Ecological and social problems of the ESPO pipeline system in Yakutia

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Abstract: **Most specific natural conditions, which can lead to environmental problems along the Pipeline ESPO in Yakutia, are analyzed in the paper. Amongst them are climatic, hydrological, cryogenic and hydrogeological conditions, providing potential risk of occurrence of dangerous natural phenomena, like seismic activity, ice dam formation, karst formation, as well as different exogenous geologic and cryogenic processes. Issues of feasible negative impact of oil spills on the environment are considered. Level of stability of natural complexes of the area to man's impact is assessed.**

In addition, problems of socioeconomic influence of the ESPO on accommodation of the native population are considered.

Keywords: **Natural and social conditions, petroleum product, impact.**

Intended to transporting oil of Siberian deposits to prospective market of the Asian-Pacific region the Pipeline system "Eastern Siberia - Pacific Ocean oil pipeline" is one of the largest investment energetic projects which is being realized in the territory of Yakutia according to "the Scheme of development of productive power, transport and energetic of RS (Y) by the year 2020".

In the Republic of Sakha (Yakutia) the right-of-way of pipeline will pass through the territories of the South-West and the South Yakutia within four regions. The sources of oil ingress are deposits of the West Siberia, the Irkutsk region and also Yakut deposits as Talakanskoe and Verkhnechonskoe deposits. Besides more than 30 million ton of oil it is planned to recover by 2015 from these deposits.

Natural conditions of the territory where the way of the ESPO passes are characterized by inhomogenous natural and climatic conditions, difficult geotechnical, geocryological and seismic conditions. Besides the oil pipeline will pass through the territory of compact inhabitancy of indigenous population of the South Yakutia – evenks, including places of their original householding – reindeer production. In this connection valuation of both ecological and social influence of constructing and exploitation of ways on natural habitat of local people has highly important ecological and social meaning.

The region of right-of-way of the pipeline is characterized by sharply continental climate. Absolute minimal temperature achieves - 60°C (Lensk), -59°C (Olekminsk), - 51°C (Aldan), - 61°C (Chulman) and absolute maximum - +36°C (Lensk, Olekminsk). In winter territory of the way is under influence of cold and dry air mass of powerful Siberian anticyclone. Winter is long, with little snow and very cold. Summer is quite short but warm.

Quantity of precipitations on the way of oil pipeline ranges from 546 mm (Aldan) to 264 mm (Olekminsk), therefrom rain precipitations are 55-70%.

The territory of the right-of-way of oil pipeline is distinguished by dominance of no-wind weather. Average annual wind speed is relatively not fast: in Lensk – 3,1 m/s; in Olekminsk – 2,1 m/; in Aldan – 2,9 m/s, in Chulman – 1,3 m/s.

One of the characteristic features of the way of pipeline is sudden alteration of temperature formation in the Siberian anticyclone conditions due to cavities of the Baikal type and deeply cut in river valleys: air temperature in foundation pits decreases until - 60°C at small-scale (20 cm.) snowpack and no-wind weather. At sudden alteration air temperature increases as absolute magnitude increases.

Multi-year frozen solids of uniform and noncontinuous spread are other natural specialties. This causes wide spread of various cryogenic geological processes which complicate conditions of oil pipeline exploitation (thermokarst saggings, rock glaciers, solifluctions, blow-ups, cavings, etc.).

Hydrographic net in the researched territory shows quite a branched system of rivers, creeks and lakes. According to data of "Transneft" JSC the way of oil pipeline crosses 248 water objects of the Lena river within the territory of the Republic of Sakha (Yakutia): 65 in the Lensk region, 73 –in the Olekminsk region, 71 – in the Aldan region, 39 – in the Neryungri region. The majority of the crossed rivers relates to minor rivers and creeks. Large rivers which cross the way of oil pipeline are: the Peleduy, the Nyuya, the Lena, the Tuolba, the Amga, the Aldan, the Bolshoy Nemnyr, the Khatymi, the Chulman and the Timpton.

The main feature of water schedule of touched upon rivers is powerful spring floods, which are reasoned by fast snow melting on water accumulation and ice-jam. Sometimes summer floods heighten the levels of spring floods, but they are more gradual.

Ice covering achieves 2,5 meters on the Lena river in spite of meaningless width of snow. Minor and even middle rivers freeze annually. Rivers with meandering streambeds and expected annual damages of banks at the transferring through water boards are dangerous.

Specific features of the territories of the South Yakutia are risky for technogenetic constructions. The most meaningful of them are seismic activity, karstification, aufeis formation and ice-jamming.

The most dangerous factors of the region influencing on safe exploitation of pipeline are earthquakes, which happen at spring floods and sometimes are reasons of catastrophic floods.

Ice-jams appear on reaches of river characterized by decrease of grades, nipping change of streambed direction and its water-way, expansion of streambed because of its branching into channels and narrowing its main streambed and existence of islands, shoals and sandbanks. The pipeline passes through the Lena river, 6 km. higher Solyanka village, 5 km. lower cavity of the river Olekma, in segment of frequent ice-jam formation. Thus according to information from the station of Solyanka in the period of hydrologic observations from 1937-1990 at this place there were 15 ice-jams.

The process of aufeis formation on the Aldan highlands are everywhere. The map of V.R. Alexeev consists of 1000 aufeises. Also the territory of the way of pipeline relates to avalanche-prone.

In addition, the pipeline from the oil pumping station (OPS) No 10, located at 1092 km. in the upper river Nyuaya to the station located at 2091 km., passes to the territory of the strong karst appearing. Thus, according to observations on the river Biryuk, located in Kileer region, intersecting with the pipeline, minimum flow rate is 0.15 l / sec. square. km. and on the map adjusted for the small drains - 0,50., i.e. loss of flow in fractures and karst formations. In case of spillage of petroleum products to the places where karst appears, they can penetrate into the underground horizons being cause of pollution of groundwater, sources of drinking-water supply of settlements in the South Yakutia.

Despite the fact that during the construction and operation of oil pipelines the full range of measures to prevent accidents and oil spills are taken into account. But anyway they sometimes happen, causing serious environmental damage.

Normative period of service of oil pipelines is 33 years, but in fact some of them are exploited for 50 years. During this period conditions of exploitation may change, such as development of soil erosion under the structure, changes in oil properties, necessity for temporary conservation or shutting down the oil pipeline, that is why pipelines damage and must be repaired.

Analysis of information according to accidents of existing pipelines showed that the main reasons are the following more common technical and natural factors: internal and external corrosion, weld defects, damage of the pipeline by soil, frost heave, as well as the "human factor", i.e. negligence and poor quality of the staff work.

Significant role in the exploitation of oil pipelines are natural characteristics of the region: permafrost, climatic and hydrogeological conditions, hydrologic water regime, specialties of technology and pipeline construction in the conditions of the North. In addition natural factors may initiate essential risks, which appeal to significant damages, such as floods and high floods, reasoning accidental and emergency situations; erosion, river bed slope processes that cause the destruction of infrastructure elements, linear structures; thermokarst processes, subsidence, and failures, the deformation of foundations and bases, provoked by the accelerated erosion and solifluction, threatening polygonal objects.

Petroleum products have a negative impact on water ecosystems: concentration of petroleum products 0,01 mg per 1 liter of fresh water is enough for dying of most of freshwater fish. Water pollution by oil and oil products causes damages for nature which in excess of other types of hydrochemical impact forming a membrane, which reduces access of oxygen to the water surface by 60%.

Sources and mechanisms of accumulation of oil pollutants in sediments are different. The depth of penetration of petroleum hydrocarbons into sediments varied and depends on structural composition of soil, oil pollutants and sediments, salinity hydrometeorological processes, geomorphology and other factors. Biochemical dissolution of the bulk of spilled oil is slow, as there is a certain type of microorganisms that can decompose all the components of oil in nature.

One of the characteristics of oil pollution is ability to capture and concentrate other contaminants such as heavy metals and pesticides. When oil is distributed over large area, the probability of different reactions is increased as well as substances which are soluble in oil, have opportunity to participate in a variety of chemical processes.

Petroleum and petroleum products are among the oxidation-prone substances by microorganisms, so self-cleaning water contaminated with oil, is long enough. In Yakutia these processes are compounded by cold climate.

Because of the geotechnical system "pipeline-environment" is a system where the interaction of technical facilities and natural systems, not only pipeline impact on natural environment, but natural environment has much influence on it.

Activation of exogenous geological and cryogenic processes at construction and operation, as well as changes in the temperature regime of soils under the influence of ESPO pipeline way complicate the operation, which could have a significant impact on land degradation and safety of technical installations. The width of zone of influence of construction works depends on type of exogenous geological processes and varies from 300-500 m. to 1-2 km. and more.

Aufeis formation. Processes of aufeis formation are significant for pipeline construction. According to degree of aufeis formation Chulman highlands allocates of all landscape provinces. It belongs to the category of ice mound with a coefficient of relative development from 0,1 to 1%. Ice dams are formed almost in the majority of valleys of local watercourses in the form of small-area entities, dedicated primarily to their floodplain and channel parts. Slope frost is usually confined to places of kinks relief, boundaries of the frozen and melted rocks on the slopes. Their size is typically less than 0.01 km and the thickness of ice - 1-1,5 m.

Rock glacier buildup. Rock glaciers are large formations and occupy large areas of

slopes. Width of the area occupied by rock glaciers is determined by length of slopes and is at least 500 meters on both sides of the way.

Thermokarst. Degradation of ice rich permafrost, resulting to activity of thermokarst starts in the zone of permanent and temporary land allocation for construction of the pipeline with width of 25-100 m.

Blow up. When territories are explored economically violations of individual components of environment lead to temperature changes and moisture regimes of soils and thus to the swelling of icy-grained soil and deformations of linear constructions (pipelines). Their width is limited by width of permanent and temporary right of way of main pipeline and the accompanying technological objects (25-100 m.).

Erosive and thermoerosive processes. While constructing in the areas of active development of erosion processes various erosive forms like scours, furrows, ditches and gullies form. Violations band is determined by natural and man-made conditions and it enters the corridor with width up to 100 meters on both sides of axis of the pipeline.

Karst and suffosion, thermosuffosion processes. Within massifs of Cambrian rocks, karst forms appear in the form of craters, subsidence, accompanied by the disappearance of water flows to the strike as along the row and in the transverse direction. At places of active karst the width of corridor is determined depending on activity of the process and is 200-300 m.

Spread of cryogenic process is applied to map of permafrost landscapes in the territory where pipeline passes to imagine distributing of landscape and geocryogenic violations.

Evaluation of the degree of sustainability of natural systems is important to define modern human impact on landscapes.

The analysis of changes of environment with two complementary methods– component influence of leading cryogenic characteristics on reduction of stability of landscape and valuation of stability of landscape and ecological systems to anthropogenic impacts - using was made.

Bioclimatic data (biologic productivity, conditions of phytomass reserves, moisturizing and thermo supplying conditions) were taken from work. All landscape provinces were ranged according to meanings attached to every subcompartment of estimating balls. The balls characterize degree of influence of definite factors on stability decreasing. Integral influence of all components was estimated by total sum of balls.

As a result the following distribution of landscape provinces of researched area according to degree of their resistance to anthropogenic impacts.

Main landscape building up factors generally determine the latitude and zonal distribution of landscape provinces of plains of researched area ways, complicated by high-zone in the mountainous part. It defines the following distribution of natural systems to their degree of resistance to human impact.

Middle taiga landscapes characterized for regions of Talakan – Olekminsk and Olekminsk – Aldan, are differentiated on landscapes with low and moderate degree of stability, depending on the nature of the distribution of permafrost - from continuous to intermittent and insular, as well as features of continental climate changes.

According to bioclimatic indices of middle taiga landscapes of Middle Viluyskaya hollow-ridges province, Nyuya-Olekma and Olekma-Aldan ridgy provinces are quite stable and Prilensk ridges province - stable, as it is characterized by high productivity and phytomass. Other three provinces have lower indices. Conditions of thermo and moisture supplement of all provinces are temperate (2 balls).

Permafrost conditions characterize these provinces as following. According to power of the seasonally frozen and seasonally

thawed layers provinces are stable (1 ball). High temperature of melt and frozen soils and low volumetric ice promote violation of soil and cryogenic processes appearing, which makes the landscapes unstable (3-4 balls). In the Middle Viluysk province continuous distribution of permafrost reduces resistance and in the Prilensk province island distribution – heighten. Other two provinces of discontinuous distribution of frozen solid are unstable.

Taiga, woodlands and cliff landscapes of mountainous part of the way according to the degree of stability is as follows.

According to moisture all the provinces are characterized as moist (1 ball) and stable. Chulmanskaya relatively flat province according to bioclimatic indices has a higher degree of stability. This favors by increased biological productivity and phytomass reserves of mountain taiga forests, and heat supply. The same parameters of Olekma - Timpton and Timpton-Uchursk provinces of woodlands type are characterized as low productive with low sources of phytomass and according to thermo supplement they are marked as moderately cold (sum of active temperatures don not heighten 1000). Thus according to bioclimatic indices the degree of stability of Chulmansk mountain taiga province ranges from weak to middle. Olekma -Timpton and Timpton-Uchursk mountain and forest provinces are unstable according to most of bioclimatic indices, except index of moisture.

According to permafrost conditions distribution of natural systems to the degree of stability is following: to volumetric ice content of surface rocks all three provinces are considered as highly volatile (4 balls) because of high ice content. But depth of seasonally thawed and seasonally frozen layers (1,0-4,0 m) of Olekma-Timpton and Chulman provinces increases their resistance to middle, while the smaller capacity of these layers in Timpton-Uchursk province (0,6 -2,2 m) determines its stability as weak.

Low soil temperatures of the first two provinces increases their resistance to 2 balls, defining their weak resistance, while low temperature in Timpton-Uchurskoy province also increases its resistance to moderate (1 ball).

Location of Timpton-Uchursk province in the zone of continuous distribution of permafrost rocks makes landscapes fragile (4 balls). Discontinuous distribution of permafrost rocks of two other natural implies a weak effect on reducing their stability and determines their weak stability on this factor (2 balls).

Thus in flat part of the ESPO way (from Talakan to Aldan) stability of middle taiga natural systems to technogenic impact is average, except the regions of Talakan - Lensk, where their resistance increases. At mountain segments of the route - Aldan - Tynda (to border of the Amur region) variety of geomorphological and climatic conditions led to broader range of sustainability of mountain landscapes from stable of Chulman to middle stability of Olekma-Timpton and weak stability of Timpton-Uchursk provinces.

As mentioned above, not only environmental impacts of construction and operation of the ESPO play important role, but also social and economic impacts on living conditions of indigenous people.

The way of oil pipeline ESPO in Yakutia touches mainly interests of indigenous people of the North – evens. Changes in the natural complex and in its main constituents have been studied quite well, but social and domestic, medical and social and cultural aspects of life of indigenous people of the North in the area of ESPO pipeline on the contrary have not been.

Meanwhile actuality of this problem is obvious especially against economic crisis. The remoteness and inaccessibility of the region, decrease of living standards, wildland, instability, alcoholism, increased crime and other negative sides of life in the territories, involved in energy construction are obvious factors. Also we can add the following: consequences of changes to degradation of natural habitat, violations of historically built natural relations,

subtraction of places of hunting, fishing and camping ground, environment pollution both harming to health of people and bases of eco-mindedness and eco-view. So all these factors raise question of necessity of studying and researching such natural and technogenic systems as the ESPO, which criteria of functioning quality is condition of physical and moral health of human – representative of indigenous people, involved in the process of natural habitat transformation. Most of indigenous people do not receive any benefits from the considerable investment that is necessary for ESPO construction. In many cases even are not used as workers because employers prefer to sign contracts with workers from other areas. Even if resettled people are used to construct the pipeline, they are not included into the permanent staff.

In conclusion we want to say that the main question is not to stop works on ESPO pipeline construction in the South Yakutia basing on negative experience of previous years, but to take into account all the mistakes that led to nature degradation and to use more integral complex approach to economically important projects of development of the republic and our country in general with priority on social and ecological aims.

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