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Features of the operation of watering gas wells in the ShimoliyBerdakh field

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ABSTRACT: The article discusses the features of the operation of waterlogged gas wells, options for eliminating this problem and the possibility of ensuring stable operation of the wells by forcibly removing and limiting the flow of fluid to the bottom of the gas wells.

KEY WORDS: Operation, gas-bearing strata, water-pumping complex, filtration, gas recovery, oil and gas content, productive stratum, resources, seal.

I. INTRODUCTION

Many gas and gas condensate fields of the Ustyurt oil and gas region are operated with natural regular watering of well production. In these conditions, the main problem is to increase the final gas condensate recovery of productive formations. Therefore, it is not surprising that much attention is currently being paid to the issue of intensifying gas extraction from water-cut reservoirs.

The ShimoliyBerdakh field was discovered in 2004, its discoverer was prospecting well No. 2, in which, when testing the interval of 2644-2640 m in the Middle Jurassic sediments, a gas flow was obtained with a flow rate of Q_g^{10} = 70,5 thousandm^3/day.

The deposit is multi-layer, characterized by a complex geological structure, which is due to the development in the section of various facies-unstable lithological types of rocks - sandstones, siltstones and clays. Reservoirs are separate layers in the form of sandstone lenses, which are unevenly distributed over the area and along the section of the productive strata.

The commercial gas content of the ShimoliyBerdakh field is mainly associated with the Middle and Upper Jurassic deposits, where, when calculating reserves, 14 commercially gas-bearing layers were identified: one in the Lower Jurassic (reservoir J11), nine in the Middle Jurassic (layers J_2^7, J_2^6, J_2^5, J_2^4, J_2^{3a}, J_2^3, J_2^{2a}, J_2^{2b}, J_2^1) and four in the Upper Jurassic (beds J_3^{11}, J_3^{10}, J_3^9, J_3^8). The terrigenous reservoirs are mainly of the pore type. The reservoirs of all members are represented by sandstones, quartz-feldspar, fine, medium and coarse-grained, with clay cement. Among the sandstones, there are interlayers of clays and siltstones, dense, hard, sandy. The upper part of the section is dominated by medium and fine-grained sandstones, in the lower part, medium and coarse-grained.
According to the hydrogeological zoning, the ShimoliyBerdakh deposit is part of the large North Ustyurt artesian basin, in which two hydrogeological stages are distinguished: the lower (zone of hindered and very hindered water exchange), including the Upper Triassic - Jurassic, Upper Jurassic - Neocomian and Senonian - Turonian water-confining complexes and the upper (zone - free water exchange), including the Neogene - Quaternary water-pressure complex and characterized by the spread of infiltration waters.

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At the ShimoliyBerdakh field, out of 48 wells of the operating fund, almost all work with water removal, with a daily water factor from 0,62 g/m^3 (well No. 74) to 168 g/m^3 (well 24) and higher. 7 wells (No. 13, 19, 36, 46, 65, 68, 70) are under overhaul of wells (workover).

II. PRESENTATION OF THE MAIN CONTRIBUTION OF THE PAPER/SCOPE OF RESEARCH

The issue of changing the productivity of gas wells, at the bottom of which a water column is formed, is of great practical interest. Until the moment when the accumulation of liquid begins to manifest itself, the movement of liquid in practically vertical wells is determined, first of all, by two physical processes. As the well performance deteriorates, a clear mode begins to develop, and then a bubble mode [1]. When fluid fills the bottom of the well, it is held back by gravity and provides additional resistance to the gas. Gas filtration uphole tends to change the structure of the liquid column and at high velocities can remove a significant portion of the liquid from the well. However, to lift particles with a gas flow, it is necessary that the flow rate be greater than a certain value, and since the flow rate increases at the bottom of the reservoir, the liquid column rises and it is necessary that the lift pipes do not reach the bottom of the reservoir [2].

The accumulation of water at the bottom of the well leads to a decrease in its productivity, and when the gas flow rate falls below the maximum allowable for a given elevator design, the well stops flowing. Therefore, at the beginning of the appearance of water in the well production, it is necessary to use effective methods for its rise to the surface. In this case, the operating mode of the well should be selected so that there is no accumulation of water at the bottomholes and its overflows into the gas-producing formations.

The choice of the method for operating a gas well depends on the dynamics of the formation fluid entering the wellbore and its type. An important reserve for reducing the rate of decline in gas production and increasing the final gas recovery factor of fields is the prolongation of the period of stable operation of watering gas wells through the use of effective methods of bringing liquid to the surface.

A rational approach to the operation of watering gas wells depends on the conditions of movement of the gas-liquid flow (GLF) in the tubing and the mechanism of fluid accumulation in the wellbore.

The analysis shows that almost all wells of the ShimoliyBerdakh field operate with parameters close to critical (Table 1). In this regard, the pressure loss increases during the movement of the gas-liquid flow in the lift pipes and the conditions for the removal of liquid to the surface worsen. Compulsory methods for liquid removal, first of all, must be introduced at wells No. 22, 24, 30 with high (118-168 g/m^3) water factors. Low-flow wells No. 9, 21 operate at low gas flow rates near the lift pipe shoe. It is possible that condensate accumulates at the bottomhole in these wells. Therefore, to extract liquid from the bottom of a gas well at low gas flow rates, additional energy is needed in the form of electrical, mechanical, chemical or their combination.

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Table 1. The results of calculating the critical parameters of the wells of the North Berdakh field

№ wells	Critical flow rate Q_g under standard conditions for water removal (10^3 m^3/day)	Actual flow rate (10^3 m^3/day)	Critical speed at the mouth (m/s)	Actual speed at the mouth (m/s)	Connection diameter, mm
9	26,183	26	3,19	3,05	12
20	27,848	28	2,99	2,8	10
22	26,427	27	3,12	3	14
24	33,393	70	2,49	5,1	12
27	27,357	30	3,04	3,04	12
37	27,365	59	2,95	5,2	12
49	26,362	25	3,12	2,9	8
52	27,871	41	2,92	4,5	10
55	27,730	51	2,99	5,05	10
57	25,248	59	3,19	7	14
61	26,2488	59	3,19	6,7	10

There are many methods for controlling water cut in gas wells, but each of them has a limited scope. There are no universal methods of combating this phenomenon, and therefore the decision on the use of one method or another should be taken when choosing a technology for operating wells in a particular field. To ensure the stable operation of gas and gas condensate in domestic and foreign practice, various methods are used, both for forced removal of liquid and limiting the flow of liquid to the bottom of the well. They can be classified into three groups:

a) methods of disposal using plunger lift and pumping pumping, which finds very limited application. In all likelihood, this is due to the low efficiency (efficiency) of submersible pumps, moreover, it sharply decreases in the presence of free gas. To increase the efficiency, it is necessary to install deep separators, which complicates the design and reduces the reliability of the entire installation;

b) method of liquid removal using foaming surfactants;

c) liquid removal methods using dispersants.

The principal advantage of using foam as a liquid removal agent from gas wells is that the liquid is trapped by a film of gas bubbles and is exposed to the liquid with a large surface area, resulting in less gas slip and a low density mixture.
In a well with a very low gas flow rate, the use of foam contributes to the effective removal of liquid to the wellhead, while without foam, liquid retention leads to its significant accumulation and to large pressure losses during multiphase flow.

Conducted geological field analysis on the use of solid and liquid surfactants in wells 22, 40, 66, 53 of the Shimoliy Berdakh field, with a water cut of 41% (well 22) to 80% (well 66) showed that before the start of application The wells were blown with surfactant from 3 to 7 times a week. When using surfactants, the effect is noted in a decrease in the amount of blowdown (Fig. 1 for the example of well 22) and, accordingly, in a decrease in the amount of gases emitted into the atmosphere. Given the high content of condensate and water, a liquid plug (condensate + formation water) is continuously accumulating at the bottom of the wells. After each loading of a solid surfactant, a sharp increase in the operating flow rates of the wells is observed. In order to further stabilize the wells operation, periodic injection of liquid surfactant is proposed.

In wells No. 30, 47, 49, a solid surfactant was also used, but no positive effect was observed from its use. This is possibly due to the low reservoir pressure of the wells (<4 MPa), which, from a hydrodynamic point of view, is not

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enough to lift the existing water column. The effectiveness of the use of a foaming surfactant also depends on the technology of its introduction into the well.

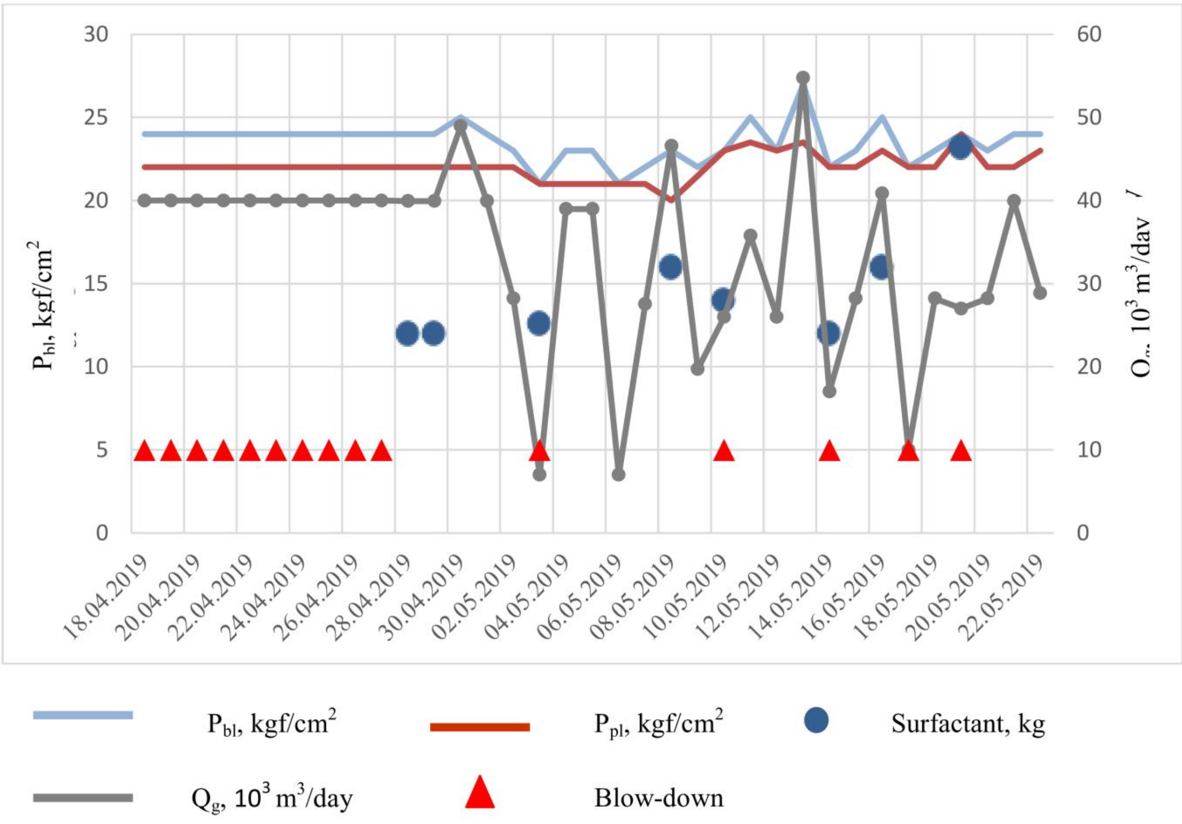

Fig. 1 Dynamics of changes in the parameters of well No. 22 with the beginning of the use of solid surfactants

III. CONCLUSION

In connection with the above, at the Shimoliy Berdakh field, a method is proposed for removing liquid from the bottom of a gas well, including introducing a solid foaming surfactant into the liquid to be removed and keeping it at the bottom of the productive formation on a solid partition installed inside the lift pipes [3]. The surfactant is kept in the zone of the productive formation 4 until it is completely dissolved. After removing the liquid 6, the incompletely dissolved surfactant remains on the plug 8 and dissolves in it when the liquid enters the well.

The proposed method is effective for marginal wells with fluid quantities of no more than 1-2 m^3/day (wells No. 16, 20, 27, 31, 34, 37, etc.).

The second proposed option is as follows. The surfactant is kept at the bottom of the productive formation on an annular mesh cuff installed on the tubing, through holes in the interval of the productive formation, the total area of which is equal to or greater than the flow area of the pipes [4]. The application of the proposed method provides effective removal of fluid from the bottom of the well while reducing the consumption of surfactants.

A promising direction for intensifying the process of liquid removal from gas wells is the use of downhole dispersants, which make it possible to transfer the liquid to a finely dispersed state and thereby improve operating conditions and increase the productivity of gas wells. To remove liquid from the bottom of gas wells, a technological mode of well operation with the use of dispersing devices is proposed. When installed on wells, the well operation period is extended without forced blowing into the atmosphere.

To intensify the process of removing liquid from gas wells, a device has been developed [5] containing a perforated casing, a lifting string and dispersants made in the form of closed volumes formed by conical cuffs installed between the casing and lifting strings, and holes are made in the lifting string, total the area of which is less than the total area of the casing. Conical collars are made of elastic material and are installed in the interval of the productive formation. It has been established that if the horizontal gas flow is divided along the height into separate sections, the conditions for water removal by gas from the well are improved. A necessary condition is the entry of the gas flow into the riser pipes from the bottom of the section. In this case, the water accumulating in the section flows downward, is captured by the gas, sprayed and carried to the surface, as a result of which watering of the well is prevented.

In order to more efficiently remove fluid from the well, the lower conical collar is installed below the bottom of the productive formation, and the upper one at the top level. At the same time, the device serves the productive formation throughout its entire thickness.

Thus, the use of surfactants and dispersants in water-cut wells of the Shimoliy Berdakh field:
1) allows to operate heavily flooded wells without blowing with an average duration of 4-5 days;
2) prevents pollution of the environment with natural gas, gas condensate and produced water;
3) prolongs the "life" of the well, since frequent blow down of the well accelerates the filtration of formation water in reservoirs with bottom water (waterfowl), rocks in the bottom hole formation zone are subject to constant impact and gradually collapse.

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