Method of Oil and Gas Fields Construction on the Continental Shelf of the Arctic Seas

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Abstract. In this article we consider the problem of field development on the continental shelf consisting in technological complexity and high capital investments of construction of sea oil and gas constructions in water areas of the Arctic seas. We consider the main advantages of a mine and tunnel way of arrangement of sea oil and gas fields as more effective and economic method of field development. We analyse conditions and possibilities of application of tunneling shield for construction of a tunnel under a seabed. We analyse a possibility of operation of coiled tubing unit for development of wells. We offer the perspective way of construction of underwater oil and gas construction combining building of an underground tunnel under a seabed by means of a tunnelling shield and application in a tunnel of the coiled tubing equipment for well-drilling.

1. Introduction
Oil and gas field development is an extremely difficult technological task. It is especially difficult to produce effective methods of field development of the continental shelf fields of the Arctic seas. The combination of severe climatic, hydrological and ice conditions, existence of a great number of sharp differences of depths and a difficult relief of a seabed define the choice of design decisions on field development.

2. Relevance
At the present day the Russian oil and gas industry sets a task of complex field development of the continental shelf fields of the Arctic seas. This perspective direction of development of this branch draws more and more attention every year that is reflected in the large volume of the scientific articles touching a subject of development of the Arctic shelf.

3. Setting of the problem
Hydrocarbon reserves development of the Arctic Ocean’s seas means creation of the technical means similar traditional, but capable to be operated in difficult ice and temperature conditions that will demand powerful investments of capital. Building of the specialized constructions having necessary production capacities will demand considerable time and heavy capital investments. Therefore it is expedient to intensify scientific search of essentially new highly effective decisions on development of the Arctic shelf along with use of the existing technologies and the fulfilled technical means.
4. Theoretical part

We consider the mine and tunnel way representing development of vertical mine shafts on the seashore and construction of the transport, oil and gas and ventilating tunnels directed towards the field under a seabed. Galleries are constructed over the place of drilling, the derrick is built in this galleries and the equipment, necessary for extraction of hydrocarbon crude, is installed. The oil and gas extracted from wells are transported on the underground system of tunnels on the land surface. The system of underground tunnels is built under a seabed by means of the standard equipment used when developing mines and mountain tunnels.

In the conditions of the Arctic seas the mine and tunnel way has a variety of advantages. This method excludes building of ice-resistant constructions and pipelines in severe sea conditions that more than by one and a half times reduces total capital investments in field development. In galleries conditions for operation of the reliable standard overland equipment for oil and gas production which can be transported without excess difficulties on tunnels are created. The microclimate, constant during all calendar year, in a cavity of a tunnel allows avoiding severe weather conditions of the Arctic that is an important factor for operation of the equipment and personnel. The lack of influence of sea water, dangerous to the equipment, damp air, rainfall, frost allows to use less expensive equipment and to increase his working capacity and service life. Due to year-round maintaining all types of works the efficiency of drilling, technical control, repair, supply and warehousing as in the conditions of the sea carrying out these processes is rendering difficult at both from weather conditions, and the limited area of a sea construction increases.

One of the dominating factors emphasizing advantage of a mine and tunnel way is extent of impact on the environment owing to environmental disaster. The methods meaning placement of the drilling and operational equipment over a seabed threaten local flora and fauna. At the same time, the tunnel under a seabed will provide the guaranteed protection to the hydrosphere during oil and gas production. Constructional features of a tunnel provide several times more reliable protection in case of emission of hydrocarbons. Considering a question of capital investment, this factor will allow cutting down expenses on the special sea installations and vessels intended for fight against pollution of an ecosystem.

The mine and tunnel method promotes achievement of economic efficiency of offshore field development of the Arctic seas as it demands the minimum capital investments in creation of underground systems. High speed of construction of tunnels is the key indicator defining economic efficiency of a method and terms of construction of underground systems.

5. Practical part

As modernization of the existing technology of marine field development in the mine and tunnel way it is offered to refuse construction of vertical mine shafts. Construction of the tunnel directed not vertically and at an angle to the land surface towards the sea field will begin with the seashore. The technology of construction of tunnels by means of a tunneling shield will be suitable for performance of this operation.

This improvement will allow refusing the vertical mine on the seashore that considerably will simplify carrying out construction works. The design of a tunnel will allow refusing hoisting operations that will reduce terms of building of a construction and will make more effective operation of the field. Rise and descent of the equipment, personnel and soil by means of the special equipment will be replaced with movement to the land surface and deep into a tunnel by means of automobile, rail or other type of transport. Introduction of this method will allow reducing capital investments and expenses of time.

In addition, it is offered to refuse building of galleries for a construction of derricks in them. For placement of a derrick it will be required to excavate the considerable volume of soil in the vertical direction that will lead to increase in investments, expenses of time and resources. Also, there is a need to deepen the main tunnel that without risk of leaking of sea water builds the gallery of necessary height. The difficult and expensive operation on construction of a tower interfaced to descent in a
tunnel of a large number of the additional equipment it is possible to avoid, applying to development of the well a new highly effective way – coiled tubing drilling.

The general height of coiled tubing drilling equipment, insignificantly exceeds vehicle height with the drum of flexible pipes placed on him, and many times less to height of a traditional derrick. Thus, coiled tubing unit is placed on special truck and is capable to move, be established and be operated without difficulties in the tunnel that was built with tunneling shield.

Combining advantages of field development by means of construction of a tunnel under a seabed in the way of tunneling shield and advantage of development of wells by method of coiled tubing drilling, the innovative type of an oil and gas extraction construction is offered. The scheme of a new way of hydrocarbon field development is submitted in the figure 1.

![Figure 1. Scheme of field development.](image-url)

Building of a tunnel 3 towards the field under a sea 1 begins on the seashore 2. After achievement of necessary length of a tunnel the tunneling shield is gone up to the surface unless the project provide further laying in case of possible detection of additional reserves of hydrocarbon crude. The tunnel is equipped with the equipment which the personnel need to be inside it: ventilation system, lighting, sensors of gas contamination and fire safety. The coiled-tubing unit 4 is transported in space of a tunnel. Due to the placement of the equipment on a frame of the car or on a rail frame the high mobility and speed of transportation is reached. Having reached an operation point, the coiled-tubing unit starts drilling of the well 6. From a drilling point to an exit from a tunnel the pipeline 5 is mounted for transportation of hydrocarbon crude to the land surface and further movement to gathering stations. All necessary equipment, expendables and working personnel will be delivered to the place of drilling by means of transport.

Construction of a tunnel by tunneling shield allows not only to deviate intentionally a straight line, but also to build branching. Therefore, the possibility of simultaneous development of several wells appears. Using several coiled-tubing units and the network of pipelines an effective use of the field can be reached and a payback period of an oil and gas construction can be reduced.

6. Conclusions
Modernizations in the form of construction of a tunnel by tunneling shield way and use of the coiled tubing equipment during the drilling and operation of the well are offered as a perspective and expedient method of development of fields of the continental shelf of the Arctic seas.
The analysis of the existing ways of marine oil and gas field development has shown that the offered modernizations will allow to reduce capital investments and expenses of time and will permit to increase efficiency of development of sea oil and gas fields.

7. References

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