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Review Article

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Development and Cleaning of the Fracture Network in the Wellbore Zone of the Formation

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Abstract
The low permeability of the downhole zone of the oil reservoir limits the production rate and injectivity of wells. Fractures adjacent to the perforation become clogged with rock particles and viscous oil components over time. During operation, regular overhauls are required using expensive methods to increase permeability.

1. Introduction

The most effective technologies used to create cracks in the bottomhole zone are torpedoing, fracking, heat treatment, and the use of chemicals. But they are the longest and most expensive. Most known well treatments have limitations on the power of the action, the size of the submersible, and the amount of energy transferred from the surface. Many technologies require the installation of equipment at the depth of the bottomhole zone, which is associated with high material and time costs.

The existing technologies of mechanical action on the bottomhole zone either increase the pressure too slowly, which leads to the formation of a single crack, or with a rapid increase in pressure contributes to brittle crushing of the rock, but without the development of cracks in the depth of the formation. It is desirable to use a technology that can create cracks on the surface of the rock and then develop them along the formation thickness in all directions.

Our technology allows us to act on fractures adjacent to the perforation of the well. Moreover, the work is carried out without lifting the pipe string and without running technological equipment into the well. The main goals of the technology are to "reciprocate" existing and create new fractures of the formation, to erase and clean fractures from small fragments of rock and viscous oil components. If sufficient energy is transferred from the wellhead to deform the formation fragments, workover is greatly simplified and downtime is reduced.

The movement of liquid in the bottomhole zone should be sufficient in energy for deformation of cracks in order to develop them, while safe for the integrity of the string and cement stone. The goal of the technology is to increase the effective radius of the well, involve the entire stratum in development, and introduce the maximum number of productive layers and remote areas. During impulse hydraulic fracturing, the liquid flow rate is low. The varying fluid pressure contributes to uniform "loosening" of the wellbore zone of the formation [1,2].

Hydraulic shocks acting on the fractures of the formation are formed on the surface and transmitted through a column of well fluid. A column of fluid can be represented as a long compression spring. If a pressure pulse is applied to the upper end of the spring, it is compressed and stores energy. When the motion energy of the fluid moves through the elastic medium and reaches the lower end of the spring, a sharp pressure drop occurs to promote brittle fracture of the rock, then the formation pressure is maintained by the accumulated inertia of the fluid motion.

The technology allows you to combine brittle and plastic rock destruction, which complement each other. To form and develop a network of cracks, it is necessary to periodically repeat the brittle fracture process in order to form microcracks and, then, maintain a high speed of movement of the liquid to fill and develop existing and formed cracks. When tensile forces are applied to the rock, the rock breaks.

The duration of increased pressure in the crack should be at least 0.5 seconds so that, under the influence of pressure, the cracks have time to expand, then, with a decrease in pressure, close within units of seconds for regular deformation and development.

The front of the pressure pulse acts on the walls of the crack as a wedge moving at a high speed. The energy of the pressure pulse is used to open the crack their deformation and development. Practice shows that with regular impulse exposure, cracks develop due to systematic deformation. The pressure shall be sufficient for periodic crack expansion resulting in strength weakening and subsequent rock fracture.

Infra-low frequencies have low attenuation, so periodic changes in bottomhole pressure are transmitted in the form of low frequency waves along the strike of formations and contributes to the redistribution of stresses in the massif, which has a positive effect on oil recovery. The movement of the liquid mass in the bottomhole zone contributes to its washing, separation of adsorption deposits from the walls of pore channels and cracks, as well as the loosening and painting of low-permeability fragments of the bed skeleton [3].

Compared to classic fracking, the proposed technology has advantages. For example, a minimum amount of equipment is used, a minimum amount of energy is used, and a small amount of liquid is pumped into the formation. In many cases, work is carried out without lifting operations, which is much more economical than most technologies close to obtaining a similar result, and practically does not harm the environment [4].

As the technology was developed, well tests were performed. The first experiments showed an increase in well injectivity by 60-80 m3/day, and a slight decrease over 10 months. For a long time after treatment, the injectivity of the well was maintained above the passport data, therefore, additional cracks form in the wellbore zone of the formation, or existing cracks after deformation increase permeability.

In 2020, the technology was tested at 10 injection wells in the Volga region. As a result of testing in injection wells, the technology made it possible to increase injectivity to values from 130 to 400 m3/day, which is significantly higher than the passport injectivity.

2. Conclusion

A large number of wells are currently being processed. Analysis of the results shows that the efficiency of the technology is 9% higher than the efficiency of typical well treatment carried out by regular workover teams. At the same time, the cost of work is ten times lower. The results are achieved by the fact that technological work is carried out by a team of 2 people within 2 hours. Currently, 2 people are working 3 wells a day, which is a record. Record results were also achieved when the injectivity of the well was raised from 0 to 800 m3/day for an hour.

Studies are underway to increase the efficiency of well treatment by reducing the viscosity of formation fluid without running process equipment into the well.

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