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ECOLOGICAL STATE OF THE AQUATIC AND SOIL ENVIRONMENT ON THE TERRITORY OF URENGOY OIL-GAS DEPOSIT

SUMMARY. The article deals with the ecological state of the water and soil environment of Urengoy oil-gas condensate field (UOGCF). Some of the sources and factors of quality transformation of the given components (in particular chemical) and the degree and amount of pollution are considered.

KEY WORDS. Ecological state, transformation, pollutants, degree of pollution.

Almost all facilities of the oil and gas production and transportation complex have negative impact on the natural environment. At the present stage of the development of oil and gas fields, as well as raw hydrocarbons transportation and processing, the impact of complex facilities on the natural environment is not decreasing, moreover it sometimes increases.

In oil and gas areas the sources of impact on surface water, groundwater, soil and underground water levels are areal and linear facilities of the primary and secondary technological processes, as well as oil and gas related infrastructure facilities [1].

Pollution of soil by drilling fluids, oil and oil products, formation water, fuels and lubricants, chemicals, etc. may occur from the surface during infiltration of drains, precipitation, surface water drainage from industrial sites, as well as during underground overflows [2], [3].

In general, typical pollutants in oil and gas areas are the following: standard macro-components (Cl, Ca, Mg, SO_4), nitrogen compounds (NH_4, NH_3, NO_3), a number of micro-components (Br, J, B, Cd, Cr, Fe, Mn, Hg, Ni, Pb, etc), oil products, and specific pollutants that are getting into waste waters due to the technology of primary and secondary production (methanol, diethylene glycol (DEG), synthetic surface-active agents (SSAA), corrosion inhibitors, phenols and etc.).

The state of surface and ground waters and soil of Urengoy OGCF is first of all affected by the chemical composition and quantitative characteristics of wastewater resulting from exploitation and liquidated by ground disposals [3].

According to the data of the operational environmental monitoring, wastewater of Urengoy OGCF in most of the sites where they are produced and pumped into lost circulation horizon (Fig. 1), is mainly low-mineralized liquid whose total mineralization is often less than 1g/l [4].Their density is from 0.973 to 1.000 g/ cm^3, pH is from 4.2 to 7.2. Some of the field facilities are noted by drains with high mineralization: up to 1.7 g/l at the Gas Treatment Unit-1; up to 4.6 g/l at the Gas Treatment Unit-2; up to 6.9 g/l at the Gas Treatment Unit-4; up to 1,9 g/l at the

Gas Treatment Unit-6; up to 2.9 g/l at the Gas Treatment Unit-9; up to 3.1 g/l at the Gas Treatment Unit 11 and up to 2.2 g/l at the Gas Treatment Unit-12. The highest mineralization is registered in wastewater from oil facilities — Central Production Facility-1 and Central Production Facility-2 (6.5 and 5.4 g/l), pH of wastewater is from 6.2 to 7.3. The composition of industrial wastewater of any salinity is mainly sodium chloride-hydrocarbonate. Iodine, according to the data of wastewater testing, is not found, with the exception of the wastewater from Central Production Facility where its content can be up to 1.9 mg/l. Bromine in many wastewaters is contained in an amount from 2.0 to 8 mg/l. Iron is present in the wastewater from almost all the facilities. Its content is 40 mg/l [5].

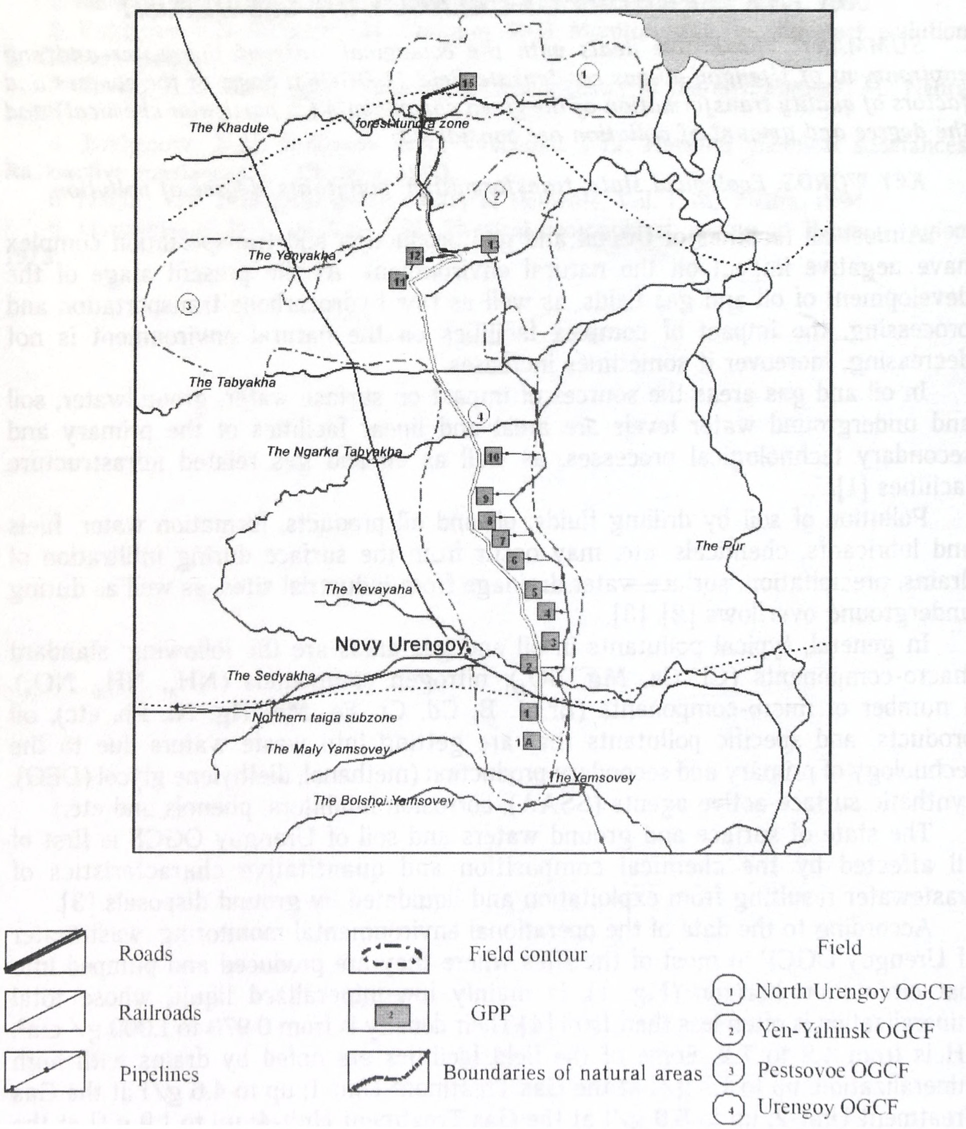

Fig. 1. Index map of Urengoy OGCF

The impact of saline wastewater results in the increase of the salinity of surface and ground water and, consequently, soil salinity. Wastewater is more active and able to penetrate than oil products, however, the principle of interaction with soils is the same as that of the oil. The degree of soil pollution by wastewater is determined by the degree of saturation of soil by chloride and oil products. Wastewater getting onto soil, lead to the change of its physical and chemical properties, reduction of water permeability, deterioration of nitrogen status, oxygen necessary for the life of plants and microorganisms is displaced out of soil [6].

Average annual content of suspended particulate matters in the wastewater is ranged from 9.5 to 23.5 mg / l, oil products from 10 to 24 mg /l (Gas Treatment Unit-13) (Fig. 2).

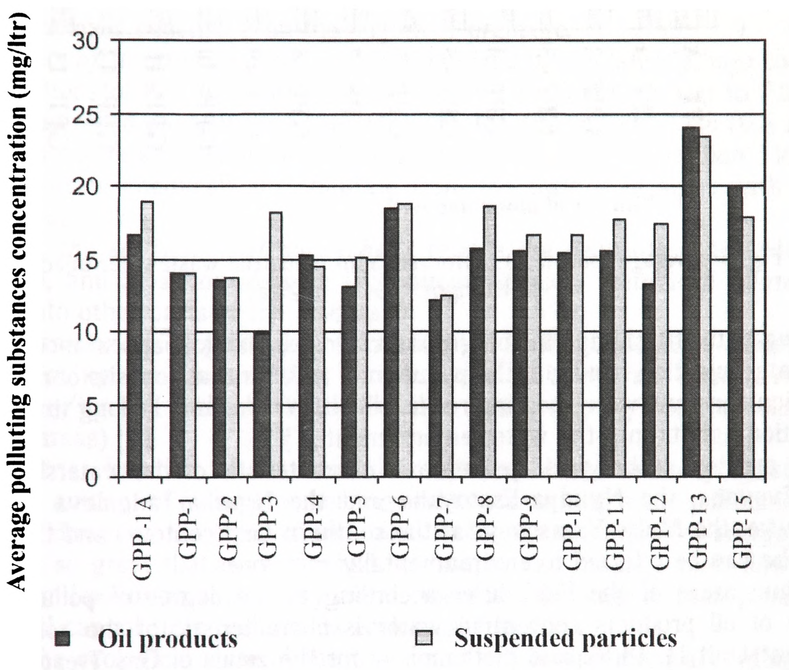

Fig. 2. The average content of oil products and suspended solids in the industrial wastewater of Urengoy OGCF, mg/l

As for the quantitative parameters of wastewater amounts, long-term average annual values for flow rates of industrial wastewater injection in wells of Gas Treatment Unit of Urengoy OGCF range from 75.2 (well 39 Gas Treatment Unit-12) to 233.2 (well 37 Gas Treatment Unit-11) m^3/day and are often from 150 to 200 m^3/day (Fig. 3). From this we can conclude that, on average 55 000 — 73 000 m^3 of wastewater a year is pumped into the reservoir. If we consider that in this case the relief gets 2% of this volume [6] that is 1100-1500 m^3 on average. It is this amount of wastewater that mainly pollutes water and soil environment of the area.

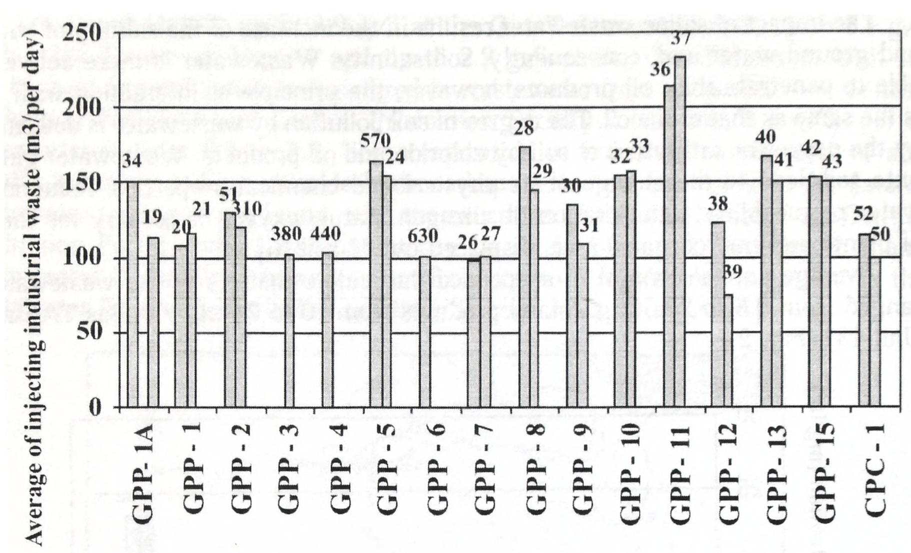

Fig. 3. Average long-term performance of industrial wastewater injection in Urengoy OGCF, m^3/day

Along with the change in the groundwater geochemical appearance, industrial wastewater injection results in the pollution of soil, benthal deposits of rivers, rocks of aeration zone and water-bearing rocks, which, in turn, may be long time suppliers of pollution agents into the water environment [1].

The greatest technogenic pollution is characteristic of the watersheds of the rivers Evoyaha, the Nyudya-Esetoyaha and the Ngarka-Tangalova. The rivers Sidemyutte, the Malyi Yamsovey (at the southern field contour) and the Ngarka-Esetoyaha can be referred to environmentally safer ones.

Certain areas of the field differ according to the degree of pollution. Some increase of oil products content in water is characteristic of the zones of Gas Treatment Unit-11, 13.15, and methanol — for the zones of Gas Treatment Unit-1AS, 5.6. In peripheral areas (near the gas-pool outline) water is much less polluted than in the central part of the field [5].

High concentration of ammonium ions confirms river water pollution by communal waste water. At the same time low concentration of nitrites and nitrates in them denote the slow process of natural self-purification of natural water in the North. Water pollution by synthetic surface-active agents is caused by industrial and communal wastewater [4], [5].

In general, concentrations of the major pollutants — oil products — in the groundwater are much lower than in the surface water, which can be explained by the input of pollutants into subsurface layers from the surface.

The input of harmful substances into the upper aquifers occurs by their filtering right from the earth's surface, where there are dump sites, fuels and lubricants storages, polluted openpits, sites of overflows and leaks of wastewater from plants. A certain role in the pollution of ground water, obviously, is played by the infiltration of melted snow precipitation, which accumulates a large number of different pollutants for a long winter period.

Analysis of the content of some chemical elements in soils of the area according to the data [7], [8] shows that the territory is characterized by a fairly homogeneous concentration level of chemical elements. The highest values of the concentration ratio of K_k are observed for mercury and are 8,5-12,5. There is a group of elements, characterized by the values of K_k that are more than 2 (Na, V, Cr).The group marked by the relation 2 $<K_k<$ 1 includes Sr, As, Mo, Ba, Ni, B, Zn, V, Cu, Cd, etc. For some elements the value is less than 1 (Pb, Co, etc.). Summary soil pollution index in relation to geochemical background is 12-16, that corresponds to a relatively acceptable level of pollution.

One can observe the differentiation of pollutants content in the soil covering of natural complexes depending on the degree of drainage.

The soils of floodplain areas are characterized by a relatively high content of mobile fractions of Fe (up to 30 g/t), Zn (up to 1 g/t) and Cd (up to 0,02 g/t). The soil watershed concentrates Cu (0.6 g/t), Pb (0.7 g/t) and Co (0.3 g/t) — the most characteristic elements of the regional technogenic interaction. Floodplain soils concentrate chemicals that migrate from the watershed areas with surface water drainage.

In turn, *the soil cover of watersheds* retains the elements coming from the atmosphere, and at a considerable technogenic loading there is a migration of elements into other parts of the landscape

Concentration of oil products in *the soils of valley-floodplain complexes* is 100-115 mg/kg, *in the soils of tundra and lake-marsh complexes* it is 200-250 mg/kg [7], if the background value is 100 mg/kg (for the soils of oil-producing areas) [9].

The barrier function of the natural complexes of the territory substantially reduces the amount of pollutants, holding and concentrating some pollutants in the soil profile. However, the input of pollutants under the conditions of anthropogenic activities is so great that no watershed landscapes can manage their flow and as a result of soil pollution with heavy metals there is a decrease in their productivity and this soil cannot fully perform its ecological functions.

Thus, the ecological state of the water and soil environment according to the majority of the quality standards is relatively satisfactory. The highest concentrations are characteristic for mercury, iron, and manganese. It is hard to evaluate the quality of groundwater according to the content of oil products, as there is no single universal technique. The main problem is the underestimation of regional threshold limit values of many components.

REFERENCES

1. Solntseva, N.P. Oil extraction and geochemistry of natural landscapes. Moscow: MSU publ., 1998. 376 p.

2. Davidenko, N.M. Environmental problems of oil-gas and mining regions of the North of Russia. Novosibirsk: Nauka. Siberian enterprise of Russian Academy of Science, 1998. 224 p.

3. Engineer's handbook on environmental management (ecologist) / Edited by Perkhutkin, V.P. Moscow: Infra-Inzheneriya, 2005. 864 p.

4. Kravtsov, Yu.V., Tsatsulnikov, V.T., Kobychev, V.Yu. The impact of oil and gas industry facilities on underground waters under the conditions of aggradation of permafrost of the North of Western Siberia // Evaluation of the impact of oil and gas complex enterprises on the environment: Collection of conference reports (Tuapse, September 30^{th}-October 5^{th} 2001). Moscow, 2002. P. 33-35.

5. Kravtsov, Yu.V. The study of ecological geochemical state of underground and surface water of Urengoy oil-gas condensate field: Synopsis of thesis... candidate of geological and mineralogical sciences. Tyumen, 2002. 24 p.

6. Keselman, G.S., Makhmudbekov, E.A. Environmental protection during production, transportation and storage of oil and gas. Moscow: Nedra, 1981. 256 p.

7. Arestova, I.Yu., Opekunova, M.G. On the problem of pollution of soil and tundra plants during the development of oil and gas fields // Geoecological aspects of functioning of West Siberia economic complex: Materials of Russian research-to-practice conference (December 7^{th}-8^{th} 2000) Tyumen, 2000. P. 15-17.

8. Moskovchenko, D.V. Oil and gas production and environment: ecological geochemical analysis of Tyumen Oblast. Novisibirsk: Nauka. Siberian enterprise of Russian Academy of Science, 1998. 112 p.

9. Annals of the pollution of the soil of USSR and Russia, 1985-1998. Publishing House of Russian Federal Agency of hydrometeorology and environmental management.