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ҰЛТТЫҚ ҒЫЛЫМ АКАДЕМИЯСЫ
Satbayev University

ХАБАРЛАРЫ

ИЗВЕСТИЯ

НАЦИОНАЛЬНОЙ АКАДЕМИИ НАУК
РЕСПУБЛИКИ КАЗАХСТАН
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НАН РК сообщает, что научный журнал «Известия НАН РК. Серия геологии и технических наук» был принят для индексирования в Emerging Sources Citation Index, обновленной версии Web of Science. Содержание в этом индексировании находится в стадии рассмотрения компанией Clarivate Analytics для дальнейшего принятия журнала в the Science Citation Index Expanded, the Social Sciences Citation Index и the Arts & Humanities Citation Index. Web of Science предлагает качество и глубину контента для исследователей, авторов, издателей и учреждений. Включение Известия НАН РК. Серия геологии и технических наук в Emerging Sources Citation Index демонстрирует нашу приверженность к наиболее актуальному и влиятельному контенту по геологии и техническим наукам для нашего сообщества.

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CAUSES AND ANALYSIS OF WATER ENCROACHMENT OF SOME OFFSHORE FIELDS PRODUCTS OF AZERBAIJAN

Abstract. The results of researches of the water encroachment of some offshore fields (Neft Dashlary, Guneshli, Pirallahi, Darwin Banka, Apsheron Banka, Western Apsheron, etc.) of the Republic of Azerbaijan, most of which are at a late stage of development, have been presented. These fields are represented by weakly cemented and loose reservoirs of heterogeneous structure, in which there is an uneven fluid flow. Water breakthrough occurs through high-permeability layers, and layers with low permeability are involved in development to a less extent. Subsequent attempts to involve them in the development process cause an irrational increase in the volume of injected water, which leads to product encroachment. The type of reservoir, characterized by the presence of fracture zones, contributing to the flow of water from the aquifers to the producing wells, as well as improving their hydrodynamic connection with the injection wells, also contributes to the growth of the rate of watering. The geological and technological reasons for the water encroachment have been determined. The heterogeneity of the above mentioned deposits has been proven. It is indicated that an additional reason for the early water encroachment of production wells is the violation of the annulus tightness. Maintaining high rates of oil production is achieved by bringing in new production wells, while most of the watered wells are retired from operation without having exhausted their potential. It is proposed to carry out the measures that will ensure isolation of the most washed out zones and depleted areas of the main productive layer of the field. Methods of selective water isolation and flow diversion technologies should be carried out, first of all, in wells with an increased density of current reserves in order to obtain additional oil production and increase the oil recovery factor, as well as in wells with a high fluid flow rate.

Key words: oil, injection wells, profile alignment, depression, tightness of the annulus, weakly cemented and loose reservoirs, water encroachment rate, efficiency of repair and isolation works

Introduction. The main deposits of the Republic of Azerbaijan have entered the late stage of development, which is accompanied by a high water encroachment in well production, with significant reserves of residual oil. Large volumes of associated water dictate the use of additional energy resources. This forces oil companies to implement large-scale methods of enhanced oil recovery and take measures to limit the production of associated water. To reduce the water encroachment of the well production, the technologies of profile alignment of the injectivity of injection wells and repair - isolation works (RIW) in production wells are usually used. Taking into account the massive water encroachment of products and the rise in prices for field geophysical research, there is a need to search for simple and cheap methods.

The nature of the water encroachment of the produced products is influenced by many factors related, on the one hand, to the geological structure and reservoir properties of the layer the physicochemical properties of oil and displacing fluid, on the other hand, to the used well placement system, the technology of their construction, and operating modes. Under the conditions of increasing depressions, a large number of wells are flooded due to water breakthrough through individual high-permeability layers of the developed object, violation of the tightness of the annular space, and also due to pulling up the bottom water cones. In addition, many oil deposits have water-oil zones and wells located in these zones, from the very first days of operation, they begin to give watered production. Premature watering of wells reduces the final oil recovery and causes large unproductive costs for production, transportation of associated water and for the fight against corrosion of production equipment [1,2].

Methods. From the point of view of water encroachment the fields of the Apsheron Peninsula and a number of offshore fields, represented by weakly cemented and loose reservoirs of heterogeneous structure, in which uneven fluid flows are observed, are of interest. Water breakthrough occurs through high-permeability layers, and layers with low permeability are involved in development to a less extent. Subsequent attempts to involve them in the development process cause an irrational increase in the volume of injected water, which leads to water encroachment in the production. The type of

reservoir, characterized by the presence of fracture zones, facilitating the flow of water from the aquifers to the producing wells, as well as improving their hydrodynamic connection with injection wells [3], also contributes to an increase in the rate of watering.

Field and analytical studies show that the main geological and physical factors that determine the anticipatory watering of oil wells are:

- high ratio of the viscosities of reservoir oil and injected water;
- permeable heterogeneity or fracturing of the formation, causing the early breakthrough of the injected water to the producing wells;
- the water-floating nature of the reservoir with a small thickness, or in the absence of a clay bridge between the differently saturated parts of the section, which causes the wells to be flooded with bottom water through behind-the-casing flows or coning of oil-water contact
- Leakage of the production string or the well bottom.

The negative effect of the permeable heterogeneity of the reservoir on the efficiency of water flooding is also enhanced by capillary forces (their effect increases with a decrease in the permeability of productive rocks), the swelling of clay cement of productive rocks in contact with the injected water, clogging of the bottom hole formation zone of injection wells with mechanical impurities [4].

Research. For 2016-2020, the results of the repair and insulation works (RIW) of "Neft Dashlary" OGPD were studied. During this period, 103 repair and isolation works were carried out at the "Neft Dashlary" field, the data on the horizons of which are presented in Fig. 1.

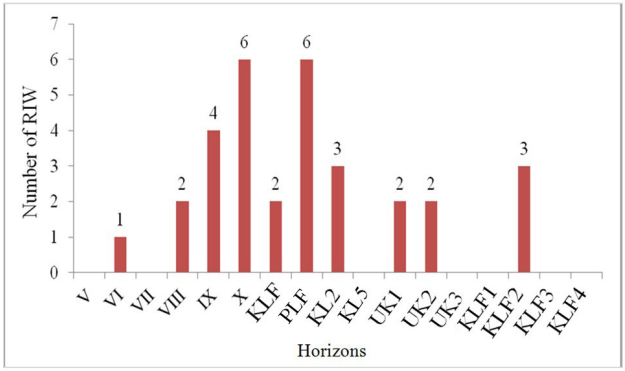

Fig.1. Distribution of RIW by horizons for the period 2016-2020 at the "Neft Dashlary" field

As it is seen from figure 1, most of the RIW were carried out in water injection facilities (VIII, IX, X, PF, UG_2) and lower horizons (UG_1, UG_2, UG_3, UG4).

The effectiveness of the RIWs carried out for 2016-2020 was presented in Fig. 2.

At the Neft Dashlary field, there are 371 wells in the operating fund. In most of them, there is an intense manifestation of water.

Watering of well production during operation is an expected process. Attention is drawn to the fact that, due to objective and subjective (long-term operation of overpasses and their failure) reasons, it is impossible to fight against encroachment, and this leads to incomplete use of potential oil and gas production rates.

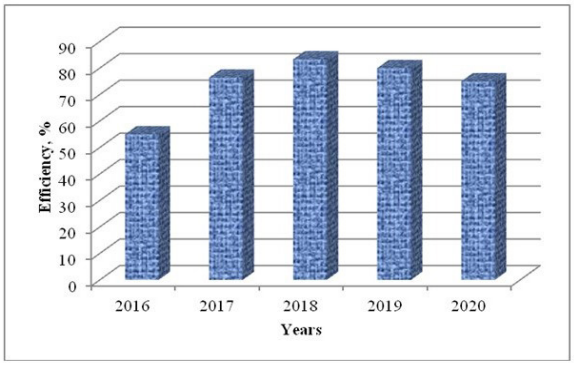

Fig.2. Efficiency of RIW by years for the period 2016-2020 at the "Neft Dashlary" field.

All this in the future may adversely affect the technical and economic indicators during the development of the field. In addition, watering of products leads to accelerated corrosion of down hole and surface equipment and becomes the reason for their premature failure.

Figure 3 shows the distribution of the operating well stock (371 wells) by the degree of water encroachment.

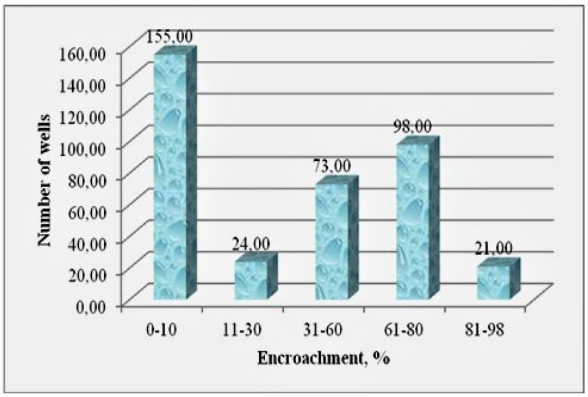

Fig.3. Distribution of the operating well stock by the degree of water encroachment.

In the period from 2016-2020, 1630 tons of oil were additionally produced due to the regulation of water inflow by the elastic-strength mass (ESM). The data of this event are shown in figure 4.

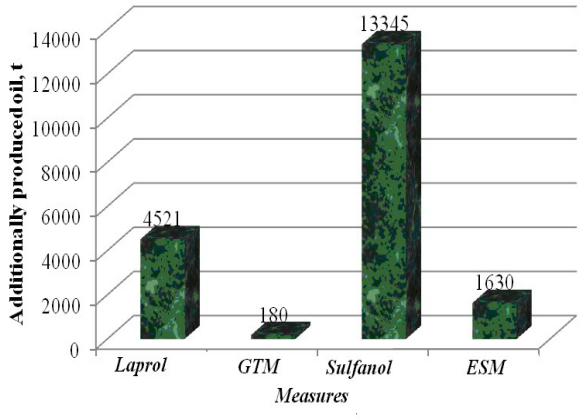

Fig.4. Additional oil produced as a result of conducting RIW

Carried out researches show that the primary cause of well failure is water containing corrosive elements, produced together with oil. These aggressive media include sulfur and hydrogen compounds, hydrogen sulfide (H_2S) and carbon dioxide (CO_2), as well as salts dissolved in formation water.

At the 28 May OGPD, two fields are being developed - Guneshli and Zhiloy. For 2016-2020, the results of the repair and insulation works (RIW) were studied. During this period, 77 RIW were carried out on the Guneshli field, and 39 RIWs on the Zhiloy field. Repair and insulation works carried out during this period are shown in Figure 5.

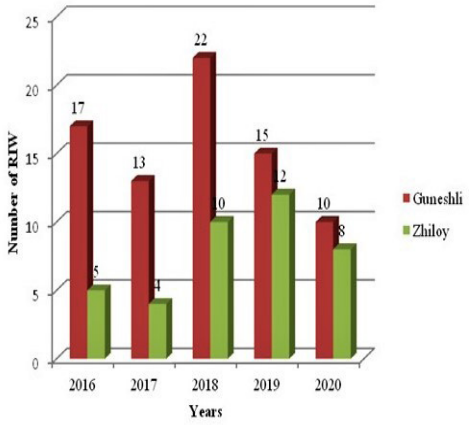

Fig.5. RIW conducted for the period 2016-2020

The collected field materials indicate that the efficiency of the exploration and survey work carried out for the period 2016-2020 was: at the Guneshli field -53-77%, at the Zhiloy field -0-50% (Fig.6).

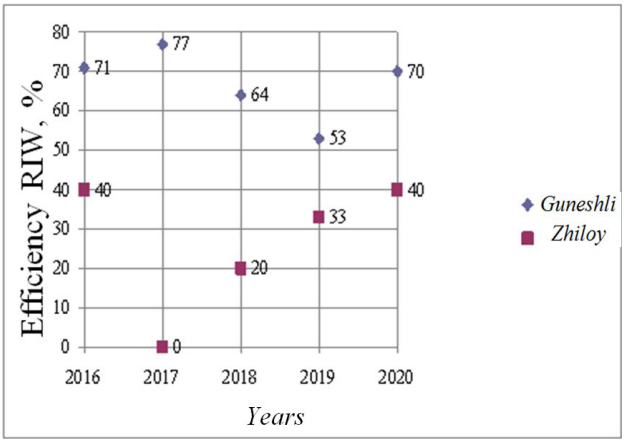

Fig.6. The efficiency of the conducted RIW for the period 2016-2020 at the Guneshli and Zhiloy fields

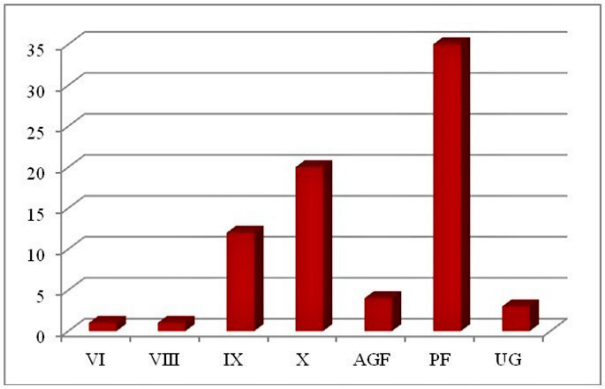

Fig.7. Distribution of RIW for the Guneshli field.

Since the efficiency of RIW for the Guneshli and Zhiloy fields varies in a large interval, the efficiency of RIW for individual horizons was analyzed. The distribution of RIW for the Guneshli field is shown in figure 7. As it can be seen from figure 7, most of the RIW falls on horizons IX, X and the Formation Pererive (FP).

At present, Апsheronneft Oil and Gas Production Directorate develops the Pirallakhi, Darwin Banka, Gyurgyan-Sea, Western Apsheron and Apsheron Banka fields. The analysis of RIW was carried out at these fields for the period 2016-2020. The dynamics of RIW changes is shown in figure 8.

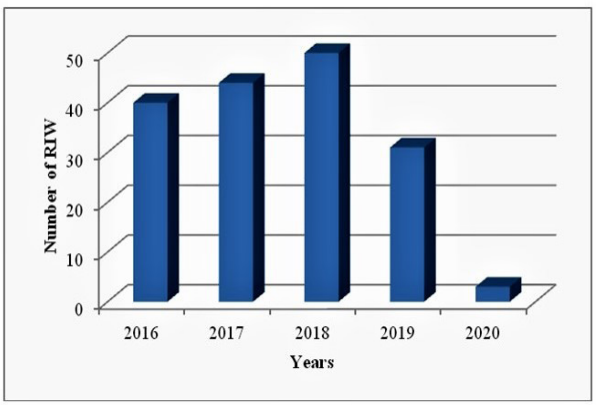

Fig.8. Dynamics of RIW changes for the period 2016-2020

According to figure 8, over the past 5 years, there has been an increase in RIW performance.

At Apsheronneft OGPD for the period 2016-2020, the results of overhaul are presented in the table 1.

Table 1

Overhaul results at Apsheronneft OGPD for the period 2016-2020

Serial number	Years	GTM name	GTM quantity	Cement consumption, t
1	2	3	4	5
1	2016	RIW	24	48
2	2017	-//-//-	23	69
3	2018	-//-//-	38	90
4	2019	-//-//-	22	85
5	2020	-//-//-	26	60
Σ			133	352

Serial number	Materials used during GTM	Measures		Additionally produced oil, t
		factual	efficiency	
	6	7	8	9
1	conventional cement used during 24 measures	24	11	3995
2	conventional cement used during 23 measures	23	12	3337
3	conventional cement used during 38 measures	38	21	5160
4	conventional cement used during 22 measures	22	10	3400
5	conventional cement used during 26 measures	26	15	3500
Σ	133	133	69	9392

As it can be seen from Table 1, 133 RIW performances have been held. 69 of the measures taken were effective. In most of the activities carried out, conventional oil well cement was used for RIW, and a small amount was made by other compositions (polymer-cement mortars based on Laprol). The effectiveness of the measures taken was 51%.

An additional reason for the early watering of production wells is the violation of the tightness of the annulus. Maintaining high rates of oil production is achieved by bringing in new production wells, while most of the watered wells are retired from operation without exhausting their potential. Carrying out regular activities for monitoring the development allows timely to identify the causes of annulus overflows. High-quality repair and isolation works can extend the service life of old wells and significantly reduce operating costs.

Conclusion.

1. Efficient exploration and survey work in producing wells should be the priority types of measures to ensure the design indicators of oil reserves recovery.

2. Technological measures should ensure the isolation of the most washed out zones and depleted areas of the main productive layer of the field through the development and implementation of new water-insulating compositions and technologies that ensure the limitation of the mobility of reservoir and injected waters and a change in the directions of filtration flows.

3. Geological and technological measures for the use of selective water isolation methods and flow diverting technologies should be carried out, first of all, in wells with an increased density of current reserves, in order to obtain additional oil produced and increase oil recovery factor, as well as in wells with a high liquid flow rate, indirectly confirming the presence in the productive perforated interval of a watered high-permeability interlayer and indicating the potentially high efficiency of geological and technical measures in terms of reducing the volume of associated water.

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ӘЗІРБАЙЖАННЫҢ КЕЙБІР ТЕҢІЗ КЕН ОРЫНДАРЫ ӨНІМДЕРІНІҢ СУЛАНУ СЕБЕПТЕРІ МЕН ТАЛДАУЫ

Аннотация. Әзірбайжан Республикасының кейбір Теңіз кен орындарын (Дашлары Нефті, Гюнешли, Пираллахи, Дарвин Банкі, Апшерон банкі, Батыс Апшерон және т.б.) суландыруды зерттеу нәтижелері ұсынылған, олардың көпшілігі игерудің кеш сатысында. Бұл кен орындары құрылымы жағынан біртекті емес, әлсіз цементтелген және борпылдақ коллекторлармен ұсынылған, оларда сұйықтық ағындарының біркелкі еместігі байқалады. Судың жоғары өткізгіш қабаттардан өтуі байқалады, ал өткізгіштігі төмен қабаттасулар аз дәрежеде дамуға қатысады. Оларды әзірлеу процесіне тартудың кейінгі әрекеттері айдалатын су көлемінің иррационалды өсуіне әкеледі, бұл өнімнің суланауына әкеледі. Суландыру қарқынының өсуіне коллектор түрі де ықпал етеді, ол сулы қабаттардан өндіруші ұңғымаларға судың ағуына, сондай-ақ олардың айдау ұңғымаларымен гидродинамикалық байланысын жақсартуға ықпал ететін жарықшақты аймақтардың болуымен сипатталады, суланудың геологиялық және технологиялық себептері белгіленеді. Жоғарыда аталған кен орындарының гетерогенділігі дәлелденді. Өндіруші ұңғымалардың өнімдерін ерте суландырудың қосымша себебі-бағанадан тыс кеңістіктің тығыздығының бұзылуы. Мұнай өндірудің жоғары қарқынын ұстап тұруға жаңа өндіруші Ұңғымаларды пайдалануға беру арқылы қол жеткізіледі, бұл ретте суландырылған ұңғымалардың көпшілігі өз әлеуетін сарқылмастан пайдаланудан шығады. Ең көп жуылған аймақтарды және кен орнының негізгі өнімді қабатының қазылған учаскелерін оқшаулауды қамтамасыз ететін оқшаулау іс-шараларын жүргізу ұсынылады. Селективті су оқшаулау және ағысты тоқтататын технологиялар әдістері, ең алдымен, қосымша өндірілген мұнай алу және мұнай алу коэффициентін арттыру мақсатында ағымдағы қорлардың тығыздығы жоғары ұңғымаларда, сондай-ақ сұйықтық бойынша дебиті жоғары ұңғымаларда жүзеге асырылуы тиіс.

Түйін сөздер: мұнай, айдау ұңғымалары, Профильді теңестіру, депрессия, бағана сыртындағы кеңістіктің герметикалығы, әлсіз цементтелген және борпылдақ коллекторлар, сулану қарқыны, жөндеу-оқшаулау жұмыстарының тиімділігі.

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ПРИЧИНЫ И АНАЛИЗ ОБВОДНЁННОСТИ ПРОДУКЦИИ НЕКОТОРЫХ МОРСКИХ МЕСТОРОЖДЕНИЙ АЗЕРБАЙДЖАНА

Аннотация. Представлены результаты исследований обводнённости некоторых морских месторождений (Нефт Дашлары, Гюнешли, Пираллахи, Банка Дарвина, Банка Апшерон, Западный Апшерон и т.д.) Азербайджанской Республики, большинство из которых находятся на поздней стадии разработки. Эти месторождения, представленные неоднородными по строению слабосцементированными и рыхлыми коллекторами, в которых наблюдается неравномерность потоков жидкости. Происходит прорыв воды по высокопроницаемым пропласткам, а пропластки с малой проницаемостью вовлекаются в разработку в меньшей степени. Последующие попытки вовлечения их в процесс разработки вызывают нерациональное увеличение объёмов закачиваемой воды, что и приводит к обводнению продукции. Росту темпов обводнения способствует и тип коллектора, характеризующийся наличием зон трещиноватости, способствующих перетоку вод из водоносных горизонтов к добывающим скважинам, а также улучшению их гидродинамической связи с нагнетающими скважинами. Установлены геологические и технологические причины обводнённости. Доказана неоднородность вышеупомянутых залежей. Указано, что дополнительной причиной раннего обводнения продукции добывающих скважин является нарушение герметичности заколонного пространства. Поддержание высоких темпов добычи нефти достигается вводом в эксплуатацию новых добывающих скважин, при этом большинство обводнившихся скважин выбывает из эксплуатации, не исчерпав свой потенциал. Предлагается проведение изоляционных мероприятий, которые обеспечат изоляцию наиболее промытых зон и выработанных участков основного продуктивного пласта месторождения. Методы селективной водоизоляции и потокоотклоняющих технологий должны осуществляться, в первую очередь, на скважинах с повышенной плотностью текущих запасов, с целью получения дополнительно добытой нефти и увеличения коэффициента извлечения нефти, а также на скважинах с высоким дебитом по жидкости.

Ключевые слова: нефть, нагнетательные скважины, выравнивание профиля, депрессии, герметичность заколонного пространства, слабосцементированные и рыхлые коллектора, темп обводнения, эффективность ремонтно-изоляционных работ.

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