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The Use of Foam Solutions in Drilling and the Development of Oil and Gas Wells Under Conditions of Abnormally Low Reservoir Pressure

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Abstract

The article considers and analyzes the use of foam solutions in drilling and development of oil and gas wells in conditions of abnormally low reservoir pressure to prevent complications and colmatations of productive horizons. The developed foam system, when used in conditions of abnormally low reservoir pressure in oil and gas field practice, led to the intensification of oil and gas production by affecting the formation, as well as the bottom-hole zone. This article can be useful in designing the development of oil and gas wells during the overhaul of wells with abnormally low reservoir pressures in order to avoid complications and colimitations of productive horizons.

Keywords: Abnormally Low Reservoir Pressure, Gas Occurrence, Development, Filtration, Solution, Foam, Repression, Absorption

1. Introduction

As you know, Turkmenistan has huge reserves of oil and gas. Increasing the technical and economic efficiency of drilling oil and gas wells is associated with the use of the most profitable types of drilling fluids. One of the main requirements for drilling fluids is to increase the drilling speed by economically using (spending) chemical reagents and materials used for the preparation and processing of drilling fluids. Drilling fluids should also not adversely affect the productivity of the reservoir. Therefore, at the present time in our country, much attention is paid to the types of drilling fluids used in the opening of productive formations, as well as in drilling wells [1].

Complex systems have been created to eliminate negative phenomena in oil and gas deposits caused both by surface phenomena in natural conditions and due to ingress of various media into the reservoir from the outside. One of the promising directions for solving the above problem is the use of foam solutions.

Long-term pilot work carried out in oil and gas fields at abnormally low reservoir pressures has proven the high efficiency of foam solutions. Currently, one of the main problems in the world that arise during drilling and development of wells is the absorption of drilling and cement mortars into formations. Absorption is understood as filtration of the washing liquid from the borehole into the surrounding rocks. The main factors of absorption are repression on the formation and the presence of filtration channels in the formation rocks. In a well construction project, the absorption zone of drilling and grouting fluids, as well as the gradient of their formation, is the determining criterion for determining the design of the well, its hydraulic flushing program and the method of cementing it during formation separation. The most frequent uptake is usually observed in areas with abnormally low reservoir pressure [2,3]. In other countries and in Turkmenistan, a huge amount of money and time is spent fighting the takeover. When absorbing solutions during drilling and operation

There are a lot of complications in the production of wells. Or rather, a large amount of chemicals and time is consumed. The development of effective measures to prevent and combat the likelihood of absorption will reduce the cost of field development, and will also contribute to improving the technical and economic efficiency of drilling oil and gas wells [4]. To solve these problems, it will be advisable to use foam solutions.

2. Materials and Methods

The low density of foam solutions provides a significant reduction in hydrostatic pressure in the well, which creates favorable conditions for both effective rock destruction and high-quality development of hydrocarbon horizons. In addition, the intake of drilling sludge and other fillers into the productive formation is sharply reduced, which helps to preserve the filtration properties of the formation. The above-mentioned properties of foams can significantly reduce

their filtration consumption up to its complete elimination. This is also facilitated by certain colmatating properties of foams due to the formation of adsorption films on the walls of wells, as well as in pores and cracks, which prevent direct contact of the liquid with the rock. Cleaning the face from the drilled rock and bringing it to the surface is one of the functions performed by the washing liquid during the opening of the formation. As is known, clay solutions, aerated solutions, foams, hydrocarbon-based solutions and gaseous agents are used as a washing liquid.

According to field data, as the density of the washing liquid decreases, the penetration rate increases. The rate of penetration also depends on the degree of cleaning of the face from the drilled rock. In turn, the purity of the face depends on both the flow rate of the liquid and its physico-chemical properties [5].

Foam systems differ from other types of washing liquids in their physical and physico-chemical properties, due to which they can change density in a larger range (0.2-0.9 g/cm3) and have a high destructive ability. Forced stops often occur during the drilling process. In order to keep the particles of the drilled rock suspended in the annular space, the washing liquid must have a retention capacity, i.e. thixotropic properties, in order to increase the shear stress limit at rest. Unlike water and clay solution, foam retains the particles of the drilled rock in suspension for a long time due to structural and mechanical properties and the phenomenon of pseudo-liquefaction. In this respect, the foam is in many ways superior to all the flushing liquids used.

The opening of a productive reservoir by perforation is one of the most important processes in the system of well completion measures [6,7]. Foam solutions injected into the lower part of the well before perforation work provide for:

• preservation of the natural permeability of the reservoir;
• prevention of deformation of the cement ring and the production column;
• long-term existence of the foam system in the column without changing its properties;
• preventing mixing of the liquid at the top of the column with foam. Being a visco-plastic elastic system, foam weakens the impact of shock waves formed during the firing of perforators. This, in turn, can contribute more to maintaining the integrity of the casing and the cement ring.

The foam cement solution is a three–phase foam. In the presence of cement particles, the stability of the foam, as well as the strength of its bubbles, increases dramatically; at the same time, the stability of the foam increases with increasing strength of adhesion of cement particles to air bubbles. The advantage of a foam cement mortar in comparison with a conventional cement mortar is also that the coverage area of the foam is significantly increased due to the clogging properties, low density and elasticity of the system.

In addition to lightweight grouting solutions, ultra-lightweight foam grouting solutions with a density of about 1000 kg/m3 are used. Foam grouting solutions are more stable than aerated ones and are used to eliminate absorption in cavernous and fractured rocks, in areas of abnormally low reservoir pressures, where the use of conventional grouting solutions can lead to hydraulic fracturing [8]. Foam grouting solutions are obtained by injecting air or nitrogen into the grouting solution together with a foaming agent and various additives. The finished cement mortar is pumped by the pump of the cementing unit into the foam generator, where, with the help of an additional pump, a foaming solution with the necessary additives and compressed air from the compressor are supplied. Another way: a special pump separately sucks in the components of the polymer grouting mixture and, together with the foaming agent, pumps the solution into a labyrinth mixer, into which compressed air is also supplied. A foam cement solution is obtained by collision of jets of cement mortar with high-grade foam in a cementing head.

Currently, the use of foams is spreading, as a result of which the number of complications and seizures of drilling tools is reduced [9]. There is a decrease in energy costs and diesel fuel consumption compared to purging wells with compressed air. Foams have a high load-bearing capacity at a low velocity of the updraft in the annular space. The success of penetration of absorption zones with foam is determined by the colming effect, which is several times lower than the pressure of the foam column on the formation compared to water. When using foams for penetrating absorbing rocks, the consumption of clay is reduced several times, and water consumption is reduced many times. The hydrophobicity of dry foams allows them to be used for drilling in clay rocks capable of collapse when interacting with water. Also, the use of foams ensures minimal environmental pollution.

3. Discussion and Results

As oil and gas field practice has shown, with the use of foam systems, it is possible to intensify oil and gas production both by affecting the formation and the bottom-hole zone. The bottom-hole zone of the formation is affected by chemical and physico-chemical methods [10,11]. In chemical methods, foaming acid and foaming acid treatments are used. In the first case, hydrochloric acid solutions are used, in the second – a mixture of hydrochloric and hydrofluoric acids.

In physico-chemical methods, multicomponent foam is used. The advantage of foam acid treatment is as follows:

- Due to the low density and high multiplicity, the foam acid covers a much larger thickness of the formation;
- Due to the high penetrating ability of the foam and the slower action of the acid on the rock, it is possible to transport the active acid deep into the formation over long distances, thereby exposing the deep zones of the formation;
- The presence of a gas phase contributes to a better removal of reaction products from the bottom hole formation zone.

Long-term field tests indicate the possibility of intensifying oil production using foam systems in fields that have entered a late stage of development, characterized by insignificant oil deposits and a high degree of waterlogging [12,13]. Pumping a

multicomponent system into the bottom hole formation zone gives positive results under the following conditions:

- The uncovered thickness of the productive layers in the well is characterized by high heterogeneity in permeability – along with highly permeable, there are also low-permeable layers that are not developed during well operation;
- Poorly permeable formations contain oil reserves that are not being produced;
- The well is located in the zone of active influence of water pumped into injection wells [14];
- The water content of the well production is 95-99% and is characterized by high productivity.

4. Conclusions

Nowadays, foam solutions as cleaning agents are of interest to many drilling specialists. At the stage of introducing foam flushing into production and crafts, it is necessary to accurately represent the area of their appropriate application. The efficiency of using foam systems in complicated geological conditions is known [15]. The economic benefits of foam solutions in comparison with clay solutions when working with different rock-crushing tools have also been proven.

Thus, our specialists set a goal, using local raw materials, to create an effective, affordable, economically cost-effective and environmentally safe component composition that can be used to prepare a low-density drilling mud that ensures trouble-free wiring and completion of wells, in particular, when opening depleted horizons characterized by abnormally low reservoir pressure.

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