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The practice of a mobile pulsation unit (MPU) to increase the efficiency of oil wells

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Annotation. The pulsatile stimulation technique (near-wellbore area) is an effective method of hydroimpulsive well treatment in oil production. The results of testing a pilot sample of a mobile pulsation unit at injection wells are presented, with an increase in injection capacity 3-4 times and other positive effects (well pressure drop, chemical composition change). The obtained results confirm the effectiveness of pulsation effects and create the prerequisites for the development of complex energy-saving ways of oil well treatment.

1. Introduction

The increased volume of extraction of hard oil (tight oil) and the current trend of a general decrease in oil recovery (oil recovery) determine the urgency of restoring well performance. Due to colmatation processes of various nature, the main well repair activities are aimed at near-wellbore area (NWA) treatment, to increase the permeability of the reservoir, to increase the depth of work, to maintain production (or to increase injectivity, etc.) [1].

Numerous studies and tests have shown that the greatest efficiency in cleaning PZP and activation of in-situ phenomena is achieved by creating a non-stationary treatment in the treatment zone. Today, there are many ways of creating non-stationary effects due to periodic waves (impulses) of pressure at the wellhead (top of well) [2,3]. In most ways, a one-time pressure pulse of a critical force (from 100atm to 250atm.) Is used, so they are related to destructive methods of stimulation.

Various hydrodynamical and hydroimpulsive effects on the reservoir are used as methods for the development of low permeability formation, as a technology for stabilizing and increasing the flow rate of wells [4-8].

The idea of the hydroimpulse effect on the PPP has found its embodiment in the creation of wellhead equipment for the formation of alternating sign pressure pulses in the near-wellbore zone due to the formation of a standing wave in the well [9]. In the tests of this method, the technological result was achieved by 70% injection and 95% production wells. In this case, after treatment, the injectivity of injection wells increased by 2-5 times, and the production well rate increased by 2-4 times, with water cutting decreasing by 15-30%.

The industrial application of the technology of complex wave and chemical effects on the PZP [10] made it possible to obtain additional production after processing at 40 wells of the order of 3.5-5.0

thousand tons per year.

Considering technologies using the infrasound range of impulse action (less than 1 Hz), one should also mention the variable pressure method [11], which is well known and is used mainly to intensify the inflow of oil fluid (fluid), including during drilling.

The success of research and development in this area and the results of industrial tests determine the feasibility of using currently unsteady hydrodynamic (bottom-hole) treatment methods (bottom-hole area treatment), and confirm their prospects in order to restore and improve the operating performance of oil wells.

In this connection, the pulsating method of action on the bottomhole zone and the mobile pulsating unit (MPA) for its realization is an effective method of hydroimpulse treatment of oil wells. The pulsation unit provides a time and power pulse response to the PZP and performs operations to lift the contamination (inclusion) at the wellhead [12].

2. Field tests

The pilot-industrial sample of the MPU installation (Fig.1, 2) is a multifunctional test bench. For the given oil field conditions the stand allows to conduct debugging of technological and regime parameters of pulsating methods of processing and repair of wells, and also to intensify the operating technologies.

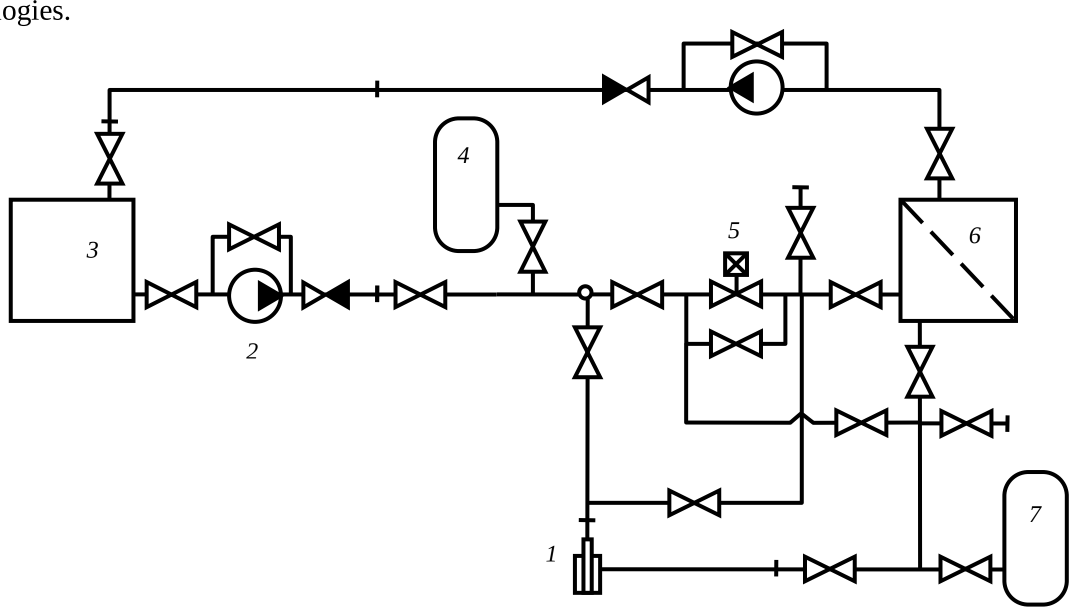

Fig. 1. Scheme MPU: 1 - well; 2 - the pump; 3,6 - tanks; 4.7 - hydraulic accumulators; 5 - control valve

Fig. 2. Field tests of MPU

The pulsating (hydropulse) regime is realized due to the creation of low-frequency (0.02-0.001 Hz) pressure pulses (up to 80 atm) at the wellhead (Fig.3, 4). At the same time, the following factors are determining the intensive cleaning of the CAP (including the removal of the colmatant (deposition of pollution) from the porous space of the reservoir): repeatedly repeated depressions to the reservoir; high velocity of fluid motion in the perforation interval; formation of a time-dependent non-stationary hydrodynamic regime with constant updating of contact zones, mixing of working agent and fluid. Cyclically repeated, undamped, turbulent pulsation stimulation (pulsatile stimulation) regulates the filtration properties and stabilizes the hydraulic conductivity of the bottomhole zone. Comparison of the calculated effectiveness of continuous and pulsation drainage regimes (drainage) shows that the energy costs in the pulsation regime are lower by 3-3.5 times [13].

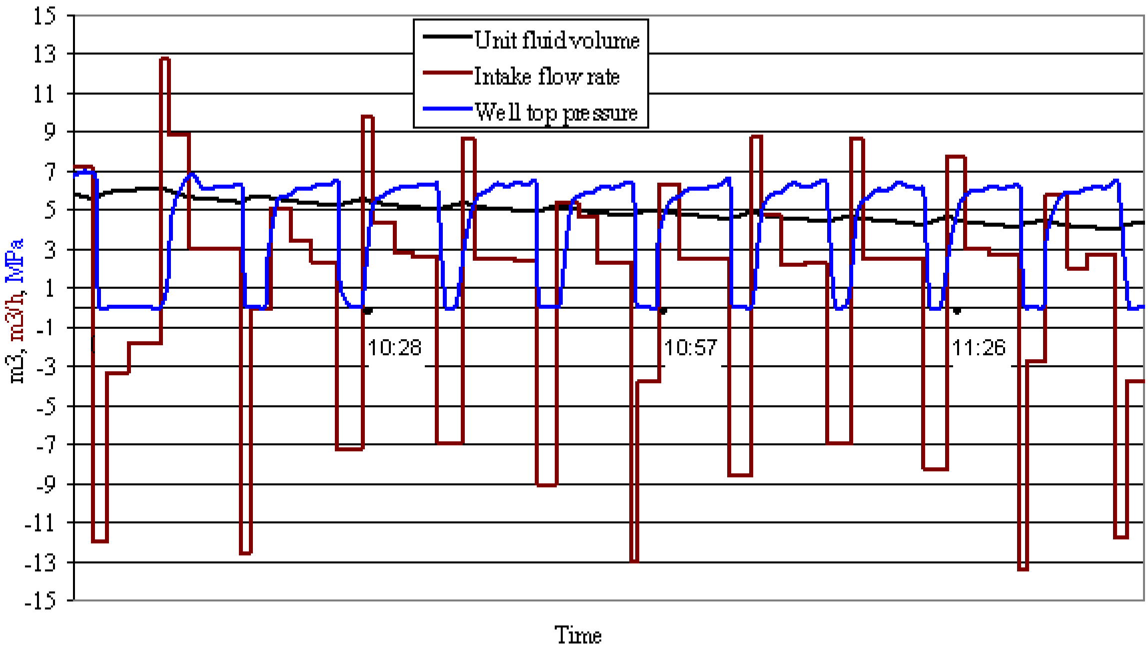

Fig. 3. Fragment of operational data at the beginning of well treatment

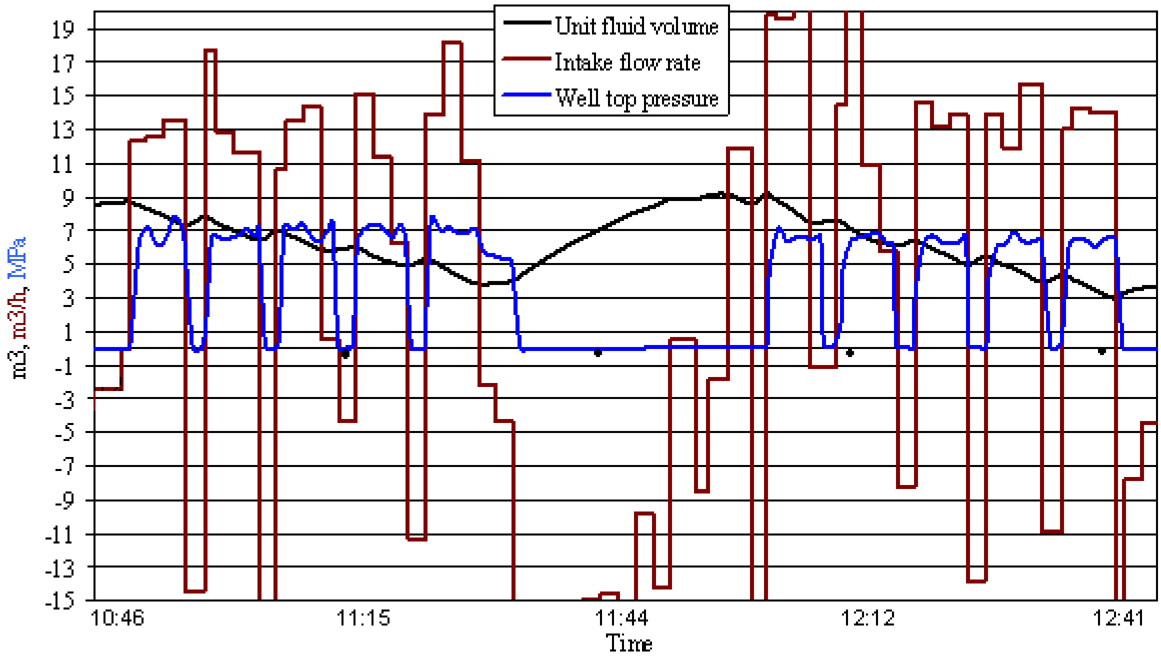

Fig. 4. Fragment of operational data at the end of the well treatment

Experimental-industrial tests of the MPA plant confirmed its operability in various technological regimes. The pulsating treatment of 9 wells (deposits in the territory of the Republic of Tatarstan, Russian Federation) showed the pattern of the appearance of characteristic positive effects (pressure decrease, flow increase, etc.) [14]. So, for example, when testing the well of the Urustamak field (depth 1550 m, reservoir thickness 3.2 m, permeability 70-100 mD, porosity 17%), the injectivity increased 4-fold (Fig. 5, well 1). A significant change in the chemical composition of the working fluid occurred (a decrease in rigidity of 2-3 times, a decrease in the chloride ion by a factor of 2), which indicates the influence of the elastic forces of pulsations on the bottomhole formation zone. In Fig. 3.4 shows the fragments of operational data recorded during the processing wells of the Urmyshlinsky deposit (depth 1280 m, reservoir thickness 7 m, permeability 137-1340 mD, porosity 15-24%), of which the dynamics of increase in injectivity during processing are visible. As a result of the test, an increase in the injectivity of the well was recorded 4.2 times (Figure 5, well 2), while the rate of acceleration over 24 hours of treatment increased from 0.66 to 3.57 m3 / (day • atm). When the well was surveyed, it was also established to open the perforation intervals and increase the actual thickness of the beds (up to 50%), reduce the mark of the current face, clean the reservoir and take out the colmatizing particles in the form of metal oxides, and significantly change the chemical composition of the working fluid.

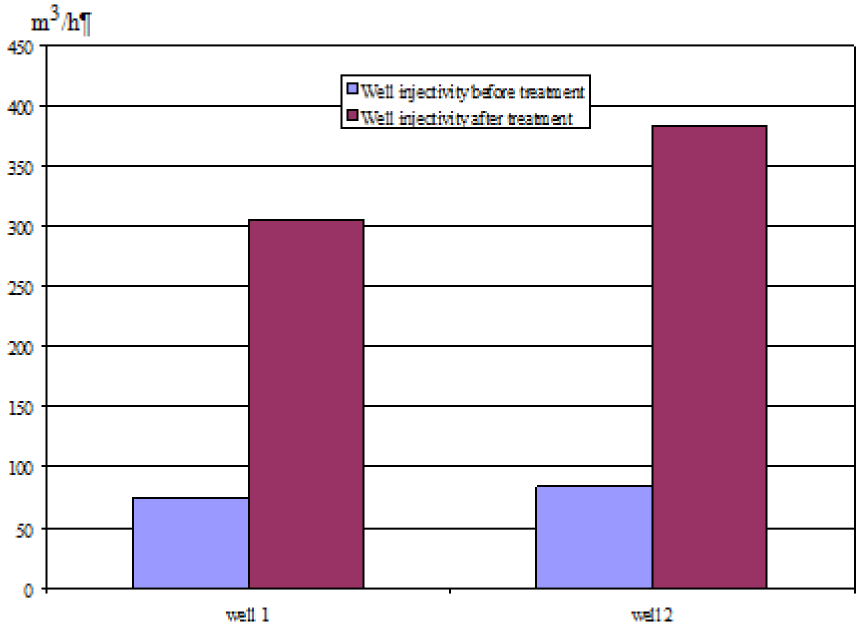

Fig. 5. Change in injection capacity of injection wells during pulsating treatment

3. Discussion

The obtained results unequivocally confirm that the influence of the elastic forces of pulsations influence the downhole and bottomhole zones. In this case, the pulsating equipment, namely the installation of MPA, is located at the wellhead. In contrast to existing technologies, pulsation processing does not use any downhole devices, machinery or equipment. To implement technological operations in pulsating mode, additional land special equipment or special equipment is not used either. Particularly it should be noted that all effects in pulsation processing are obtained due to hydrodynamic regimes of exposure to commercial water, without the use of active reagents. The obtained results of field tests are of great interest for the development of efficient technologies for pulsating processing of oil wells. The practice of servicing oil wells and the success of technological operations has already unequivocally proven that complex processing methods are the most effective in achieving repair objectives and the most economically viable [15]. Functional and technological capabilities of the MPA unit allow successfully combining the advantages of pulsating effects with the capabilities of complex or combined well treatment technologies, including chemical, physical, thermal, and others.

In the pulsation treatment of producing wells, the conditions for the formation of characteristic regularities and effects will appear similarly, as in the treatment of injectors. The combination of the resulting hydrodynamic effect from the pulsating effect and the activity of the reagents will enhance the efficiency of the reaction and heat and mass exchange processes taking place in the PPP. At the same time, the intensification of these processes by keeping them in the non-stationary mode will ensure a reduction in the required amount of active substances or a replacement for cheaper ones, increase the depth of its penetration into the formation, reduce processing time, or increase success, all other things being equal.

Conclusion

The results (changes in the chemical composition, removal of the colmatite, increase in injectivity, reduction in pressure, increase in the thickness of the reservoir, etc.) obtained during the pilot industrial tests confirm the effectiveness of the pulsational (hydroimpulse) effect in the treatment of the bottomhole zone of the wells, and the technological advantages of the method and the functionality

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of the apparatus allow us to consider pulsation processing as a kind of effective energy resource saving method of repairing oil wells, especially when implementing reagent, complex or combined methods.

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