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Research Article

Elaboration of a Technology for the Liquidation of a Gas Cone Coming from a Gas-Saturated Part of a Reservoir into the Oil Producing Well

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ABSTRACT.
At the present time, the majority of oil fields entered a late stage of development. This is characterized by an active decrease in rock pressures in reservoirs, an increase in water production, as well as the gas contamination of oil-producing wells. The complexity of reservoir development containing both oil and gas is conditionedby a two-phase system, which is in a state of equilibrium under the initial reservoir conditions. Later on, in the process of development, a change in the thermobaric conditions of the reservoir occurs, resulting inthe violation of this initial equilibrium. The general decrease in the reservoir pressure throughout the reservoir (or a decrease in it in individual areas) inevitably leads to the displacement of the gas-oil contact level, contributes to the formation of cones and the breakthrough of this gas through the available perforation channels into the oil-producing wells. As a rule, the installation of a gas isolation shield can significantly extend the gas-free operation time of an oil-producing well. However, it was observed that the formation of a gas cone can occur even after the shield installation, but the process is relatively slow. The authors of this article propose a new technology for isolating gas coming from a gas cap into the perforation interval of an oil-producing well.

Keywords: Gas cap, Gas-insulating makeup, Gas-insulating method, Radial drilling.

INTRODUCTION

At the present time, a significant number of oil fields entered or are entering late stages of development, which is characterized by a decrease in the reservoir pressure, the high water cut and the gas contamination of oil-producing wells.

Main reasons forhigh oil well gas pollution are[1, 2]:

- gas breakthrough throughout a cone in homogeneous monolithic reservoirs which do not have tight sections at the gas-oil contact (GOC) level;
-lateral gas filtration throughout permeable interlayers in the perforation interval (gas from the "gas cap");
-gas entry due to the perforation in the gas-saturated reservoir part (with the inexact determination of a GOS position);
- the occurrence of gas behind-the-casing flows;
- advance flow of the gas dissolved in the oil.

It is known that the complexity of the development processof reservoirs containing oil and gas is conditioned by a two-phase system, which under the initial reservoir conditions is in a steady state. In the development process, a change in the thermobaric reservoir parameters and the violation of the initial steady state take place. A general reduction in the reservoir pressure throughout the reservoir (or its reduction in individual parts) leads to the displacement of the GOS level downwards,

which contributes to the formation of cones and the breakthrough of gas into oil-producing wells through perforations.

Thus, the development of oil and gas reservoirs is complicated by [1, 2]:

- the difficulty of the technological regulation of the GOS level displacement;
- the equality of the initial reservoir pressure and gas saturation pressure;
- the pressure communication of the oil reservoir with the gas cap and the probable GOS mobility in the well vicinity in the development process;
- the close proximity to bottom holes of GOS wells during the operation of an oil rim.

The analysis shows that the first two reasons prevail, and in connection with this, when designing and choosing the isolation technology of gas discharges, it is necessary first of all to solve the problem of creating an extended radial isolation shield in a reservoir, the dimensions of which shall be comparable to the dimensions of the gas cone base.

Installing a gas isolation screen can significantly extend the time for gasless operation of an oil producing well. However, it was observed that the formation of a gas cone can occur even after the installation of a shield, but the process goes on relatively slow.

In the world practice, the main methods of isolating gas discharges are [1]:

- Injection of water with the purpose to obtain crystalline hydrates in the gas-saturated reservoir part;
- injection of aqueous solutions of alkali or alkaline-earth metal chlorides, during or after which, as a result of a decrease in the pressure in the gas-saturated zone, the formed salts precipitate;
- injection of oil;
- injection of the condensate and the aqueous surfactant solution;
- creation of a gas-isolation shield;
-selective methods of blocking gas breakthrough paths whereby physical and chemical gas interactions with a solution of asphalt-tar substances (ATS) in aromatic solvents are used, which result in the deposition of high-molecular-weight ATS in a gassy pore area of the rock.

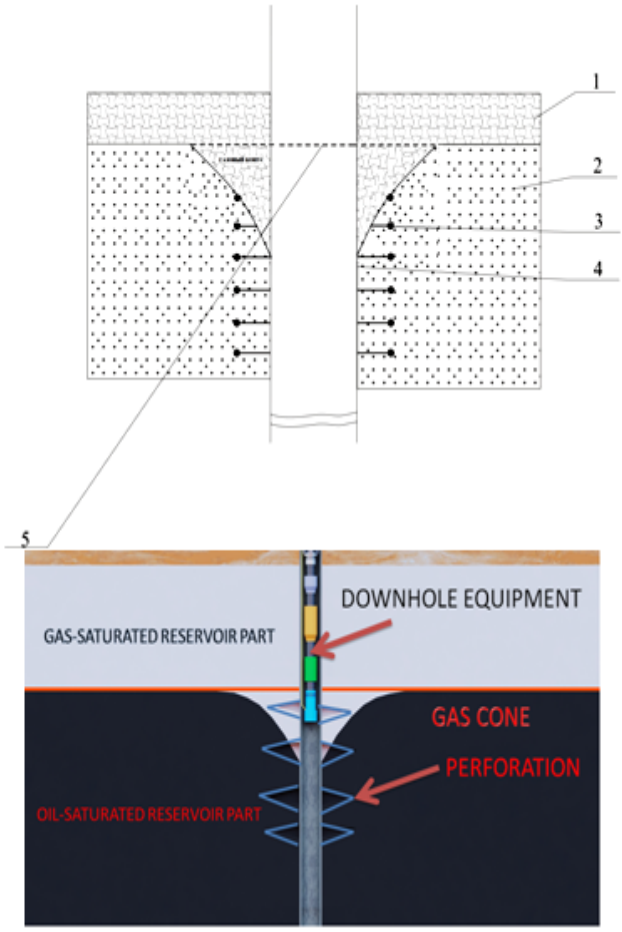

Fig. 1 The formation of a gas cone in the oil-producing well.1 – gas-saturated part; 2 – oil saturated part; 3 – perforations; 4 – production casing string; 5 – GOS.

Methods based on the creation in a reservoir at the GOS level of an extended radial isolating shield are of particular interest. Repair and insulation works (RIW) proved to be the most effective in limiting gas dischargesinto oil wells, where viscoelastic compositions (VEC) on the basis of high-molecular-weight water-soluble polymers were used as gas-isolating compositions. Such compositions in reservoir conditions in a wide range of temperatures enter into a reaction of hydrolytic polycondensation with the formation of a gel of hetero-organic polymers which selectively block pores of the rock. The use of VEC on the basis of high-molecular-weight water-soluble polymers as a gas insulating composition was tried out, for example, in many wells of the Lyantorskoye field. The isolation is achieved as a result of the adsorption and the mechanical retention of

polymer molecules in a porous medium by creating a viscoelastic structure which provides blocking gas filtration zones.

In any case, to prevent the gas breakthrough around the wellbore somewhat lower than GOS, it is necessary to install an impermeable gas isolation shield.

In the absence of objective information about the location and thickness of the gassy interval in the cross-section of a productive stratum, opened up by the borehole, negative results can be obtained with the installation of a gas isolating shield. The uneven distribution of the gas isolating composition throughout the section of a gassy interval, the gas isolating rim can turn out to be open, have a different length in different directions, which provides a short gas-free period of the well operation [3].

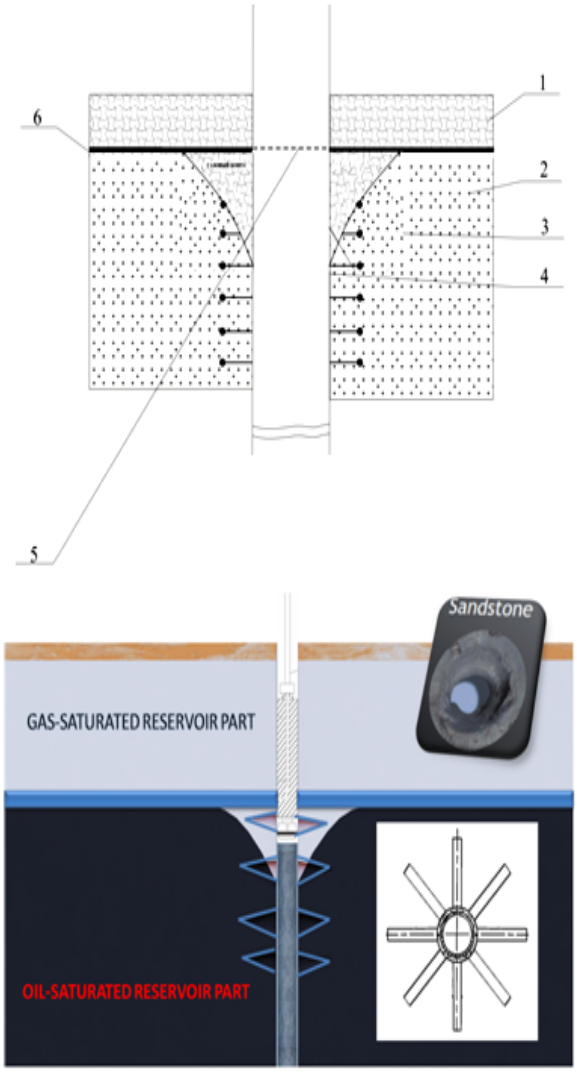

Fig. 2 Drilling of radial channels at the GOS level.1 – gas-saturated part; 2 – oil saturated part; 3 – perforations; 4 – production casing string; 5 – GOS; 6 – radial channels (branches).

The Object and Research Methods

The authors of this article propose the technology for isolating gas coming from a gas cap into the perforation interval of an oil producing well, which includes:

killing a well, removing the downhole equipment, lowering a packaging arrangement for the radial drilling on a flexible pipe, drilling radial channels at the level of gas-oil contact along a radius longer than the gas cone radius, rising a packaging arrangement for radial drilling, the descent of a continuous pipe (CP), the injection under pressure through the CP in radial branches of the isolating composition on the basis of micro-cement (Mikrodurof the U grade), lifting CP, waiting a time of micro-cement hardening, descend of the arrangement with the perforator, carrying out the additional perforating of the production casing string below the gas-barrier shield installation, completing and commissioning a well [4].

As an isolating composition, it is necessary to use the composition of Mikrodurof the U grade with the addition of a polyfunctional modifier and a superplasticizer, followed by the reinforcement of the composition with cement slurry, with the formation of a gas isolating shield with a large radius of an extended zone under the isolation.

Radial channels before the injection of an isolating composition on the basis of Mikrodurof the U grade are not cased, which provides the ability of an isolating composition to spread over near-tunnel zones to obtain a shield of the specified thickness.

Mikrodur is a particularly fine mineral cementitious matter with a guaranteed smooth change in the grain size distribution.

Figs. 1, 2, 3 and 4 present the realization scheme of the work technology [5].

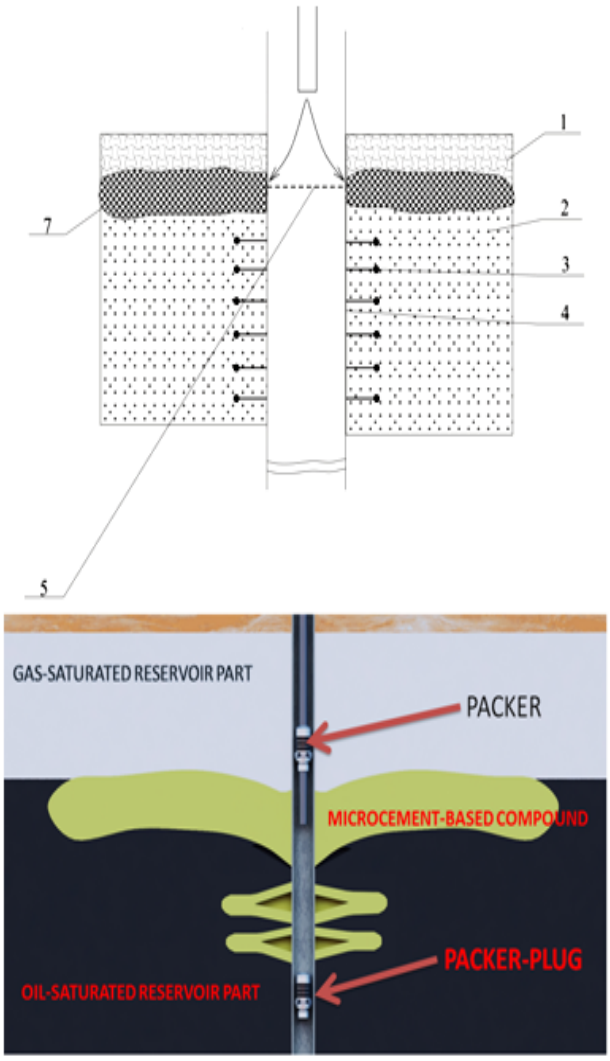

Fig. 3 The injection of the plugging material on the basis of micro-cement. 1 – gas-saturated part; 2 – oil saturated part; 3 – perforations; 4 – production casing string; 5 – GOS;7 – cementing slurry on the basis of Mikrodur.

The well, wherein the gas from the gas cap 1 broke into the oil reservoir 2 through the available top perforations 3 (Fig. 1), is stopped and killed. The downhole equipment (not shown) is removed from the well, from its production casing string 4. At the level of the current GOS 5, radial channels 6 are drilled with the required length equal to or slightly higher than the static radius of the gas cone by 1-2 m (Fig. 2). After that, the injection under pressure is carried out through a continuous pipe of an isolating composition on the basis of Mikrodur of the U grade, a polyfunctional modifier and a superplasticizer 7 (Fig. 3). They carry out torquing with a cement mortar 8, thereby creating a strong gas-insulating shield (Fig. 4), if necessary, they carry out an additional perforation (for example, the hydraulic abrasive jetting) of the production casing string and below the installation of the gas-isolating shield, well production testing and its commissioning.

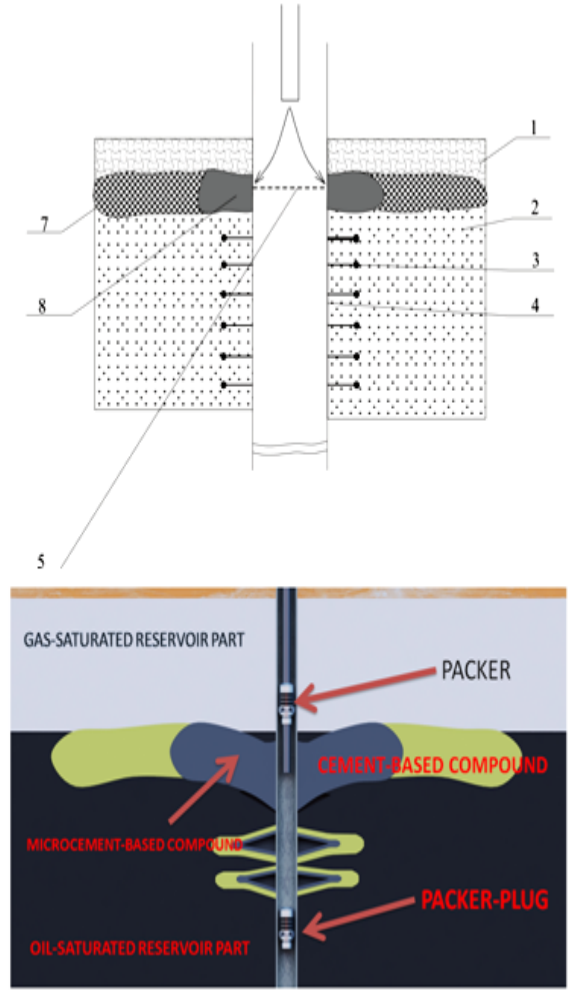

Fig. 4 Torqueing the gas isolation shield with the cement slurry.1 – gas-saturated part; 2 – oil saturated part;3 – perforations; 4 – production casing string; 5 – GOC;7 – cementing slurry on the basis of Mikrodur; 8 – cement-based torqueing slurry.

CONCLUSION

The authors propose a new technology to liquidate a cone of the gas coming from the gas-saturated reservoir part into the oil-producing well, using the radial drilling at the level of a gas-oil contact [6-8].

The achievable technical result, which is obtained as a result of the technology implementation, involves the creation of a strong gas isolation shield with a large radius of the extended isolated zone.

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