

ANNOTATION

Thesis submitted for the degree of Doctor of Philosophy (PhD) by specialty
6D070800 - Oil and Gas Business
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«Improvement of pressure maintenance system by forming uniform oil displacement profile on the example of Uzen field»

General characteristics of the dissertation research

This research deals with improvement of maintaining the reservoir pressure system to achieve a close to uniform displacement of oil in heterogeneous in terms of permeability layers. The performed studies suggest the modification of conventional waterflooding in relation to heterogeneous reservoirs, which allows a significant reduction in reservoir water cut.

The relevance of the study lies in the fact that, despite the huge interest in oil recovery methods from heterogeneous reservoirs, there is still no unique technology to control the movement of injected water. The main difficulty lies in geological heterogeneity of reservoirs. This study is aimed at reducing the harmful effects of water coming in the area with a high permeability, and provides a method of improving oil recovery by controlling the water injection rate in different layers of formation.

The technology involves the use of special perforated holes on the tubing liner to control the flow rate of water to differently permeable layers and prevent uneven movement of oil. The uniformity of the discharge front is governed by the simultaneous injection of water with different densities of perforated holes in tubing liner.

The results show that the adjustment of perforated holes sizes on tubing liner allows more efficient and uniform displacement of oil volumes and reduces the water cuts of production wells.

The purpose and objectives of the study

The aim of the work is to improve the system for maintaining reservoir pressure by developing a new method of water injection in heterogeneous reservoirs.

In the framework of this study, the following tasks were set and solved

1. Identification of the main characteristics affecting on layers sweep efficiency in heterogeneous in terms of permeability reservoirs.
2. Investigation of the amount of oil retained in heterogeneous reservoirs depending on the variation of reservoir properties.
3. Development of technology to optimize and improve the method of water injection into heterogeneous reservoirs, as well as identifying the main characteristics of the proposed technology.
4. Designing and collecting a new experimental installation, which is analogous to the proposed technology and carrying out relevant research on this installation.

5. Construction of hydrodynamic models for the application of new technology on the example of several wells from Uzen field.
6. Identification of the effect and limitations of the proposed technology.

Problem-solving methods

The solution of the tasks was carried out by conducting theoretical, experimental and numerical studies, analyzing the results using software.

The objects of study are heterogeneous layers of 13-15 horizons on Uzen field.

The subject of research is the bottomhole zone of injection wells at 13-15 horizons on Uzen field.

Scientific novelty of the study

This thesis first proposed a new technology for displacing oil from heterogeneous reservoir; mathematically derived the necessary theoretical solutions for the selection of the required technological characteristics of tubing liner depending on the reservoir properties of the reservoir.

For the first time, an experimental facility has been created for conducting experimental studies for application of proposed technology; conducted experimental studies.

For the first time, hydrodynamic models for application of proposed technology for several wells at Uzen field have been created.

Scientific and practical significance of the study

A technology has been proposed for regulating the oil displacement profile in a heterogeneous reservoirs, which makes it possible to increase the efficiency of waterflooding as one of the methods for maintaining reservoir pressure while reducing the water cuts of the productive horizon.

Reservoir simulation conducted using the new technology at Uzen field that determines the efficiency and limitation the use of new technology to 13-15 horizons of the field.

The theoretical significance of the research lies in the fact that by regulating the flow of water to differently permeable layers, the efficiency of flooding increases. Feature of the study is focused on the practical solution of the fundamental problems associated with a high well water cuts and non-uniform water flow.

The main provisions for the thesis defense

1. The results of theoretical and analytical studies to identify the main characteristics affecting the reservoir sweep efficiency, as well as the amount of oil retained in heterogeneous in terms of permeability reservoirs based on the use of fundamental laws of fluid filtration in a porous medium.
2. Conditions for the application of new technology, which allows close to uniform oil displacement in heterogeneous in terms of permeability reservoirs, as well as the main characteristics and limitations of the proposed technology.
3. The results of experimental studies to verify theoretical solutions.
4. The results of numerical studies of new technology, taking into account the variation of reservoir properties and modelling proposed change in system of maintaining reservoir pressure at Uzen field

5. Technical and technological calculations for waterflooding in heterogeneous layers at Uzen field (13-15 horizons)

The author personal contribution in the practical implementation of work on the review of literature on topic of the thesis, setting tasks, developing a strategy for research, analytic research to identify theoretical solutions of proposed technology, conducting experimental studies, processing and interpreting the results, numerical studies of building hydrodynamic models, and also calculating the economic effect of proposed technology.

Approbation of work. The dissertation materials were reported and discussed at international conferences:

-XIV International Scientific and Practical Conference «Advances in Science and Technology», (Moscow, RF, 2018)

-XX International Scientific and Practical Conference «World science: problems and innovations», (Penza, RF, 2018)

-XXXVII International Scientific and Practical Conference «Actual scientific research», (Moscow, RF, 2018).

-XL International Conference «Science development in the 21st century», (Kharkiv, Ukraine).

Publications

The main results of the study are presented in 4 articles in publications from the list approved by the Committee for the Control of Education and Science of the Republic of Kazakhstan, 1 journal included in the Scopus database, 5 abstracts at international conferences

The scope and structure of the thesis

The thesis is presented on 129 pages of computer text, consists of an introduction, 5 chapters, conclusion, bibliography of 86 titles, contains 84 figures, 37 tables and appendix in the form of additional mathematical calculations.

In the first chapter of the thesis, a literary review and analysis of research projects aimed at maintaining reservoir pressure and increasing oil recovery in reservoirs with heterogeneous permeability are carried out. According to the literature review and analysis of the research works of authors from different countries of the world, it can be concluded that at the moment there is a problem of reservoir sweep efficiency in heterogeneous in terms of permeability layers.

In the second chapter, a new technology for maintaining reservoir pressure was proposed with the goal of a close to uniform profile of oil displacement by water or some other agent.

The third chapter shows the results of experimental studies aimed at studying the flow rate of liquid during the flow through the sand of various fractions.

In the fourth chapter, using the geological data and oil properties of Uzen field, two models were built for five cases.

In the fifth chapter, the economic efficiency was calculated for each case individually.