

ANNOTATION

for the dissertation work of Khadieva Albina Sagyngalikyzy
on the topic "Improving the efficiency of physicochemical exposure technologies
in deposits of highly viscous oils," submitted for the degree of Doctor of
Philosophy (PhD)
specialty 8D07210 (6D070800) - "Oil and gas business"

The relevance of research.

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.

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 potential for field-specific polymeric techniques 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 thesis. Study of the effectiveness of the use of polymer compositions for the development of a combined method of exposure based on a polymer solution and a water-gas emulsion.

The main objectives of the study:

- Research of rheological properties of polymers in porous media;
- Study of compatibility of polymers with injected water;
- Study of the effect of salts in formation waters on the process of oil displacement;
- Study of oil displacement, change in water and oil saturation from core samples depending on the injection volume of R-1 and GL-50 polymers;
- Study of the effectiveness of PAA + with electrochemically modified water when displacing oil from a layered heterogeneous formation;
- Study of the effectiveness of using a rim of PAA, PAA + water-gas mixture, pure water-gas mixture when displacing oil from a homogeneous formation;
- Description of the least squares study;
- performance of technical and economic analysis of development indicators using combined impact technology based on forecasting;
- Generalization of obtained results and formation of basic regularities of combined technologies.

Object of study - oil and gas reservoirs of high-viscosity oil Yu-3S Yu-4S Kalamkas field.

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

Research methods - based on solving the tasks, processing the initial information, using mathematical calculations and practical methods, as well as using the appropriate option in order to increase oil efficiency with comparison of the values of the analogy criteria.

Main provisions submitted for protection.

1. Identification of traceable patterns based on the use of the identity criterion.

2. Application of experimental and industrial research methods with comparison of mathematical statistical regressive equations during oil displacement from the reservoir.

3. Evaluation of the efficiency of oil displacement in homogeneous and heterogeneous formations using the complex method of AAA + water-gas impact.

Scientific novelty of the work.

1. A complex method of influencing the formation with polymer compositions and a water-gas emulsion, as well as electrochemically modified water, has been developed.

2. A special regressive equation is proposed to determine the oil recovery factor when using polyacrylamides of different concentrations by planning experiments, which allows obtaining results without conducting several additional experimental studies.

3. The use of polymer types of grades R-1 and GL-50 is recommended based on the identification of their advantages in increasing the efficiency of oil production.

Practical significance of the work. The studies made it possible to better understand and develop the mechanisms of oil field development using complex effects based on polymer compositions in various geological and physical conditions. The results of these studies can serve as the basis for the use of polymer exposure methods on an industrial scale in the oil fields of Kazakhstan. The use of polymer technologies opens up opportunities for increasing oil production and improving the technical and economic indicators of field development. Thus, the results of the study contribute to improving production efficiency in the oil industry and contribute to 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 2) "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 reliability and validity of scientific provisions, conclusions and recommendations of the dissertation work are confirmed by the use of modern research methods, processing of the results obtained and conducting experimental tests. In addition, the accuracy of experimental and computational

tests is based on the characteristics of similarity criteria through mathematical regression equations. This ensures the reliability of the research results and increases the possibilities 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 laboratory tests of polymers, recovery factors were determined for polymer injections of grades R-1 and GL-50. Based on laboratory studies, it was proposed to use polymer grade R-1 for injection in highly viscous fields.

2. The composition of polymer and catholyte solutions was determined, and the technology for influencing inhomogeneous formations was improved. This composition was aimed at changing the rheological characteristics of oil in order to increase the coefficient of oil recovery.

3. The accuracy of the experiments was determined using the least squares mathematical regression equation. On the basis of similarity theory, the number of experiments was reduced, and the results were obtained through analytical calculations.

4. A comprehensive exposure method based on the PAA + water-gas method was developed and investigated. The possibility of increasing the oil recovery factor in highly viscous fields has been confirmed experimentally. The use of this technology in homogeneous and heterogeneous formations showed an increase in oil recovery factor by 8% compared to the use of distilled water and PAA. The complex technology of injection of polymer solution (PAA) with electrochemically converted water (catholyte) and PAA + water-gas has shown its effectiveness experimentally.

5. The technical and economic efficiency of the PAA + water-gas method was determined based on modeling. This method has demonstrated high efficiency compared to other methods.

Similarity theory is an important tool in the study of physical and chemical processes. This theory allows you to establish general patterns of processes at different conditions and scales, determine the optimal conditions for experiments and effectively generalize the results.

Experiments in similarity theory can require considerable time and financial resources. Therefore, researchers develop mathematical models and conduct many experiments at different conditions and scales to obtain the necessary data and test hypotheses.

Based on laboratory studies, a complex impact technology was proposed to increase the oil recovery factor in geological structures. This method is based on the principles of similarity theory and allows you to effectively increase oil production in various geological conditions.

Connection of work with other research works. The dissertation work is carried out within the framework of the Zhas Galym state grant of the Science Committee of the Ministry of Education and Science of the Republic of Kazakhstan for 2024-2026. AR22685524 was carried out within the framework of the project "Improving an integrated approach to intensifying oil production with high viscosity."

Approbation of work results: The results of the dissertation and its main provisions were reported and discussed at the international scientific and practical conference "Geological and technological aspects of the development of hard-to-recover hydrocarbons of fields," Aktau, 18.04.2019; At the international scientific and practical conference "Financial, economic and legal aspects of international cooperation of the Caspian littoral states," Aktau, 29.11.2018; At the international scientific and practical conference "Geological and technological aspects of the development of hard-to-reach hydrocarbons," Aktau, 18.04.2019; At the international scientific and practical conference "Modern technologies in science and education," Aktau, 28.04.2021. At these conferences, the results of the dissertation and its main provisions were presented, and the scientific and practical significance of the research was widely discussed.

Publications: The main results of the dissertation are published in 12 scientific articles, including in the leading peer-reviewed scientific journals recommended by the CCCH of the Ministry of Education and Science of the Republic of Kazakhstan - 5 publications, as well as in the journal that is part of the Scopus and Web Science 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, basic recommendations, a list of used literature, including 3 titles and appendices. The work contains 107 pages, 25 tables and 28 figures.