ANNOTATION

for the dissertation work of Khadieva Albina Sagyngalikyzy
on the topic "Improving the efficiency of physical and chemical impact technologies on deposits of high- viscosity oils," submitted for the degree of Doctor of Philosophy (PhD)
specialty 8D07210 (6D070800) - "Oil and gas business"

Relevance of the study. The issue of effective development of oil fields, especially in developing countries, is becoming urgent due to the growing demand for oil and oil products. The effectiveness of traditional water pressure technologies is limited in conditions of depletion of oil fields and low reservoir permeability.

Currently, it is important to use active methods of stimulation of formations saturated with oil and water to increase the oil recovery factor. These methods allow the redistribution of fluid movement in formations and increase the coverage of water pressure, which opens the way to effective oil production. From a scientific and technical point of view, this is an important task, since it contributes to the efficient use of oil fields in the long term. Since the use of oil and oil products is increasing every year, this is especially noticeable in settlements where the economy is developing and flourishing. 90% of fields are developed by fluid injection. Therefore, the problem of developing depleted oil fields for sustainable energy supply is urgent.

Efficient production of high-viscosity and asphaltene-containing oil, found in many oil fields in Kazakhstan, is one of the key and difficult tasks. The viscosity of oil directly affects its activity during reservoir filtration, which, in turn, determines the production rates of producing wells and the final oil recovery indicators. In formations with high viscosity, only 10% of the original in-place oil reserves are recovered in natural development mode, which indicates a low oil recovery factor. In such fields, the use of water pressure does not bring significant results. Therefore, it is necessary to develop technologies to improve the efficiency of high-viscosity oil recovery by increasing the oil recovery factor and reducing the saturation factor of residual oil. It is proposed to use tertiary methods to reduce residual oil in the formation through capillary and adsorption forces. Tertiary methods include thermal, physical, chemical, hydrodynamic, gas injection, acoustic and bacterial methods. Chemical stimulation methods include surfactants, polymers, alkalis, acids, etc. These methods can be used alone or in combination with other methods, which can significantly increase the efficiency of oil production.

One of the most effective and promising methods for stabilizing oil production is physical and chemical technologies based on the injection of polymer compositions. These methods regulate the permeability of oil reservoirs, simplify the movement of oil and increase production efficiency.

Polymer-based methods are the most effective technologies for slowing the decline in oil production and increasing reserves. The results of the studies show

that the options of combined impact on the formation are the most suitable for implementation in specific conditions. These methods ensure efficient oil production, taking into account the geological characteristics of the formations.

However, further experimental and production studies are needed to further improve technologies and improve their efficiency. These studies will help determine the possibilities of applying polymer methods in specific fields and their long-term effects.

Justification of the need for this research work. The demand for oil and oil products is growing annually, this trend is especially noticeable in developing economies. Currently, 90% of oil fields are developed by liquid injection. However, the effectiveness of such methods decreases over time, which threatens the stability of oil production. Therefore, the issue of effective development of depleted oil fields in order to ensure sustainable energy supply is urgent. To solve this problem, it is necessary to increase the efficiency of oil production using new technologies, including the use of polymer compositions.

Purpose of work. Study of the effectiveness of the technology for influencing high-viscosity oil deposits with polymer compositions, as well as complex technology in combination of polyacrylamide with electrochemically modified water and a water-gas mixture.

Study object - high-viscosity oil Yu-3S, Yu-4S Kalamkas field.

Subject of study - the method of physical and chemical impact on oil formations.

The main objectives of the study:

- Study of oil displacement processes from core samples using R-1 and GL-50 polymers.
- Study of the effectiveness of the complex use of polyacrylacmide and electrochemically modified water when displacing highly viscous oil in a layered heterogeneous formation;
- Study of the effectiveness of using a combination of a polyacrylacmide solution rim and a water-gas mixture when displacing high-viscosity oil from a heterogeneous formation;
- Technical and economic analysis of development indicators using a combined impact technology based on forecasting.

Problem solving methods. In solving the tasks, an integrated approach was used, including a combination of theoretical and experimental methods, as well as the use of numerical studies and mathematical modeling to analyze the results using software. Mathematical modeling made it possible to digitally process the data obtained during the studies. Experimental studies were carried out on the basis of approximate modeling, while mathematical models of physicochemical processes were created, which made it possible to assess their impact in real conditions. In addition, data generated by T-Navigator models and software were systematically analyzed and compared with experimental results. This approach made it possible to find the most effective solutions through modeling the impact of various factors during the research process.

In the course of laboratory and experimental studies, the following devices and installations were used: LXRT-400T installation, automatic MCR 702 TwinDrive rheometer, Brookfield viscometer, Dean-Stark apparatus, UltraPorePerm 500 porosimeter.

Main provisions submitted for protection.

1. The use of polymers of grade GL-50 and R-1 at a concentration of 1.5 g/l to affect the Kalamkas deposits is justified. Experimental data confirmed the effectiveness of oil displacement with these polymers.

2. The effectiveness of a complex technology for influencing layered heterogeneous formations based on a polymer solution with a concentration of 0.25% and electrochemically modified water has been proven. The results of pilot studies showed an average increase in the oil recovery factor by 8%.

3. The effectiveness of the integrated method of affecting deposits with high-viscosity oil using AAA with a concentration of 0.25% and a water-gas emulsion was substantiated. The introduction of this technology made it possible to increase oil recovery by 17-32.9%.

4. A technical and economic analysis of the use of combined impact technology based on forecast data was carried out, which showed the economic efficiency of the proposed method, including a decrease in production costs and an increase in the total volume of extracted oil.

Scientific novelty of the work.

1. The use of polymers of grades GL-50 and R-1 at a concentration of 1.5 g/l is justified to increase the effectiveness of the impact on deposits with high-viscosity oil, which contributes to increasing the technological efficiency of oil production and has application value for development of hard-to-recover reserves.

2. A comprehensive method of influencing inhomogeneous formations using polymer compositions with a concentration of 0.25% based on electrochemically modified water has been developed, which makes it possible to increase the oil recovery factor by an average of 20% from high-permeability and 26% from low-permeability formations. The method is a new technological solution that increases the efficiency of impact on low-permeability formations.

3. A complex technology of formation stimulation is proposed, based on the use of a water-gas mixture with 0.25% and 0.5% polymer compositions, which makes it possible to increase the oil recovery factor by 32.4% and 32.9%, respectively. This approach contributes to the efficient development of hard-to-recover reserves, reducing production costs and increasing the volume of high-viscosity oil production.

Practical significance of the work. The novelty of this work made it possible to supplement and develop ideas about the mechanism of oil field development with complex technologies based on polymer compositions in various geological and physical conditions. The results of these studies were discussed at the technological meetings of Ushkuyu JSC, where a positive recommendation was received for their use in the oil fields of Kazakhstan, which makes it possible to increase oil production by improving the technical and economic indicators of field development using polymer technologies. Thus, the research results contribute to

improving production efficiency in the oil industry and the development of the national economy.

Compliance with the directions of development of science or government programs. The dissertation work corresponds to one of the priority areas of scientific development approved by the Higher Scientific and Technical Commission of the Government of the Republic of Kazakhstan. In particular, this work corresponds to the direction 1) "Ecology, environmental protection and efficient use of natural resources," including 21) "Development and operation of oil and gas fields." The results of the study are aimed at increasing the efficiency of oil production and the rational use of natural resources, which fully corresponds to the strategic goals of our state and priority areas of scientific and technical development.

The author's personal contribution consists in: The author's contribution is manifested in the conduct of experimental and theoretical studies, the description and processing of measurement results, as well as the publication of research results in scientific articles. In addition, the author participated in the discussion of research results at scientific conferences, the wording of the questions posed and the discussion of their results together with scientific leaders. Thus, the author actively participated in all the main stages of the research process and made a significant contribution to the improvement of its results.

Validity of results. The correctness and validity of scientific rules, conclusions and recommendations of the dissertation work are confirmed by the use of modern research methods, processing of the results obtained and experimental checks. In addition, the accuracy of experimental and computational tests using mathematical regression equations is based on the characteristics of similarity criteria. This ensures the reliability of research results and increases the possibility of their application in practice.

Description of the main results of the study: Experimental studies made it possible to draw the following conclusions:

1. Based on the results of laboratory tests of polymers, oil displacement coefficients were determined for wetting polymers GL-50 and R-1 with a concentration of 1.5 g/L. Polymer testing showed a displacement factor of 0.667 units for R-1 and 0.592 units for GL-50. When comparing the displacement factors at the initial stages of polymer injection, the displacement dynamics of polymer R-1 is higher than that of GL-50. This can be explained by the fact that with the use of polymer grade R-1, oil displacement is observed over the entire cross-sectional area of the test sample (continuous displacement), while with the use of grade GL-50, oil begins to be displaced first through large pore channels, forming breakthrough tongues. Based on laboratory studies, it is recommended to inject polymer R-1 into oil reservoirs with high viscosity.

2. The technology of influencing layered heterogeneous formations has been improved, representing a solution composition with a concentration of 0.25% based on polymer and catholyte. This composition is aimed at changing the rheological characteristics of oils in order to increase the oil recovery factor. Due to the use of this technology in a layered heterogeneous formation, the average oil

recovery factor is 8% higher than when using the PAA rim with distilled water injection.

3. The possibility of using regression and correlation analysis methods to plan an experiment that can reduce the number of experimental tests is shown. This provides the basis for determining the ORF when oil is displaced by a rim of PAA with different concentrations.

4. A method of complex exposure based on the AAA method with a concentration of 0.5% +water-gas exposure was proposed. This method makes it possible to increase the oil recovery factor by 32.9% from fields with high viscosity.

5. The efficiency of the technology of combined injection of AAA and water-gas impact for two wells was assessed on the basis of forecast values, which confirmed that its use leads to additional oil production, which amounts to 162,897 thousand tons, with economic efficiency of 640.681 thousand tenge. These factors show that the proposed method can increase oil production.

Approbation of the results of the work: The results of the dissertation and its main provisions were reported and discussed at international scientific and practical conferences: "Geological and technological aspects of the development of hard-to-recover hydrocarbons" (Aktau, 18.04.2019), "Financial, economic and legal aspects of international cooperation of the Caspian states" (Aktau, November 29, 2018), "Geological and technological aspects of the development of hard-to-extract hydrocarbons" (Aktau, 18.04.2019), "Modern Technologies in Science and Education" (Aktau, 28.04.2021).

Connection of work with other research works. The dissertation work was carried out within the framework of the Zhas Kalym project on the topic "Improving a comprehensive method for intensifying high-viscosity oil production," funded by the Science Committee of the Ministry of Education and Science of the Republic of Kazakhstan (grant AR22685524).

Research publications: The main results of the dissertation were published in 14 scientific articles, including in leading peer-reviewed scientific journals recommended by the CCCH of the Ministry of Education and Science of the Republic of Kazakhstan – 7 publications, as well as in the journal that is part of the Scopus database - 2 articles, the rest of the article is at International scientific conferences published.

The scope and structure of the dissertation work: The dissertation work consists of an introduction, three chapters, main recommendations, a conclusion and 4 appendices, as well as a list of used sources, including 104 titles. The work contains 107 pages, 25 tables and 28 figures.