ANNOTATION

dissertation work of Tauova Nursaule on the topic: « Investigation of engineering-geological and geoecological conditions within the oil production wells of the Tengiz field», submitted for the degree of Doctor of Philosophy (PhD) in the specialty 8D07208-Geology and exploration of mineral deposits

Assessment of the current state of the solved scientific or scientific-technological problem

The topic of the dissertation is devoted to the main problems of earth sciences considered within the framework of geoecology and engineering geology - the study and assessment of geodynamic activity of the natural geological environment and the upper part of the lithosphere. The improvement of their theoretical, methodological foundations, methods, research technologies, and assessment of the geo-ecological state is necessary for the rational use of natural resources, geological and environmental safety of development and economic development of any territory, including the oil and gas region. In recent years, this problem has become a particularly important link with global environmental change and the development of emergency situations in many regions of different countries. This is largely due to an increase in the synergistic impact of technogenesis and geological factors, especially geodynamics, on the environment. Geodynamics and technogenesis are two powerful modern factors at the planetary and regional levels that lead to global changes in human habitat and the geological environment. The study and assessment of the ecological-geodynamic and ecological-geochemical state of the natural environment is an important general and regional environmental problem of many territories of varying severity. However, until now, when studying the geoecological and engineering-geological conditions of natural and urbanized territories, insufficient attention is paid to the assessment of geodynamic activity.

The relevance of the topic. This paper presents the experience of studying the oil and gas region of the Atyrau region of the Republic of Kazakhstan on the territory of the Tengiz field. In Atyrau region, the first oil fountain was raised at the Karashungulskoye field in 1899. This became the starting point for the formation of the Kazakh oil and gas industry and is characterized by favorable conditions for studying the influence of the oil and gas technogenesis of the Atyrau region. The discovery of a number of oil and gas fields, such as Tengiz, Dauletaly, Zhana Makat, Borkildakty, East Tegend, will make it possible to consider this region as the largest fuel and energy base in the western part of Kazakhstan. For their successful development, a comprehensive characterization of geological and hydrogeological conditions is necessary. In recent years, due to the intensification of geological exploration for oil and gas, the issue of environmental protection has become increasingly relevant. The most mobile component - the surface hydrosphere and lithosphere - is exposed to particularly strong anthropogenic impact. The solution to this problem requires a comprehensive study of geoecological conditions by methods of geoecological mapping and the development of a system for monitoring

and monitoring the state of the geological environment. The geoecological methods used in this area may be a reference for other areas.

Drilling operations provide a significant anthropogenic load on all components of the environment. Natural ecosystems in the territories of drilling waste storage are exposed to the greatest man-made impact, which is a consequence of the imperfection of drilling technologies and the disposal of drilling sludge. The placement of drilling waste containing toxic substances at an environmental facility is the main reason for the progressive deterioration of environmental quality in drilling areas.

In this regard, research aimed at studying the engineering-geological and geoecological conditions of the Tengiz field within the oil production wells is very relevant.

Studies on the study of sandy soils of the Tengiz deposit of the Zhylyoy district of the Atyrau region of the Republic of Kazakhstan have shown that all lithological and facies groups of soils forming an engineering-geological section to a depth of 20.0 m are very salty in terms of the chloride nature of salinity. All lithological groups of soils contain carbonates, gypsum and a small amount of organic matter. Portland cements range from corrosion to high corrosion, and for chlorides, all types of Portland cements are very aggressive.

The main difficulties encountered when drilling wells in salt deposits are that when flushing wells, water-based drilling fluids are saturated with salts, which causes intensive coagulation of clay particles, the formation of caves on the walls of wells, and the collapse of wells. This dissertation work suggests solutions to this problem on the use of grouting solutions based on sulfur composite materials, which is relevant for regions with highly saline territories.

The purpose and objectives of the study. The purpose of the dissertation is an engineering-geological and geoecological analysis and reduction of the impact of the oil production process, wells at the Tengiz field on the environment.

To achieve this goal, the following tasks are set:

-geological and environmental assessment of the state of oil and gas fields and environmental protection;

- drilling of engineering-geological wells and soil sampling;

- analysis of the geological structure, hydrogeological and seismic condition of the territory;

- hydrodynamic study of wells and formations;

- assessment of the efficiency of gas injection based on the results of hydrodynamic research of wells;

- assessment of the methodological foundations of the application of the diagnostic approach to the assessment of well interaction;

- chemical analysis of groundwater and wastewater in the field area;

- improvement of drilling mud preparation technology;

- description of the features and importance of using sulfur for the manufacture of a chloride-resistant grouting solution.

The idea of the work consists in a geological and geoecological assessment of the oil producing wells of the Tengiz field, on the basis of which measures are

proposed to obtain drilling fluids resistant to a chloridoagressive environment. One way to solve this problem is to create new materials resistant to aggressive chemicals using sulfur and use them as a composite material. Based on the results of the conducted research, a technology has been developed for producing modified drilling fluids from sulfur waste using a mixture of aluminum chloride with high strength properties.

The object of the study. The Tengiz field is located in the Zhylyoysky district of the Atyrau region of the Republic of Kazakhstan.

The subject of the study. The study of engineering-geological and geoecological conditions within the oil wells of the Tengiz field and the development of technology for the production of chloride-resistant drilling fluids based on sulfur composite materials.

Research methods. The basic principle of the research is based on a systematic approach to the study, modeling, assessment and forecasting of the quality of the state of the natural and geological environment; subordination to complexity, continuity and scale of work. The general methodology of the study is a systematic analysis of the natural-geological environment, natural-technical systems and geodynamically active zones based on methods about the earth.

The author applied the following methods: dynamic probing of the soil, as well as the probing process itself, using a standard penetrating soil, soil samples of a disturbed structure were taken from a selected depth; static probing of the soil was carried out with an electric CPT probe. The analyses were carried out in the integrated geotechnical laboratory of JSC NIPI "Caspian Munai Gas". In the process of desk processing of materials, all extensive and exhaustive primary information was systematized and statistically processed: field work, including documentation of engineering and geological workings (drilling wells), production of static SRT and dynamic sounding SPT; results of laboratory studies of soils, groundwater and wastewater. Methods of mathematical statistics, geoinformation technologies, and cartographic modeling were widely used in the processing of materials.

The practical value of the work lies in the fact that the results of geological and geoecological studies of oil-producing wells of the Tengiz field can be applied in a comprehensive assessment of the anthropogenic impact of wells on the environment, as well as the use of drilling mud based on a sulfur composite material with qualities of a resistant nature against increased chloride content in soils, surface and groundwater.

Implementation of research results.

The conducted experimental studies made it possible to supplement and develop ideas about the geological structure and hydrogeological conditions of the territory of oil fields based on methods of dynamic and static soil sounding, seismic interpretation and evaluation of well productivity coefficients. Based on geoecological studies, an increased content of chlorides in surface and groundwater and soils was revealed. The use of sulfate-resistant cements on drilling rigs is ineffective to reduce the aggressive effects of chlorides in soils. To solve this problem, a technology for producing drilling mud obtained on the basis of sulfur waste modified with aluminum chloride is proposed.

Scientific statements submitted for protection.

1. Static sounding of the soils of the Tengiz deposit during the performance of engineering and geological exploration made it possible to isolate the salt layer; wide-azimuth seismic exploration made it possible to determine the structural and stratigraphic features of the Tengiz platform, which is a key step in further sustainable, environmentally reliable field development and conducting hydrodynamic studies of wells necessitated the creation of a methodology for determining downhole pressures from wellhead measurements using an identification method based on comparing the productivity parameter with the productivity coefficient determined according to research data by the method of steady-state selections, allowing to assess the condition of the bottomhole zone of the formation and not requiring knowledge of additional data on the perfection of wells according to the degree and nature of the opening of the formation, the radius of the supply circuit, etc.

2. The results of laboratory studies of soils, groundwater and wastewater allowed us to determine the indicators of the content of anions and cations in the wastewater wells of the Tengiz field and to identify the comparative degree of aggressive effects of chloride and sulfate salts soil, groundwater and wastewater on concrete for water resistance.

3. The use of sulfur as a composite material when modifying the soil with aluminum chloride made it possible to obtain a mixture of modified drilling and grouting mortar with high strength chloride-resistant properties.

The completed dissertation work has a connection with other studies devoted to geological and geoecological studies of deposits and well drilling.

The scientific novelty of the work. The uniqueness of the deposit lies in its complex geology, therefore, the study of geological and geomorphological processes is a key step in further sustainable, environmentally reliable development of the deposit. To better understand the heterogeneity of the reservoir at Tengiz, a new wide-azimuth seismic survey was conducted. The deployment of receivers and sources over a wider area increased the diversity of ways of propagation and recording of seismic waves, which ensured an increase in the multiplicity of displaying the total depth point by 6 times – from 40 to 240 reception points, and as a result, geologically more accurate images of the deposit were obtained. For the first time, a technology for producing a chloride-resistant drilling mud based on a sulfur composite material has been developed. Physical and mechanical tests have established that the developed grouting solution has high mechanical properties and resistance to aggressive media.

The practical significance of the work. As a result of geological studies of the Tengiz field, it was found that the deposits of the largest deposits of the Caspian basin are represented by carbonate rocks, in most wells the reservoir formation is diagnosed as fractured-porous. A geoecological study in surface and groundwater, as well as in the soil, shows an increased content of chloride ions, which negatively affects the drilling rig. Obtaining a drilling mud based on a sulfur composite material opens the way to solving the problem of creating a grouting solution resistant to

chloride-aggressive media, since a properly selected and qualitatively prepared drilling mud is fundamental to the successful drilling process.

Compliance with the directions of scientific development or government programs. The dissertation corresponds to the priority direction of science development approved by the Higher Scientific and Technical Commission under the Government of the Republic of Kazakhstan in the direction 1. Ecology, environment and rational use of natural resources: V.T.ch. 2. Development and operation of oil and gas fields. Its content corresponds to the National Development Plan of the Republic of Kazakhstan until 2025 (2018-2025), as well as the State Program for the Development of Regions (2020-2025).

Personal contribution of the author. The dissertation is the result of research by N.R. Tauova in the period 2021-2024. The author independently set the goal, defined the tasks and plan of the ongoing research of engineering-geological and geoecological conditions within the oil wells of the Tengiz field, sampling of soil, surface and groundwater samples in the research object, conducted laboratory physico-chemical analyses, experimental and field studies. Laboratory studies were also carried out to obtain samples of drilling fluids based on sulfur composite materials. The analysis and generalization of the experimental results of the work is carried out.

Reliability of the results: The reliability and validity of scientific statements, conclusions and recommendations of the dissertation work are confirmed by the use of proven modern research methods, processing of the results obtained by methods of mathematical statistics, as well as laboratory tests.

Approbation of the results of the work and publications

The main provisions of the dissertation work were presented at international scientific and practical conferences in Atyrau "Youth and Science: today and the future" (2022), Aktau "Scientific modernization: the legacy of personality", dedicated to the 95th anniversary of Academician Sh. Yesenova (2022).

In the period from June 01 to June 26, 2023, she completed a scientific internship at the National University of Uzbekistan named after Mirzo Ulukbek.Tashkent, Uzbekistan, under the supervision of Candidate of Geological and Mineralogical Sciences, Professor A.R. Kushakov Certificate (Appendix A).

The main provisions of the dissertation work have been published in 10 scientific papers, including 3 articles published in journals included in the Scopus database, 1 article recommended by the Committee for Quality Assurance in Science and Higher Education, KOKSNVO:

– News of the National Academy of Sciences of the Republic of Kazakhstan. Series of Geology and Technical Sciences. – 2022. – 5 (455);

– News of the National Academy of Sciences of the Republic of Kazakhstan. Series of Geology and Technical Sciences. – 2023. – 6 (462);

– International Journal of Design & Nature and Ecodynamics – 2022. – 17(5);

– Scientific and technical journal "Oil and Gas" - 2022. - 2(134).

Scope and structure of the work

The dissertation consists of an introduction, the main part, including a literature review, materials and methods, and the results of his own research, a conclusion, a

list of references, including 96 sources, appendices. The work contains 204 pages of computer text, 53 figures, 53 tables.

The dissertation work was performed at the Department of Ecology and Geology of the Sh. YesenovCaspian State University of Technology and Engineering.