margin of a lower platform exceeds factual loads. All wells to be drilled at the field are located within the platform. The platform basement also serves as buffer between the well and the open sea.

Besides, the installed equipment is intended to prevent the uncontrolled oil and gas release.

Oil storage system at the platform provides a "wet" method of placing raw materials in reservoirs, which prevents oxygen passage and formation of explosive mixtures.

Mikhail Ulyanov and Kirill Lavrov, oil tankers of the strengthened ice class and deadweight (cargo weight) of 70 tons will provide year-round export of products. These vessels are specially designed to oil transport from Prirazlomnaya.

Offloading line to transfer oil to the tanker is equipped with emergency shutdown with a seven second response time.

Near the platform the Ice Breaking Emergency Evacuating Vessels are on permanent emergency duty, fitted with the latest oil recovery systems equipment for operation in winter conditions. In addition, at the banks of the Varandey settlement, the Oil Spill Response Equipment is located, which helps to protect the coastline.

According to the world's practices and the Russian legislation requirements, a detailed plan of prevention and response to possible oil spills was developed. Due to this, various scenarios of risk were considered, resources and manpower calculation for forming facility emergency organizations was made, professional units for prevention and management of Oil Product Spills and etc.

The design progress and construction of OIRFP can be divided into five stages:

1) Design and factory setting of the platform in the water area of the production association "Sevmash" in Severodvinsk;
2) The platform towing from Severodvinsk to Murmansk;
3) Further construction, completion and concrete ballasting of the platform in the water area of Kola Bay (Murmansk);
4) The platform towing from Murmansk to the field;
5) The platform installation in the field, back filling of protective berm, and start-up operations, drilling the first three wells.

In November 18, 2010 the initial construction phase of the platform was completed: the platform factory setting was accomplished in the production association Sevmash, the living quarter platform installation in OIRFP, preparatory works for the platform towing to Murmansk to the 35 shipyard.

During the period from 18 to 27 November 2010, the second phase was completed: the platform towing from Severodvinsk to the completion site of the substructure (caisson) - the 35 shipyard in Murmansk. For the platform transportation seven ships were used.

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MODERN TECHNOLOGIES OF OIL TRUNK PIPELINE SYSTEM CONSTRUCTION IN PERMAFROST ENVIRONMENT

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In the near future oil production levels will rise due to development of new fields, the majority of which are located in the regions of the Far North. Oil fields of the Yamal Peninsula, the North of Krasnoyarsk Krai and Yakutia are considered perspective areas; the potential of hydrocarbon extraction on the shelves of the Arctic seas is being currently discussed. Increasing volumes of production in this region demands the development of oil trunk pipeline system in extremely severe conditions.

The difficulty of pipeline construction in the region of the Far North is connected not only with features of climate, but also with special geocryologic conditions which occur due to permafrost. The term frozen soil refers to all types of soil having zero or negative temperature and containing the frozen water in the form of ice inclusions, which cement the soil. During the summer period thawing takes place in the top (active) layer of the permafrost soil, which, in its turn, causes and intensifies various physical-mechanical processes connected with soil movement. Soil rebound, cryogenic cracking, thermokarst can lead to pipeline displacement from the design position, change its stress-strain behaviour and cause emergency situations. Being transported through the pipeline, high viscosity oil is heated, which, in its turn, increases thermal impact on frozen soil and leads to significant increase in thickness of an active layer [2]. The measures aimed at minimizing pipeline impact on frozen soil are obligatory to consider in constructing facilities in areas affected by permafrost; their efficiency ensures safety of pipeline operation in hazardous geocryologic conditions.

Special conditions of northern latitudes make it necessary for designers and builders to accomplish tasks, which require extraordinary solutions; therefore each pipeline laid in areas of permafrost distribution is a unique project. Both Messoyakh – Norilsk gas pipeline which is 263 km long, laid in the conditions of Arctic Circle, and the Trans-Alaska oil pipeline, which was pulled in the areas characterized not only by extensive permafrost, but also high seismic activity, belong to this group. The experience of these facilities has been considered in developing technical solutions to lay Zapolyarje-Purpe oil pipeline which is being constructed using up-to-date technologies and had to be completed by December, 2015 [1].

Based on frozen subsoil conservation principle, pile-supported above-ground pipelining was chosen as a construction method for Zapolyarje-Purpe pipeline [3]. This construction type minimizes heat exchange between oil and ground, but involves certain difficulties due to temperature fluctuations of surrounding air. This leads to rise of oil viscosity when air is cooled and because of temperature it causes more severe deformations than those which can occur in underground pipelines.

For the above ground Zapoljarje-Purpe pipeline sections a set of pipe design requirements is identified. A pipe should be steel with corrosion resistant coating, heat isolating coating, and protective covering. Influence of atmosphere corrosion is much lower comparing to underground corrosion, that is why one-layer yard epoxy coating is used. Extremely low temperatures in Far North conditions require special heat isolation, therefore cast polyurethane is applied (thermal conductivity coefficient 0,024 – 0,035 Wt/mK). Thickness of the layer can be determined by thermotechnical calculations. Spiral lockseam tube with 1,5 mm thickness is used as protective covering [6].

To compensate temperature-caused piping stresses three types of piled pipeline support configuration are applied which are fixed, laterally moveable and free moveable. Fixed supports are spaced within 500 m interval, while, moveable and free moveable supports, which allow pipeline longitudinal and cross-sectional movements in case of temperature-induced stresses, are mounted between them. Smooth sliding of a pipe is provided due to installation of fluoroplastic chafting plate on a pile toe, whereas a siloxane shim between the pipeline and lodgment prevents protective cover and thermal pipe isolation coating from damage while sliding [3].

Piled support configuration allows a pipeline to operate in case when two moveable supports fall down (in the section between two fixed ones). However, to avoid such emergencies in Zapoljarje-Purpe pipeline an unusual engineering solution which implies application of soil thermostabilizers (Fig.) is employed. The effect of the device is aimed at local freezing of thawed soil and decrease in temperature of frozen soil around the pile, which, in its turn, increases pipeline bearing capacity and reliability. Structurally a cooling device represents a sleeve filled with non-freezing liquid which is embedded in a pile and is separated from the air by the heat-insulation liner. The lower part of the device placed in the sleeve is a vapourizer filled with refrigerant, and there is a horizontally- finned condenser at the top [5].

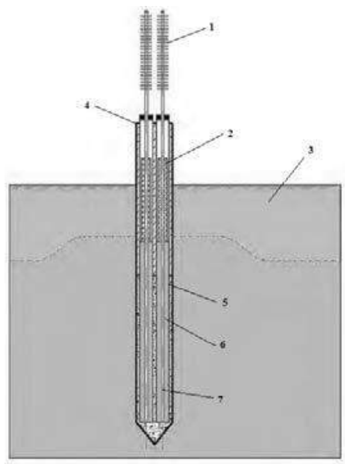

Fig. Soil thermostabilizer: 1 – condenser; 2 - heat-insulation liner; 3 – active soil layer; 4 – pile; 5 – sleeve; 6 – non-freezing liquid; 7 - vapourizer

The device works as follows: heat from the soil is transferred by means of non-freezing liquid to the operating section of the vapourizer, where refrigerant starts boiling and the received steam moves up. Then, steam moves through the condenser, releasing heat into cold air, hereafter the condensed fluid moves down towards the vapourizer, thus cooling the ground. This results in ice-soil holder formations which decrease loads sustained by main piles [5].

The cost of above-ground pipeline is higher than that of underground line. Therefore, the possibility of underground pipelining in the regions with insular permafrost was considered. About 35% of pipelines are situated in such areas, which can decrease costs significantly. However, underground pipelining requires more rigorous exploration and thermal stabilization of soils [4].

To reduce the thaw halo effect around the underground pipe the following design details of thermal insulation construction has been proposed: a steel pipe, yard three-layer polyethylene anticorrosive covering, polyurethane coating and metalpolymeric protective cover. The higher protection against corrosion, external mechanical influence and smaller thickness of polyurethane layer (75 mm) which protects frozen soil from thermal impact of the transported oil distinguishes subsurface pipe thermal isolation from a thermal insulation design of above-ground pipelining [6].

Certain sections of pipelines experience destructive effects of melting and soil subsidence, despite yard heat isolating covering. These processes lead to disastrous stresses in pipe walls, as a consequence, additional measures to stabilize the soils have to be undertaken, including replacement of frozen soil by dry soil immediately before laying the pipes in the trench. Moreover, additional heat isolation can be provided by placing sheets of isolating material at the bottom of a trench as well [4].

Building long-distance oil trunk pipeline systems in the Far North environments is a very complicated activity, which requires not only large funds, but also accurate design and surveying. A lot of innovative and modern ideas were implemented in Zapoljarje-Purpe pipeline construction to decrease costs and provide high level of safety for the next 50 years.

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THE MODIFYING OF CLAY FORMATIONS

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The quality of drilling wells highly depends on interaction between rocks and drilling mud. If drilling mud is picked up not correctly, there is a set of complications in the process of drilling. Improvement of processing behavior of drilling mud is quite an actual task since large volume of drilling in our country is conducted in unstable clay rocks. Clay formation can be divided into two categories, depending on a stage of lithogenesis: supplied (stage of diagenesis and early catagenesis) and friable (stages of an average and late catagenesis).

The microstructure of clay formation is very sensitive to change of physical and geochemical fields and therefore it is transformed in the process of lithogenesis. [4] One of the most typical directions of diagenetic transformation of silt waters is increase in concentration of salts and increase in content of Mg^{2+}, Ca^{2+} and K^{+} as a result of which the exchange complex of sludge also has changes. It leads to reduction of hydrophily of clay particles and degree of diffusion of their double electric layer.

Clay changes into typical supplied systems with development of near coagulatory contacts. Such systems are described by viscous nature of deformation, ability to supplied flow in a wide interval of loadings with the greatest supplied viscosity, average values of indicators of compressibility and swelling capacity.

Appearance of structural bonds of the mixed type at a late stage of diagenesis causes essential change of strength and deformation properties of clays. Appearance of stronger transitional contacts leads to formation of a rigid framework that is capable to perceive external loading at an initial stage of deformation. [3] Therefore, under loadings which are less than durability of a rigid framework these clays behave as elastic systems, and in destruction of a framework and higher loading are deformed as plastic bodies. Compressibility of such clays considerably decreases, and indicators of strength properties increase, and the size of swelling reaches the maximum value.

In case of clay rocks at the diagenesis stage, when clays are condensed under the weight of overlying rocks the adsorbed water is squeezed out together with steam water. The amount of the remaining water depends on depth of occurrence, a volume fraction of clay minerals, existence of exchange cations in them and geological age of formation. In the process of exposure of clay formation to horizontal stress in rocks in a borehole are removed and the dehydrated rocks adsorb water from drilling mud. If the swelling pressure developing this way causes increase in the centrifugal pulling stress to the level exceeding a yield point, the borehole is deformed. Deformation is shown in the form of a supplied flow when rocks come into contact with drilling mud [1].

In case of existence of supplied clays in practice of washing-over of wells calcium chlorine, gupseous, silicate, baric and calcium drilling fluid are used most widely. The use of such fluids in the fields of Central and Lower Volga area, in Turkmenistan, in Ukraine and many other areas of drilling operations allowed to considerably reduce cave-ins, taluses, well narrowings and a caving formation, to reduce time for washing and study of wells.