ABSTRACT

of dissertation on theme:
"The investigation of reservoir geological conditions influence on efficiency of polymer solution oil displacement "
submitted for the degree of doctor of philosophy (PhD) on a specialty 6D070800–"Oil and gas"

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The relevance of the study is the fact that today a multi-factor technical and economic problem has not been solved, which makes it possible to ensure the most effective involvement in the active work of poorly drained or generally undrained sections of the reservoir that are at a late stage of development. In this regard, it is necessary to develop the best technological development options for each specific field with different geological and physical conditions.

This work is devoted to the study of the mechanism of influence of flow-deflecting technologies (FDT) based on polymer solutions on the factors that characterize the process of leveling the intake profiles of injection wells in various geological and physical conditions.

Analysis of existing research has shown that the mechanism of FDT based on polymer solutions is not fully studied and needs in serious and targeted research and generalizations, which determines the relevance of the dissertation theme.

Purposes and objectives of study. The purpose of this work is to increase the efficiency of using flow-deflecting technologies based on polymer solutions in various geological and physical conditions.

The following research tasks are formulated to achieve this goal:

- analysis of works on the development of oil deposits with polymer solutions, justification of choice of methods to improve the efficiency of their application.
- analysis of influence of reservoirs geological and physical parameters and fluids saturating them on the oil recovery coefficient.
- justification of using cross-linked polymer systems (CPS) in flow-deflecting technologies by conducting experimental studies of rheological and filtration characteristics.
- analysis of the results and assessment of the technical and technological efficiency of flow-deflecting technology application at Karazhanbas field.

Methodology of research. In solving these problems, we used experimental research methods, statistical methods, and methods known from the theory of fuzzy sets to build models and evaluate the effectiveness of their application in predicting the oil recovery coefficient in various geological and physical conditions.

Scientific novelty of the thesis:

- linear and multiplicative models for predictive estimation of the oil recovery coefficient are constructed, the scope of their application is justified from the point of view of individual conditions due to the ambiguity of the calculation results.

- it was found that CPS based on the investigated polymer FP-307 with chromium acetate as a crosslinking agent, depending on the type of deformation (volume or shear), shows viscous or elastic properties.

- the influence of degree of formation heterogeneity on the amount of CPS entering the interlayers is established.

The conducted experimental studies allowed to supplement and develop ideas about the mechanism of oil field development with flow-deflecting technologies based on polymer compositions in various geological and physical conditions

Field tests of the flow-deflecting technology based on increasing the reservoir coverage by flooding by leveling the injection well intake profile made it possible to increase the efficiency of oil deposit development at the Karazhanbas field pilot site.

Scientific points to be defended:

- methods and models for predicting the oil recovery coefficient;
- regularities established in the course of studying the influence of geological and physical conditions of deposits on the effectiveness of flow-deflecting technologies based on polymer compositions;
- the presence of viscous or elastic properties in cross-linked polymer systems, depending on the type of deformation;
- quantitative regularities that reflect the influence of degree of formation heterogeneity on the filtration characteristics of cross-linked polymer systems;
- by aligning the injection well pickup profile, the composition based on cross-linked polymer systems makes it possible to effectively control the direction of filtration flows.

Practical value of work and implementation of results.

Experimental studies allowed to supplement and develop ideas about the mechanism of oil field development using flow-deflecting technologies based on polymer compositions in various geological and physical conditions.

Field tests of the flow-deflecting technology based on increasing the reservoir coverage by flooding by leveling the injection well intake profile allowed to increase the efficiency of oil deposit development at Karazhanbas experimental site.

Publications. 10 scientific papers have been published on the topic of the dissertation, including 3 articles in leading peer-reviewed journals recommended by the science Committee of RK, 2 articles in foreign scientific publications with a non-zero impact factor included in the Scopus database.

Structure and scope of the dissertation. The dissertation work consists of an introduction, 4 chapters, conclusion, and a list of used sources from 146 titles. The work is presented on 102 pages, including 16 figures and 19 tables.

Summary of the dissertation.

The relevance of the dissertation theme is justified, the purpose and main tasks of research, methods for solving the tasks set, scientific novelty, the degree of reliability and practical value of t obtained results are formulated **in the introduction**. Information about the approbation of the work and the structure of the dissertation is given.

The first chapter of the dissertation examines the current state of knowledge of

the problem of influence of geological conditions on the efficiency of oil displacement by polymer solutions.

The analysis allowed to develop a methodology of research on the theme of the thesis, which requires a statistical analysis of influence of geological-physical conditions on the performance of field development, constructing appropriate models describing this influence, the study of rheological and filtration characteristics of polymeric reagents and the rationale for their applicability in flow-deflecting technologies.

The second chapter analyzes the influence of geological and physical parameters of reservoirs and their saturating fluids on the oil recovery coefficient (ORC).

Obtained results allowed to come to the following conclusions.

1. Comparative analysis of previously constructed statistical models for estimating the oil recovery coefficient was made, errors were calculated when applying them for the conditions of Karazhanbas field. It showed that they could not be used and confirmed the opinion that it is necessary to build such models for the conditions under consideration.

2. Linear and multiplicative models for predictive estimation of oil recovery coefficient are constructed. We justified the necessity to determine the scope of their application from the point of view of individual conditions due to the ambiguity of the calculation results.

3. Using fuzzy cluster analysis based on Karazhanbas field data, four classes are identified that are characterized by certain values of parameters corresponding to various geological and physical conditions.

4. We established classes of mutual correspondence of geological and physical characteristics and errors for two obtained models, that allowed us to determine the conditions for the applicability of these models, namely:

The first cluster, characterized by high values of permeability, average oil saturation and the ratio of viscosities of oil and water, low values of the ratio of net-to-gross and net pay thickness. Errors of calculations are assessed as low. Multiplicative model can also be applied for the third and fourth clusters. However, these models are not applicable for the second cluster due to the high values of the errors. For the second cluster, the estimation can be given according to quality compliance which obtained in the result of fuzzy cluster analysis.

The third chapter is devoted to experimental studies of the rheological and filtration characteristics of cross-linked polymer systems used in flow-deflecting technologies.

The results of the research allow us to draw the following conclusions.

1. Polymer FP-307 is well compatible with the mineralized water of Karazhanbas field. CPS based on the investigated polymer FP-307 with chromium acetate as a crosslinking agent, depending on the type of bulk or shear deformation, show viscous or elastic properties. For successful application of CPS in the field conditions, the correct choice of the object and parameters of the process is necessary.

2. Researched CPS are able to block high-permeable and low-permeable interlayers. The obtained results also showed that then formation heterogeneity is greater, the greater amount of SPS enters the highly permeable interlayer.

The fourth chapter presents the results of the implementation of research at the Karazhanbas field.

Based on the results of pilot tests of flow-deflecting technology at Karazhanbas field, the following conclusions can be made:

1. Field tests of the technology based on increasing the reservoir coverage by flooding by leveling the intake profile of injection well based on the creation of a flow-deflecting screen in the bottom-hole zone made it possible to justify its effectiveness in the considered geological conditions;

2. An improved methodological approach to the use of flow-deflecting technology to increase the efficiency of oil field development based on a cross-linked polymer system (FP-307 polymer (PAA) with chromium acetate as a cross-link) and wood flour is proposed. This approach allows to reduce water cut and increase production, which in turn will minimize the economic and technological risks of the oil company;

3. The composition based on cross-linked polymer systems (polymer FP-307 (PAA) with chromium acetate as a cross-link) and wood flour makes the possibility for effective regulating the direction of filtration flows and connect weakly drained zones into the operation;

4. Almost all wells that used a composition based on cross-linked polymer systems (polymer FP-307 (PAA) with chromium acetate as a crosslinking agent) and wood flour had a decrease in the average water content of the produced products, a decrease in its growth rate and an increase in the flow rate.

There are main results and findings of the dissertation work **in conclusion**.