IJABR

International Journal of Advanced Biotechnology and Research (IJABR)
ISSN 0976-2612, Online ISSN 2278–599X,
Special Issue-1, 2019, pp292-296
http://www.bipublication.com

Research Article

Development of a Technology for Cutting off the Bottom Water Cone

Dmitrii LEONTIEV[a, *], Anastasiya SEMENENKO[b], Mashkhura MANSUROVA[c] and Sergey Mikhailov[d]

Industrial University of Tyumen, Tyumen, Russia
[a]leontevds@tyuiu.ru, [b]semenenkoaf@tyuiu.ru, [c]mansurovamm@tyuiu.ru, [d]mihajlovsj@tyuiu.ru

ABSTRACT.

The technology for cutting off the bottom water cone in oil wells, including shutting off a well, removing downhole equipment from the motherbore production string, installing a packer plug 1 m below the lower perforations, landing the tubing string with a packer, injecting a selective insulation composition, followed by injecting a microcement-based grouting composition, followed by injecting a cement-based grouting composition, installing a cement sleeve down to the productive formation top, retrieving the tubing string with the packer, waiting on cement, drilling the cement sleeve with a packer plug, running in the slot perforator with the tubing into the oil-saturated formation interval, perforating the formation, exploring the well and bringing it to stable production.

Keywords: Bottom water cone, Selective water shutoff composition, Microcement-based grouting composition, Cement-based grouting composition.

INTRODUCTION

Currently, most of operated oil fields are, unfortunately, at the final stages of development. This is characterized by a gradual decrease in formation pressures of reservoirs and flow rates of production wells, a progressive increase in the water cut of produced oil.

Huge oil reserves are concentrated in oil-water zones, where the water cut of the main production facilities reaches more than 90%, which negatively affects the final oil recovery factor. The most acute problem is the high (premature) water-cut of oil recovered from wells.

The rational use of water suppression technologies significantly increases the efficiency of oil field development [1,2].

METHODS AND RESULTS

The challenge facing authors is to increase the efficiency of water shutoff activities in oil wells by creating a long and sufficiently thick water shutoff screen.

The technical result achieved as a result of the technology implementation consists in increasing the thickness and the radius of the water shutoff screen, as well as delaying the water flooding.

The task and the technical result are achieved by the fact that the method for cutting off the bottom water cone in oil wells includes shutting off a well, removing downhole equipment from the motherbore production string, installing a packer plug 1 m below the lower perforations, landing the tubing string with the packer, injecting a selective insulation composition, followed by injecting a microcement-based grouting composition, followed by injecting a cement-based grouting composition, installing a cement sleeve down to the productive formation top, retrieving the tubing string with the packer, waiting on cement, drilling the cement sleeve with a packer plug, running in the slot perforator with the tubing into the oil-saturated formation interval, perforating the formation, exploring the well and bringing it to stable production. Figs. 1-4 are schematic representations of the method implementation.

The well 1, which recovers oil from the productive formation 2, in the lower part of which bottom water 3 occurs, is shut down due to the high water cut resulting from the formation of a bottom water cone 4 that blocked the lower perforation interval 5. The downhole equipment 6 is removed by a production packer 7 from the motherbore production string, a packer plug is installed 1 m (not shown) below the lower perforations (Fig. 1), the tubing string with a packer 8 is landed, a selective insulation composition 9 is injected (Fig. 2), then a microcement-based composition 10 is injected, which allows pushing the selective composition deep into the formation (Fig. 3), after which a cement-based grouting composition 11 is injected, which allows pushing the microcement-based grouting composition and the selective composition deep into the formation, as well as fixing the water shutoff screen (Fig. 4). The three-cycle injection allows cutting off the bottom water cone 4 and creating a long reliable water shutoff screen in the OWC interval. After the third portion has been injected, the cement sleeve is installed down to the productive formation top (not shown), the tubing string with the packer 8 is retrieved, the cement is waited on, the cement sleeve is drilled with a packer plug (not shown), the perforator is run with the tubing into the oil-saturated formation interval, the formation is perforated, the well is explored and brought to stable production[3].

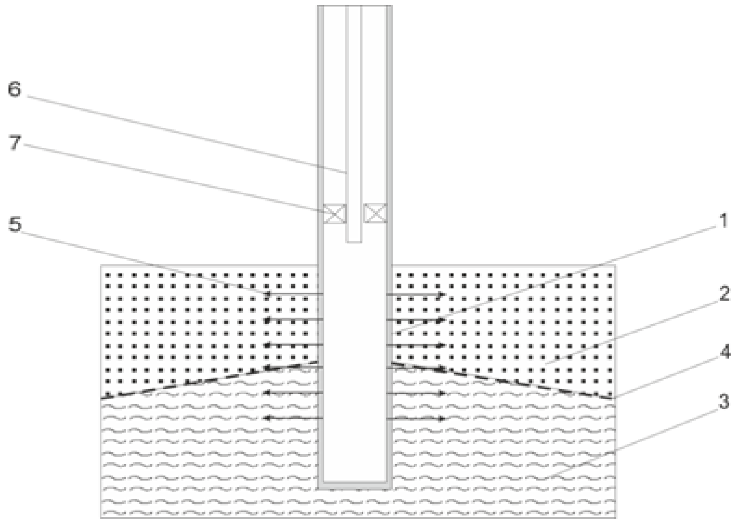

Fig. 1 Pulling up the bottom water cone.1 – well; 2 – oil-saturated part of the formation; 3 – water-saturated part of the formation; 4 – oil-water contact; 5 – perforations; 6 – downhole equipment; 7 – production packer.

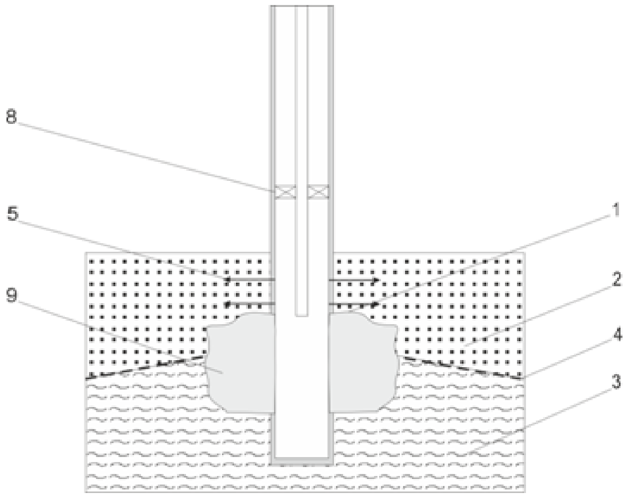

Fig. 2 Injection of the selective insulation composition.1 – well; 2 – oil-saturated part of the formation; 3 – water-saturated part of the formation; 4 – oil-water contact; 5 – perforations; 8 – tubing with packer; 9 – selective composition.

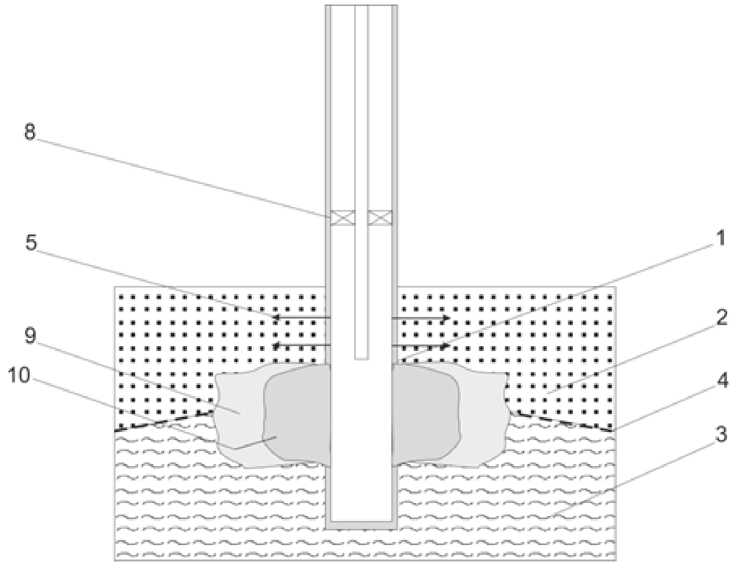

Fig. 3 Injection of the microcement-based composition.1 – well; 2 – oil-saturated part of the formation; 3 – water-saturated part of the formation; 4 – oil-water contact; 5 – perforations; 8 – tubing with packer; 9 – selective composition; 10 – microcement-based grouting composition.

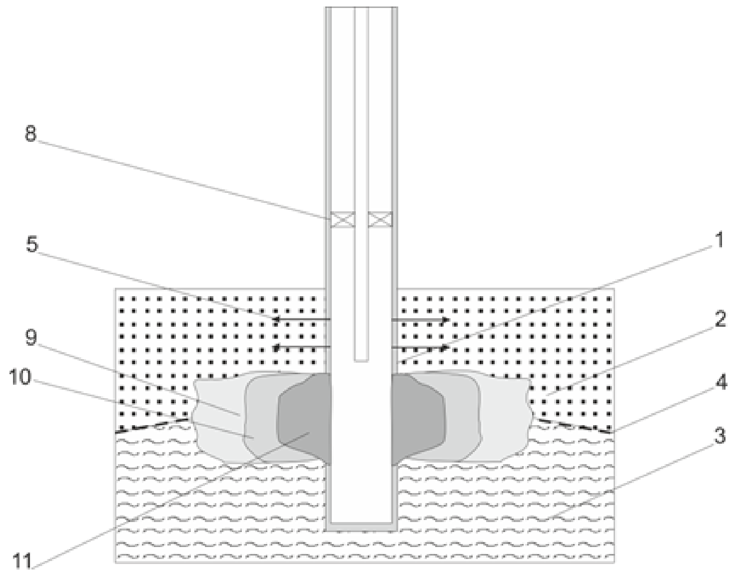

Fig. 4 Injection of the cement-based composition.1 – well; 2 – oil-saturated part of the formation; 3 – water-saturated part of the formation; 4 – oil-water contact; 5 – perforations; 8 – tubing with packer; 9 – selective composition; 10 – microcement-based grouting composition; 11 – cement-based grouting composition.

As a selective grouting composition, it is recommended to use a selective composition for repair and insulation activities in oil and gas wells, including 10 vol% of hydrophobic silicon-organic liquid (NGL-11N), 85 vol% of ethyl silicate ETS-40 as a catalyst, 5 vol% of diatomite as a thickener [4]. The formulation and technological characteristics of the ETS-40-based selective water shutoff composition with diatomite are given in Table 1.

Table 1: Formulation and technological characteristics of the ETS-40-based selective water shutoff composition with diatomite

Seq. No.	Core porosity, [%]	Ratio of components: ETS-40 /diatomite/ NGL-11N	Formation water-measured permeability, $\cdot 10^{-3}$ [μm^2]		Kerosene-measured permeability, $\cdot 10^{-3}$ [μm^2]		Plastering effect of the composition acc. to formation water, [%] $\frac{k_1 - k_2}{k_1} \times 100$	Plastering effect of the composition acc. to kerosene, [%] $\frac{k'_1 - k'_2}{k'_1} \times 100$
			k_1 before treatment	k_2 after treatment	k_1^1 before treatment	k_2^1 after treatment		
1	23.7	65/15/20	7.7	1.44	6.5	3.3	81.2	49.2
2	23.3	75/10/15	6.2	1.1	5.3	3.7	82.2	30.2
3	16.9	85/5/10	17.5	0.4	15.7	14.1	97.7	10.2
4	15.5	85/5/10	38.0	1.0	31.5	29.4	97.3	6.7
5	15.6	85/5/10	17.8	0.4	16.1	13.9	97.7	13.7
6	22.1	85/5/10	47.2	1.4	33.0	29.7	97.0	10.0
7	20.8	90/5/5	54.7	17	48.1	41.8	68.9	13.1

As a microcement-based grouting composition, it is recommended to use a solution containing a 2.0% aqueous solution of polyvinyl alcohol PVA-V1N and a mixture of U Mikrodurwith calcium hypochlorite $Ca(ClO)_2$ in the following ratio of components, vol%. 2.0% aqueous solution of PVA-V1N – 50.0; a mixture of U Mikrodurwith calcium hypochlorite $Ca(ClO)_2$ – 50.0, including U Mikrodur– 48, $Ca(ClO)_2$ – 2.0 [5].The formulation and results of measuring the time of curing and formation of a durable water shutoff material are given in Table 2.

Table 2: Formulation and results from measuring the time of curing and formation of a durable water shutoff material

Formulation of working solution	Ratio of PVA aqueous solution: (Mikrodur+ calcium hypochlorite)	Start of curing/ End of curing, [h]	Qualitative characteristic of created insulation material
7.5[%] solution of PVA-V1N + (mixture of U Mikrodur with calcium hypochlorite)	2:1	5/48	Poorly-cemented medium-strength compound
5.0[%] solution of PVA-V1N + (mixture of U Mikrodurwith calcium hypochlorite)	2:1	4/48	Viscoplastic medium-strength compound
2.5[%] solution of PVA-V1N + (mixture of U Mikrodurwith calcium hypochlorite)	1:1	4/48	Medium-strength stonelike material
2.0[%] solution of PVA-V1N + (mixture of U Mikrodurwith calcium hypochlorite)	1:1	4/48	Durable stonelike material

Change in the relative permeability of core samples after treatment with repair composition is given in Table 3.

Table 3: Change in the relative permeability of core samples after treatment with repair composition

Sample No.	Formulation of working solution, [vol%]	Water-measured permeability, $1 \cdot 10^{-3}$, [μm^2]		Bridging factor, unit fraction $K_2 = \frac{K_{perm.1} \quad K_{perm.2}}{K_{perm.1}} \times 100$
		Before treatment, $K_{perm.1}$	After treatment, $K_{perm.2}$	
1	2.0[%] aqueous solution	49.2	5.6	0.886
2	of PVA-V1N mixture of U	100.8	10.1	0.899
3	Mikrodur– 50.0. (48.0	500.3	complete	-

	[vol%]) with calcium hypochlorite $Ca(ClO)_2$ (2.0 [vol%])		bridging	

CONCLUSION

The proposed technology for cutting off the bottom water cone in wells allows increasing the radius, thickness,and area of the water shutoff screen and increasing the anhydrous period of well operation, delaying the inevitable water flooding of the well [6-8].

REFERENCES

[1] A.P. Telkov, Yu.I. Stklyanin, Formation of Bottom Water Cones in Oil and Gas Production, Nedra, Moscow, 1965.

[2] I.I. Kleshchenko, G.P. Zozulya, A.K. Yagafarov, Theory and Practice of Repair and Water Shutoff Works in Oil and Gas Wells, Industrial University of Tyumen, Tyumen, 2010.

[3] V.A. Dolgushin, I.I. Kleshchenko, D.S. Leontiev et al.,Patent 2529080, Russian Federation, IPC E21B 33/138 (2006.01), C09K 8/506 (2006.01). Selective Composition for Repair and Insulation Activities in Oil and Gas Wells, 2014.

[4] I.I. Kleshchenkoet al.,Patent 2326922, Russian Federation, IPC C 09K 8/504 (2006.01). Composition for Repair Activities in Wells, 2008.

[5] D.S. Leontiev, I.I. Kleshchenko, A.K. Yagafarov et al., Patent 2655490, Russian Federation, IPC E21B 43/32 (2006.01). The Method for Cutting off the Bottom Water Cone, 2018.

[6] Mardani, M., Lavasani, S. M., &Omidvari, M. (2014). An investigation into DOW and MOND indices with fuzzy logic based on fire and explosion risk assessment in Iran oil refinery, *UCT Journal of Research in Science, Engineering and Technology, 2(3)*: 126-137.

[7] Seddigh, R., Keshavarz-Akhlaghi, A. A., Azarnik, S., Bahrmpour, S., &Shariati, B. (2018). Why the caregivers of bipolar patients need to be in constant touch with a physician: A qualitative study of text messages from patient caregivers to a physician. *Electronic Journal of General Medicine*, *15*(6).

[8] Bedel C, Tomruk Ö, Yolcu S, Albayrak L. Duodenal Perforation by an Ingested Nail. J ClinExp Invest. 2018;9(3):135-6.