Crossref

DOI: 10.31643/2023/6445.28
Earth sciences

creative commons

On the degree of influence of waterflooding on the oil recovery factor from productive formations of high-viscosity reservoirs X, represented by terrigenous reservoirs

[1]Agzamov A.,[2]Efendiyev G., [3]Moldabayeva G.Zh*.,[3]Syzdykov A., [4]Suleimenova R., [3]Tuzelbayeva Sh., [3]Zaurbekov K.

[1] Tashkent State Technical University named after Islam Karimov, Tashkent, Uzbekistan
[2]Azerbaijan National Academy of Sciences, Baku, Azerbaijan
[3]Satbayev University, Almaty, Kazakhstan
[4] Atyrau University of Oil and Gas named after Safi Utebayev

** Corresponding author email: g.moldabayeva@satbayev.university*

Received: *05 June 2022*
Peer-reviewed: *July 19, 2022*
Accepted: *November 28, 2022*

ABSTRACT
On the basis of the generalization of experience in the development of multilayer high-viscosity fields X the influence of waterflooding in the late stage on the oil recovery factor of productive formations has been studied. By applying statistical methods of data processing the dependence of the oil recovery factor on the reservoir flushing factor, with a sufficiently high correlation coefficient, has been obtained. The dependence obtained confirms the theoretical basis of oil recovery from productive formations developed with waterflooding and can be used when designing the process on similar objects. In many oil-producing regions of the world, the tendency of deteriorating quality of the resource base and incomplete replenishment of oil production by the growth of their reserves due to the discovery of new fields is observed. At the same time, the costs of prospecting and exploration works are increasing, and geological, andphysical conditions and specific reserves per each discovered field are worsening.
Keywords: Field, deposit, development, flooding, flushing, extraction, compensation, selection.

Information about authors:

Agzamov Avaz Khamidillaevich	*Doctor of Technical Sciences, Professor of the Department of Development and Operation of Oil and Gas Fields, Tashkent State Technical University named after Islam Karimov, Tashkent, Uzbekistan, 180100, University №2.*
Efendiyev Galib Mamed oglu	*Doctor of Technical Sciences, Professor, Corresponding Member of Azerbaijan National Academy of Sciences, AZ1001, Republic of Azerbaijan, Baku, Istiglaliyyat str., 30. Email: galib_2000@yahoo.com*
Moldabayeva Gulnaz Zhaksylykovna	*Doctor of Technical Sciences, Professor of the Department of Petroleum Engineering, Satbayev University, 050013, Satpayev 22a, Almaty, Kazakhstan. Email: moldabayeva@gmail.com*
Syzdykov Askar Khamzaevich	*Candidate of Technical Sciences, Professor of the Department of Petroleum Engineering, Satbayev University, 050013, Satpayev 22a, Almaty, Kazakhstan. Email: a.syzdykov@satbayev.university*
Suleimenova Raikhan Taupikhovna	*PhD, Atyrau University of Oil and Gas named after Safi Utebayev, Baymukhanova 45 a, Atyrau, Kazakhstan. Email: raika_83@mail.ru*
Tuzelbayeva Sholpan Ryskulbekkyzy	*Doctoral student of the Department of Petroleum Engineering, Satbayev University, 050013, Satpayeva 22a, Almaty, Kazakhstan. Email: tuzelbayeva.s@gmail.com*
Zaurbekov Kadyrzhan Seitzhanovich	*Doctoral student of the Department of Petroleum Engineering, Satbayev University, 050013, Satpayeva 22a, Almaty, Kazakhstan. Email: k.zaurbekov@satbayev.university*

Introduction

As a result, an increasing number of fields are prepared for the development of a limited number of prospecting and exploratory wells, there is a problem associated with the lack of basic geological and field data for the reliable calculation of hydrocarbon reserves and addressing issues of a rational and profitable development of these objects. It is necessary to note, that now a number of these fields are developed by single exploration wells, and the overwhelming part of them is mothballed and commercially developed.

There is an urgent need to solve the issues of the effective development of these objects, including waterflooding since this method is the most widespread method of increasing the oil recovery factor due to relative ease of implementation and availability of water.

To solve these problems in practice, various methods of forecasting development indicators are used, which are conventionally divided into the following two groups:

1. Personal experience of the specialist and intuition.
2. The method of analogy.
3. empirical methods based on data correlation.
4. Waterflood and depletion curves.
5. Analytical mathematical models.
6. Numerical mathematical models.

Numerical mathematical models are the most modern, they allow taking into account known physical processes, heterogeneity of formation properties and complexity of structure, arbitrary well operation and their irregular arrangement, etc. At the same time, numerical mathematical models require a large quantity of quality input data, a high qualification of a specialist, and a lot of working time. Therefore, when analyzing and predicting the development, the need arises to use empirical dependencies and various waterflood curves, obtained on the basis of the generalization of geological and field data of long-developed fields.

For instance, this approach was used for substantiation of optimal compensation by the surrounding production wells and reduction of risk of water breakthrough by injecting wells through highly permeable reservoirs.

The waterflood curves are used to evaluate the influence of injected water volumes on the technological performance of wells. All the constructions and conclusions are based on the compensation of withdrawals by injection for each producing well.

In papers [[1], [2], [3], [4], [5]], the dependencies obtained as a result of the generalization of the experience of oil field development in the Timan-Pechora province of the Russian Federation are used to predict development indicators and the correctness of calculation results based on hydrodynamic models.

The results of the generalization show that one should not expect unambiguous answers from experts about flooding efficiency due to the diversity of mining and geological conditions of each oil-bearing region of the world, as well as geological and physical features and technological solutions implemented at specific sites. Despite this and considerable progress in the direction of providing a theoretical basis for the development of oil fields, the results of analysis, generalization, and comprehension of the accumulated experience do not lose their importance.

In this connection, let us consider a generalization of reservoir flushing factor (RFF) and oil recovery factor (ORF) dependence on the example of long-developed deposits of high-viscosity field X, represented by terrigenous reservoirs.

Research Materials

The geological structure of the X field and the features of their development are considered in many works. A more detailed description of the parameters of geological and physical conditions and the realized systems of development are given in works [[6], [7], [8]]. However, the authors of this study found it necessary to give a brief description of the geological and physical conditions and the implemented systems of development of field X, which is as follows.

Neogene, Paleogene, Mesozoic (Cretaceous, Jurassic), and Paleozoic sediments are involved in the structure of the X field area. The total thickness of the sedimentary cover in the central parts of the depression is more than 10.0 - 12.0 * 10^3 m. in the apparatus - 2.5 - 4.0 * 10^3 and more [[9], [10]].

A characteristic feature of the distribution of hydrocarbon deposits is a significant increase in gas content down the section. While Neogene and Paleogene sediments are mainly oil-bearing, and free gas accumulations are associated with gas caps and single gas deposits, in the Cretaceous and Jurassic sediments gas and gas condensate deposits are predominantly developed. In the Paleogene section, up to eight productive strata are distinguished. Strata I, III, and IV are represented by fine-grained sandstones and siltstones. Formations V, VI, VII, VIII, and IX are carbonate rocks (limestones and dolomites) [[11], [12]].

The reservoirs of the Mesozoic productive strata are, as a rule, sandstones with interlayers of siltstones. Only some horizons of the upper and lower Cretaceous are represented by limestones.

Known small deposits of oil are of non-industrial importance oil inflows from them are short-term and unstable.

Oils of Paleogene deposits are mainly light (826-884 kg/m^3), low-sulfur (0.05-0.75 %), paraffinic (1.4-10.1 %), highly resinous (silica gel tar 5.29-30.2). The viscosity of formation oils is low - 0.7-0.6 mPa*s, with initial gas saturation from 2-5 to 100-150 m^3/t.

Oil deposits are confined to narrow asymmetric folds, the length of which is 10 15*10^3 m, width does not exceed 2-3*10^3 m, bed dip angles are 20-30ºC and more. Known oil and gas reservoirs are mainly of formation-well type /5, 9, 10/. However, as a result of intensive tectonic activity, tectonically screened reservoirs are observed among them according to the degree of their complication by disturbances. Lithological screened deposits in the region are distributed limited.

The productive deposits of the objects under consideration are heterogeneous; they are characterized by layered, zonal heterogeneity and uneven fracturing.

Almost all fields are multilayer. Oil reservoirs are characterized by low height, a small difference between the initial reservoir pressure and the pressure of oil saturation with gas.

During the development of the studied oil reservoirs, regardless of the type of reservoirs, due to their small depth of comparable size (oil reserves), almost identical development systems were implemented.

The following features of the implemented systems are highlighted: [[5], [7], [8]]:

- drilling of deposits by a relatively dense network of wells, placed in a triangular grid;
- joint exploitation of deposits of KKS, Ia, Ib, III horizons of some fields;
- deposit exploitation in the initial period on a natural mode with subsequent use of various waterflooding systems (deposits with relatively small reserves are developed without reservoir pressure maintenance).

Due to close values of initial reservoir pressure of oil deposits and pressure of oil gas saturation, as well as late application of flooding, and low activity of contour waters, which more often than not had no significant influence on the development process, the vast majority of oil deposits were drained in the initial stage of development in the mode of dissolved gas.

Reservoir pressure maintenance by water injection began with waterflooding. Exploration wells and waterflooded oil wells were typically used to perform waterfloods underwater injection. Earlier studies on the efficiency evaluation of waterflooding point out that in spite of a number of factors favorable for its successful application (small size of deposits, low oil/water viscosity ratio), it turned out to be relatively inefficient due to [[13], [14], [15]]:

- poor hydrodynamic connection of the deposits with the zonation zone, due to a sharp deterioration of the reservoir properties of the productive formation in the area of the initial water-oil contact. The specified factor impeded the development of the designed fund for injection wells, as a result, the latter covered only separate, not long stretches of the perimeter of the oil-bearing area, and flooding had a focal character;
- significant heterogeneity of producing objects, caused by the presence of tectonic and lithologic screens and extensive zones of an outcropping.

Under the influence of these factors pumping affected small areas of the deposit, and most often only some of the production wells. Pressure redistribution occurred very slowly and unevenly, its growth was noted mainly in the zones of injection, while the central parts of reservoirs continued to be developed in the depletion mode:

- big difference in permeability of reservoirs, which did not allow even by increasing the injection pressure to cover the whole deposit by the flooding effect. When the injection pressure was increased, most of the injected water flowed into the borehole area or through communicating fracture systems penetrated deep into the reservoir, prematurely watering the production of the producing wells. After displacing small amounts of oil from the more permeable fractured interlayers, the injected water subsequently advanced along the same path, isolating areas of the reservoir with low permeability.

In 1960-1965, in order to intensify the waterflood process, many reservoirs widely used the transfer of the injection line from the initial to the current oil-bearing contour and the development of various types of intracircuit waterflood. The transition from bypass to various types of bypasses waterfloods stabilized reservoir pressure and increased annual oil withdrawals.

Implementation of this flooding enabled many reservoirs to increase the efficiency of injected water use owing to exclusion of water leakage into the flooded zone, to stabilize the pressure in those zones of the deposit, which were not influenced by water flooding during flooding, to embrace tectonic and lithologic screened zones of deposits [[5], [7]].

At present all objects under consideration are at the fourth stage of development, which is characterized by low rates of oil recovery - less than 2.0% of the initial recoverable reserves, high watering of produced oil, and depletion of reserves of (more than 90%), a significant drop in reservoir pressure, despite the implementation of measures to maintain it and relatively low values of the oil recovery factor.

The achieved ORF values in connection with the presence of objects in the closing stage of development (in a part of them the development has already been suspended because of full watering of the produced oil) are close to their final values. Therefore, we consider the achieved ORF values as a result of the efficiency of the implemented development system, in particular the waterflooding method efficiency.

Research Methods

With the introduction of a new generation of multidimensional computer modeling software in recent years, there was a qualitative development of methods for the geological and hydrodynamic study of oil fields. As the experience of these software applications, the results are determined by the completeness and quality of the initial geological and field information.

Solving geological and development tasks on the basis of using literature and reference data or analogue objects when building geological and hydrodynamic models of oil fields can lead to distortion and reduction of the credibility of the results [[12], [16]].

In this connection, with the lack of necessary qualitative initial geological and reservoir information, research to solve various problems of development of models based on integral indices and obtained by a generalization of geological and reservoir materials of long-operated deposits is also relevant in the current level of knowledge of the theory and practice of oil field development [13].

On the basis of the above-mentioned arguments, we used the least squares method, which is the basic method of regression analysis in order to solve the assigned task. In connection with a choice of a method of studying the set problem, it is appropriate to remind the words of the scientist-geologist V.I. Vernadsky "Not hypotheses and theories, but scientific facts and empirical generalizations come into conflict with the theory but confirmed by new facts, then the scientific theory should change, not to contradict empirical generalizations" [17].

Theory. Currently, the main oil reservoir development technologies are based on the water displacement of oil. The efficiency of these technologies depends on the geological and physical properties of oil-saturated reservoirs, oil and water properties, and extraction conditions. As the experience of oil field development shows, the oil recovery factor (ORF) from reservoirs during waterflooding is most strongly influenced by: the ratio of oil and water viscosity; reservoir heterogeneity in permeability; average permeability and dissection, reservoir temperature; relative sizes of water-oil zones; microheterogeneity of the porous medium; oil saturation and capillary forces; density of the net and waterflood systems [[8], [9], [12], [13], [18]].

In [18] the results of studying the degree of influence of these factors on the oil recovery factor on the basis of multifactor analysis of 50 objects of the Ural-Volga region. The analyzed objects, confined to terrigenous reservoirs, were at a late stage of development. Out of 50 studied objects, 18 were developed by in-situ flooding, 15 - by out-of-situ flooding, and 17 - under the conditions of a natural water-storage regime. The values of geological and production factors at the analyzed objects changed in a rather large range: oil/water viscosity ratio from 1 to 25; average permeability from 0.15 to 2.5 μm^2; reservoir temperature from 25 to 75 ^oC; effective oil-saturated thickness from 3 to 20 m; sand ratio from 0.55 to 0.95 relative reserves of water-oil zone from 25 to 100%; oil saturation from 0.75 to 0.95; well grid density from 10 to 60 ha/sq.m.; fluid production rate from geological reserves from 2.5 to 7.5% [18].

In the indicated ranges of geological and production factors changes, their relative influence on the ORF was (%): oil/water viscosity ratio -21.1; average permeability +15.4; reservoir temperature +7; effective oil-saturated thickness +6; sand ratio +6; relative reserves of water-oil zone -5.6; oil saturation +3.6; well grid density -3; flooding system +2.2; fluid production rate from geological reserves +0.6 ("+" and "-" are the positive and negative influence of factors, respectively) [18].

Thus, we can conclude that in the considered ranges of changes of geological and production factors, the strongest influence on EOR is provided by: the ratio of oil and water viscosity and average permeability of strata; almost the same influence - reservoir temperature, effective oil-saturated thickness, sand ratio and relative reserves of the water-oil zone; the least influence - oil saturation, the density of well grid, flooding system and the rate of fluid extraction.

At the same time, multifactor analysis established that at different stages of development, the degree of influence of geological and field factors on ORF changes. For example, at later stages the degree of influence of oil and water viscosity ratio decreases, whereas the role of well grid density increases. But at all stages of development, the dominating influence of natural factors on the oil recovery ratio is preserved.

At the same time according to many scientists, the reservoir operating mode is a determinant one. However, the wide use of this method of oil field development is impossible without its further improvement. In this connection, a lot of attention has been paid to the peculiarities of artificial waterflooding of reservoirs in various geological and physical conditions and to the ways of its improvement. Such studies, as is well known, on the one hand, allow using the accumulated experience of reservoir operation by artificial water flooding in the process of designing the development of new fields, and on the other hand, contribute to effective post-development of depleted objects, in which great material and technical resources have already been invested [[12], [13]]. This is evidenced by numerous works devoted to various issues of oil field development in Bashkortostan, Tatarstan, Kuibyshev, Orenburg and Perm regions, Ukraine and Azerbaijan using waterflooding [[18], [19]].

The dependence of oil recovery on the completeness of reservoir flushing in reservoir development with waterflooding is the basis of the well-known expression [20]:

$$ORF = K_d * K_{cv}, \quad (1)$$

where Kd - displacement coefficient, which is the ratio of displaced oil volume to its initial volume in the reservoir during prolonged and intensive flushing of the homogeneous element of the porous medium; Kcv - coefficient of reservoir coverage by volume of impact processes.

Coefficient Kd and Kcv change in time, as the front of incoming water into the reservoir, as it advances captures more new areas of the reservoir, layers, and with changes in the direction of filtration flows, stagnant and dead-end zones.

To evaluate the efficiency of the implemented development systems, many researchers recommend using the dependence of ORF on the degree of formation flushing [[12], [13], [18]].

In this case, as a criterion for evaluating the technological efficiency of development systems implemented in the field is taken as achieved, the oil recovery factor at the same degree of flushing the volume of pores occupied by oil,

$$ORF = f(\tau), \quad (2)$$

where $\tau = \frac{\sum Qf}{IGOR}$ – flushing rate, $\sum Q_f$ – accumulated fluid withdrawal under reservoir conditions; IGOR - initial geological oil reserves.

In contrast to numerous forms and types of displacement characteristics long used in practice, this method is convenient because it allows to use of primary, and therefore less distorted source data, such as fluid withdrawal, accounted in the field conditions reliably enough, geological oil reserves at the late and final stages of development of category A + B, coefficients of conversion of physical parameters of the fluid into reservoir conditions and vice versa. The flushing ratio τ, being a relative value, is convenient for comparison, since it is equally applicable in the analysis of both small deposits and large fields [[12], [13], [20], [21]].

Calculation. Earlier in [13] for FNGO oil reservoirs represented by terrigenous reservoirs, straight-line dependences of ORF on RFF were proposed:

- for the whole sample

$$ORF = 0{,}1266 + 0{,}2329 * \tau, \quad (R=0{,}8890); \quad (3)$$

- for objects developed in the natural mode

$$ORF = 0{,}0169 + 0{,}5604 * \tau, \quad (R=0{,}8983); \quad (4)$$

- for objects developed with the use of water flooding

$$ORF = 0{,}1346 + 0{,}1946 * \tau, \quad (R=0{,}8700); \quad (5)$$

Analysis of the proposed dependences (3) - (5) show that at values τ > 1.5, the ORF becomes more than 1, which does not make physical sense.

In this regard, the initial data used in /13/ for obtaining dependencies (3) - (5) we re-processed and obtained exponential dependences (Fig. 1 - 2) of ORF on RFF:

- for all 25 development sites

$$ORF = 0{,}6996 * (1 - e^{-0{,}8915*\tau}), \quad (R=0{,}824); \qquad (6)$$

- for 16 objects developed with water flooding

$$ORF = 0{,}7553 * (1 - e^{-0{,}6204*\tau}), \quad (R=0{,}953); \qquad (7)$$

- for 9 objects developed without waterflooding

$$ORF = 0{,}2241 * (1 - e^{-0{,}8915*\tau}), \quad (R=0{,}954); \qquad (8)$$

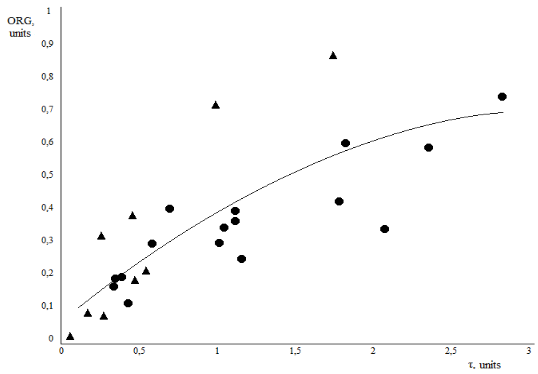

Fig. 1. Dependence of the oil recovery factor on the reservoir flushing ratio for all FNGO objects represented by terrigenous reservoirs:

● - objects developed by waterflooding;

- objects developed withc ▲ waterflooding.

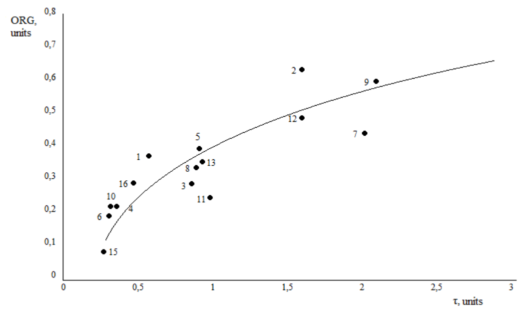

Fig. 2. Dependence of the oil recovery factor on the reservoir flushing ratio for FNGO objects, represented by carbonate reservoirs and developed with the use of waterflooding:

1 - Andijan field, CCS + I horizons; 2 - Andijan field, III horizon; 3 - South Alamyshik field, I+Ia horizons; 4 - South Alamyshik deposit, Ib horizon; 5 - South Alamyshik deposit, CCS horizon; 6 - South Alamyshik deposit, III horizon; 7 - South Alamyshik deposit, XVIII horizon; 8 - South Alamyshik deposit, XIX-XXII horizons;
9 - Khojaabad deposit, BPS+I horizons; 10 - Khojaabad deposit, III horizon; 11 - Western Palvantash deposit, BRS horizon; 12 - Western Palvantash deposit, III horizon; 13 - Hankyz deposit, II horizon; 14 - Chongora-Galcha deposit, IV horizons; 15 - Boston deposit, CCS+ I+Ia+Ib horizons; 16 - Boston deposit, III horizon.

Analysis of the obtained dependences (7) - (8) show that their separate consideration for the objects under development with and without waterflooding considerably increases their reliability in comparison with the earlier proposed (4) - (5). This allows us to conclude with their more correct description of the mechanism and efficiency of waterflooding of oil deposits.

Conclusions

The obtained results, the dependence of ORF on RFF, show that the mechanism of reservoir flushing by water inflow from the water-bearing area and water injection into the formation through the wells is the same. The achievable EOR value is determined by the degree of formation flushing. However, after each increase in the flushing ratio, the volume of displaced oil naturally decreases. The difference in the ORF values at the identical values of CPR for the objects being developed with and without waterflooding testifies that the effect of water injection is achieved due to the increase of coverage of the reservoir volume by the drainage.

It is recommended to use the obtained dependences of ORF on RFF to assess the flooding efficiency, and to compare and refine the results of hydrodynamic calculations under similar geological and physical conditions of the objects and the implemented development systems.

Cite this article as: Agzamov A, Efendiyev G, Moldabayeva GZh, Syzdykov A, Suleimenova R, Tuzelbayeva Sh, Zaurbekov K. On the degree of influence of waterflooding on the oil recovery factor from productive formations of high-viscosity reservoirs X, represented by terrigenous reservoirs. Kompleksnoe Ispolzovanie Mineralnogo Syra = Complex Use of Mineral Resources. 2023;326(3):50-58. https://doi.org/10.31643/2023/6445.28

Терригенді коллекторлардан тұратын, ұсынылған Х кен орнының тұтқырлығы жоғары коллекторларының өнімді қабаттарынан мұнай алу коэффициентіне су айдаудың әсер ету дәрежесі туралы

[1]Агзамов А.Х., [2]Ефендиев Г.М., [3]Молдабаева Г.Ж., [3]Сыздыков А.Х., [4]Сулейменова Р.Т., [3]Тузелбаева Ш.Р., [3]Зауырбеков К.С.

[1] Ислам Каримов атындағы Ташкент мемлекеттік техникалық университеті, Ташкент, Өзбекстан
[2] Әзірбайжан Ұлттық Ғылым Академиясы, Баку, Әзірбайжан
[3]Satbayev University, Алматы, Қазақстан
[4] Сафи Өтебаев атындағы Атырау мұнай және газ университеті

Мақала келді: *05 маусым 2022*
Сараптамадан өтті: *19 шілде 2022*
Қабылданды: *28 қараша 2022*

АНДАТПА
Бұл мақалада көп қабатты тұтқырлығы жоғары кен орындарын игеру тәжірибесін жалпылау негізінде соңғы кезеңдегі суланyының салдарынан өнімді қабаттардың мұнай беру коэффициентіне әсері зерттелді. Деректерді өңдеудің статистикалық әдістерін қолдану арқылы мұнай алу коэффициентінің салыстырмалы түрде жоғары корреляция коэффициентімен қабаттарды жуу коэффициентіне тәуелділігі алынды. Алынған тәуелділік су айдау арқылы жасалған өнімді қабаттардан мұнай алудың теориялық негіздерін растайды және оны ұқсас объектілерде процесті жобалау кезінде қолдануға болады. Сулану жағдайы құбылыстары, соның ішінде қабат қысымын су айдау үрдісі арқылы тиімді дамыту мәселелерін шұғыл шешу қажет, өйткені бұл әдіс су айдау салдарынан мұнай беру коэффициентін арттырудың ең кең таралған әдісі болып табылады. Өнімнің сулану үрдісін тежеу және бақылау істері есепке алынған.

Түйінді сөздер: кен орны, игеру, су айдау, жуу, өндіру, өнім**.**

Информация об авторах:

Агзамов Аваз Хамидиллаевич	*Техника ғылымдарының докторы, мұнайды игеру және пайдалану кафедрасының профессоры және газ кен орындары, Ислам Каримов атындағы Ташкент мемлекеттік техникалық университеті, Ташкент, Өзбекстан, 180100, Университет №2 көшесі*
Эфендиев Галиб Мамедович	*Әзірбайжан Ұлттық Ғылым Академиясының корреспондент мүшесі, техника ғылымдарының докторы, профессор. Email: galib_2000@yahoo.com*
Молдабаева Гульназ Жаксылыковна	*Техника ғылымдарының докторы, "Мұнай инженериясы" кафедрасының профессоры, Satbayev University, 050013, Сәтпаев 22а, Алматы, Қазақстан. Email: moldabayeva@gmail.com*
Сыздыков Аскар Хамзаевич	*Техникалық ғылымдар кандидаты, "Мұнай инженериясы" кафедрасының профессоры, Satbayev University, 050013, Сәтпаев 22а, Алматы, Қазақстан. Email: a.syzdykov@satbayev.university*
Сулейменова Райхан Таупиховна	*PhD, Сафи Өтебаев атындағы Атырау мұнай және газ университеті, Баймуханова 45 А, Атырау, Қазақстан. Email: raika_83@mail.ru*
Түзелбаева Шолпан Рысқұлбекқызы	*Мұнай инженериясы кафедрасының докторанты, Satbayev University, 050013, Сәтпаев 22а, Алматы, Қазақстан. Email: tuzelbayeva.s@gmail.com*
Заурбеков Кадыржан Сейтжанович	*Мұнай инженериясы кафедрасының докторанты, Satbayev University, 050013, Сәтпаев 22а, Алматы, Қазақстан. Email: k.zaurbekov@satbayev.university*

О степени влияния заводнения на коэффициент извлечения нефти из продуктивных пластов высоковязких коллекторов месторождения Х, представленных терригенными коллекторами

[1]Агзамов А.Х., [2]Ефендиев Г.М., [3]Молдабаева Г.Ж., [3]Сыздыков А.Х., [4]Сулейменова Р.Т, [3]Тузелбаева Ш.Р, [3]Зауырбеков К.С.

[1] Ташкентский государственный технический университет имени Ислама Каримова, Ташкент, Узбекистан
[2]Национальная Академия Наук Азербайджана, Баку, Азербайджан
[3]Satbayev University, Алматы, Казахстан
[4] Атырауский университет нефти и газа имени Сафи Утебаева

Поступила: *05 июня 2022*
Рецензирование: *19 июля 2022*
Принята в печать: *28 ноября 2022*

АННОТАЦИЯ
В статье рассматривается на основе обобщения опыта разработки многослойных высоковязких месторождений изучено влияние заводнения на поздней стадии на коэффициент нефтеотдачи продуктивных пластов. Путем применения статистических методов обработки данных получена зависимость коэффициента извлечения нефти от коэффициента промывки пласта с достаточно высоким коэффициентом корреляции.

Полученная зависимость подтверждает теоретические основы извлечения нефти из продуктивных пластов, разрабатываемых заводнением, и может быть использована при проектировании процесса на аналогичных объектах. Возникает острая необходимость решения вопросов эффективной разработки этих объектов, в том числе заводнением, так как этот метод является наиболее распространенным методом повышения коэффициента извлечения нефти за счет заводнения.

Ключевые слова: Месторождение, месторождение, разработка, заводнение, промывка, добыча, компенсация, отбор.

Информация об авторах:

Агзамов Аваз Хамидиллаевич	*Доктор технических наук, профессор кафедры разработки и эксплуатации нефти и газовых месторождений, Ташкентский государственный технический университет имени Ислама Каримова, Ташкент, Узбекистан, 180100, ул.Университетская № 2*
Эфендиев Галиб Мамедович	*Член корреспондент Национальной Академий Наук Азербайджана, Доктор технических наук, профессор. Email: galib_2000@yahoo.com*
Молдабаева Гульназ Жаксылыковна	*Доктор технических наук, профессор кафедры «Нефтяная Инженерия», Satbayev University, 050013, Сатпаева 22а, Алматы, Казахстан. Email: moldabayeva@gmail.com*
Сыздыков Аскар Хамзаевич	*Кандидат технических наук, профессор кафедры «Нефтяная Инженерия», Satbayev University, 050013, Сатпаева 22а, Алматы, Казахстан. Email: a.syzdykov@satbayev.university*
Сулейменова Райхан Таупиховна	*PhD, Атырауский университет нефти и газа имени Сафи Утебаева, Баймуханова 45 а, Атырау, Казахстан. Email: raika_83@mail.ru*
Түзелбаева Шолпан Рысқұлбекқызы	*Докторант кафедры «Нефтяная Инженерия», Satbayev University, 050013, Сатпаева 22а, Алматы, Казахстан Email: tuzelbayeva.s@gmail.com*
Заурбеков Кадыржан Сейтжанович	*Докторант кафедры «Нефтяная Инженерия», Satbayev University, 050013, Сатпаева 22а, Алматы, Казахстан Email: k.zaurbekov@satbayev.university*

Reference

[1] Afanaskin IV, Korolev AV, Gaushakov AA. i dr. Model' dlya analiza razrabotki neftyanykh mestorozhdeniy s gazovoy shapkoy metodom yacheyek zavodneniya [Model for the analysis of the development of oil fields with a gas cap by the method of cell flooding]. Moskva: Neftepromyslovoye delo [Moscow: Oilfield business]. 2020;3(615):5-8. (in Russ).

[2] Sentsov AYU, Ryabov IV, Ankudinov AA. i dr. Analiz sistemy zavodneniya s primeneniyem statitsticheskikh metodov obrabotki dannykh [Analysis of the waterflooding system using statistical methods of data processing]. Neftepromyslovoye delo.Moskva [Oilfield business. Moscow]. 2020;8(620):5-9. (in Russ).

[3] Ankudinov AA, Vaganov LA. Metodika raspredelniya ob"yemov zakachivayemoy vody po ploshchadi neftyanogo mestorozhdeniya [The method of distributing the volumes of injected water over the area of the oil field]. Geologiya, geofizika i razrabotka neftyanykh mestorozhdeniy. Moskva [Geology, geophysics and development of oil fields. Moscow]. 2013;9:19-24. (in Russ).

[4] Kazakov KV, Koreposnova VS, Nikitin VT, Nikiforov VP. O podkhodakh i nekotorykh rezul'tatakh obobshcheniya opyta razrabotki neftyanykh mestorozhdeniy Timano-Pechorskoy provintsii [About approaches and some results of generalization of experience in the development of oil fields in the Timan-Pechora province]. Neftepromyslovoye delo. Moskva Oilfield business. Moscow]. 2020;1(613):5-12. (in Russ).

[5] Irmatov EK, Agzamov AKH. Zavodneniye neftyanykh mestorozhdeniy s oslozhnennymi gorno-geologicheskimi usloviyami i puti povysheniya yego effektivnosti [Waterflooding of oil fields with complicated mining and geological conditions and ways to improve its efficiency]. Tashkent: AN RUz. 1992, 60. (in Russ).

[6] Khodzhayev AR, Akramkhodzhayev AM, Azimov PK. i dr. Neftyanyye i gazovyye mestorozhdeniya Uzbekistana [Oil and gas fields of Uzbekistan]. Tashkent: Fan. 1973, 188. (in Russ).

[7] Irmatov EK, Agzamov AKH. Opyt i problemy sovershenstvovaniya razrabotki neftyanykh i neftegazovykh mestorozhdeniy Sredeney Azii i metody povysheniya ikh nefteotdachi [Experience and problems of improving the development of oil and oil and gas fields in Central Asia and methods for increasing their oil recovery]. Tashkent: Fan. 1991, 71. (in Russ).

[8] Karimova A, Akhmetov N, Mardanova L. Experimental support of field trial on the polymer flooding technology substantiation in the oil field of western Kazakhstan. Periodico Tche Quimica. 2020;17(35): 963-975

[9] Akhmetov S, Shayakhmetova Zh, Suyungariyev G. The process of monitoring the current condition of oil recovery at the production fields in Western Kazakhstan. Journal of Applied Engineering Sciencethis. 2021;19(4):1099-1107.

[10] Buktukov N, Mergenov M. Improvement of oil field development using enhanced oil recovery methods. Naukovyi Visnyk Natsionalnoho Hirnychoho Universytetu. 2021;6:23-28

[11] Bimagambetov KB, Logvinenko A, Tuzelbayeva SR. (2021). Experimental studies of chemical and technological characteristics of cross-linked polymer systems applied in flow-diversion technologies. NEWS of the Academy of Sciences of the Republic of Kazakhstan. SERIES OF GEOLOGY AND TECHNICAL SCIENCES. 2021;4(448):50-58

[12] Elefteriadi DK, Abileva SZh, Baldanov BA. (2021). Hydrodynamic modeling of field development using enhanced oil recovery methods. Kompleksnoe Ispolzovanie Mineralnogo Syra = Complex Use of Mineral Resources. 2021;2(317):14-22

[13] Abileva SZh, Baldanov BA, Karimova AS. The effectiveness of the application of physical impact on the productive reservoir to reduce viscosity and increase oil recovery [Efficiency of application of physical impact on a productive formation to reduce viscosity and increase oil recovery]. Kompleksnoe Ispolzovanie Mineralnogo Syra = Complex Use of Mineral Resources. 2021;1(316):53-61. (in Russ).

[14] AL-Obaidi SH, Smirnov VI, Khalaf FH. New Technologies to Improve the Performance of High Water Cut Wells Equipped With ESP. Technium. 2021;3(1):104-113

[15] Nazarov SN, Alidzhanov GA, Akramov AA. Opyt zakachki gazokondensatnogo gaza vysokogo davleniya na VIII plast mestorozhdeniya Severnyy Sokh [Experience of injection of high-pressure gas condensate gas into the VIII layer of the Northern Sokh field] Azerbaydzhanskoye neftyanoye khozyaystvo [Azerbaijan oil industry]. Baku. 1965;3:27-29. (in Russ).

[16] Sipachev NV. Issledovaniye osobennostey pozdney stadii razrabotki mestorozhdeniya Yuzhnyy Alamyshik [Study of the features of the late stage of development of the South Alamyshik field]. Dissertatsiya na soiskaniye uchenoy stepeni kandidat tekhnicheskikh nauk. Tashkent: TGTU [Dissertation for the research of the degree of candidate of technical sciences. Tashkent: TSTU]. 1974, 25. (in Russ).

[17] Liu W., He H. Influence of the Injection Scheme on the Enhanced Oil Recovery Ability of Heterogeneous Phase Combination Flooding in Mature Waterflooded Reservoirs. ACS OMEGA. 2022, 6. DOI: 10.1021/acsomega.2c02007

[18] Javad Razavinezhad, Arezou Jafari, Seyed Masoud, Ghalamizade Elyaderani. Experimental investigation of multi-walled carbon nanotubes assisted surfactant/polymer flooding for enhanced oil recovery. Journal of Petroleum Science and Engineering. 2022, 214. DOI: 10.1016/j.petrol.2022.110370

[19] Zhang GY (Zhang Guoyin), Yu JJ (Yu Jianjia). Effect of commonly used EOR polymers on low concentration surfactant phase behaviors. FUEL. 2021, 2. DOI: 10.1016/j.fuel.2020.119465

[20] Ximena Guerrero, Daniel Ricardo Medina, Alberto Munoz, Jhon Rubiano, Alied Bejarano, Hernando Trujillo, Nicolas Saltel, Julian Trillos, Jerson Becerra, Diego Castellanos, Cesar Coronado. Water Isolation and Sand Control: Breaking Barriers with Expandable Steel Patch Technology. Society of Petroleum Engineers. SPE-201432-MS. 2020. DOI: 10.2118/201432-MS

[21] Tariq K Khamees, Ralph E Flori. Can the Viscoelasticity of HPAM Polymer Solution Make the Polymer Flooding Compete with Gel Treatment to Improve Sweep Efficiency. A Comparison with Different Polymer Gel Systems. SPE International Conference on Oilfield Chemistry. SPE-193592-MS. 2022. DOI:10.2118/193592-MS