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Restoration of intake capacity of injection well by vibrations

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Abstract. Nowadays deterioration of productivity and intake capacity of wells cause different problems in exploitation of oil and gas fields. It happens because of some irreversible physicochemical processes in the bottomhole formation zone: swelling of clay materials, colmation, formation of stable emulsions, confluence of salts, iron oxides etc. Various methods and technologies are used to solve these problems. However, they have disadvantages, for example, material and energy intensity, short-lived equipment, technological complexity. The method of pulse action by various vibrations seems to be the most effective solution. Vibrations are mechanisms that create controlled fluctuations of the working body influencing a recycled material and a reservoir. Now they are widely used in different industries.

1. Introduction

Deterioration of productivity and intake capacity of wells cause different problems in exploitation of oil and gas fields. It happens because of some irreversible physicochemical processes in the bottomhole formation zone [1-3]. Experience shows that especially in complicated geological conditions there are shale hydration, colmation, plugging of productive horizons due to penetration of drilling mud and cement filtrates and their dispersed phases in the bottomhole formation zone, formation of persistent emulsions, loss of poorly soluble sediments of salts, iron oxides, paraffins, asphalt and resin compounds in the interval of perforations of formations, directly on the walls of wells and the bottomhole formation zone during well operation [4-9].

The treatment of bottomhole zone was carried out by an oil-well service crew during a well maintenance. The well was washed with a backwash to clean a downhole, perforation zones, well walls from suspended mechanical particles. Then a hydraulic vibrator was lowered into the well using the oil-well tubing. The work depth was selected experimentally. A pressure gauge was installed on the injection line to monitor the processing of the well bottom-hole zone and the operation of the vibrator itself [10–13]. The authors created several modifications of vibrators consisting of a housing, a calibrated sleeve, a rectangular cross section, an upper and lower sub, a crank connected to the axis of the housing and a toggle valve (Figure 1) (Patent RU 2265710 C1 E21B 4/14, Patent RU 2287661 C2, IPC E21B 28/00, E21B 43/25, Inventor 's certificate SU 1515812 A1 E21 B7/24). Figure 2 shows different positions of the system “valve-crank” during a vibrator operation.

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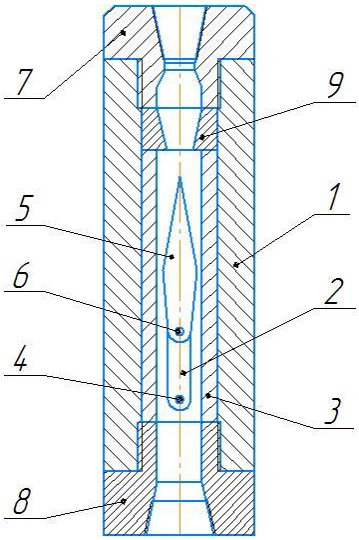


Figure 1. Hydromechanical vibrator: 1-housing; 2 – carrier; 3 – gage plug; 4 – axis; 5 – valve unit; 6 – pin; 7 – upper sub; 8 – lower sub; 9 – nose cone.

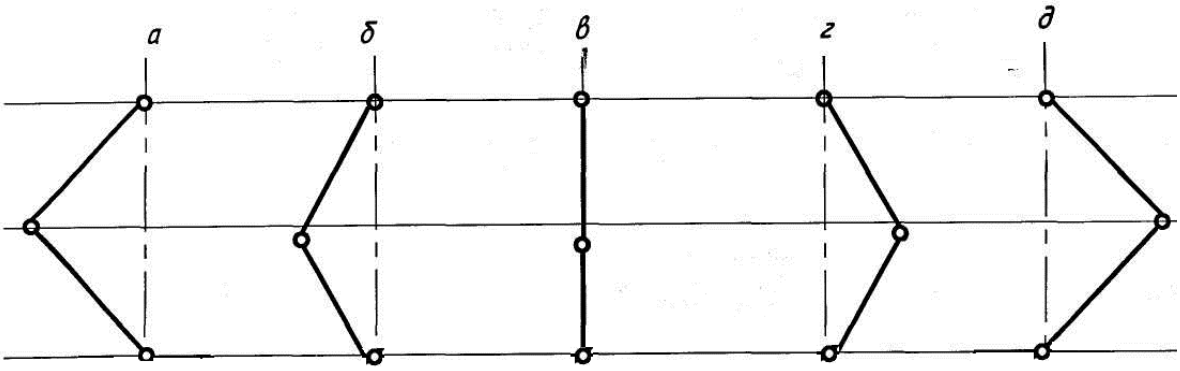


Figure 2. Different positions of the system “valve-crank” during a vibrator operation.

2. Results and Discussion

Depending on the characteristics of the well in the oil-and-gas production department "Tuimazaneft" the technology of well treatment is used with a vibrator. After completion-preparation works the treatment of bottomhole zone was started. It was the pulsed injection of oil or solvent. The treatment had several stages. At the initial moment, the pressure was raised 1.3-1.5 times higher than the discharge pressure of wastewater into the reservoir. The purpose of pressure increase was to maintain reservoir pressure during the operation at injection wells or the intake pressure of an oil well. The injectivity pressure of the oil well was determined experimentally before the treatment by a test completion of oil into the reservoir. Then the injection was carried out at a pressure of 1.3-1.5 times and continued to finish the working fluid until the next drop. The cycle was repeated 3-4 times depending on the time of the injection start until the pressure dropped.

The information below show wave treatment results of the D1 formation of the injection well No. 2974. The treatment was made with technical water. In the well a lineup was launched using oil-well tubings with a diameter of 2.5". The plug was placed at a depth of 1778 m, a pipe-mesh was lowered at a depth of 1776 m in front of the perforation zone, a vibrator – at a depth of 1770 m. After the circulation call a packer was planted at a depth of 1722 m to isolate the annular space so that the oscillations spread directly to the treated formation D1.

The treated well was put into overhaul with zero injectivity, since asphalt-resin-paraffin-containing

sediments (ARPS) were clogged with iron sulfide particles and mechanical impurities. The content of petroleum products, the amount of particles and iron in the wastewater of oil treatment plants ranged from 50-100 mg / l. The well was washed with distillate in order to clean well walls from ARPS. According to the RGD data the well injection capacity was 275 m^3 / day at a pressure of 9 MPa after flushing with distillate before treatment with a vibrator. The productive horizon took in the range of 2m.

In the well a lineup of deep equipment was lowered using tubing pipes with a diameter of 2.5". The vibrator was lowered at a depth of 1847 m. It was 13 m above the level of upper perforations with a grid at a depth of 1860 m opposite the upper holes of the perforation zone. A packer was installed above the vibrator at a depth of 1825 m to isolate the annular space and propagate dynamic oscillations directly into the perforation zone.

The working fluid was pumped using the TSA-320 unit. After completion-preparation works, technical water was pumped into the reservoir D2 for an hour and 30 min. During the first 15 min the pressure in the pump discharge line was 9,0 - 10,0 MPa before the first sharp drop to 8 MPa.

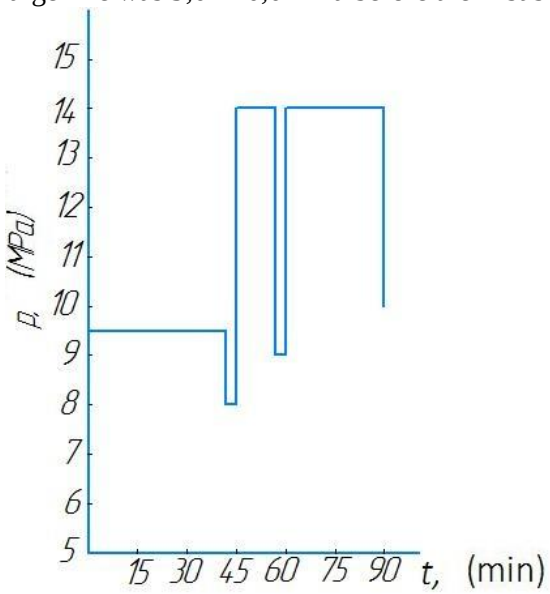


Figure 3. Pressure change dynamics depending on the processing time of injection well No. 3186

Then, the injection pressure was increased to 14 MPa using the TSA-320 unit. The injection had been contining for 15 min, whereupon the pressure sharply decreased to 9 MPa. During the subsequent injection at a pressure of 14 MPa during 25 min the injection pressure dropped to 10 MPa (Figure 3). Next the treatment of bottomhole zone was stopped. According to the RGD data, as a result of well bore zone treatment, its injectivity increased from 275 to 530 m3 / day at a injection pressure of 9 MPa.

The height of input profile changed from 2 to 7.2 m. The input profile in the upper and middle part of the reservoir had a significant increase. However, in the lower part of the profile there was a decrease of the reservoir injectivity due to the formation of new cracks and disclosure of old ones in the upper part of the profile, and in the lower part - clogging .

3. Conclusion

The results of vibration treatments are presented in Table 1.

In all cases, after the treatment with vibrators the height of the injectivity profile (with the exception of well No. 2032) and the formation injectivity (from 18 to 238%) increased. The injection well No. 2524, which did not accept technical water before, began to take 125 m^3 / day of water after the treatment.

Table 1. Results of vibration treatments

№ well	Height of input profile, m		Injection, m^3/day	
	Before treatment	After treatment	Before treatment	After treatment
2032	1.2	1.2	250	596
3186	2	7.2	275	530
2939	1.6	2.4	110	115
2707	1	4	295	380

The treatment efficiency depends on the location of vibrator. Experience showed the following result: if the hydraulic vibrator is installed at the level of the upper perforations of the perforation zone, the effect will be maximal.

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