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APPLICATION ANALYSIS OF FLOW-DEFLECTING TECHNOLOGY BASED ON A BIOPOLYMER SYSTEM

***BISSEMBAYEVA K.**
Caspian University of Technology
and Engineering named after Sh.Yessenov,
Aktau, Kazakhstan
E-mail: karlygash.bissembayeva@yu.edu.kz
ANJUM M.RESHMA
Hamburg University of
Applied Sciences, Hamburg, Germany
Corresponding author: karlygash.bissembayeva@yu.edu.kz

Annotation. At present, many oil fields are on the third and fourth stages of development, which are characterized by significant volumes of associated water production and low degree of depletion of oil reserves from individual sections of the deposit.

The volume of oil produced from the deposits is constantly decreased. This is due to the influence on the operation of wells of complex geological structures of productive formations, and fluid compositions that manifest themselves in production processes. In dense reservoirs with high geological heterogeneity, separate undeveloped areas and areas that are not covered by flooding remain in the development process. In these conditions, in order to increase the efficiency of flooding systems, the task is to maximize the coverage of reservoirs by exposure, which can be achieved by introducing water into low-permeable oil-saturated intervals.

In this case, the elastic-capillary-cyclic method and the method of changing the direction of filtration fluid flows in the reservoir have significant possibilities, both in area and in the section. In this case, the elastic-capillary-cyclic method and the method of changing the direction of filtration fluid flows in the reservoir have significant possibilities, both in area and in section.

One of the most effective and promising methods of stabilizing oil production is physics-chemical technology based on the application of injection of polymer compositions. This paper provides an analysis of the application of the technology of redistribution of filtration flows in a multilayer field. This technology used a biopolymer-based chemical composition.

To study the effect of the biopolymer system on the oil production process, an analysis of changes in the technological parameters of the reacting production wells was carried out. The article provides an assessment of the technological effectiveness of methods for changing the direction of filtration flows in the reservoir based on the analysis of the results of the use of biopolymer compositions at one of Mangystau deposits.

Keywords: Well, oil deposit, influence on the formation, flow-deflecting technology, filtration flow, polymer composition, biopolymer system, efficiency

Introduction. Currently, there are many active development technologies known all over the world, both from near and far abroad. Nevertheless, the discovery of new and development of existing fields allowed us to identify a number of additional geological, physical and technological factors, such as a change in the hydraulic fracturing gradient taking into account the angle of inclination of the borehole, the optimal and minimum injection pressure for formations with different filtration properties, the frequency of pressure changes at the mouths in injection and at the faces of producing wells, insufficiently complete their research led to a decrease in the efficiency of the processes of

producing hard-to-recover reserves. The deformation processes manifested in productive reservoirs during technological measures to improve reservoir permeability are investigated. [1-3]. Basically, they show that the effectiveness of intensification processes depends on the ratio of stress values, changes in reservoir volume and reservoir pressure. At the same time, it is noted that in order to maximize the practical use of the possibility of vibrational filtration processes of fluids, it is necessary to numerically model them in a significant volume of the reservoir.

To improve the effect of the adopted development technology, it is necessary to change the volume of the acting agent injected into the pore - crack system [4-6]. The sedimentological features of the formation create surfaces with different shapes and directions inside it, which can reflect the fluid flow and create areal permeability anisotropy [7]. It is proposed to use flow-separating methods to improve the impact system and justify the optimal bottom-hole pressure in producing wells [9].

A detailed literature review devoted to the study of filtration processes shows that modern technologies and methods of exposure to deposits with hard-to-recover reserves have not found proper justification for the theory and practice of fluid filtration, taking into account changes in the structure of a low-yield reservoir. In addition, it requires further development of the theoretical position on non-stationary spatial filtration of fluids in a deformable low-productive porous-fractured medium, taking into account the sharp fluctuations in permeability coefficients, hydroconductivity and energy in multilayer formations, which have the most significant effect on the process of producing hard-to-recover reserves. As the practice of exploitation of multilayer deposits shows, an increase in oil production by improving the technology of producing reserves from low-yielding reservoirs is equivalent to the discovery of new hydrocarbon deposits.

The efficiency of oil displacement by water depends on the geological characteristics of the formations, their zonal and layered heterogeneity, fragmentation, and properties of the fluids saturating the formation. In dense reservoirs with high geological heterogeneity, separate undeveloped areas and areas that are not covered by flooding remain in the development process. In these conditions, in order to increase the efficiency of flooding systems, the task is to maximize the coverage of reservoirs by exposure, which can be achieved by introducing water into low-permeable oil-saturated intervals.

In this case, the elastic-capillary-cyclic method and the method of changing the direction of filtration fluid flows in the reservoir have significant possibilities, both in terms of area and section [9].

But as practice has shown, it is necessary to use the technology of exposure to physical-chemical reagents in a complex with flooding. One of the most effective and promising methods of stabilizing oil production is the physical-chemical technologies based on the use of injection of polymer compositions [10-12]. One of these methods is the flow-deflecting technology.

Materials and methods of research. Flow-deflecting technology is aimed at increasing the current and final oil recovery coefficient by increasing the coverage of the reservoir by flooding. The essence of the technology is to block the most permeable zones with gel compositions. As a result of this the volume of water injection is redistributed, both in thickness and in the area of the deposit, and applied to the development of previously uncovered or poorly covered zones of the reservoir by flooding.

The rapid development of biotechnology in recent years has led to the possibility of using biopolymers in the oil industry, which are polysaccharides of both plant and microbial origin. Biopolymers are biomacromolecules obtained from renewable resources with universal functions, including thickening, crosslinking, adsorption, etc. Having high efficiency and low cost, they have found wide application at all stages of oil production. Biopolymers are commonly used as additives to liquids to improve their properties. This affects the productivity of oil production. Research on the synthesis and characterization of polymers, as well as control of their structure by modification, is aimed at developing new recipes for processing biopolymers with new fields of application [13].

The researchers evaluated the effect of biopolymers in many cases of oil production, which made it possible to establish a correlation between their physics-chemical properties and

operational characteristics. As their operational characteristics are strongly influenced by the local environment, the selection and testing of polymers under controlled conditions is a necessary step to ensure the effectiveness and safety of biopolymer processing.

The main advantages of biopolymers are high salinity and temperature stability due to the spiral structure. In addition, these polymers do not harm the environment during production and subsequent use.

The practical value of biopolymers is determined primarily by their ability to dramatically change the rheological properties of aquatic systems in low concentrations – to increase viscosity, form gels, and serve as stabilizers of suspensions and emulsions.

Compared with water-soluble synthetic polymers traditionally used in oil production, biopolymers have a number of significant advantages, including those that allow them to be used in very harsh conditions where the use of synthetic polymers is ineffective. Biopolymers are stable at temperatures up to 100–120˚C, and some representatives even up to 150˚C, which covers the entire temperature range of the fields being developed. Biopolymers are stable in a wide pH range, both in acidic and alkaline environments. This allows them to be used both for the preparation of alkaline compositions with increased oil-displacing properties, and acidic ones with prolonged dissolving ability in relation to carbonates of reservoir rocks.

An important property of biopolymers is resistance to mechanical, chemical (in particular, oxidative) degradation.

The technology using a biopolymer-based chemical composition was applied at a field in Kazakhstan, exactly, at Zhetybai field. The purpose of this method is the redistribution of filtration flows (RFF).

The flow-deflecting technology provides for the injection into injection wells of chemical compositions based on a biopolymer consisting of cellulose-containing materials.

Cellulose is a biopolymer, which is the basis for many materials and products due to such unique properties as high strength, biocompatibility, and biodegradability. In addition, cellulose-containing materials are environmentally safe, non-toxic and widespread due to their renewable raw material base [13]. In recent years, a large group of innovative materials with special properties has been created on the basis of cellulose for use in various fields of science, technology and medicine. Developments in the field of obtaining materials and reagents with superhydrophobic properties belong to a number of relevant areas.

The results of the introduction of flow-deflecting biopolymer technology are:

-redistribution of filtration flows over the area and section of the treated area of the deposit;

-containment of water breakthrough from injection wells to production wells;

-involvement in the development of hard-to-recover reserves from areas with reduced permeability.

At Zhetybai field, filtration flow redistribution technology has been applied in 20 injection wells. The effectiveness of the RFF technology was evaluated based on the data of geophysical surveys (GS) performed before and after the technological work. According to the results of the use of RFF technology in the operation of wells, either changes have occurred or not, but for some wells it is not possible to judge the change in pick-up according to GS data [14].

The technological efficiency of the RFF was evaluated analytically. For this purpose, an analysis of changes in the technological parameters of the reacting production wells was carried out. The following indicators are defined as an efficiency criterion: the average increase in oil production per well, the total additional oil production from wells over the effective period of operation, and the success of the work.

Results of research. According to field data, the analysis of technology application efficiency for 12 wells was carried out. The change in the technological parameters of injection wells is presented in Table 1 [14].

Table 1-Changes in technological parameters of injection wells operation

№ of injection wells	Horizon	Q (average), м^3/day		Perforation interval, м	$К_{pick-up}$, м3/day*MPa		Specific $К_{pick-up}$, м3/day* MPa*м	
		before	after		before	after	before	after
655	3	240	210	1810-1825	45,103	39,465	3,007	2,631
1013	8	200	100	2100-2142,5	43,962	21,981	3,663	1,832
1146	8	180	180	2090-2141	25,371	25,371	1,425	1,425
1149	8	147	125	2087-2136	30,931	26,319	1,947	1,655
1342	8	120	106	2137-2150	16,262	14,365	1,506	1,33
824	10	200	250	2187-2255	40,182	45,642	1,4	1,59
2792	10	200	240	2198-2260	35,337	40,957	2,265	2,625
2861	10	275	158	2212-2238	59,542	34,209	2,589	1,487
245	11	150	150	2294-2305	19,767	19,767	2,824	2,824
2266	5v, 6a	300	160	1925-1973	75,459	40,245	7,256	3,87
1259	5v, 6ab	280	290	1918-1991	81,577	84,491	-	-
2360	5v, 6ab	300	70	1935-1992	49,792	11,618	3,83	0,894
Total		216	170		43,607	33,703	2,883	2,015

As follows from the table, of 12 injection wells, the pick-up rate in 8 wells decreased after injection of the biopolymer. The indicators of two wells (1146, 245) remained unchanged. There was an increase in pick-up in wells 824 and 1259. According to GS data, a violation of the columns was detected at certain intervals, into which 22% of the injected liquid goes.

In general, as a result of injection of biopolymer solution, the pick-up coefficient in injection wells decreased by an average of 23%, which characterizes the success of the work.

The results of the analysis of changes in the technological parameters of the reacting production wells are presented in Table 2 [14].

Table 2 - Efficiency of applying RFF technology

№ of well	Horizon	Number of reactive production wells	Q_{fluid}(aver), м^3/day		Q_{oil}(aver), Additional oil production		Water cut, %		Additional oil production, t	Accumul. add. oil production, tons	Success rate, %
			before	after	before	after	before	after			
2266	5v, 6a	3	9	11	0,7	2,9	92	74	2,2	129	77
1259	5v, 6ab	5	43	45	11,8	19,2	72	57	7,4	04	38
2360	5v, 6ab	5	18	21	4,4	5,6	76	74	1,2	100	21
1013	8	3	18	30	12,6	18,1	31	39	5,5	676	31
1146	8	3	22	29	2,6	7,4	88	74	4,8	419	65
1149	8	5	23	19	4,7	9,7	80	42	5,0	546	51

1342	8	4	15	9	2	12	65	64	10	519	55
2792	10	6	15	30	4	8	55	50	4,5	417	44
2861	10	6	5	5	0,5	1,1	89	79	0,6	46	53
245	11	4	15	14	4	7	77	77	3,1	350	47
655	3	3	51	39	21	18	61	61	0,0	0,0	0,0
824	10	3	22	17	8	6	64	67	0,0	0,0	0,0
Total		50	18	21	4,7	9,1	72	63	4,4	3705	41

As follows from the data presented in the table, the injection of biopolymer composition affected 14 production wells. Additional oil production per well amounted to 4.4 tons / day, the accumulated additional oil production due to the work was 3,705 thousand tons. The success rate of the event was 41 %.

Conclusion. The introduction of filtration flow redistribution technology makes to partially block areas with high permeability of collectors and redirect the displacing agent to areas with lower permeability, while increasing the flood coverage coefficient.

Injection of the biopolymer system leads to blocking of the pore space of the washed formation intervals, reducing their permeability, and, accordingly, to inhibition of water filtration rates in these intervals at the greatest possible distance from the injection well, that is, the heterogeneity of the formation is eliminated not only in thickness, but also in area at a predetermined distance.

In conclusion, we can say that the technology of redistribution of filtration flows with the use of biopolymer is a sufficiently effective method of influence for the complete coverage of reservoirs by flooding.

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Қарлығаш Таңбайқызы Бисембаева

Ш. Есенов атындағы Каспий технологиялар және инжиниринг университеті

Anjum M.Reshma

Гамбург қолданбалы ғылымдар университеті, Гамбург, Германия

БИОПОЛИМЕРЛІК ЖҮЙЕГЕ НЕГІЗДЕЛГЕН АҒЫНДЫ АУЫТҚУ ТЕХНОЛОГИЯСЫН ҚОЛДАНУДЫ ТАЛДАУ

Аңдатпа. Қазіргі уақытта көптеген мұнай кен орындары игерудің үшінші және төртінші кезеңдеріне енуде, олар ілеспе суды өндірудің едәуір көлемімен және кен орнының жекелеген учаскелерінен мұнай қорларының төмен өндірілуімен сипатталады.

Кен орындарында өндірілетін мұнай көлемі үнемі азайып келеді. Бұл ұңғымалардың жұмысына өнімді қабаттардың күрделі геологиялық құрылымдарының және өндірудің технологиялық процестерінде көрінетін сұйықтықтардың құрамына әсер етуімен байланысты. Жоғары геологиялық гетерогенділігі бар тығыз коллекторларда игеру процесінде су басумен қамтылмаған жеке өңделмеген учаскелер мен аймақтар қалады. Мұндай жағдайларда су басу жүйелерінің тиімділігін арттыру үшін қабаттарды экспозициямен барынша қамту міндеті қойылады, оған суды өткізгіштігі төмен мұнаймен қаныққан интервалдарға енгізу арқылы қол жеткізуге болады.

Бұл жағдайда серпімді-капиллярлық-циклдік әдіс және қабаттағы сұйықтықтың сүзу ағындарының бағытын өзгерту әдісі аудан бойынша да, кесу бойынша да айтарлықтай мүмкіндіктерге ие.

Мұнай өндіруді тұрақтандырудың ең тиімді және перспективалы әдістерінің бірі полимерлі композицияларды айдауды қолдануға негізделген физика-химиялық технологиялар болып табылады. Бұл жұмыста көп қабатты кен орнында сүзу ағындарын қайта бөлу технологиясын қолдану талдауы келтірілген. Бұл технологияда биополимер негізіндегі химиялық құрам қолданылды.

Биополимерлік жүйенің мұнай өндіру процесіне әсерін зерттеу үшін реакцияға түсетін өндіруші ұңғымалар жұмысының технологиялық параметрлерінің өзгеруіне талдау жүргізілді. Мақалада Маңғыстау кен орындарының бірінде биополимерлік құрамдарды қолдану нәтижелерін талдау негізінде қабаттағы сүзу ағындарының бағытын өзгерту әдістерінің технологиялық тиімділігін бағалау келтірілген.

Кілт сөздер: Ұңғыма, мұнай кен орны, қабатқа әсер ету, ағынды бұру технологиясы, сүзу ағыны, полимер құрамы, биополимер жүйесі, тиімділік

Карлыгаш Танбаевна Бисембаева
Каспийский университет технологий и инжиниринга имени Ш.Есенова
Anjum M.Reshma
Гамбургский университет прикладных наук, г. Гамбург, Германия

АНАЛИЗ ПРИМЕНЕНИЯ ПОТОКООТКЛОНЯЮЩЕЙ ТЕХНОЛОГИИ НА ОСНОВЕ БИОПОЛИМЕРНОЙ СИСТЕМЫ

Аннотация. В настоящее время множество нефтяных месторождений вступают в третью и четвертую стадии разработки, которые характеризуются значительными объемами добычи попутной воды и низкой степенью выработанности запасов нефти из отдельных участков залежи.

Объемы добываемой нефти на месторождениях постоянно снижаются**.** Это связано с влиянием на работу скважин сложных геологических строений продуктивных пластов, и составов флюидов, которые проявляются в технологических процессах добычи. В плотных коллекторах с высокой геологической неоднородностью в процессе разработки остаются отдельные невыработанные участки и зоны, неохваченные заводнением. В этих условиях для повышения эффективности систем заводнения ставится задача максимального охвата пластов воздействием, что может быть достигнуто за счет внедрения воды в малопроницаемые нефтенасыщенные интервалы.

Значительными возможностями в этом случае, как по площади, так и по разрезу обладает упруго-капиллярно-циклический метод и метод изменения направления фильтрационных потоков жидкости в пласте.

Одним из максимально эффективных и перспективных методов стабилизации добычи нефти являются физико-химические технологии, основанные на применении закачки полимерных композиций. В данной работе приводится анализ применения технологии перераспределения фильтрационных потоков на многопластовом месторождении. В данной технологии использовался химический состав на биополимерной основе.

Для изучения влияния биополимерной системы на процесс добычи нефти был проведен анализ изменения технологических параметров работы реагирующих добывающих скважин. В статье приводится оценка технологической эффективности методов изменения направления фильтрационных потоков в пласте на основе анализа результатов применения биополимерных составов на одном из месторождении Мангыстау.

Ключевые слова: Скважина, нефтяная залежь, воздействие на пласт, потокоотклоняющая технология, фильтрационный поток, полимерный состав, биополимерная система, эффективность.