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Satbayev University

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ИЗВЕСТИЯ

НАЦИОНАЛЬНОЙ АКАДЕМИИ НАУК
РЕСПУБЛИКИ КАЗАХСТАН
Satbayev University

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IMPROVEMENT OF HYDRAULIC FACING METHOD TO INCREASE WELLS PRODUCTIVITY

Abstract. The article considers that in recent years, there has been a tendency towards a deterioration in the structure of residual reserves in the fields, and hard-to-develop reserves are located in reservoirs with low permeability. Fracturing fluids used in hydraulic fracturing for the purpose of increasing oil recovery in multilayer fields with low permeability is analyzed. It is noted that the requirements for the use of these fluids in fields with a complex geological structure are high. The article proposes the use of a high-boiling oil fraction as a fracturing fluid in hydraulic fracturing, when comparing water-based gel usage, which is economically ineffective.

The exposure process in porous cavities and capillary tubules during injection of oil-based fracturing fluid into the formation was theoretically comprehensively analyzed and the importance of laboratory experiments was noted.

In laboratory conditions, a scheme for separating a high-boiling fraction of oil was shown on a special device and work was carried out to separate it into fractions by heating oil at a high temperature.

The course of experimental work was demonstrated using a high-boiling oil fraction to displace the original oil from oil-saturated cores using a specially prepared device. Before and at the end of oil displacement, displacement work with lighter oil was performed in the core with heavier oil, data on the porosity of the core, the volume of displaced oil, etc. were obtained. These data reveal the formation of cracks.

Summing up the results of laboratory studies, the advantages and disadvantages of hydraulic fracturing using an oil-based fracturing fluid were compared with a water-based fluid.

Key words: hydraulic fracturing, fracturing fluid, boiling point oil fraction, formation permeability, saturation.

Introduction. In the deposits of Kazakhstan, there has been a declined tendency within the structure of residual reserves in recent years. A significant part of the reserves is located in low-permeability reservoirs and in areas not covered by waterflooding. The main factor that negatively affects the productivity and efficiency of development is the heterogeneity of oil reservoirs.

There are multi-layer oil deposits that differ in permeability from each other, Therefore, the use of existing methods of uniform displacement of oil from multilayer deposits and stimulation of oil inflow to wells does not fully solve the problem of increasing oil recovery and increasing the production rate of producing wells. Hydraulic fracturing (HF) has become one of the most popular enhanced oil recovery methods today.

Currently, hydraulic fracturing is carried out mainly using a water-based gel as the fracturing fluid [1,2]. The application of this method requires the use of a high concentration of proppant to create longitudinal fractures in reservoirs with low conductivity, as well as in layers with high conductivity [3], and this process is possible only when using a polysaccharide gel with high viscosity. But, reagents for the preparation of an aqueous polysaccharide gel are quite expensive. To obtain a mixture with this property, the addition of various components in an amount of 10 or more is required [4]. Experimental studies show that reservoir conductivity is restored only by 40% after hydraulic fracturing using an aqueous polysaccharide gel based on guar and its derivatives [5,6]. These given circumstances, instead of water used as fracturing fluid, a high-boiling oil fraction should be used, and this requires laboratory research. The high-boiling oil fraction is extracted from the field oil itself.

When an oil-based fracturing fluid is injected into the formation, its viscosity decreases with increasing temperature, and the filtration rate becomes more stable than that of water. The pumped burst fluid expands cavities, opens up blockages within the capillary tubes and can cause cracks. An oil-based proppant fluid is then injected into the formation to prevent open cavities and fractures from re-closing as the pressure decreases. The oil-based fluid provides a uniform transfer of proppant into the porous cavities of the formation [7]. Therefore, using an oil-based fracturing fluid to increase well productivity is more effective than using a water-based fracturing fluid.

Materials and methods. In the laboratory, oil is poured into a container for oil to obtain a high-boiling oil fraction and a current is supplied at 100 ° C, 150 ° C, 200 ° C, 250 ° C to heat the oil. The heated oil is poured through a pipe into a vessel with an opening, where the heavy oil fraction remains and is removed through the pipe, and the light oil fraction passes through the opening into the cooling space. The light fraction of the cooled oil is discharged through a branch pipe (Figure 1).

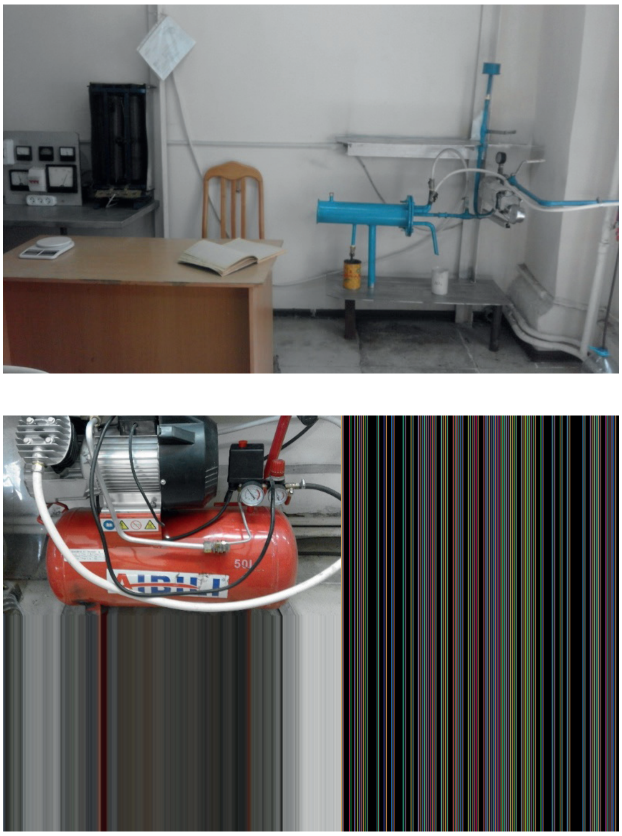

Figure 1. Oil fractionation equipment

The viscosity of the crude oil and the light and high viscosity oils obtained by the equipment is determined at 20 ° C, 60 ° C, 80 ° C and 100 ° C.

Under laboratory conditions, the process of hydraulic fracturing with an oil-based fluid is carried out in the following stages. First of all, with the help of a special diamond bit, the core required for the experiment is prepared. To remove dust from the cavities, the core is placed in a special device (Figure 2) and cleaned by injecting high pressure air using a compressor. The weight of the cleaned core is measured using an analytical laboratory balance.

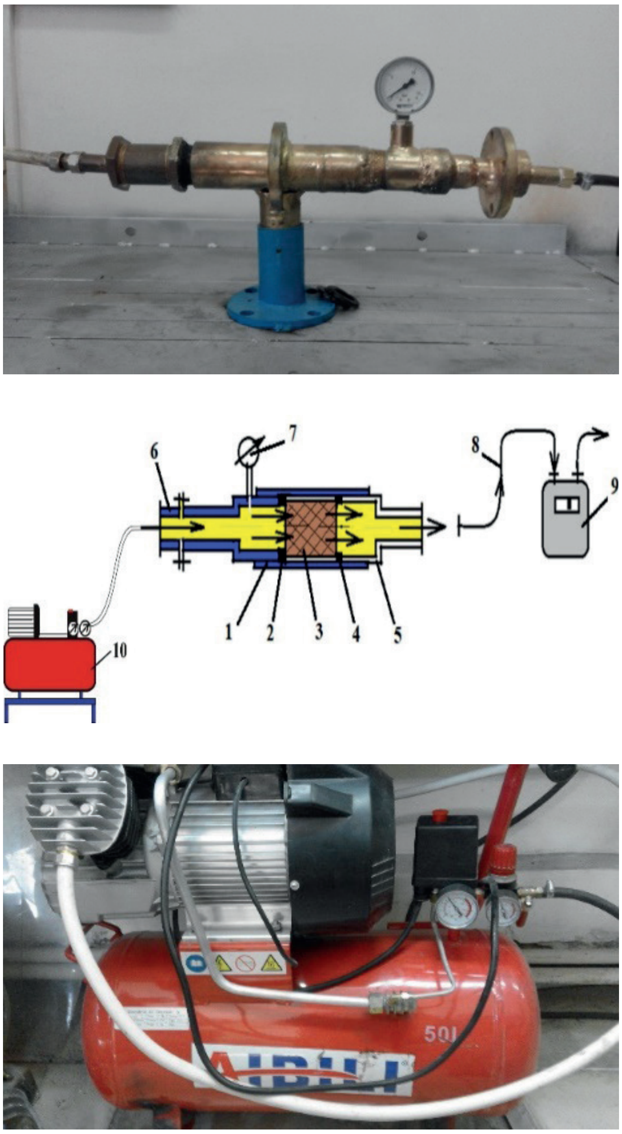

Figure 2. Device for removing dust from core cavities

In order to test the fracturing process in the core from the initial high-boiling fraction of the produced oil, the primary oil is first pumped into the core using a high-pressure compressor through the installation shown in Figure 3.

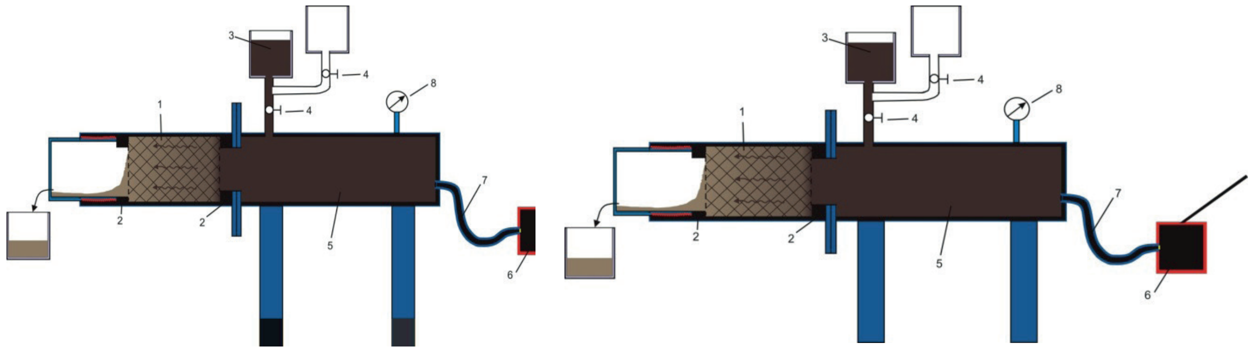

Figure 3. Schematic of the installation for breaking the core with oil in laboratory conditions

The time of pushing out light oil under high pressure and the weight of oil from the core are recorded in a special log, and at the end of the work, the core is removed and weighed on a special analytical laboratory balance and the data is recorded in a special log. By calculating the data obtained, the weight of oil obtained by pushing light oil into the porous cavities of the core is determined. After completing the pushing with the light oil in the same order, the core is pressed with high boiling oil, and then the light oil is pushed in again.

Laboratory results. For the separation of the high-boiling oil fraction, the density of the original oil is 0.860 g / cm3. The viscosity of oil was determined in the laboratory using the Poiseuille formula (Table 1).

Table 1. Viscosity of oil used in laboratory conditions

№	T, ºC	ρ, grp/cm^3	μ, Па*с
1	20	0,860	0,020
2	60	0,848	0,017
3	80	0,824	0,010
4	100	0,816	0,009

The density of the high-boiling fraction of the extracted oil was 0.943 g / cm3, the viscosity is shown in Table 2.

Table 2. Viscosity of high-boiling fraction of recovered oil

№	T, ºC	ρ, gr/cm^3	μ, Па*с
1	20	0,943	0,057
2	60	0,851	0,013
3	80	0,832	0,011
4	100	0,808	0,008

In order to determine the initial permeability of the core, the light oil fraction was first pumped into the core. The pressure when pumping light oil into the core was 5 MPa. The recovery time and the weight of oil recovered from the core were measured.

After the completion of the injection of the light oil fraction into the core, the high-boiling oil fraction will be injected.

At the end of the high boiling oil fraction injection, the light oil fraction was injected back into the core to determine the degree of fractures and cavities in the core.

The porosity coefficient of the core when analyzing the data obtained under laboratory conditions is shown in Table 3.

Table 3. Coefficient of porosity of the core

Kern №	1	2	3	4
$K_к$, %	13,42	12,89	12,54	12,23

he permeability coefficient of the core before and after the injection of the high-boiling oil fraction is shown in Table 4.

Table 4. Core conductivity coefficient

№ Kern	Permeability coefficient after primary oil injection, mkm^2	Conductivity coefficient after injection of high boiling oil, mkm^2
1	1,71	8,59
2	4,17	18,96
3	1,27	5,03
4	0,44	1,77

According to the results of experimental studies, it can be seen that after mini-hydraulic fracturing, the core permeability in comparison with the initial value increased several times. Thus, it was found that the method of mini-hydraulic fracturing using high-boiling oil fraction in reservoir conditions plays an important role in enhancing oil recovery.

Analysis of the obtained results of experimental studies. At high pressure in a special installation, light oil was first used as the fracturing fluid for the oil-saturated core, and then the high-boiling oil fraction obtained by heating. Finally, another experiment was carried out using light oil to determine the degree of expansion or cracking of porous cavities.

When light oil was used as the fracturing fluid in the special unit, the permeability of the cores was 1.71; 4.17; 1.27 and 0.44, and after using the high-boiling fraction of oil as a fracturing fluid, the permeability of the cores is 8.59, respectively; 18.96;

5.03 and 1.77. Here we see the expansion of the core cavities due to the fact that the core permeability has increased several times (Figure 4).

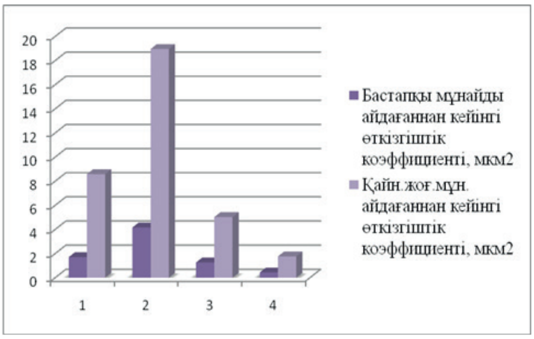

Figure 4. Core permeability coefficient after primary oil injection and after high-boiling oil injection

Discussion. The results of experimental studies show that the use of the hydraulic fracturing method using a high-boiling oil fraction can significantly increase oil recovery and well productivity. Considering the complex geological field structure, uneven reservoir properties of oil reservoirs and a large number of tectonic disturbances, it is convenient to use oil-based fracturing fluids.

Conclusion. Hydraulic fracturing using a high-boiling oil-based fracturing fluid has the following advantages over a water-based fracturing fluid:

1) A fracturing fluid based on a high-boiling oil fraction has a low cost due to production from the oil of the field;

2) Does not require the addition of any expensive additives as for a water-based fracturing fluid;

3) Since the fracturing fluid based on the high-boiling oil fraction is produced in the oil reservoir of the field, it does not undergo any reactions, coinciding with the properties of water formation and injected layer oil;

4) The water-based fracturing fluid can lose its properties at high temperatures in the oil reservoir, and the high-boiling oil-based fracturing fluid is resistant to high temperatures;

5) Due to the fact that the filtration properties are lower than that of water-based fluids, it is able to penetrate into voids and capillary channels in the reservoir rocks and open them evenly;

6) Due to its high viscosity, proppant can be evenly transported to open voids and cracks.

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ҰҢҒЫНЫҢ ӨНІМДІЛІГІН АРТТЫРУ МАҚСАТЫНДА ҚАБАТТЫ ГИДРАВЛИКАЛЫҚ ЖАРУ ӘДІСІН ЖЕТІЛДІРУ

Аннотация. Мақалада қазіргі кездегі игеріліп жатқан кенорындарында мұнайдың қалдық қорларын игеру қиындап бара жатқандығы және игерілуі қиын қорлар өткізгіштігі төмен қабаттарда орналасқандығы айтылған. Өткізгіштігі төмен көпқабатты кенорындарында қабаттың мұнай бергіштігін арттыру мақсатында қабатты гидравликалық жаруда қолданылатын жару сұйықтықтарына талдау жасалына келе, геологиялық құрылысы күрделі кенорындарында ол сұйықтықтарды қолдануға деген талап жоғары екендігі айталады. Бұл жұмыста қабатты гидравликалық жару кезінде жару сұйықтығы ретінде су негізіндегі гельді қолданудың экономикалық тиімсіз және өнімділігі айтарлықтай жақсы емес екендігі салыстырыла келе, мұнайдың қайнағыштығы жоғары фракциясын қолдану ұсынылды.

Мұнай негізіндегі жару сұйықтығын қабатқа жіберген кездегі кеуекті қуыстардағы және капиллярлы түтікшелердегі әсер ету процесі теориялық тұрғыдан жан-жақты талданып, зертханалық тәжірибе жасаудың маңыздылығы айтылды.

Зертханалық жағдайда мұнайдың қайнағыштығы жоғары фракциясын арнайы құрылғыда бөліп алудың схемасы көрсетіліп, жоғары температурада мұнайды қыздыру арқылы оны фракцияларға бөліп алу жұмыстары жүргізілді.

Арнайы дайындалған құрылғының көмегімен мұнайға қаныққан керндерді бастапқы мұнайды итеру үшін, бөлініп алынған мұнайдың қайнағыштығы жоғары фракциясын қолданып жасалынған тәжірибелік жұмыстың барысы көрсетілді. Керндегі мұнайды қою мұнаймен итерудің алдында және соңында жеңіл мұнаймен итеру жұмыстары жасалынып, керннің кеуектілігі, итеріліп шыққан мұнайдың көлемі және т.б. мәліметтер алынды. Сол арқылы жарықшақтардың пайда болған-болмағандығы анықталды.

Зертханалық зерттеу нәтижелерін қорытындылай келе, мұнай негізіндегі жару сұйықтығын қолданып қабатты жарудың су негізіндегі жару сұйықтығына қарағандағы артықшылықтары мен кемшіліктері салыстырылды.

Түйін сөздер: қабатты гидравликалық жару, жару сұйықтығы, мұнайдың қайнағыштығы жоғары фракциясы, қабаттың өткізгіштігі, қаныгу.

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УСОВЕРШЕНСТВОВАНИЕ МЕТОДА ГИДРОРАЗРЫВА ПЛАСТА ДЛЯ ПОВЫШЕНИЯ ПРОИЗВОДИТЕЛЬНОСТИ СКВАЖИН

Аннотация. В статье рассматривается, что в последние годы на месторождениях наметилась тенденция к ухудшению структуры остаточных запасов и трудноразрабатываемые запасы находятся в пластах с низкой проницаемостью. Анализируя жидкости разрыва, используемые при гидроразрыве пласта с целью увеличения нефтеотдачи на многопластовых месторождениях с низкой проницаемостью, отмечается, что требования к использованию этих жидкостей на месторождениях со сложным геологическим строением высоки. В статье предлагается использование высококипящей фракции нефти в качестве жидкости разрыва при гидроразрыве пласта, при сравнении использования геля на водной основе, которая является экономически неэффективным и малоэффективным.

Процесс воздействия в пористых полостях и капиллярных канальцах при закачке жидкости разрыва на нефтяной основе в пласт был теоретически всесторонне проанализирован и отмечена важность проведения лабораторных опытов.

В лабораторных условиях была показана схема отделения высококипящей фракции нефти на специальном устройстве и проведены работы по ее разделению на фракции путем нагрева нефти при высокой температуре.

Был продемонстрирован ход экспериментальной работы с использованием высококипящей фракции нефти для вытеснения исходной нефти из нефтенасыщенных кернов с помощью специально подготовленного устройства. Перед и в конце вытеснения нефти в керне с более тяжелой нефтью были выполнены вытеснительные работы с более легкой нефтью, получены данные о пористости керна, объем вытесненной нефти и др. По этим данным выясняется образование трещин.

Подводя итоги лабораторных исследований, были сопоставлены преимущества и недостатки гидроразрыва пласта с использованием жидкости разрыва на нефтяной основе по сравнению с жидкостью на водной основе.

Ключевые слова: гидроразрыв пласта, жидкость разрыва, высококипящая фракция нефти, проницаемость пласта, насыщенность.

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