites for safety and environmental protection aspects, etc., comprehensive site-survey data are needed first [3].

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OIL AND NATURAL GAS ARCTIC FIELDS EXPLORATION ON THE KARA SEA SHELF

L.V. Metlyakov, S.D. Zlobin

Scientific advisor associate professor G.P. Pozdeeva

National Research Tomsk Polytechnic University, Tomsk, Russia

The Kara Sea is as an extension of the West Siberian oil and gas basin and accounts for 60% of oil production in Russia. Directly influenced by natural features: the depth of the sea - 40-350 meters, the ice held 10 months a year, and its thickness reaches a half meters, and winter temperatures go down to 46˚C below zero. In 2010 JSC ‘NK Rosneft’ received a permission to investigate the shelf of the Arctic seas and started projects in three East Prinovozemelsky areas of the Kara Sea. In September 2014 the drilling results of the University-1 well in the first prospective oil land were obtained. During drilling operations, oil was discovered at a depth of 2000 meters. In short terms of drilling (one and half a month) all environmental and technological requirements were followed. ‘Pobeda’ is a new field name [2].