УДК 622. 244.6 (477).

THE TECHNICAL MEANS AND ONE OF THE TECHNOLOGY VARIANT FOR TESTING THE GASONATED LAYERS IN THE TEST OPERATION MODE

Roy M.M.
Poltava National Technical Yuri Kondratyuk University; Candidate of Technical Sciences, Associate Professor, Ukraine
Solovyov V.V.
Poltava National Technical Yuri Kondratyuk University; Doctor of Physical and Chemical Sciences, Professor, Head of Physics Department, Ukraine
Usenko I.S.
Poltava National Technical Yuri Kondratyuk University; Candidate of Technical Sciences, Associate Professor, Ukraine
Usenko D.V.
Poltava National Technical Yuri Kondratyuk University; PhD student, Ukraine

Abstract. To solve the problem of testing gas-saturated formations in the trial operation mode and in order to obtain significantly more information about gas-saturated formations, a technological approach is proposed based on the use of pumping compressor pipes as a product for discharge column. It goes down into the drill pipe and is sealed with the lower end in the packer.
An increase in the volume of information about the gas-hydrodynamic and productive qualities of the reservoir under investigation is aimed at determining and optimizing the search even at the stage of drilling the gas-hydrodynamic characteristics of the reservoirs for further disclosure of the studied well.
Keywords: formation tester, surface gas release, tubing, drill packer.
[3, c. 115].
The investigation of production wells is carried out in order to determine its gas-hydrodynamic parameters, production characteristics and adjust, if necessary, the

technological regime of its further operation. But doing this kind of work in exploratory wells, that is, in an open wellbore, is very difficult. This can lead to complications at best and accidents at worst. This means that the information that can be obtained in the production well becomes inaccessible to exploratory wells. However, successful cases of practical testing in an open wellbore are known, the bottom hole depth of which does not exceed 3500 m. Therefore, the question of the fundamental possibility of research in deeper wells and finding ways to achieve positive results is relevant. The goal is to discuss one of the possible technological areas of research in the process of drilling gas-saturated formations with the release of gas to the surface. It turned out that this problem was solved with a positive result when testing objects only at shallow depths. Domestic literary data for the last 20 years are missing. This indicates the complexity of the problem. Almost recently, it did not considered. Therefore, it requires its decision.

Based on the analysis and systematization of existing technological approaches and technical means to ensure them, a concept of an approach to solving the problem of investigating gas objects was developed not only at shallow depths but also at depths of 3,500-6,000 m. According to traditional technology, well research is carried out using 5-8 research modes. This technology may not be acceptable for the test mode of gas wells in trial operation. But now this is possible due to the fact that the technology for researching gas wells was created only in one actually tested mode, regardless of whether it is stationary [1] or non-stationary [2]. The methodological support of these methods was created thanks to the theoretical achievements of scientists and through its improvement through the use of complex parameters.

Based on the features of the process of researching gas wells in an open wellbore, which means in other words, the process of testing gas wells in trial operation mode, technical means were developed to ensure the implementation of this process in an open wellbore. These include a rotary shut-off flush valve, a circulation valve, a reamer packer. The shut-off and rotary valve allow parallel flushing of the well while recording the pressure recovery curve in the reservoir under investigation. This reduces the residence time of the test tool in the well and prevents it from seizing.

The circulation valve is responsible for the optimal flushing of the well. The expansion packer functions as a packer, that is, reliably isolating the sub-parker from the over-packer. In the event of emergency tacking, it allows you to quickly drill it and thereby eliminate tacking of the tool.

In contrast to existing technological approaches, a new approach is proposed. It consists in the use of tubing to divert products from the formation. This increases the reliability and success of the investigation of gas objects and allows to determine a larger number of its gas-hydrodynamic characteristics. They are important for determining the strategy for further drilling. In addition, this will eliminate the need to test these gas objects in cased-hole wells, and significantly reduce the cost of working in the well, since the process of research in the string is an expensive process.

In the long run, the prevailing depth of well drilling in the Dnieper-Donetsk Depression (DDD) in Ukraine, where the main forecast oil and gas reserves are concentrated, is the interval of 4000 - 7000 m. With increasing drilling depths, the difficulty in carrying out work and evaluating the oil and gas potential of oil and gas reservoirs.

The widespread use of reservoir testers for this is hampered by the imperfection of the research methodology for deep-seated reservoirs, which could ensure the determination of reliable filtration parameters of the reservoir and its production characteristics.

The equipment that is available does not ensure the reliability and safety of research on deep wells that are drilled with the release of gas to the surface. In addition, there are a number of promising areas with fractured-type reservoirs; at the initial moment after the stimulation of the inflow, they are quite active and work with a high initial flow rate, which decreases significantly over time. Stabilization of the gas flow rate in such wells is achieved for a long time; it is impossible to withstand the use of the test tool because of the danger of it becoming entrapped in the open bore or through gas fouling with flushing fluid in the annulus of the well. The reason for this is the inability to flush the well during the test. The investigation of such reservoirs in cased-hole wells is still labor-intensive and inefficient.

In this regard, the development of methods for assessing the oil and gas potential of the strata during the drilling of deep wells, ensuring the determination of all parameters of the stratum and its production characteristics, which can be obtained only in wells cased with columns, is relevant.

Determining the value of the reservoir pressure and the filtration parameters of the reservoir will determine the optimal technology for drilling wells while providing storage conditions for the initial conditions of permeability of the bottom-hole formation zone. Investigating the state of the bottom-hole formation zone, which is characterized by the magnitude of the skin effect and the plugging coefficient of the formation together with the summary radius of the well, is fundamental in determining the quality of the formation opening during drilling in order to determine further effective measures for restoring the permeability of the layers after the production string is lowered. And the determination of the potential production capabilities of the discovered reservoirs will allow us to resolve the issue of the need to lower production casing into the studied wells.

One of the significant drawbacks of the generally accepted technology for testing wells by pipe formation testers during drilling is the inability to investigate deep-seated formations in stationary modes, including trial operation. This is caused by the crushing of the drill pipe flushing fluid column by the external pressure after the gas is displaced by the fluid previously poured into the pipe. When controlling backpressure in drill pipes by keeping a high pressure of the gas at the mouth, it is possible to gas out the flushing fluid in the annulus of the well by penetrating gas through the drill pipe tool joints and not be able to flush the well during the test.

Attempts to test gas-saturated formations through the use of a string of pipes of increased strength (with a safety margin of 1.3) ended successfully. But the disadvantage was the inability to flush the well during the test. This threatened to foul off the annulus and the sludge to fall on the packer during a longer test, which could cause the packer to pile up.

Another attempt to conduct tests with the release of gas to the surface, using rigid piping of the wellhead and a set of STT-146 test tools, was also successful, but for conditions of limiting the depth of the well of 2500 m and provided that the flushing fluid was not necessary.

The experience of other scientists and practitioners has shown that it is possible to apply tests with the release of gas to the surface through the use of tubing pipes lowered into the drill string using one or two packers lowered into the borehole on the drill pipes. In this case, the tubing was tied to a compressor and the drill pipe string to a measuring tank. A tubing was used to supply air while lowering the level in the drill pipes in order to cause inflow from the reservoir. Drill pipes were used as the product of the outlet string. The main disadvantage of this method was that for testing deep wells it is impossible to use drill pipes as a product of the discharge line due to the risk of crushing them. That is, the application of this method is possible only in shallow wells.

Also known in industrial practice is the method of lowering into a lifting column of small diameter tubes wound on a drum, with inert gas (nitrogen) being pumped through them. In the process of lowering the pipes, the fluid in the pipes is aerated and carried to the surface, causing this to flow from the formation. The disadvantage is the inability to use in deep wells through the collapse of drill pipes.

The determination of the filtration parameters of gas-saturated formations during drilling by the method of processing the pressure recovery curve (PRC) after stopping the well operation is carried out with some error since the calculation uses an unstabilized gas flow rate.

In [3, p. 178], the main condition for determining the formation filtration parameters with unsteady research methods is assumed to achieve a stable (stable) well production rate before shutting it down for recording PRC.

All this suggests that this task requires its solution.

Currently, it is possible to propose for testing deep gas-saturated formations in trial operation, a technology based on the use of tubing or tubing as a visible column, which can be lowered into the drill pipe and sealed to the packer.

The essence of this technology is explained in Fig. 1 and consists of the following.

A packer 9 with a supporting liner-filter 10 is lowered into the borehole on drill pipes 4 with radial holes 7 into the test zone. During descent through the lower holes 7, flushing fluid fills the cavity of the drill pipes. After the descent of the test tool is completed, the packer is installed by unloading the drill pipes to the bottom of the well, isolating the test formation from the rest of the well. An adapter with a flange 12 is screwed into the upper sleeve of the drill string and then the drill string is installed using the elevator 3 on the rotor or suspended on air wedges. A crosspiece 13 is mounted on the flange 12, and tubing 5 with a flushing valve 6 and a circulation adapter 11 is lowered into the drill pipes.

The valve provides a combination of the inner cavity of the tubing with the drill pipe when creating excessive pressure inside the compressor string.

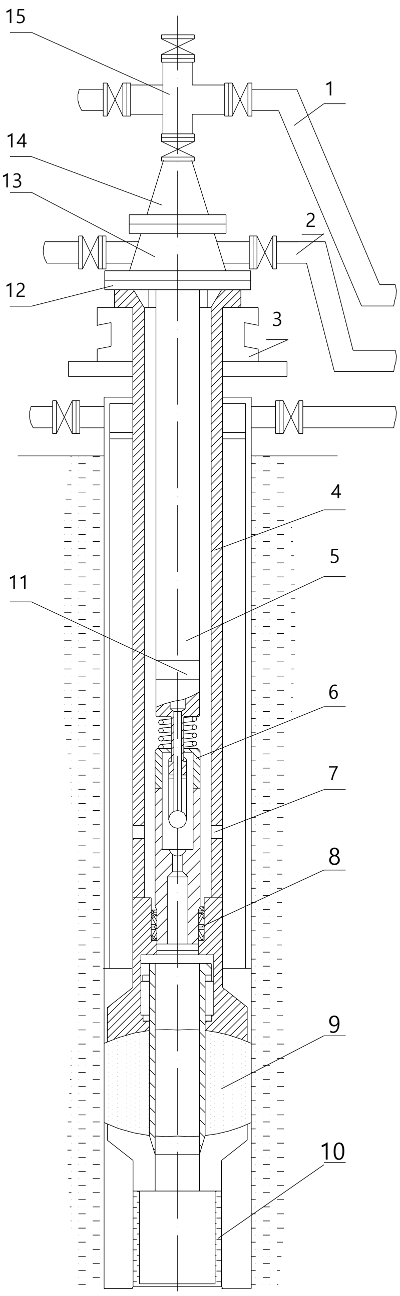

Fig. 1. Assembling the test tool

1,2,3-pipeline; 4-drill pipe; 5-oil-well tubing; 6- flushing valve; 7-lower holes; 8-seals; 9-packer; 10-shank filter; 11-circulation adapter; 12-flange; 13-cross 14-pedestal; 15-pipe head

Oil-well tubing 5 are suspended in a pedestal 14, which is connected by means of flanges to the cross 13. At the same time, the lower end of the compressor pipes is sealed in the packer 9 by means of a seal 8, which provides a tight connection of the internal cavity of the tubing with the tested part of the well. A pipe head 15 is installed on the pedestal 14 and a pipe 1 with a compressor and a cementing unit is connected to a working foundation branch, and a pipe 2 with a drilling pump.

To create a depression on the formation and stimulate the inflow from the formation, the water-air mixture is first pumped through the pipe 1 into the tubing of the air-water mixture and the washing liquid is forced out of them through the valve into the annulus. Then, by smoothly discharging the excess pressure on the pipe head 15, the pressure in the test zone (under the packer) of the well is reduced, the flow from the formation is caused, and after the well is purged, the wells are tested in the mode.

In the process of exploring the well, gas from the reservoir through oil-well tubing 5 and pipe 1 enters the metering line and is burned through a torch. The flow rate measurements when operating in the mode are carried out using a gas flow meter, and the bottomhole pressure is measured with depth gauges that are installed in the support liner-filter or descend into the tubing through the lubricator.

Simultaneously with the inflow of gas through tubing, it is possible to carry out constant or periodic flushing. To this end, the flushing fluid through the manifold line 2 and the cross 13 is pumped into the annular space between the drill pipe 4 and the oil-well tubing 5 with the circulation through the lower holes 7 into the annulus between the drill string and the borehole. If there is gas in the flushing fluid leaving the well, it must be passed through a vacuum degasser. In addition, flushing the well during a long test prevents sludge and weighting agent from settling on the packer.

At the end of the well investigation, a rod is thrown into the tubing and, after opening the circulation adapter 11, the gas is removed by backwashing. In this case, flushing fluid with a closed preventer is pumped into the annulus between the drill and tubing, and the gas from the tubing is removed through the pipeline and burned through a torch.

After removing gas from the tubing and flushing the well until the flushing fluid is completely aligned, the tube head 15 and pedestal 14 are removed, and then the tubing is lifted from the well. Next, the cross 13 is dismantled and after removing the packer by tensioning the drill pipes, the pipes and the packer are lifted from the well.

Thus, the application of the described technology is able to provide testing of prospective gas or gas condensate horizons in an open wellbore immediately after opening these formations by drilling. This will provide the best conditions for inducing inflow from the reservoir, selection and investigation of reservoir fluid, determination of reservoir pressure and gas-hydrodynamic characteristics and production capabilities of the reservoirs.

Knowing the magnitude of the reservoir pressure and the filtration parameters of the reservoir will determine the optimal technology for drilling wells while providing storage conditions for the initial conditions of permeability of the bottom-hole formation zone. Investigating the state of the bottom-hole formation zone, which is characterized by the magnitude of the skin effect and the plugging coefficient of the formation together with the summary radius of the well, is fundamental in determining the quality of the formation opening during drilling in order to determine further effective measures for restoring the permeability of the layers after the production string is lowered. And the determination of the potential production capabilities of the discovered reservoirs will allow us to resolve the issue of the need to lower production casing into the studied wells.

REFERENCES

1. Пат. 51729 Україна. Спосіб дослідження газових свердловин: МПК3 E21B 47/06. № U 200601237; заявник і патентовласник Матус Б.А. заявл. 01.04.99; опубл. 16.12.02, Бюл. №12. 8 с.
2. Пат. 121860 Україна. Спосіб дослідження високопродуктивних газових та газоконденсатних свердловин при нестаціонарному режимі фільтрації: МПК (2017.01) E21 B 47/00.; заявник і патентовласник Рой М.М.; заявл. 09.02.2017; опубл. 26.12.2017, Бюл. №24. 5 с.
3. Guidance on research of wells / [Gritsenko A.I.,. Alyev Z.C, Ermilov O.M.] . – M.: Nauka, 1995. – 523 p.