Bottomhole zone treatment by creating pressure pulses at the wellhead of low-viscosity oil pools

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Abstract. It is shown that when a borehole fluid surface is impacted by a compressor and receiver, the wave propagates to the bottom hole zone, where its amplitude increases due to the addition of the reflected wave. It was found that if it is necessary to obtain high speeds, it is more expedient to pump down of the liquid using more accessible hydraulic equipment, such as a pumping unit. It is noted that the use of simple and inexpensive supporting equipment allows creating a fluid flow at the wellhead with the required speed.

1. Introduction
To increase the efficiency of oil field development are widely used methods of stimulating production [1-8].

Many years of experience in applying various technologies to reduce flow coefficients in the bottom hole formation zone (BHFZ) have shown high efficiency of hydraulic fracturing (HF). With successful HF is possible multiple increases in the filtration rate in the BHFZ [9, 10].

Despite its high efficiency, the HF method requires significant material costs for technical, technological, and geophysical support of the event.

To increase the size of existing cracks and perforation channels, it is advisable to use their "pacing" by periodically alternating the growth and reduction of the movement speed and pump pressure of the fracturing fluid. With a pressure surge in the treated area of the reservoir, the fracturing fluid penetrates the reservoir channel, acting as a wedge that pushes the rock apart and forms fractures in it. With repeated hydraulic preloading of the rock sample, the stress limits naturally decrease. In the case of existing microfractures in rocks, their further development occurs at significantly lower fracturing fluid pressures [11].

2. Materials and methods
It is possible to create pressure pulses at the bottom hole directly from the wellhead. A hydraulic shock pressure pulse is created using wellhead equipment without performing descent operations. Short-term pressure applications on the wellhead, creating a resonant movement of the compacted mass of the borehole fluid column, lead to compression of the underlying strata and their movement, therefore, to an increase in the moving mass, which, when the sump is reached, creates a pressure pulse that exceeds the wellhead in amplitude.

The energy of a hydro shock is determined by its duration, which depends on the depth and column...
stiffness. The impact of power depends on the pressure rate change in the perforation zone, which in turn is proportional to the flow rate at the time of stopping. The pressure build-up at the time of the hydraulic shock corresponds to a certain flow rate, but the duration of the hydraulic shock, and therefore its total energy increases with well depth. To preserve the casing integrity of the string and the hydrated cement behind it, it is necessary to limit the power of the hydraulic shock, which means the maximum pressure exerted on the column walls.

The advantages of the hydraulic shock method of impact on the well bore zone of the formation in comparison with the constant pressure used in HF are that:
- the hydraulic shock method creates a new network of fractures, which opens up additional drain in the bottom hole zone and provides a significant increase in the inflow or capacity of formations;
- the hydraulic shock use during HF contributes to the creation of large short-term pressures in the perforation zone, which cannot be created with a stationary flow of liquid due to pressure restrictions on pumping units and tubing strings;
- pulsed pressure creates such fractures that, due to the irreversibility of the rock deformation process, do not completely close under the influence of rock pressure without the use of a propping agent.

The borehole fluid can be set in motion by the impact of pressure gas (air or nitrogen) from the wellhead or by the liquid pumped by the pumping unit. The pumping unit design does not allow to sharply increase the flow rate of the injected fluid. For example, using the CA-320 unit, it is necessary to "gas" after opening the fluid supply valve to the well to increase the flow rate of the injected fluid as quickly as possible.

3. Results and Discussion

Figure 1 shows diagrams of pressure changes in the bottom-hole zone of the well during gas injection (see figure 1, a) or fluid injection (see figure 1, b). The diagrams were made using an ACM-4s submersible pressure gauge.

In both cases, the rate of pressure rise in the bottom–hole zone is 2.25-5.0 MPa/min. With such a low-pressure rise in the bottom-hole zone, wave processes that affect the productivity of the well bore zone are impossible. It is necessary to use special wellhead equipment that allows you to set the required speed of the injected medium. For example, in [12] it is proposed to give the necessary speed to the well fluid due to the discharge of the carbonic gas cylinder.

When the blast effect of gas impacts the surface of the borehole fluid, the wave propagates to the bottom-hole zone, where its amplitude increases due to addition with the reflected wave. Figure 2 shows the wave interference when the settling pond is reached. The diagram was obtained using a submersible pressure gauge in the settling pond of a well with a depth of 1270 m. In this case, a gas cylinder with a gas pressure of 4 MPa is discharged at the wellhead. The diagram shows that the pressure in the bottom-hole zone due to the addition of direct and reflected waves increases to 6.1 MPa. A similar effect can be obtained when pumping fluid into the well, which is more important since the compressor in the oil fields is more scarce equipment than the pumping unit. An example of a technological scheme for creating a high-speed pumping down is shown in figure 3.
Figure 1. Diagrams of pressure changes in the bottom-hole zone when gas (a) or fluid (b) is injected into the well

Figure 2. Diagram of pressure changes in the bottom-hole zone when a gas cylinder is discharged into the well

Figure 3. Example of implementation of the technology of wave action by a fluid
Between the output of the pumping unit and its gauge tank, a safety valve SPRV-4 is installed, which has an actuating area: 5.3–9.0; 8.5–12.4; 12.4–14.1; 14.0–16.0 MPa. First, the quick-acting valve connecting the pumping unit, and the wellhead is closed. When the unit starts working, the pressure assembly at the outlet increases to the operating value of the safety valve, then the valve opens, and the liquid is poured into the gauge tank. The safety valve pressure is maintained at the outlet of the pumping unit. When the quick-acting valve is opened, the pressure at the outlet of the unit decreases, the safety valve closes, and all the fluid energy from the pump running at full capacity is transferred to the oil-well tubing.

The use of a pumping unit with high-speed and safety valves allows you to create a high speed of fluid injection, for example, for intensive cleaning of the bottom-hole zone of the injection well.

4. Conclusion
1. When the borehole fluid surface is impacted by a compressor and receiver, the wave propagates to the bottom hole zone, where its amplitude increases due to the addition of the reflected wave.
2. It is necessary to obtain high speeds, it is more expedient to pump down of the liquid using more accessible hydraulic equipment, such as a pumping unit.

The use of simple and inexpensive supporting equipment allows creating a fluid flow at the wellhead with the required speed.

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