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Research Article

Elaboration of a Technology for Preventing an Inflow of Bottom Waters in the Oil Producing Well

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ABSTRACT.

The technology for preventing the inflow of bottom waters into an oil production well prior to its commissioning includes the perforator descent on tubing to the OWC level, the perforation of the production string for 1.5 m lower and higher than the OWC level, raising the perforator, lowering the tubing string to perforations, injecting the first portion of the makeup based on Uniflockand $CuSO_4$ at the following ratio of components, wt%: 1wt% solution of Uniflock+ 5wt% $CuSO_4$. After that, the injection of the second portion of the makeup at the following ratio of components, wt%: 1wt% solution ofUniflock+ 10wt% $CuSO_4$ + ETS-32 (volume ratio ETS-32:$CuSO_4$ = 0.33:0.17). After that, the injection of the third portion of the composition in the following ratio of components, wt%: 2 wt% solution of Uniflock+ 10wt% $CuSO_4$ + ETS-32 (the volume ratio ETS-32:$CuSO_4$ = 0.33:0.17). Injecting in three cycles will allow the creation of an extended reliable water-isolating shield in the OWC interval. After injecting the third portion, a micro-cement solution based on Mikrodur is injected in order to torque the water-isolating shield with the installation of the micro-cement sleeve to the top of the producing reservoir. Lifting the tubing string, waiting for the micro-cement strengthening, drilling out the micro-cement sleeve to the shield roof, lowering the perforator on the tubing in the oil-saturated reservoir interval, perforating the reservoir, developing the well and its commissioning.

Keywords: Water-isolating shield, Viscoelastic makeup, Micro-cement slurry, Water-isolating makeup, Water shutoff.

INTRODUCTION

At the final stage of the oil field development, as the reservoir pressure decreases, bottom water begins to penetrate into the oil-saturated reservoir part. Initially, bottom water begins to move up in the form of a water cone to the well bottom, and as OWC rises, it approaches the bottom, and liquid begins to gradually accumulate at the bottom through perforations of the perforation interval with its slow rise along a wellhole covering the perforation interval, preventing oil from coming out of the well to the surface. The well is watered out and the production from it stops.

At the final stage of the oil field development, as the reservoir pressure decreases, bottom waters begin to penetrate into the oil-saturated reservoir part. Initially, the bottom water begins to pull up in the form of a water cone to the well bottom, and as OWC rises, it approaches the bottom and there takes place the gradual liquid accumulation at the bottom through perforations of the perforation interval and its slow rise along the wellhole covering the perforation interval and preventing oil from coming out of the well to the surface. The well is watered out and its production shuts down.

The creation of a movable buffer fluid margin (shield) between the oil and water-saturated reservoir parts should be considered as more correct contributing to the uniform displacement of oil by water without the formation of cones.

A movable viscoelastic shield (MVES) must consist of liquid with the viscosity of the aqueous phase not less than the viscosity of the displaced oil and a density less than the density of the reservoir water, but greater than the density of the oil under displacement.

This can be achieved with the help of injecting through special apertures in the producing string into the upper part of the water-saturated reservoir zone (at the contact with oil) of a mobile viscoelastic shield solution [1,2].

The Object and Research Methods

The task assigned to the authors is solved by the method of carrying out water-isolating works in a well, which comprises injecting into a reservoir under the isolation of the water-swellable polymer suspension in three cycles and installing a movable viscoelastic shield.

The technical result when using the technology will be an increase in the duration of the effect of water-isolating works due to the creation of a mobile viscoelastic water-isolating shield to pressure drops by increasing the injection depth and the volume of the injected suspension of the water-swellable polymer, increasing the effectiveness of water-isolating works.

The set task and the technical result are achieved by the fact that the technology of preventing the inflow of bottom waters into the oil-producing well prior to its commissioning includes the descent of the perforator on tubing to the OWC level, the perforation of the production string for 1.5 m below and above the OWC level, the rise of the perforator, the descent of the tubing string to perforations, the injection of the first portion of the makeup on the basis of Uniflockand $CuSO_4$ in the following ratio of components, wt%: 1wt% solution of Uniflock+ 5wt% $CuSO_4$. After that, the injection of the second portion of the makeup in the following ratio of components, wt%: 1wt% solution Uniflock+ 10 wt% $CuSO_4$ + ETS-32 (the volume ratio of ETS-32:$CuSO_4$ = 0.33:0.17). After that, the injection of the third portion of the makeup in the following ratio of components, wt%: 2wt% solution of Uniflock+ 10wt% $CuSO_4$ + ETS-32 (the volume ratio of ETS-32:$CuSO_4$ = 0.33:0.17). Injecting in three cycles will allow the creation of an extended reliable water-isolating shield in the OWC interval. After the third portion injection, a micro-cement solution based on the Mikrodur OTDV is injected with the purpose of making-up the water-isolating shield with the installation of the micro-cement sleeve to the producing reservoir roof. Lifting the tubing string, waiting for the micro-cement strengthening, drilling out the micro-cement sleeve to the shield roof, lowering the perforator on the tubing in the oil-saturated reservoir interval, perforating the reservoir, developing the well and its commissioning [3].

As an installation of the micro-cement sleeve, a solution containing 2.0% aqueous solution of a polyvinyl alcohol PVS-V1N and a mixture of Mikrodur"U" with calcium hypochlorite $Ca(ClO)_2$ is recommended in the following ratio of components,wt%: 2.0% aqueous solution of PVS-V1N – 50.0, the mixture of Mikrodur"U" with calcium hypochlorite $Ca(ClO)_2$ – 50.0, including Mikrodur"U" – 48, $Ca(ClO)_2$ – 2.0 [4-6].

The composition and results of determining the strengthening time and the time of the formation of a strong water-isolating material are presented in Table 1.

The change in the relative permeability of samples of cores after the treatment with a makeup for repair works is presented in Table 2.Uniflock is an analogue of hydrolyzed polyacrylonitrile and other polyacrylates. Properties are normalized by TU 6-00-0203.

Copper sulphate ($CuSO_4$) is represented by crystals of the light blue colour. In the makeup, it is a polymer crosslinker.

Ethyl silicate (ETS-32) is an oily liquid with a density of up to 1,220 kg/m^3, it is not poisonous.

The technology is implemented as follows [3].

1. In the well, completed by drilling and lowering the production string, a perforator (for example, a cumulative one) is lowered on tubing to the OWC level (Fig. 1).
2. The perforation of the production string is carried out 1.5 m above and below the OWC level.
3. The perforator is raised.
4. The tubing string is lowered to perforations (Fig. 2).

5. The first portion of the makeup based on Uniflock and $CuSO_4$ is injected, with the following ratio of components, wt%: 1 wt% solution of Uniflock + 5 wt% $CuSO_4$.

Table 1: The composition and results of determining the time of the isolating material formation

Compositionof the working solution	The ratio of the water solution toPVA: (Mikrodur+ calcium hypochlorite)	Strengthening beginning/ Strengthening completion, hours	Qualitative characteristic of the formed insulating material
7.5%-solution PVA-V1N + (the mixture of Mikrodur"U"with calcium hypochlorite)	2:1	5/48	Low-cement medium strength mass
5.0%-solution PVA-V1N + (the mixture of Mikrodur"U"with calcium hypochlorite)	2:1	4/48	Viscoplastic mass of the average strength
2.5%-solution PVA-V1N + (the mixture of Mikrodur"U"with calcium hypochlorite)	1:1	4/48	Medium strength stone material
2.0%-solution PVA-V1N + (the mixture of Mikrodur"U"with calcium hypochlorite)	1:1	4/48	Strong stone-like material

Table 2: Change in the relative permeability of core samples after the treatment with a makeup for repair works

No. of the sample	Composition of the working solution, [vol%]	Permeability to water, $1{\cdot}10^{-3}$, [μm^2]		The bridging factor, [unit fractions] $C_{br} = \frac{C_{per1} - C_{per2}}{C_{per1}}$
		before the treatment, C_{per1}	after the treatment,C_{per2}	
1	2.0%-water solution of PVA-V1N + (the mixture of Mikrodur–50.0 "U" (48.0 vol%) with calcium hypochlorite $Ca(ClO)_2$ (2.0 vol%)	49.2	5.6	0.886
2		100.8	10.1	0.899
3		500.3	fullbridging	-

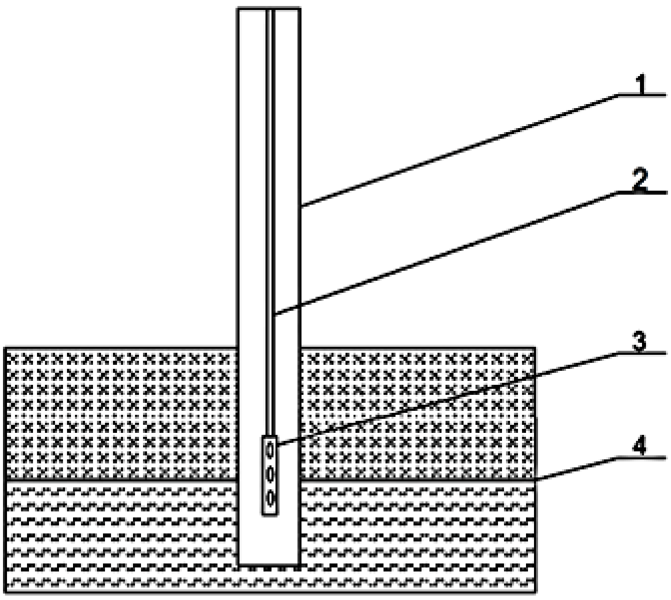

Fig. 1 The descent of the perforator to the OWC level. 1 – the producing string; 2 – the tubing with the packer; 3 – the perforator (for carrying out the perforation of the producing string for 1.5 m higher and lower than the OWC level); 4 – OWC.

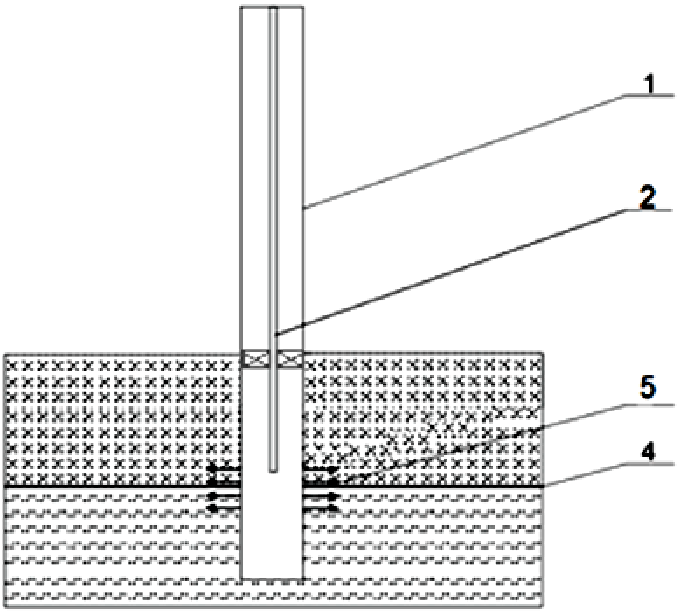

Fig. 2 The descent of the tubing string to perforations. 1 – the producing string; 2 – the tubing with the packer; 4 – OWC;5 – perforations.

6. After that, the second portion is injected, with the following ratio of components, wt%: 1 wt% solution ofUniflock+ 10wt% $CuSO_4$ + ETS-32 (the volume ratio of ETS-32:$CuSO_4$ = 0.33:0.17).
7. After that, the third portion of the makeup is injected, with the following ratio of components, wt%: 2wt% solution of Uniflock+ 10wt% $CuSO_4$ + ETS-32 (the volume ratio of ETS-32:$CuSO_4$ = 0.33:0.17).
8. After injecting the third portion, the micro-cement solution is injected with the purposeof making up the water-isolating shield with the installation of the micro-cement sleeve to the producing reservoir roof (Fig. 3).

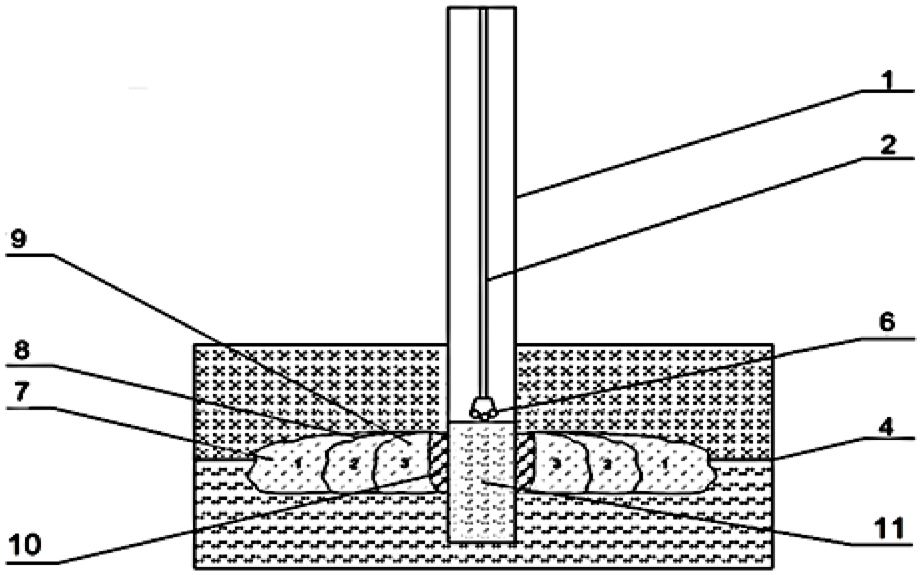

Fig. 3 Installed water-isolating shield. 1 – the producing string; 2 – the tubing with the packer; 4 – OWC;6 – the chisel; 7 – the first WIM portion; 8 – the second WIM portion; 9 – the third WIM portion; 10 – the micro-cement solution; 11 – the cement sleeve drilled out to the water-isolating shield roof.

9. The tubing packaging arrangement is raised.
10. WOC is conducted.
11. The micro-cement sleeve is drilled out up to the shield roof.
12. Theperforatoris loweredon the tubing string into the oil-saturated reservoir interval.
13. The reservoir perforation is carried out, the well is developed and commissioned (Fig. 4).

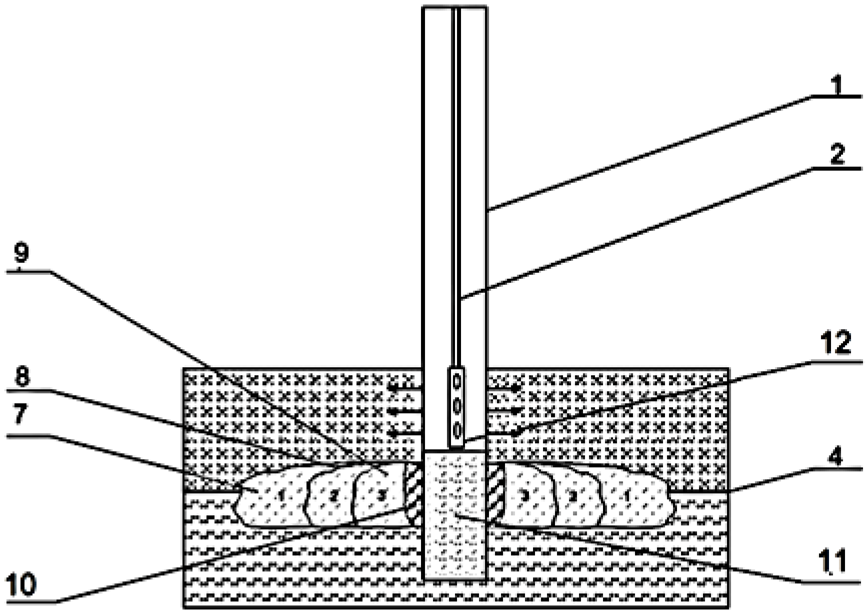

Fig. 4 Carrying out perforating works in the oil-saturated reservoir part. 1 – the production string; 2 – the tubing string with the packer; 4 – OWC; 7 – the first WIM portion; 8 – the second WIM portion; 9 – the third WIM portion; 10 – the micro-cement solution; 11 – the cement sleeve drilled out to the water-isolating shield roof; 12 – the perforator (for carrying out the perforation in the oil-saturated reservoir part).

CONCLUSION

Thus, when implementing the technology, it is planned to increase the duration of the effect of water-isolating works due to the creation of the mobile viscoelastic water-isolating shield in the well which opened up the water-oil reservoir to pressure drops by increasing the injection depth and the volume of the injected polymer composition, increasing the effectiveness of water-isolating works [7, 8].

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